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SUPPLEMENT TO "THE ELECTRICIAN," APRIL 28, 1905.

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[illegible]—Mtg. [illegible]
Mersey Railway—Rpt. [illegible], Mtg. [illegible]
Mexican Electric Traction and Lighting—[illegible]
Metropolitan District Railway—[illegible], Mtg. [illegible]
Metropolitan Electric Supply—[illegible], Div. [illegible], Rpt. [illegible], Mtg. [illegible]
Metropolitan Electric Tramways—Rpt. [illegible]
Metropolitan Railway—Rpt. [illegible], Mtg. [illegible] (see also Harrow and Uxbridge Railway)
[illegible] Railway—[illegible]
Middlesbrough, Stockton and Thornaby Electric Tramways—Mtg. 817
Mines and General Trust—Mtg. [illegible]
[illegible] Telephone—Rpt. [illegible], Mtg. [illegible], Stat. 240
[illegible] Electric Light and Power—[illegible]
[illegible] Tramways—Rpt. [illegible], Mtg. [illegible]
[illegible]
[illegible]
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January 13, 1905 … … … … … … Sheet Tables of Electricity Supply Works, Tables I. and Ia., 1904-5.
January 20, 1905 … … … … … … Sheet Table of [illegible] Supply Works, Table II., 1904-5.
January 27, 1905 … … … … … … Sheet Table of [illegible] Power Companies, Table III., 1904-5.
February 3, 1905 … … … … … … Sheet Tables of [illegible] Railways and Tramways, Tables IV., V., and VI., 1904-5.

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NOTES.

In view of the enormous extension of electric power supply during the past few years, the Board of Trade and the Home Office have wisely decided upon a modification of their regulations, the effect of which will be to simplify the methods and to remove some of the formalities now exacted when electric power at a higher pressure than 250 volts is to be supplied. Under the old Board of Trade regulations, the pressure of supply to any consumer might not exceed 250 volts without the express consent of the Board of Trade, and transformers on consumers' premises were only allowed up to the limits of high pressure (3,000 volts), extra-high-pressure supply (*i.e.*, above 3,000 volts) being forbidden except in premises in the sole occupation of the undertakers. The new Board of Trade regulations, the preliminary draft of which was published in our issue of August 26th, permit the employment of "medium" pressure—*i.e.*, from 250 to 650 volts—on consumers' premises without express permission, on the consumer undertaking to comply with certain regulations which are set forth. High pressure and extra high pressure may also be supplied to factories, mines and electric traction works with the consent of the Board of Trade and, in the case of factories and mines, subject to regulations made by the Home Office. A draft of the proposed regulations for mines was issued some months ago, and also a draft of the proposed Home Office regulations for sub-stations, but the extra-high-pressure regulations for factories have not yet appeared. The draft regulations issued by the Home Office this week, and appearing on another page of this issue, refer only to the use of medium pressure in factories. As a matter of fact, the new Board of Trade regulations already referred to, cover the same ground as the regulations drafted by the Home Office, but it is considered that they will have more effect in the shape of regulations under the Factory Act, for then the occupier or consumer is made responsible for their observance. The Board of Trade regulations only prescribe penalties in the case of non-observance of the regulations by undertakers, so that the "undertaking" by the consumer to comply with the Board's medium pressure regulations has not much value. We therefore consider that the action of the Home Office is a wise one, and the only criticism we have to offer is that the text of the Home Office and Board of Trade medium pressure regulations ought to be identical.

◆

Nernst lamps, especially the earlier types, have, unfortunately, earned a reputation for capriciousness, and opinions on them have varied from the highest praise to the uttermost condemnation. The photometric results obtained by disinterested German experimenters will, therefore, help to define more clearly the qualities of the Nernst lamp. These tests, of which details are given in another column, were carried out in a methodical manner and on a fairly comprehensive scale by the Hamburg inspectorate of electric lighting, between April and June of this year. It is characteristic of both the quarter-ampere type and the half-ampere type that their illuminating power falls very rapidly in the first 25 hours, then decreases gradually during the next 500 hours or so, and finally falls rapidly after this time. The consumption of energy, according to the tables, remains for several hundred hours between the limits of 2 and 2·5 watts per candle-power, increasing towards the end to more than 3 watts. This result is excellent, the more so when it is borne in mind that the smaller lamp, at any rate, is of the 16 c.p. size only. On the other hand, it must not be forgotten that the illuminating power was measured only in the direction of the axis of the lamp. For this reason, the figures quoted are not directly comparable with those concerning incandescent electric lamps, whose consumption figures generally relate to hemispherical measurements. By comparing the figures for the larger type of lamp with those obtained by Mr. R. P. Hulse (see *The Electrician*, Vol. XLVIII., pp. [illegible] and [illegible]) some two years ago for a similar [illegible] lamp of the older pattern, it is seen at once that not only is the efficiency of the lamp of the B pattern better, but that the life also of the lamps tested at Hamburg was considerably longer.

◆

THE [illegible] supply [illegible] by the Local Government Board when asked to sanction [illegible] It is a story which we have had to preach on several occasions lately. Another case occurred at Hastings last week, when the report of a Local Government Board inspector into an unopposed application for a loan of £3,416 for electric lighting purposes was placed before the Corporation. It appears that from 1890 to 1903 inclusive a deficit which has been thrown upon the electricity undertaking has been allowed to accumulate. Although Hastings does not stand alone in this matter, it is, nevertheless, [illegible] and it is surprising that town clerks are not more alive than they seem to be to the responsibilities placed upon local authorities on entering upon the business of electricity supply. Before, therefore, Mr. [illegible], the Local Government Board inspector, could see his way to recommend the granting of the sanction asked for, he wished to know what steps it was proposed to take to wipe out the accumulated deficiency of £4,465 [illegible] 11d. as shown in the accounts. During the current financial year the Corporation had estimated for securing £[illegible] from the general district rate as a contribution towards settling this deficit, and now, in answer to the Local Government Board, it has been decided to place a similar sum every year until this object has been attained.

◆

THE recent action of the Local Government Board in sending back for further consideration the proposal of the Wood Green Urban District Council to erect a generating station of their own although a supply of electricity in bulk had been offered them, and the mild excitement created in municipal [illegible] thereby, give a special interest to the first annual report of the Bridgend Urban District Council's electricity department, since this Council has the distinction of being the first to take a supply of electricity in bulk from a properly constituted Power Company. Bridgend is a town of about [illegible] inhabitants and has a rateable value of £24,000, so its prospects of establishing a profitable electricity department were none too rosy. A Provisional Order obtained by the Council in 1893 was, therefore, allowed to lie fallow for several years, and it was only when the South Wales Electrical Power Distribution Co. obtained Parliamentary sanction in 1900 that the opportunity arose of putting the Order into effect. Negotiations between the Council and the Company speedily resulted in a mutually satisfactory arrangement, whereby the Company agreed to erect a pioneer station in the Bridgend area and to supply the Council in bulk. This station—two-phase 60 period—was set to work in May of last year, and the Bridgend Urban District Council, who have recently published the results of their 10½ months' working to March 31, are to be congratulated on having made a net profit of £150 after paying interest and sinking fund charges. The South Wales Company supply the necessary step-down transformers, and deliver to the Council two-phase current at a pressure of 210 volts on a flat rate of [illegible] per unit. The Council's capital expenditure is, therefore, very low—only £6,150—of which £[illegible] is for mains and services and £179 for street lamps. The latter are equivalent to [illegible] c.p. incandescents, while the connections in private houses amount to about 3,000 lamps, the maximum observed load being [illegible].

◆

DURING the year's operations, the current purchased amounted to 77,000 Board of Trade units, and of this 37,800 units were consumed by the public lighting, for which £443 was paid (2·8d. per unit) and 39,200 units were supplied to private customers, producing £702, the tariff being 4½d. per unit. The gross receipts were thus £1,145, or 18½ per cent. upon the capital expenditure. The total costs, on the other hand, came to £583, made up of £442 paid to the Power Company for the bulk supply, and £141, which covered management expenses, &c. The gross profit realised was, therefore, £562, of which £238 was required for payment of interest, and £174 for sinking fund instalment, leaving a net surplus of £150, or practically 2½ per cent. on the capital of the Council's undertaking. This result cannot be regarded as other than highly satisfactory, considering the smallness of the concern, the low power-factor prevailing ([illegible] per cent.) and the very reasonable tariff that has been adopted. The customers are but [illegible] in number, and only 8 H.P. of motors are connected to the Council's mains, since the South Wales Company supply current direct to the various works and manufactories in the area.

◆

CONSIDERABLE alarm is being created by the daily papers regarding the danger attending the use of Röntgen rays. It has been affirmed that many medical men who have been in the habit of handling and using X ray tubes are now suffering from a peculiarly painful disease which closely resembles cancer. This "disease" attacks the skin, and is said to be incurable. Until there is definite medical testimony to the contrary, however, we refuse to believe that cancer can possibly result from the application of X rays. It is, perhaps, just conceivable that repeated X-rays burns might, in particularly adverse circumstances cause, the tissue to get into such a condition that it may fall an easy prey to cancer. But is it equally conceivable that the same effect might ensue from a neglected wound or a blow, which tends to enfeeble the tissue? Any discovery connected with electrical science is still set down as mysterious by the mystery-loving public, and the cause of cancer is still unknown; the vulgar mind loves to force a connection between two "mysteries," whether they be those with which men of science are concerned or those of Scotland Yard. So far as regards the X-ray burns themselves, although our sympathies are naturally with the men who are suffering from this painful ailment in the cause of humanity and science, it must, nevertheless, be remembered that if due care is taken by the operator to shield himself by proper screens, no danger of X ray dermatitis need exist. If, however, the present scare will diminish to some extent the number of unqualified persons who apply X ray treatment, we shall have no cause to regret it.

In his Paper on "Rotary Converters and Motor-generator Sets," read before the Electrical Congress of St. Louis, Mr. Wm. C. L. Eglin reviewed briefly the *pros* and *cons* of both means of converting alternating current to continuous current. Nothing of striking novelty to engineers in this country was communicated by the author, whose Paper appears in another part of this week's issue; but some interesting figures and one or two useful hints were given. For instance, an announcement was made, that will be read with some surprise, that, on starting a set from the continuous-current 'bus bars, the current required may be reduced to half, or less than half, by manually helping the armature at starting with a bar. Of course, in any case, the current taken is only momentary, but a reduction of 50 per cent. may save an unpleasant flicker.

Personal.—His Majesty the King has given Prof. L. F. Vernon-Harcourt, M.A., professor of Civil Engineering and Surveying at University College, London, permission to accept and wear the Comthur Cross of the Imperial Order of Franz Josef, conferred upon him by the Emperor of Austria in recognition of valuable services.

Cable Interruptions.	**Date of Interruption,**
Cayenne—Pinheiros	Aug. 18, 1902
Reisei-Isaa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Cayenne—Paramaribo	July 18, 1904
Cap Haitien—Mole St. Nicholas	Aug. 20, 1904
Bundaberg—Gomen (New Caledonia)	Aug. 30, 1904
Cap Haitien—Puerto Plata	Sept. 26, 1904
Trinidad—Demerara	Oct. 11, 1904
Bolama—Bissao	Oct. 13, 1904

South Wales and Monmouthshire University College.—The twenty-first anniversary of this college was celebrated on Wednesday last week, when the president, Sir Alfred Thomas, M.P., and Mrs. Griffiths received about 3,000 guests, amongst whom were the Court of Governors, the College Council and staff, and past and present students. Sir Alfred Thomas, in the course of his address, expressed the hope that during the next twelve months the foundation stone of the new college buildings would be laid in Cathays Park, on a site presented by the Cardiff Corporation. The total expenditure would amount to a million, of which they had £77,500.

Extension of the Paris Metropolitain Railway.—The first section of an extension of the Metropolitan Railway of Paris was opened on Monday. The whole extension will run from the Avenue Villiers to the Place Gambetta, but the section referred to above only goes as far as Père Lachaise Cemetery. A four-minute service will be maintained, the trains consisting of five or more coaches, three of which are motor cars, these being placed one at either end and one in the centre of the train. The lighting of the tunnels is maintained from independent circuits and at intervals of 100yds. throughout the length of the tunnel switches are placed, which, when operated, cut off the current from the line and at the same time warn the officials at the nearest station that a breakdown has occurred.

The Cable to Iceland.—According to an announcement by *The Times*, this cable (particulars of which were given in our issues of September 30th, p. 935, and October 7th, p. 975) is to be landed on the East Coast of Iceland (Seydisfjord or Reydarfjord), and connected with Reykjavik, the chief town of Iceland, by land lines, which are to be erected and worked by the Icelandic Government, and to which the Great Northern Telegraph Company pays £16,700 once for all. As regards the cable and the land lines on Iceland, the rates are to be fixed by the Minister of Public Works and the Icelandic Government respectively. An engineer has been sent to Iceland, the Shetland and the Faroe Islands, to investigate the conditions and best landing places. The telegraph poles, about 15,000, will be prepared in Norway and Sweden. The cost of the cable is estimated at about £111,000, and that of the land lines at £21,100. Several telegraph stations will be established on Iceland, and probably a network of telephone lines connected therewith.

Wireless Telegraph Notes.—In view of the opening of the wireless telegraphy stations at Ushant and Porquerolles for the despatch of private messages between ships at sea and France, Algeria and Tunis, *The Times*, in its financial and commercial supplement of Monday, gave some interesting particulars of the principal regulations. The telegrams should bear the inscription "Radiotelegramme," and be written in accordance with the international telegraphic regulations established in London in 1903. In addition to the ordinary address they ought to give the name and official number of the ship and its nationality. The charge is 75c. (7½d.) a word, in addition to the cost of transmission of the telegram at the ordinary rate to the wireless telegraphy station. The sender may mention the number of days during which the station may keep his telegram, and after the 29th day may extend it for a like period. The wireless telegraphy charge will be refunded if the message cannot, for any reason, be delivered. In a general way the provisions of the London telegraphic regulations of 1903, in so far as they are not opposed to the preceding stipulations, will be applicable to wireless telegrams.

The Stanger Electric-Tannin Treatment for Rheumatism.—A new system of electric baths for the cure of rheumatism, gout, &c., is being introduced into this country from the Continent by Mr. G. Stanger, who has, until recently, been connected with the tanning industry, and Mr. T. W. Baker, an electrical engineer. The bath itself is of impregnated wood and is filled with a fluid consisting of a solution of extracts of barks and herbs and of a certain percentage of tannic acid; the latter is, it is claimed, eminently adapted for dissipating uric acid deposits which settle in the tissues and joints. The solution is used at temperatures ranging from 90°F. to 105°F. and the maximum duration of a bath is half-an-hour. Metal strips run along both sides of the bath, and are connected to the two terminals of an electric supply. Ten carbon electrodes, in the form of large rectangular plates, hang down into the bath at either side. They are electrically connected to the metal strips by brass supports, the construction of which is such that the carbon plates may be fixed at practically any point within the bath and at any angle. The voltage across the terminal strips may be regulated by a rheostat, and is usually about 30 volts. A voltmeter and ammeter are mounted, one on each side of the regulating resistance. The current—about 2 to 3 amperes—flows from one set of electrodes to the other set, and it may be localised or varied in strength by suitable fixture of the electrodes. A switch is also provided for changing the direction of the current. Certain diseases are treated by means of an apparatus, which takes the form of a chair, at various parts of which are cushions of metal gauze. These are covered with cloth soaked in the solution, and are so connected up to the + pole and − pole of the supply, that the current passes in a predetermined manner through the patient's body. We are given to understand that the company which is to be formed for administering the treatment will only receive patients sent them by qualified medical men.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, October 21st.

North-East Coast Institution of Engineers and Shipbuilders.

7:30 p.m Annual General Meeting at the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. The Right Hon. Lord Armstrong will deliver his Presidential Address.

Institution of Mechanical Engineers.

8 p.m. General Meeting at Storey's-gate. Paper to be read: "A Scientific Investigation into the Possibilities of the Gas Turbine," by R. M. Neilson.

TUESDAY, October 25th.

Faraday Society.

8 p.m Ordinary Meeting in the Library of the Institution of Electrical Engineers, 92, Victoria-street, Westminster, S.W. The following Papers are down for reading:—(1) "Note on a Suggested New Source of Aluminium," by B. Pool. (2) "The Measurement of the Potential of the Electrodes in Stationary Liquids: The Determination of Changes of Concentration at the Cathode during Electrolysis," by H. J. S. Sands. (3) "Electrolytic Oxidation of Hydrocarbons of the Benzene Series: Part I.—Hydrocarbons containing the Methyl Group," by H. D. Law and F. Mollwo Perkin.

THE LOT'S ROAD GENERATING STATION OF THE UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON.

This station, which is the largest of its kind in Great Britain, is now rapidly nearing completion, the switch gear being practically finished. Work on it was commenced about two years ago, and, considering the magnitude of the undertaking and the various alterations and additions to the scheme as originally planned, the actual time occupied is anything but excessive. Not only will the station supply electrical energy to the entire District Railway, but also to the Great Northern. Piccadilly and Brompton, the Baker Street and Waterloo, the Charing Cross, Euston and Hampstead and the Hampstead and Edgware and Edgware and Watford Railways. Nearly all the permanent-way work, feeder system and sub-stations of the District Railway are finished, while thework on the other railways is in various stages of advancement.

The generating station is situated in Lot's-road, Chelsea, and is bounded on one side by the Thames and on another by Chelsea Creek, which runs into the river at this point. Thus there will be entire independence of railways so far as coal supply is concerned. It will be seen in Fig. 1 that a special basin has been provided for the accommodation of barges. On the opposite side of the creek there is a branch of the West London Extension Railway, by means of which rail-borne coal can be delivered. The barge basin is spanned by a couple of huge travelling gantry cranes, each capable of dealing with one ton of coal at a time. After being weighed in one of the crane towers, the coal is deposited on to a belt conveyor and raised to a height of 140ft., at the top of one end of the building, by means of duplicate inclined elevators. Coal brought in by the railway is discharged into a hopper under the waggons and taken to the top of the other end of the boiler house by an inclined elevator. It will thus be seen that the bunkers can be fed from either end of the building, and for this purpose duplicate belt conveyors are installed, the direction of travel, in both cases, being reversible. No less than 15,000 tons of coal can be stored in the bunkers at the same time, and it is anticipated that about 800 tons per day will be required under normal working conditions.

When the station is complete there will be no fewer than 80 B. and W. boilers, each of which will be fitted with a chain grate stoker having 83 sq. ft. of heating surface. Each boiler has 5,212 sq. ft. of heating surface and 672 sq. ft. of superheating surface. At the present time 64 of these boilers are in position, these representing eight batteries of eight boilers per battery. American practice has been followed regarding the boilers, and it is noteworthy that Lot's-road is the first station in this country in which they have been arranged on two floors. Eight boilers on one floor (four on each side of the gangway) form a battery. Directly opposite each battery of boilers is situated a generator set, each of which is supplied with steam by eight boilers; on the switchboard, each generator panel is opposite its machine, and, in fact, the entire station, from feed pumps to feeder cables, is a striking example of the individual unit system now becoming standard practice. In the removal of ashes a departure from ordinary practice has been made. Owing to the enormous quantity of ashes which will be produced, a special railway track has been laid under the boilers, and on this will run a small train of trucks hauled by a storage battery locomotive. The ashes from the boilers on both floors fall by gravity, through shoots, directly into trucks, which automatically dump their contents into barges after being raised by pneumatic hoists on the dock wall at the western end of the building. In the event of there being no barges empty the ashes may be deposited, for the time being, in an adjoining ashpit.

As shown in Fig. 1, there are four chimneys, erected by the Alphons Custodis Chimney Construction Co., each having an internal diameter of 19ft. at the base and a height of 275ft. They are practically devoid of ornamentation, as is the building itself, which consists of steel framework filled in with terra cotta and bricks, the interior of the engine room being painted white. Fig. 2 is a plan of the engine room and boiler house, from which the arrangement of the economisers can be clearly seen. There are as many economisers as boilers, and it will be observed that they are situated behind the boilers, somewhat further apart than is usual. Each has 1,540 sq. ft. of heating surface, and the tubes are 10ft. in length. The usual by-pass flue is, of course, provided. All boiler feed pumps are steam-driven and are situated on the ground floor. Feed water is obtained from an 8½in. artesian well, having a depth of 475ft., and this water is delivered into ring mains on both boiler room floors. From each battery of boilers there are eight 6in. pipes feeding into a main 14in. steam header placed inside the boiler house, and from this header steam pipes are taken through the wall to the turbine opposite, in the engine room. There is one feed pump for each group of boilers, and there is no steam connection between the various groups with the single exception that a supplemental header is provided at the east end of the boiler house for connecting the two end groups. The function of

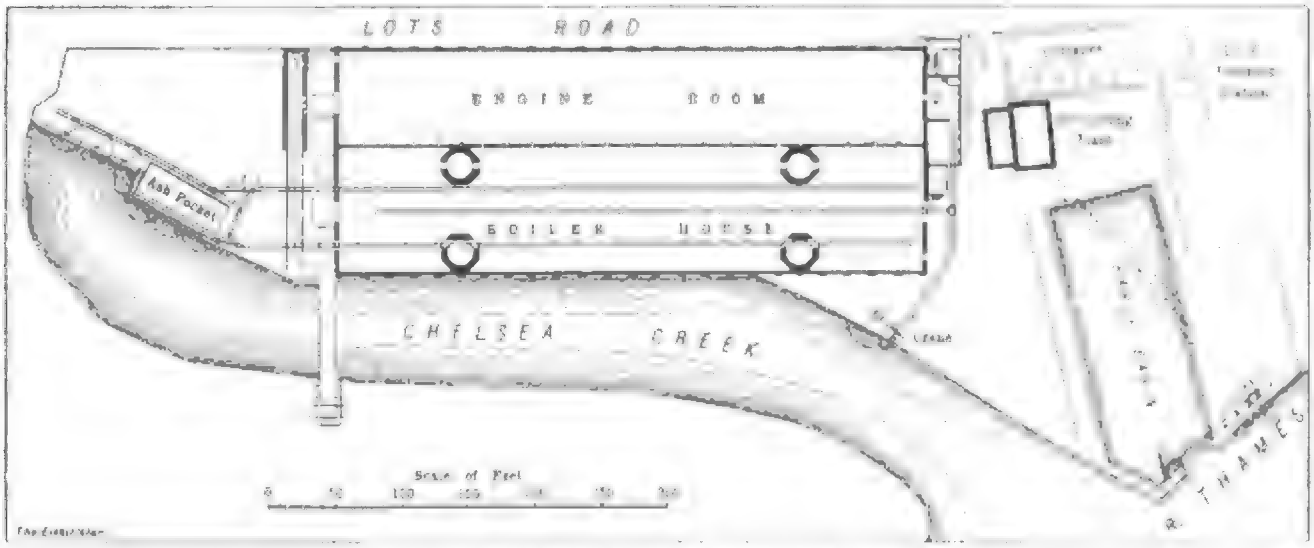


Fig. 1.—Plan Showing Position of Generating Station

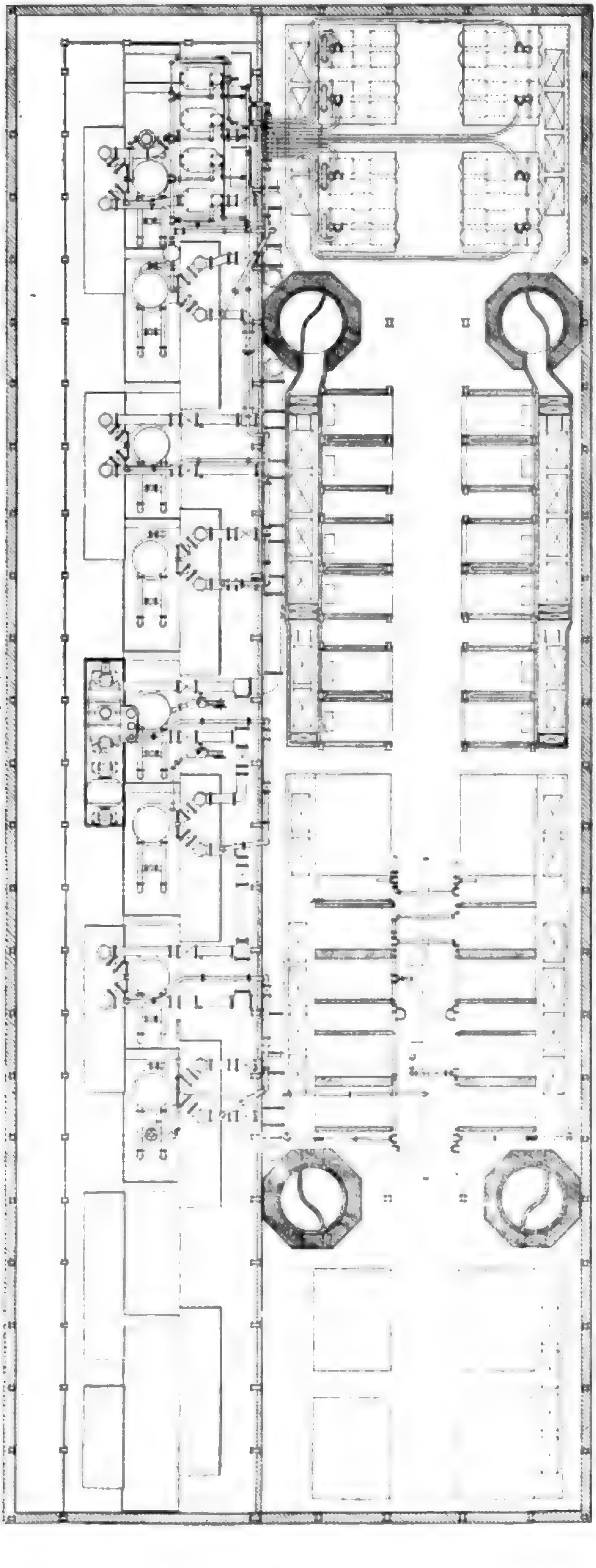


FIG. 2.—PLAN OF ENGINE ROOM AND BOILER HOUSE.

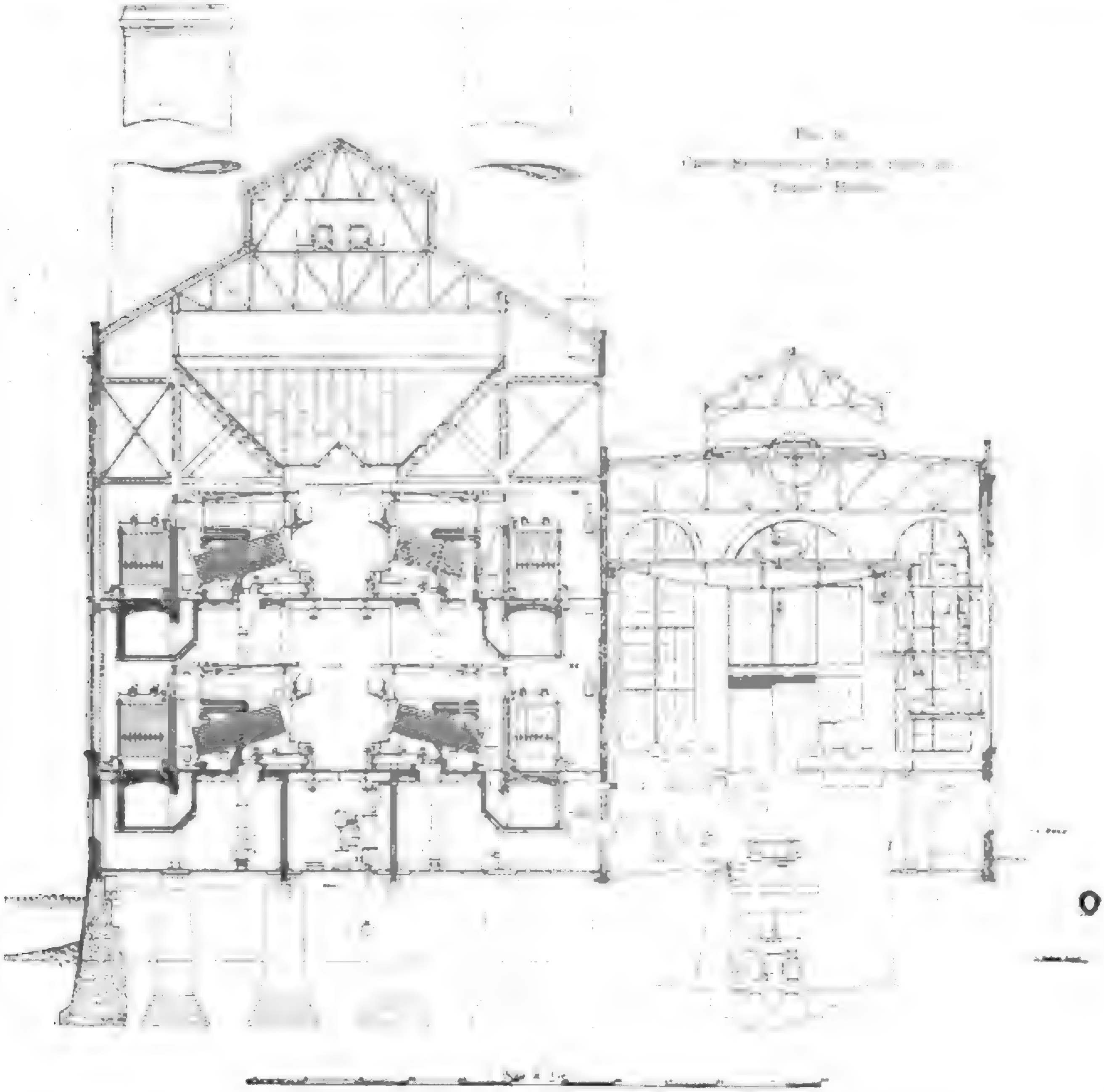
this supplemental header is to supply the steam-driven auxiliaries, such as exciters, air compressors, &c.

The turbines are of the Westinghouse-Parsons four-stage parallel flow type. Each is coupled to a three-phase generator rated at 5,500kw., and having an overload capacity of 50 per cent. for two hours at practically the same consumption of steam per kilowatt-hour. When running at 1,000 revs. per min. these machines generate 11,000 volts at a frequency of 33⅓ ~ per second. One vertical surface condenser, having a cooling surface of 15,000 sq. ft., is provided for each generator, and, as may be seen from Fig. 2, the condensers are situated below the engine-room floor between the turbine foundations. It may be remarked here that the greater portion of the engine-room floor consists of removable chequer plates, which facilitates the inspection and repair of plant situated in the basement. Circulating water is obtained from the Thames by means of a 66in. pipe (shown dotted in Fig. 1), and as the outlet is at the same level as the inlet, the arrangement acts as a syphon, and it is merely necessary to overcome the friction of the pipes. This is effected by a 20in. centrifugal pump to each condenser, and at minimum low tide the tops of the condensers are within 29ft. of water level. It is possible to cause the circulating water to flow in either direction, and the condensers work on the dry vacuum principle, separate air and water pumps being employed. Electric driving has been adopted for all condenser pumps.

Returning to the generators, these machines are excited by four 125kw. 125-volt continuous-current dynamos, driven by reciprocating engines at a speed of 375 revs. per min. They are star-wound, and the neutral point is connected to earth through a resistance which limits the current going to earth to 1,000 amperes. The negative excitation leads are connected directly from the exciters to the generator fields, by means of duplicate cables, which are carried in iron pipes on a rack underneath the engine-room floor. These leads run the entire length of the engine room, and are tapped opposite each generator, the services being controlled by switches contained in iron boxes situated at the junctions. All regulators, meters and service switches are in the positive wire.

The switchboard is of the remote-control type, and occupies three galleries running the entire length (454ft.) of the engine room. Opposite each generator set, on the engine-room floor, is a cable uptake consisting of three compartments divided off by bricks. This extends from the engine-room floor to the underside of the first gallery and carries in each of its compartments one of the generator cables. For the purpose of getting the cables from the generators to the bottom of the uptakes, earthenware pipes have been embedded in concrete laid between certain pairs of girders supporting the engine-room floor. The cables are then drawn into these pipes and proceed direct to the switchboard, via the brick uptakes. Near the underside of the floor of the first gallery and in the uptakes are the current transformers, these, it will be observed, being interposed between the generators and their oil switches. The cables are then carried through the first gallery floor by means of porcelain tubes to the generator motor-operated oils witches, which are of the B.T.-H. type, capable of dealing with a current of 500 amperes. They are very similar in design to those at the Carville power station of the Newcastle-upon-Tyne Electric Supply Co., described and illustrated in *The Electrician* of July 8th, p. 470. On one side of each oil switch are built two brick chambers, one above the other, and on the other side is a third brick chamber. Each of these chambers accommodates a potential transformer, one being for each phase. These are star-connected on both the primary and secondary sides, and the neutral is earthed. They stand on asbestos composition trays, are oil-cooled, and reduce the voltage from 11,000 to 110. Current from their secondaries is employed for working the generator wattmeters, voltmeters and reverse-current relays. The secondary leads themselves are carried to the various instruments in iron pipes buried in the concrete flooring of the gallery. The generator oil-switches stand out towards the gallery hand-rail, away from the cable panels, and the cables are taken from them to the panels by means of separate brick compartments on the floor. Porcelain insulators are fixed to the gallery floor and the cables are fastened to their tops, a stone slab covering all three compartments.

On reaching the panels, the cables are supported vertically on triple petticoat insulators and pass upward through the floor to the second gallery. Before leaving the first gallery panels, however, each passes through an isolating knife-switch which is, of course, intended to be operated only when no energy is passing, although the terminals may be alive. The opening and closing of these switches is effected by means of a hook on the end of an insulating rod. The generator cable compartments are divided by artificial stone barriers 2in. thick, the compartments themselves being 20in. between centres. On the second gallery are the main 'bus bars, also in three separate brick compartments, one above another and extending the entire length of the engine room. These 'bus bars, like those on the third gallery, consist of three copper bars, measuring 2in. by [illegible]in., spaced [illegible]in apart, and supported at intervals by porcelain insulators. They are divided lengthwise into five sections, and between adjacent sections there is placed a B.T.-H. 1,200-ampere motor-operated oil switch. Normally, these four switches remain closed, and the five sections thus constitute one long 'bus bar. To each section are connected the cables from two generators, which come through the floor from the first gallery. The last section has, however, been designed for three generators. The generator cables, still kept apart by stone partitions, come up at the back of the 'bus bars, and are attached to brass studs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which pass through insulators in the panels, and are then bolted to the 'bus bars. Thus, between the generators and the main 'bus bars there are the following: Main generator oil switch, disconnecting knife switch and potential and current transformers. The function of the disconnecting knife switches is simply to allow of all gear on the generator side of the 'bus bars being made dead so as to permit of cleaning and inspection. It has already been mentioned that the five 'bus-bar sections are connected through motor-operated oil switches, but, in order that these switches may also be attended to while the station is running, disconnecting knife switches are inserted in the cables on both sides of the oil switches. Cables have, of

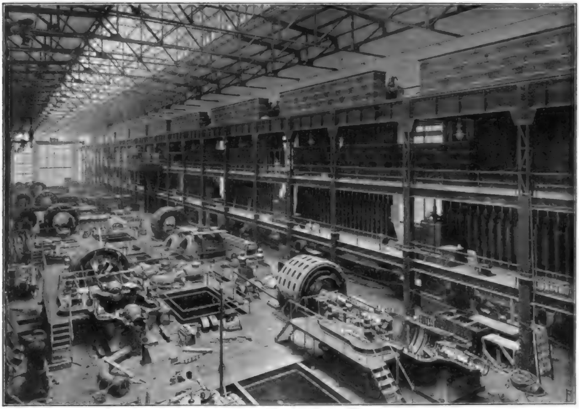

FIG. 4.—GENERAL VIEW OF ENGINE ROOM AND SWITCHBOARD.

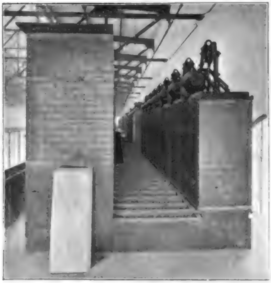

FIG. 5.—FEEDER MOTOR-OPERATED OIL SWITCHES.

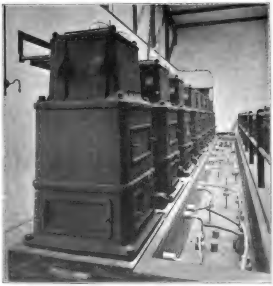

FIG. 6. TRANSFORMERS FOR STATION LIGHTING AND AUXILIARIES.

necessity, to be used for making connections from the knife switches to the oil switches, and these are carried on insulators in separate brick compartments, under a false floor. Not only are the section switches between adjacent sections electrically, but they are also in this position physically, and therefore the actual length of cable used is a minimum.

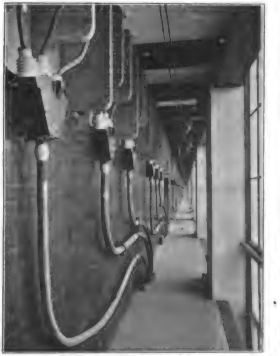
Fig. 7.—Feeders Leaving the Board.

On the third gallery are the feeder 'bus bars, also extending the length of the engine room and housed in separate brick compartments; they are, in fact, almost a counterpart of the generator 'bus bars. There is, however, one great difference—viz., their division into 10 instead of five sections. Bolted to the studs, which connect the generator cables to the main 'bus bars, are other cables which proceed vertically through the floor above to motor-operated oil switches, each being capable of breaking a circuit carrying 1,200 amperes. Knife disconnecting switches are inserted in the cables previous to their entering the oil switches. Two of these cables are connected to each section of main 'bus bar, and after passing through the oil switch each cable is connected to one section of feeder 'bus bar. The oil switches are termed "group switches," since each controls the six or seven feeders which are connected to its section of feeder 'bus bar. There are, altogether, 68 feeders connected to the 'bus bars, each being controlled by a motor-operated oil switch, which may also be isolated by a disconnecting knife switch on the 'bus-bar side. Our illustration (Fig. 5) gives an excellent idea of the appearance of the feeder oil switches. The stone slabs which are shown in the foreground are employed for covering the separate brick compartments in which the cables are run from the 'bus bars to the switches. Of the 68 feeders, 65 are for operating the various lines of railway, while the remaining three supply three banks of transformers (Fig. 6), which reduce the voltage from 11,000 to 220 for the purpose of supplying low-tension three phase current for lighting and working certain of the electrically-driven auxiliaries in the station. There are three single-phase $166\frac{2}{3}$kw. transformers in each bank, and they were supplied by the Westinghouse Company. As may be seen by the illustration, the high-tension cables are brought up to the transformers on insulators in a false floor, while the low-tension leads pass downwards through the floor on the opposite side. The transformers themselves are air-cooled, the blast being created by means of electrically driven fans.

Returning to the feeders, these pass from the oil-switch terminals at the back of the board on the third gallery, through the floor to the second gallery, where they still continue as three separate cables and where the current transformers are interposed. After passing through the floor of the second gallery each of the three cables forming one feeder is attached to the terminals of two knife-disconnecting switches in such a manner that the lightning arrester may still be left connected to the feeder even when the latter is not being fed from the generating station. On the other hand, when it is desired to clean or inspect the arrester, this operation may be effected while the feeder is in service, by pulling out one of the disconnecting switches. The cables are then brought into three-way dividing bells, from which each feeder emerges as a three core lead-covered cable. All these cables are cleated to the wall and then taken through the floor to the conduit, and so to the sub-stations. All cables within the station, except those which have been specifically mentioned as being lead-covered, are rubber-covered and asbestos insulated.

The control boards are very similar in arrangement and construction to those at Carville. Fig. 8 shows the generator control board, which is of the bench type and is mounted in a bay of the second gallery, facing the engine room. The instruments are on a level with the operator's eye and the switches are all situated so as to be manipulated with the greatest ease. In each phase there is an ammeter, while each generator is provided with one indicating and one recording polyphase wattmeter, a power-factor indicator, a voltmeter and a field ammeter. Synchronisers of the dial type are mounted on swinging brackets at both ends of the board. Each panel, so

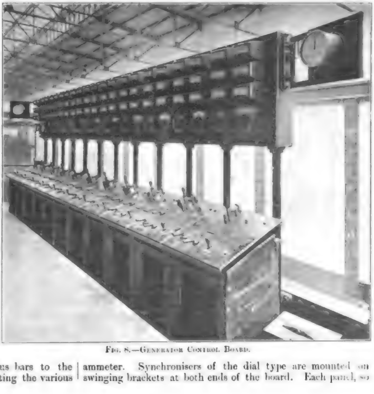
Fig. 8.—Generator Control Board.

far as instruments are concerned, is an exact duplicate of every other panel, but there is a certain amount of difference with regard to the switches. Altogether, there are 11 panels on the operating board, and, apart from the instruments mentioned above, the following are common to all:—One control switch for each generator oil switch, one for each group switch, one for each motor-operated generator field rheostat, one control switch for each motor-operated turbine governor, one push button for signalling to the driver and one synchronising receptacle. Since the main 'bus bars are divided into five sections by four switches, only four control switches are required, and these have been placed on panels 2, 4, 6 and 8, while the corresponding synchronising receptacles for the 'bus-bar sections are on panels 1, 3, 5 and 7. In addition to the above, there is a field switch of the knife-blade pattern on each panel. All the control leads are carried in iron pipes buried in concrete, and the circuits are operated from a battery at 110 volts, which is the same potential as that used in the instrument circuits.

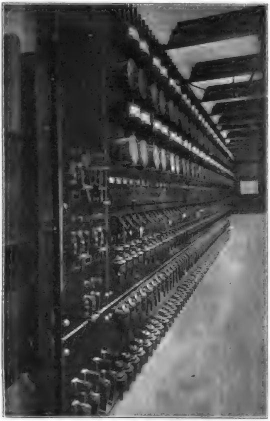

Fig. 9.—Feeder Control Board.

The feeder control board (Fig. 9) consists of 18 panels, 17 of which are equipped with feeder instruments and switches, while the eighteenth is set apart solely for the control battery. Each of the 17 feeder panels carries an ammeter and a wattmeter, with an overload relay in each phase and a control switch for operating the oil switch. All control switches, both on the generator and feeder boards, are accompanied by coloured signal lamps which indicate whether the main switch is open or closed.

For controlling the electrically-operated auxiliaries and the station lighting there is an auxiliary board consisting of 24 panels. Of these four are exciter panels, each carrying a single-pole switch. There is also one panel for a motor-generator, whose function it is to charge the battery. The high-tension oil switches for the station transformers are operated from this board, and the low-tension switches are of the automatic oil-break type. There is nothing of special interest with regard to this switchboard with the exception that the low-tension alternating 'bus bars have been sectioned up in such a manner that at times of light load all repairs and inspection may be carried out without the necessity of working on live metal. In a station such as that at Lot's-road, where a shut-down would spell disaster, this is a point not to be despised. In the engine room are two 18-ton cranes, driven by continuous-current motors of the B.T.-H. type. Each crane is equipped with three motors and control gear with automatic release.

The feeders, after leaving the switchboard, are led into a conduit which runs from the generating station to Earl's Court. This conduit consists of 64 pipes embedded in concrete, 32 being one side of a 9in. brick wall and 32 on the other. Every feeder is in duplicate, the spares all being laid on one side of the brick wall, which runs the entire distance. Three-core paper-insulated lead-covered cables of 0·15 sq. in. section are employed in the conduit, but wire-armoured cables, supported by brackets, are used along the railway line. After the cables were laid, tests were made at a pressure of 22,000 volts, and the result was perfectly satisfactory. This voltage was applied between conductors and between conductors and earth. Of the above cables Messrs. Callenders supplied 36 miles. They also supplied 1 mile of 0·221 sq. in., 1 mile of 0·52 sq. in. and ½ mile of S.W.G. 6. Most of this was used in connection with the switchboard. It is single cable, insulated with vulcanised rubber, and covered with a double layer of prepared cotton braid. Over this is a covering of asbestos. Other cables in connection with the undertaking were supplied by the British Insulated and Helsby Cables and Messrs. W. T. Henley's Telegraph Works Co.

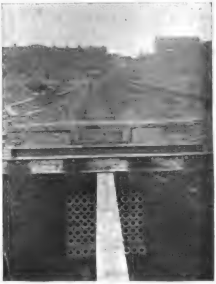

Fig. 10.—Feeder Conduit.

For permission to view the station and for much of the information contained in this article we are indebted to Mr. Jas. R. Chapman, general manager and chief engineer to the Underground Electric Railways Co. of London (Ltd.), and to Mr. J. W. Towle, resident engineer at Lot's-road. To the British Thomson-Houston Co. our thanks are also due for a great part of the information concerning the switch gear, for which they secured the entire contract.

Elektrotechnischer Verein.—In connection with the celebration of the twenty-fifth anniversary of the foundation of the Elektrotechnischer Verein, which is to take place from November 22nd to 24th, an exhibition of electrical apparatus is to be held at the Berlin General Post Office.

POWER HOUSE OF THE NEW YORK RAPID TRANSIT SUBWAY.

Although the travelling facilities of New York at the present time are numerous and well organised, yet of late it has become more and more evident that the ever-increasing passenger traffic called for new and rapid means of locomotion. This fact led to the inception, some years ago now, of a network of shallow underground electric railways. The lines at present under construction aggregate about 18 miles, and that part running under Broadway is expected to be opened very shortly. A short description of the subway system and of the power house furnishing the energy for operating it was given by our special correspondent who accompanied the Institution of Electrical Engineers on their American tour (see *The Electrician*, Sept. 23rd, p. 899). The New York system of subway traction is of special interest to engineers in this country on account of the work of a similar description which is being carried out at present in London, and the power station, which is to furnish electric energy for the whole network of New York subways, also merits close attention, not only on account of its size, but also because it marks the present-day practice in central station engineering in the United States.

The city, as the actual owner of the subway, was authorised in 1900 to issue bonds not in excess of $50,000,000 at 3½ per cent., and $5,000,000 for property rights, and to enter into a contract for the private construction and operation of the system, the term of contract being 50 years on a rental equal to the interest on the bonds and 1 per cent. additional. The contract for the part of the system decided upon at that time was secured by Mr. John B. McDonald, but he, in his turn, assigned later on to the Interborough Rapid Transit Co. the lease of operating part of his contract with the city, that company thereby becoming directly responsible to the city for the equipment and operation of the road. This company was formed in the spring of 1902 for the express purpose of operating the network of subways. Extensions, which were later decided upon by the Board of Rapid Transit Railroad Commissioners, were carried out by the Rapid Transit Subway Construction Co., affiliated with the operating company alluded to above. In January, 1903, the Interborough Rapid Transit Co. acquired the elevated railway system by lease for 999 years from the Manhattan Railway Co., thus assuring harmonious operation of the elevated roads and the subway system, including the Brooklyn extension. The power house, which was erected by the Interborough Rapid Transit Co. for working the whole of the subway system, is situated on the banks of the North River, between West Fifty-eighth and Fifty-ninth streets. It was designed and equipped under the supervision of Mr. L. B. Stillwell, the electrical director, and Mr. John Van Vleck, mechanical engineer to the company. Fig. 1 represents the building in course of construction.

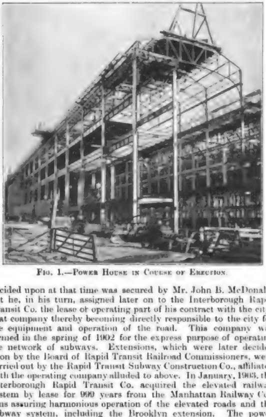

Fig. 1.—Power House in Course of Erection.

It is about 700ft. long and 200ft. wide, and is so arranged that it readily admits of future extension. It is designed to accommodate 82,000 rated horse-power, made up of 10 main units of 7,500 H.P. each, the remainder consisting of four 1,250kw. turbines and two 600 H.P. exciter engines. The overload capacity of the large units is 50 per cent. The arrangement of the plant has been made on the basis of a division into six sections which are normally operated independently, each section consisting of six batteries of boilers, one chimney, two engines, each direct-connected to a 5,000kw. alternator; two condensing equipments, two boiler-feed pumps, two smoke flue systems, and detail apparatus necessary to make each section complete in itself. The only variation is a turbine plant. In addition to the space occupied by the sections, an area was set aside, at the Eleventh-avenue end of the structure, for the passage of the railway spur from the New York Central tracks. In the fourth section it was decided to omit a regular engine with its 5,000kw. generator, so that this outfit can afterwards be replaced by a regular 5,000kw. traction generator. The operating room section is practically symmetrical in its structure, with respect to its centre; it consists of a central area, with a truss roof over the space, and galleries along both sides. The galleries along the northerly side are primarily for the electrical apparatus, while those along the southerly side are given up chiefly to the steam-pipe equipment. Figs. 2 and 3 show the general arrangement of the power-house.

The steel structure of the power house is independent of the walls, the latter being self-supporting and used as bearing walls only for a few of the beams in the first floor. Although structurally a single building, in arrangement it is essentially two, lying side by side and separated by a brick division wall. There are 58 traverse and nine longitudinal rows of main columns, the longitudinal spacing being 18ft. and 36ft. for different rows, with special bracing in the boiler house to accommodate the arrangement of boilers. Both the boiler house and the engine house have five tiers of floor framing below the flat portion of the roof, the three upper tiers of the engine house forming galleries on each side of the operating room, which is clear for the full length of the building. The boiler house floors are, in general, framed with transverse plate girders and longitudinal rolled beams, arranged to suit the particular requirements of the imposed loads of the boilers, economisers, coal, &c., while the engine-room floors and pipe and switchboard galleries are, in general, framed with longitudinal plate girders and transverse beams.

Several plans were taken up with a view to the construction of a power house of massive and simple design, but it was finally decided to adopt an ornate style of treatment by which the structure would be rendered architecturally attractive and in harmony with the recent tendencies of municipal and city improvements from an architectural standpoint. The Eleventh-avenue facade is the most elaborately treated, but the scheme of the main facade is carried along both the Fifty-eighth and Fifty-ninth-street fronts. The westerly end of the structure, facing the river, may ultimately be removed in case the power house is extended to the Twelfth-avenue building line for the reception of 14 generating equipments, and for this reason this wall is designed plainly. This general style of the face-work is what may be called French Renaissance, and the colour scheme has, therefore, been made rather light in character. The base of the exterior walls has been finished with cut granite up to the water table, above which they have been laid up with a light-coloured buff pressed brick. This brick has been enriched by the use of similarly coloured terra-cotta, which appears in the pilasters, about the windows, in the several entablatures and in the cornice and parapet work The Eleventh-avenue facade is further enriched by marble medallions framed with terra-cotta, and by a title panel directly over the front of the structure. The economisers were placed above the boilers instead of behind them, which made a material saving in the width of the boiler room. This saving permitted the setting aside of a gallery at the side of the operating room, closed off from both boiler and engine rooms, for the reception of the main pipe systems and for a pumping equipment below it. The main engines, combined with their alternators, lie in a single row along the centre line of the operating room, with the steam or operating end of each engine facing the boiler house and the opposite end toward the electrical, switching and controlling apparatus arranged along the outside wall Within the area between the boiler house and operating room there is placed, for each engine, its respective complement of pumping apparatus, all controlled by and under the operating jurisdiction of the driver of that engine. Each driver has thus full control of the pumping machinery required for his unit. Symmetrically arranged with respect to the centre line of each engine are the six boilers in the boiler room, and the piping from these six boilers forms a short connection between the nozzles on the boilers and the throttles on the engine. The arrangement of piping is alike for each engine, which results in a piping system of maximum simplicity that can be controlled in the event of difficulty with a degree of certainty not possible with a more complicated system. The main parts of the steam-pipe system can be controlled from outside this area.

The single tier of boilers makes it possible to secure a high and well-ventilated boiler room with ventilation into a story constructed above it, aside from that afforded by the windows themselves. The boiler room will, therefore, be cool in warm weather and light, and all difficulties from escaping steam will be minimised. The placing

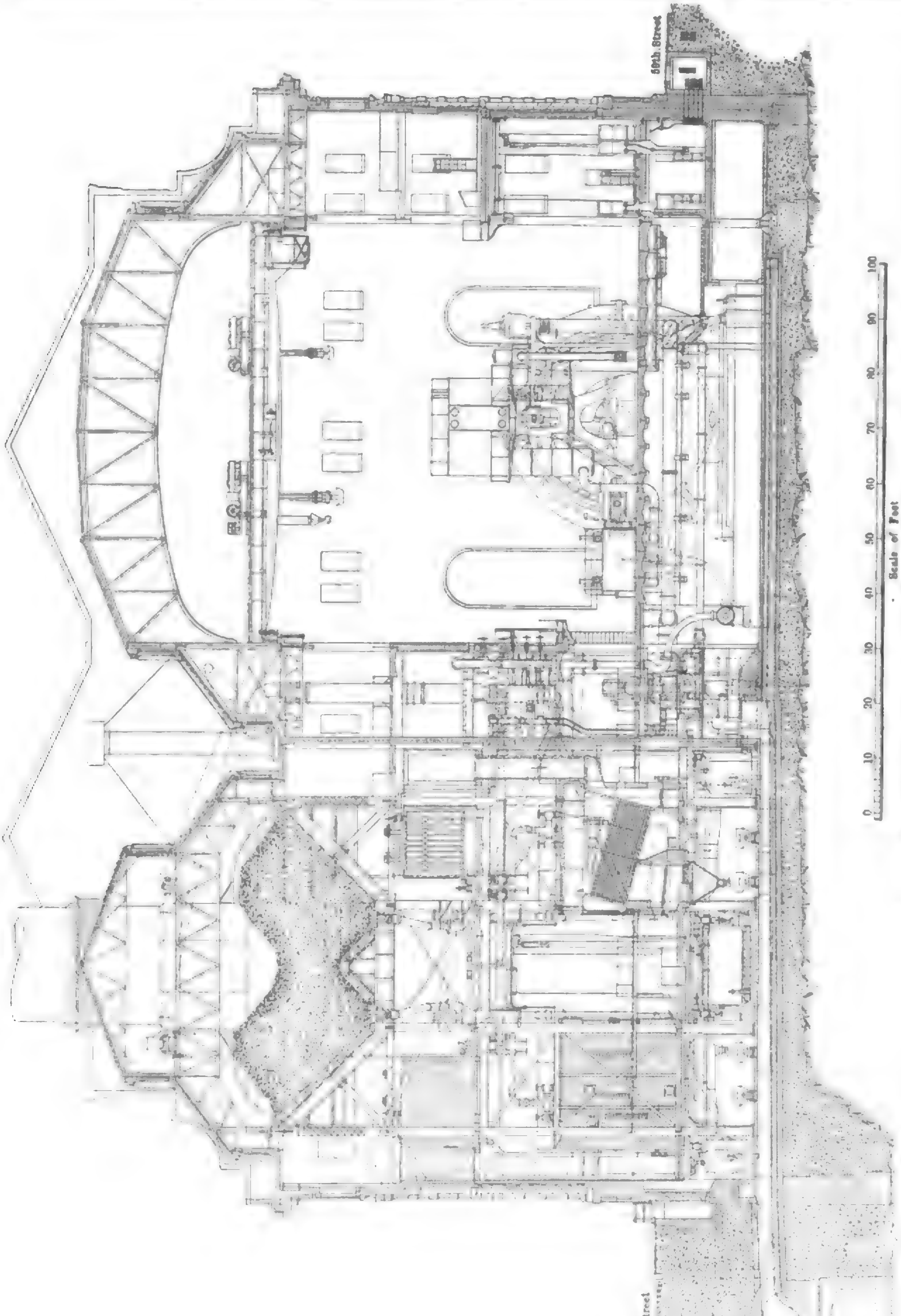
59th Street
58th Street
0
10
20
30
40
50
60
70
80
90
100
Scale of Feet

FIG. 2.—CROSS SECTION OF THE INTERBOROUGH RAPID TRANSIT CO.'S POWER HOUSE.

of the economisers, with their auxiliary smoke flue connections in the economiser room, all symmetrically arranged with respect to each chimney, removes from the boiler room an element of disturbance and makes it possible to pass directly from the boiler house to the operating room at convenient points along the length of the power house structure. Each chimney is situated in the centre of the boiler house between sets of six boilers, and thus the coal bunker construction is divided into separate pockets by which trouble from spontaneous combustion can be localised, and the divided coal bunkers can provide for the storage of different grades of coal. The unit basis on which the economiser and flue system is constructed will allow of making repairs to any one section without shutting the portions not connected directly to the section needing repair. The floor of the power house between the column bases is a continuous mass of concrete 2ft. thick.

Water for condensing purposes is drawn from the river and discharged into it through two monolithic concrete tunnels parallel to the axis of the building. The intake conduit has an oval interior, 10ft. by 8½ft. in size, and a rectangular exterior cross-section; the outflow tunnel has a horseshoe-shape cross-section and is built on top of the intake tunnel. Adjacent to the condensing water conduits is a 10ft. by 15ft. rectangular concrete tunnel, through which the underground coal conveyor is installed between the shore end of the pier and the power house.

Babcock and Wilcox safety water-tube three drum boilers, rated at 600 H.P. each, have been installed, there being 6,000 sq. ft. of heating surface and 100 sq. ft. of grate surface per boiler. There are 52 boilers arranged on both sides of the boiler room in batteries of two each, with a wide aisle between the opposite rows. The boilers are designed for a working steam pressure of 225lb. per square inch and for a hydraulic test pressure of 300lb. per square inch. Each boiler is provided with 21 vertical water-tube sections, each and section is 14 tubes high. A few of the boilers are equipped with superheaters, both the B. and W. and Foster types being used.

The setting embodies several special features which are new in boiler erection. They are set higher up from the floor than in standard practice, the centres of the drums being 19ft. above the floor line. This feature provides a higher combustion chamber, for either hand-fired grates or automatic stokers; and for inclined grate stokers the fire is carried well up above the supporting girders under the side walls, so that these girders will not be heated by proximity to the fire. As regards the masonry setting, practically the entire inside exposed to the hot gases is lined with a high grade of firebrick. The back of the setting, where the rear cleaning is done, is provided with a sliding floor plate, which is used when the upper tubes are being cleaned. There is also a door at the floor line and at a higher level for light and ventilation when cleaning. Over the tubes arrangements have been made for the reception of superheating apparatus without changing the brickwork. Where the brick walls are constructed, at each side of the building columns at the front, cast-iron plates are erected to a height of 8ft. on each side of the column. An air space is provided between each cast-iron plate and the column, which is accessible for cleaning from the boiler front, the object of the plates and air space being to prevent the transmission of heat to the steel columns.

In front of all the boilers is a continuous platform of open-work cast-iron pipes, laid on steel beams, the level of the platform being 8ft. above the main floor. The platform connects across the firing area, opposite the walk between the batteries, and at these points this platform is carried between the boiler settings. Each boiler is provided with two water columns, one on each outside drum, and each boiler will have one steam gauge above the platform for the water tenders and one below the platform for the firemen. The stop and check valves on each boiler drum have been made specially heavy for the requirement of this power house, and this special increase of weight has been applied to all the several minor boiler fittings. Hand-fired Gibson grates of the shaking pattern have been furnished with 36 boilers, and for each of these grates a special lower front has been constructed. These fronts are of sheet steel, and the coal passes down to the floor through two steel buckstays, which have been enlarged for the purpose. There are three firing doors and the sill of each door is 36in. above the floor. The 12 boilers, which will receive coal from the coal bunker located between the fourth and fifth chimneys, have been furnished with automatic stokers. It is proposed to employ superheaters to the entire boiler plant.

The boiler-room ceiling has been made especially high, and in this respect the room differs from most power houses of similar construction. The distance from the floor to the ceiling is 35ft., and from the floor plates over the boilers to the ceiling is 18ft. Over each boiler is an opening to the economiser floor above, covered with an iron grating. The height of the room, as well as the feature of these openings, and the stairway wells, and with the large extent of window opening in the south wall, will make the room light and especially well ventilated. Under these conditions the intense heat usually encountered over boilers will largely be obviated. In addition to making provisions for the air to escape

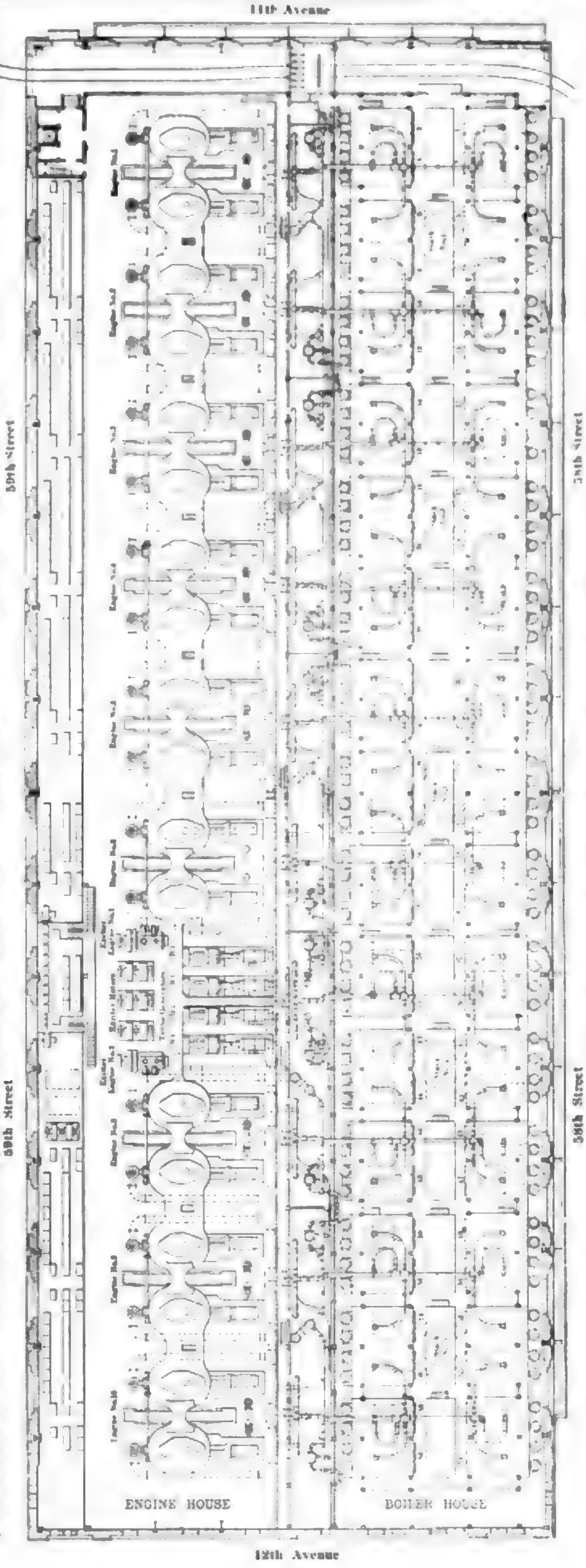

FIG. 3.—PLAN OF THE INTERBOROUGH RAPID TRANSIT POWER HOUSE.

from the upper part of the boiler room, arrangements have been provided for allowing the air to enter at the bottom. This inflow of air will take place through the southerly row of basement windows, which extend above the boiler-room floor, and through the wrought-iron open-work floor construction extending along in the rear of the northerly row of boilers.

In order to burn the finer grades of anthracite coal in sufficient quantities to obtain rating with the hand-fired grates, and in order to secure a large excess over boiler rating with other coals, a system of blowers and air ducts has been provided in the basement under the boilers. One blower is selected for every three boilers, with arrangements for supplying all six boilers from one blower. The Sturtevant blowers are 11ft. high above the floor and 5ft. 6in. wide at the floor line. Each blower is directly-connected to a two-crank 7½in. by 18in. by 6½in. upright automatic compound steam engine of the self-enclosed type, and is to provide a sufficient amount of air to burn 10,000lb. of combustible per hour with 2in. of water-pressure in the ash-pits. The main flues are arranged and fitted with dampers, so that the gases can pass directly to the chimney, or else they can be diverted through the economisers and thence reach the chimney.

Coal is brought in from a pier, 700ft. long and 60ft. wide, on the river bank. It is unloaded at this pier from barges and is carried by means of a 30in. Robbins electrically-operated belt conveyor to the power house, where it is received on 20in. inclined conveyor, which distributes it to the bunkers. It is elevated to the top of the boiler house (110ft. high) at the rate of 250 tons per hour or more, if so desired. These conveyors have automatic self-reversing trippers, which distribute the coal evenly in the bunkers. For handling different grades of coal, distributing conveyors are arranged underneath the bunkers for delivering the coal from a particular bunker through gates to the downtake hoppers in front of the boilers. The coal-handling system in question was adopted because any serious interruption of service would be of short duration, as any belt, or part of the belt mechanism, could quickly be repaired or replaced. The system also possesses advantages with respect to the automatic even distribution of coal in the bunkers, by means of the self-reversing trippers. These derive their power from the conveying belts. Each conveyor has a rotary cleaning brush to cleanse the belt before it reaches the driving pulley, and they are all driven by induction motors. The tower frame and boom are steel, the former running on two rails along the dock, and is self-propelling. The lift is unusually short, for the reason that the weighing apparatus is removed horizontally to one side in a separate house, instead of lying vertically below the crusher. This arrangement reduces by 40 per cent. the lift of the bucket, which is of the clam-shell type, of 44 cubic ft. capacity. The main hoist is directly connected to a 200 H.P. motor with a special system of control, and the trolley engine for hauling the bucket along the boom is also directly coupled to a multipolar motor. The receiving hopper has a large throat, and a steel grizzly in it which sorts out coal small enough for the stokers and by-passes it around the crusher. The crusher is of the two-roll type, with relieving springs, and is operated by a motor, which is also used for propelling the tower. Coal is weighed in duplex 2-ton hoppers. The seven bunkers have an aggregate capacity of about 18,000 tons, and are built above the boiler room, between the stacks. Coal is brought to the boilers through chutes which deliver on the floor in front of the fire-doors. Each bunker has eight cast-iron outlets, four on each side, and to these outlets are bolted gate valves for shutting off the coal from the corresponding downtakes. From these gates the downtakes lead to hoppers which are on the economiser floor, and from the hoppers the lower sets of downtakes extend down to the boilers. Just above the hoppers on the economiser floor the coal downtakes are provided with valves and chutes to feed the coal, either into the hopper or into the distributing flight conveyor alongside it. These distributing conveyors, one corresponding with each row of downtakes, permit the feeding of coal from any bunker or bunkers to all the boilers when desired. They are the ordinary type of flight conveyor, capable of running in either direction and provided with gates in the bottom of the trough for feeding into the several above-mentioned hoppers. In order to eliminate the stresses that would develop in a conveyor of the full length of the building, the conveyors are of half the entire length, with electric driving engines in the centre of each continuous line. The installation of this conveyor system, in connection with the coal downtakes, makes it possible to carry a high-grade coal in some of the bunkers for use during periods of heavy load and a cheaper grade in other bunkers for the periods of light load. Each section of 12 boilers has its individual stack. Four circular flues are led from each battery and connect to a horizontal flue of rectangular cross-section, two of the latter flues serving for the three batteries of the section which are on the same side of the boiler room. These flues enter into a common uptake, which leads to the stack. The flues are lined with brick and are provided with slip expansion joints, and while the present equipment of the plant does not include economisers, provision has been made so that the gases may be passed through the economisers should they be installed in the future, or else may be delivered directly to the stack. The stacks have been designed in such a manner as to encroach upon the boiler-room space as little as possible, and are carried on structural-steel columns, the bases of the stacks being at the level of the lower part of the coal bunkers. They were built of brick, by the Alphons Custodis Construction Co., and weigh about 1,160 tons, the top, which is 15ft. in diameter, being 221ft. above the level of the grates. They are surmounted by an iron top and are provided with a gallery and well equipped with lightning conductors. Where the chimney passes through the roof of the boiler house, a steel plate and angle curb, which clears the chimney by 6in. at all points, is provided in connection with the roof framing. This is covered by a hood flashed into the brickwork, so that the roof has no connection with or bearing upon the chimney. At a point 4ft. 6in. below the cap of the chimney the brickwork is corbeled out for several courses, forming a ledge, around the outside of which is placed a wrought-iron railing. Galvanised iron ladder rungs were built in the brickwork, for ladders both inside and outside the shaft.

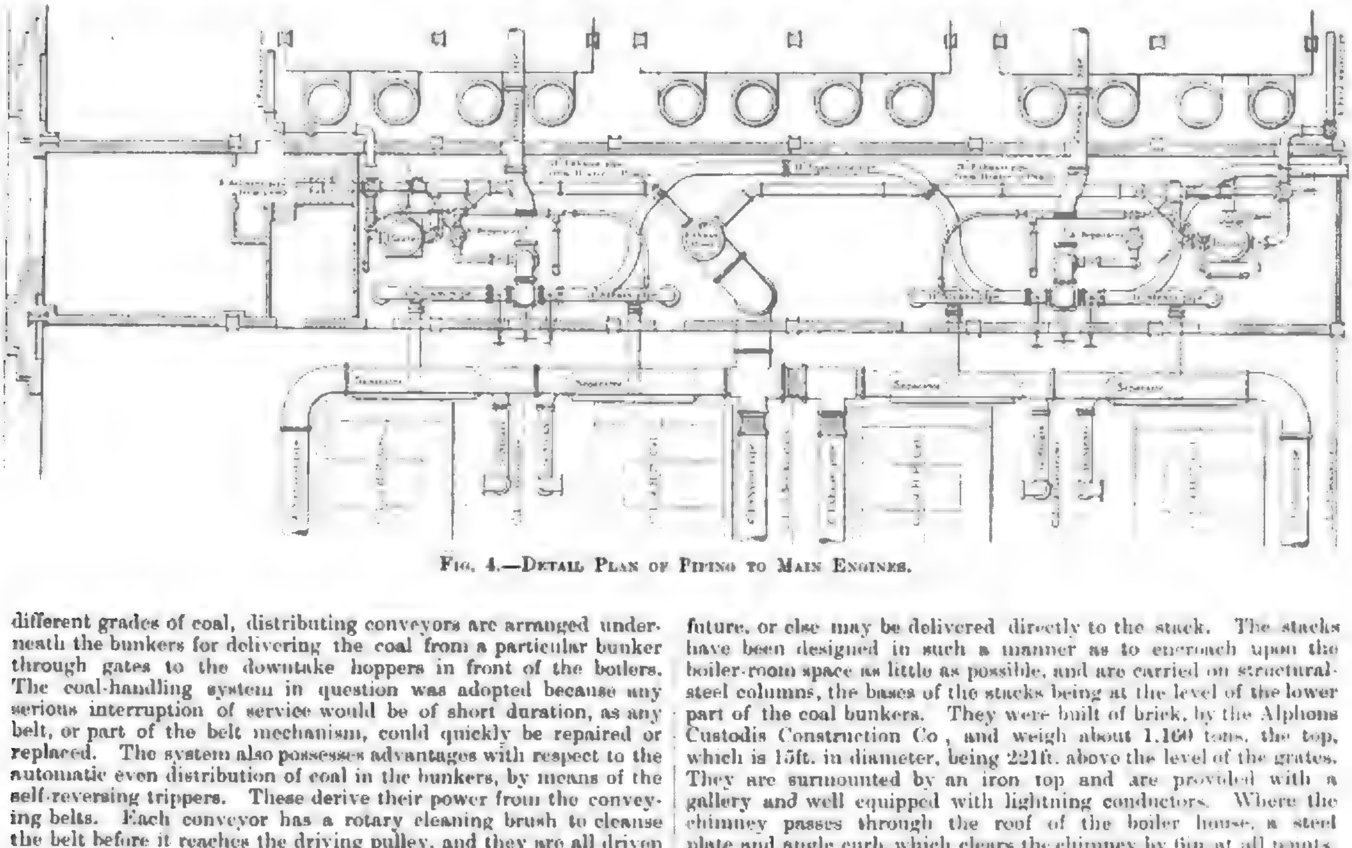
FIG. 4.—DETAIL PLAN OF PIPING TO MAIN ENGINES.

In the basement, under the boiler room, are four ash tracks, two under each boiler row. The ash is discharged through hoppers into 24 electrically-driven cars of 2 tons capacity, by which it is conveyed to the pier at the river, and there loaded upon scows for disposal. Each car has two four-wheel pivoted trucks with springs. Motive power is supplied by an electric storage-battery locomotive. The cars deliver the ashes to an elevating belt conveyor, which fills the ash bunker. This will contain 1,000 tons, and is built of steel with a suspension bottom lined with concrete. For delivering stored ashes to barges, a collecting belt extends longitudinally under the pocket, being fed by eight gates. It delivers ashes to a loading belt conveyor, the outboard end of which is hinged so as to vary the height of delivery and to fold up inside the wharf line when not in use. Under the aisle of the boiler room are located the water-storage tanks, which are filled from the city water supply. These tanks, which are 10 in number, are 46ft. long, 14ft. wide and 78ft. deep. The entire series is connected by a pipe line, and the admission of water controlled by means of floats. The feed water for the boilers is drawn from these tanks through an 8in. suction line and is delivered through a 7in. discharge, either to the heaters or directly to the boilers. The feed-water piping is constructed wholly of cast-iron, except the piping above the floor line to the boilers, which is of extra-heavy semi-annealed brass with extra-heavy cast-iron fittings.

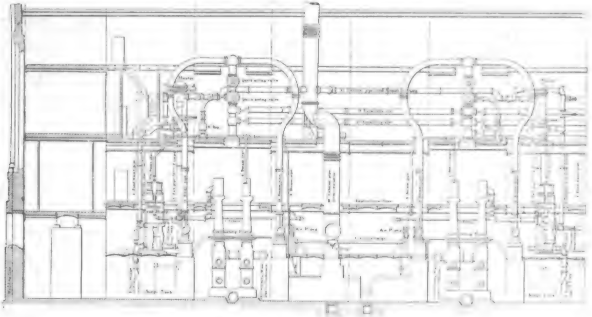

Fig. 5.—Detail View of Main and Auxiliary Steam and Exhaust Piping.

Between the boiler and engine rooms is an area-way, in which has been located, as far as possible, all the main steam piping, the lower part of this space serving for the pumps, and the heaters being carried on the raised floor of the area-way. Starting at the side of the boiler house away from the engine room, the three boilers of a section are connected by means of 9in. pipes to a 14in. header which crosses the boiler room, and is increased to 17in. where the 9in. pipes from the other three boilers of the section join. From this point the 17in. header passes through the wall between the boiler and engine room, and enters the pipe areas where it branches into two 14in. lines which drop below the engine-room floor and turn with large bends and enter steam separators, from which a 14in. pipe leads up to the throttle valve at the bottom of the high-pressure cylinder. In addition to this direct connection between the engine units and the boilers, three 12in. headers have been provided, which are run throughout the length of the building. At the point where the 17in. header divides into the two 14in. lines leading to the engine, a manifold is provided to which the three 12in. headers previously mentioned are connected and to which also is connected, by means of a by-pass, the 17in. header from the six boilers. With this arrangement it is possible to serve any engine unit from any group of boilers, and thus the chances of interruption to the service are rendered as remote as possible. The disposition of the piping is shown in detail in Figs. 4 and 5.

The entire main steam piping is of extra heavy wrought iron with loose flanges of forged steel; no expansion joints of any kind have been provided in the steam lines, expansion being taken care of by means of long-radius bends. Valves are introduced in such a way as to provide for easy and positive operation, and quick closing valves have been used wherever necessary. The valves for controlling the operation of the manifold, and also the lines to the engines have their stems extended through the wall of the pipe area, and are arranged to be operated from a gallery above the engine room floor.

The main engines are twin compound, and are rated at 7,500 H.P. each. The high-pressure cylinders are 42in. in diameter and the low-pressure 86in., the stroke being 60in. Poppet valves are fitted on the tops of the high-pressure cylinders, and the low-pressure cylinders are provided with Corliss valves. The speed of the engines is 75 revs. per min., and they were designed and manufactured by the Allis-Chalmers Company. They are guaranteed not to require more than 12¼lb. of dry steam per indicated horse-power per hour, when indicating 7,500 H.P. at 75 revs. per min. with a vacuum of 26in., a steam pressure at the throttle of 175lb., and with saturated steam at normal temperature. The guarantee includes all the steam used by the engine, jackets and reheater. For the lubrication of the engines an extensive oil-distributing and filtering system is provided. The piping to the engines is constructed on a duplicate, or crib system, by which the supply of oil cannot be interrupted by a break in any one pipe. The oil on leaving the engines is conducted to the filtering tanks. A pumping equipment then re-delivers the oil to the elevated storage tanks. All piping carrying filtered oil is of brass, and fittings are inserted at proper pipes to facilitate cleaning. The present installation includes two oil filtering tanks at the easterly end of the power house, but the completed plant contemplates the addition of two extra filtering tanks at the westerly end of the structure. Each low-pressure cylinder is connected by a short length of 30in. pipe to an Alberger barometric condenser. These condensers are carried on a structural-steel support on the front of the engine. The circulating water enters at one side of the condenser through a 14in. pipe, and, after being divided by means of a spray plate, is brought into

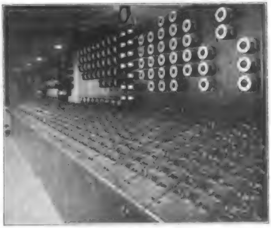

Fig. 6.—Control Switchboard.

contact with the exhaust steam in the main body of the condenser. The discharge is carried by means of a tail pipe to a hot well in the basement, from which it is led to a discharge tunnel which empties into the river. Condensing water is obtained directly from the river through a second tunnel built under the discharge tunnel.

The circulating pump for the condenser draws the water through a 24in. suction pipe and delivers it through an 18in. pipe, which branches into two 14in. pipes, each of which leads to one condenser of a unit. All the pumps, as previously stated, are located in the areaway under the piping, and are so arranged as to be capable of being controlled from the engine-room floor. All are steam driven, and are of the vertical cross-compound pumping engine type, without side-packed plungers. Their foundations are upon the basement floor level, and the steam cylinders extend above the engine-room floor; the starting valves and control of speed is, therefore, entirely under the supervision of the engineer. Each pump has a normal capacity of 10,000,000 gallons of water per day, so that the total pumping capacity of all the pumps is 120,000,000 gallons per day. While the head against which these pumps will be required to work, when assisted by the vacuum in the condenser, is much less than the total lift from low-tide water to the entrance into the condensing chambers, they are so designed as to be ready to deliver the full quantity the full height if for any reason the assistance of the vacuum should be lost or not available at times of starting up. A temporary overload can but reduce the vacuum only for a short time, and the fluctuations of the tide, or even a complete loss of vacuum cannot interfere with the constant supply of water, the governor simply admitting to the cylinders the proper amount of steam to do the work. The high-pressure steam cylinders are 16in. in diameter and the low-pressure are 20in.; the two double-acting water plungers are each 20in. in diameter, and the stroke is 30in. for all. The water ends are composition fitted for salt water, and have valve decks and plungers entirely of that material.

The dry vacuum pumps are of the vertical form, and each is located alongside of the corresponding circulating pump. The steam cylinders also project above the engine-room floor. The vacuum cylinder is immediately below the steam cylinder, and has a valve that is mechanically operated by an eccentric on the shaft. These pumps are of the close-clearance type, and, while controlled by a governor, can be changed in speed while running to any determined rate. From each atmospheric exhaust valve, which is directly connected to the condensing chamber at each low pressure cylinder, is run downward a 30in. riveted-steel exhaust pipe. At a point just under the engine-room floor the exhaust pipe is carried horizontally around the engine foundations, the two from each pair of engines uniting in a 40in. riser to the roof. This riser is between the pair of engines and back of the high-pressure cylinder, thus passing through the so-called pipe area, where it also receives exhaust steam from the pump auxiliaries. At the roof the 40in. riser is run into a 48in. standpipe. This is capped with an exhaust head, the top of which is 35ft. above the roof.

The two condensers of a unit are connected by means of a 10in. equalising pipe, and from each condenser a 5in. pipe leads to one 8in. pipe which connects to the dry-vacuum pump for the unit.

One section of the present plant is equipped with four 1,250kw. Westinghouse-Parsons turbines, which are directly-connected to generators, three of the turbines being at present in place. They run condensing at a speed of 1,200 revs. per min. and the generators, which are of the Westinghouse Company's manufacture, are equipped with six poles and furnish three-phase current at 60 ~ per second and 11,000 volts. The turbine is guaranteed to operate satisfactorily with steam superheated to 450°F. The economy guaranteed with a steam pressure of 175lb. per square inch and 27in. vacuum is as follows:—Full load of 1,250kw., 15·7lb. of steam per electrical horse-power-hour; three quarter load, 937½kw., 16·6lb. per electrical horse-power-hour; half load, 625kw., 18·3lb.; and quarter load, 312½kw., 28·2lb. When operating with a pressure in the exhaust pipe of 27in. vacuum, and with steam at the throttle superheated 75°F. above the temperature of saturated steam at that pressure, the guaranteed steam consumption is as follows:—Full load 1,250kw., 13·8lb. per electrical horse-power-hour; three-quarter load, 437½kw., 14·6lb.; half load, 625kw., 16·2lb.; and quarter load, 312½kw., 20·8lb. The output of these turbo-generator units is to be used exclusively for the purpose of lighting the subway, power-house and stations on the system. In addition to the turbine units in this section there are five exciter sets, two of them consisting of 600 H.P. compound engines, directly connected to continuous-current generators, the remaining three sets being motor-driven and having a capacity of 300kw. each. Each engine unit is supplied with its own condenser equipment, consisting of two barometic condensing chambers, each attached as closely as possible to its respective low-pressure cylinder. For each engine also is provided a vertical circulating pump along with a vacuum pump and, for the sake of flexibility, the pumps are cross-connected with those of other engines and can be used interchangeably. The condensing equipment was supplied by the Alberger Condenser Company.

The main generators are of the revolving-field flywheel type, and are mounted on the engine shaft. The weight of the revolving field is about 335,000lb., which gives a flywheel effect of about 350,000lb. at a radius of gyration of 11ft. They have a capacity of 5,000kw. each and generate three-phase current at 11,000 volts, 25 cycles per second. The fields consist of 40 poles and rotate at a speed of 75 revs. per min. They were built by the Westinghouse Company, and are 42ft. in height; the diameter of the revolving part is 32ft., its weight 332,000lb., and the aggregate weight of the machine 889,000lb. The design of the engine-dynamo unit eliminates the auxiliary flywheel, the weight and dimensions of the revolving alternating field being such with reference to the turning moment of the engine as to secure close uniformity of rotation. The hub of the revolving field is of cast steel, and the rim is carried, not by the usual spokes, but by two wedges of rolled steel. The angular velocity of the revolving field is remarkably uniform. This result is due primarily to the fact that the turning movement of the four-cylinder engine is far more uniform than is the case, for example, with an ordinary two-cylinder engine. The large flywheel capacity of the rotating element of the machine also contributes materially to secure uniformity of rotation. It is so arranged that the field magnets constitute the periphery of the revolving field, the poles and rim of the field being built up by steel plates, which are dovetailed to the driving spider. The heavy steel end plates are bolted together, the laminations breaking joints in the middle of the pole. Field coils are secured by copper wedges, which are subjected to shearing strains only. In the body of the poles, at intervals of approximately 8in., ventilating spaces are provided, these spaces registering with corresponding air ducts in the external armature. The field winding consists of copper strap on edge, one layer deep, with fibrous material cemented in place between turns, the edges of the strap being exposed. The armature is stationary and exterior to the field. It consists of a laminated ring with slots on its inner surface and supported by a massive external cast-iron frame. It comprises seven segments, the topmost segment being in the form of a small keystone. This may be removed readily, affording access to any coil field, which, in this way, may be easily removed and replaced. The armature winding consists of U-shaped copper bars in partially-closed slots. There are four bars per slot and three slots per phase per pole. The bars in any slot may be removed from the armature without removing the frame. Exciting current at 250 volts is employed, and five 250kw. machines for such work and for motor current are provided, driven by engines of 400 H.P., supplemented by a Chloride storage battery of 8,000-ampere capacity for one hour, supplied by the Electric Storage Battery Co. The entire electrical system of the plant, including the feeders to the various sub-stations, is controlled from an operating table (Fig. 6), which is located in a gallery built above the engine-room floor on the north side of the building. The 'bus-bar system, which runs almost the entire length of the building, and the circuit-breakers and switches are all placed under the switchboard gallery and away from the operating portion of the engine room. Part of the electrical equipment is at the level of the engine-room floor and a part below, between the basement and engine room. The switches are of the oil-break type, built in closed brick compartments, and are operated by motors controlled from the operating table in the switchboard gallery. The motors which drive the three exciter generators are furnished with current from step-down transformers which reduce the tension from 11,000 to 4,000 volts, at which pressure current is furnished to the motors.

The power house is provided with the following travelling cranes:—For the operating room one 60-ton electric travelling crane and one 30-ton electric travelling crane. For the area over the oil switches one 10-ton hand-operated crane. For the centre aisle of the boiler room, one 10-ton hand-operated crane. The span of both of the electric cranes is 74ft. 4in. and both cranes operate over the entire length of the structure. The 60-ton crane has two trolleys, each with a lifting capacity, for regular load, of 50 tons. Each trolley is also provided with an auxiliary hoist of 10 tons capacity. From the power house, underground cables are led through conduits to the nine sub-stations, eight of which are in New York and one in Brooklyn. The present equipment of each sub-station consists of from four to six rotary converters of 1,500kw. each. Current from the power house is stepped down from 11,000 volts by means of 550kw. transformers to 400 volts, at which pressure it is supplied to the alternating-current side of the rotaries. On the continuous-current side the current is fed to the line leading to the third rail at a pressure of 625 volts. In addition to the rotaries, there is in each sub-station an exciter set, consisting of a 100 H.P. or 150 H.P. motor directly connected to a continuous-current generator which furnishes exciting current. The motors of these sets also take their current from the transformers at a tension of 400 volts. Each sub-station is also provided with a 45 H.P. motor-generator set, the generator of which furnishes single-phase current for operating the signal and switching system. The ultimate capacity of this plant will be more than 180,000 H.P., thus making it the largest power plant of its kind in the world.

(To be continued.)

THE LEAD VOLTAMETER.*

BY ANSON G. BETTS AND DR. EDWARD F. KERN.

The voltameters which are employed for measuring the amount of electricity passing through an electric circuit are the silver voltameter, the copper voltameter and the oxy-hydrogen or detonating gas voltameter. These are named in the order of their scientific importance. "The uniform results obtained in the electrolysis of a concentrated neutral solution of silver nitrate have lead to the adoption of the silver voltameter as the standard instrument for measuring electric currents" (Carhart's "University Physics," p. 260). "It is not employed for currents much larger than 1 ampere, because of the high cost of the material used for constructing the apparatus." For larger currents the copper voltameter is employed.

The results obtained by the use of the copper voltameter are not so uniform as those obtained by the silver voltameter, because the electrochemical equivalent of copper is so small, and also because the weight of copper deposited is a function of the temperature and of the current density at the cathode. But for ordinary current measurements, the copper voltameter is employed, as it has been found that with current densities of 1·5 to 14 amperes per square foot of cathode exposure, the results are fairly accurate, enough so for ordinary experimental purposes, and, besides, it is an inexpensive apparatus.

"The high equivalent weight of silver and the fact that a very considerable quantity of metal is precipitated by comparatively feeble electric currents reduces the error of weighing the deposit to a minimum. The disadvantage which must be recognised in using the silver voltameter is that the silver is greatly inclined to separate as crystals, which are loosely attached to the cathode; consequently, strong currents cannot be sent through the apparatus for any length of time without the possibility of some of the deposited silver becoming detached. The electrolyte recommended is a moderately concentrated neutral solution of silver nitrate, about 15 to 20 grammes of pure silver nitrate in 100 cubic cm. solution. The anode is a bar of pure silver, wrapped with muslin or filter paper, and the cathode is either a sheet of silver or a platinum dish" (Oettel's "Electrochemical Experiments," p. 38). Prof. Barker wrote that "it is evident that the results obtained by using a voltameter for measuring electric currents will be the more accurate in proportion as the electro-chemical equivalent of the ion employed is higher." In most precise voltametric work, therefore, the silver voltameter is preferred, since the chemical equivalent weight of silver is 107·93. As a precaution he recommends that "the strength of current which is allowed to pass through the apparatus should not exceed 5 milliamperes per square centimetre cathode surface" (about 5 amperes per square foot) (Barker's "Physics," p. 745). In practice, however, a current density of 9 amperes per square foot cathode exposure is employed by the Westinghouse Electric Co. for calibrating electrical measuring instruments.

Modifications of the silver voltameter have been described by Farup (*Zeitschrift für Electrochemie*, August 14, 1902) and by T. W. Richards, who found that with the ordinary type of silver voltameter the results obtained were not quite satisfactory. Richards pointed out that the main trouble arises from the formation of complex ions at the anode, and which, when transported to the cathode, deposits too much silver. This he prevented by using a fine-grained porous cup for the anode compartment. In the *Physical Review* of June, 1904, K. E. Guthe describes a series of experiments which he made in order to compare the different forms of silver voltameters. He found that "the usual form of silver voltameter is not a very reliable instrument for measuring quantities of electricity, but that the Richards porous cup voltameter is the most satisfactory form for the purpose" (*Electrochemical Industry*, Vol. II., p. 288).

Judging from the results obtained by these able experimenters and by several others, the inaccuracies resulting from using the silver voltameter are very small, and for general purposes need not be considered. "The variation of the electrochemical equivalent of silver is from 0·011156, obtained by Mascart, to 0·011195, obtained by Pellat and Leduc. G. Van Dijk and J. Kunst found the mean value of 24 experiments to be 0·0111818, which the authors believe to be accurate to within one part in 10,000" (*Electrochemical Industry*, Vol. II., p. 117).

It is not the intention of the authors of this Paper to try to replace the silver voltameter by the lead voltameter, but to describe the lead voltameter and show wherein it possesses features which might be a means of its replacing the copper voltameter for technical purposes, such as calibrating electrical instruments and for comparison of electro-efficiency of electrochemical methods.

A glance at a table of electro-equivalent weights of the metals will show that the metals which are deposited as solid metal on the cathode, and which possess high electro-equivalent weights, are silver (107·93), lead (103·46) and mercury (100·00). The first two metals, on account of forming hard solid cathode deposits, are well suited for voltameters.

THE LEAD VOLTAMETER.

We are not aware that lead has ever been employed as a voltameter for measuring electric currents by anyone except ourselves. Previous to the invention of the Betts process of refining lead alloys, the crystalline non-adherent deposit which forms on the cathode in the ordinary solutions was not suited for voltametric measurements. One of the claims of the Betts' patent is the formation of a smooth, dense, coherent, solid deposit of lead on the cathode in an acid solution of lead fluosilicate, which contains an organic reducing agent, such as gelatine, glue or pyrogallol, &c. This solution has been used constantly for over two years in the refinery at Trail, British Columbia. It is an inexpensive solution, easily prepared and easily maintained. It conducts the current well, is non-volatile and is stable under electrolysis, which properties make it a suitable electrolyte for a voltameter. It also possesses the property that under ordinary conditions, when a soluble anode is used, no lead peroxide is formed, because the electrical potential required is so low, being in the proximity of 0·18 volt for concentrated solutions and about 0·40 volt for very dilute solutions, when using a current density of 10 to 15 amperes per square foot.

Several months ago the lead voltameter was compared by one of us with the copper voltameter, and the results were such that the lead voltameter has since been employed in our laboratory for measuring current efficiencies of electrochemical experiments.

The results given in this Paper are those obtained by comparing the lead voltameter with the silver voltameter.

Experimental Part.—The lead electrolyte was prepared by treating ordinary white quartz with commercial hydrofluoric acid (50 per cent. acid) forming a solution of hydro-fluo-silicic acid (H_2SiF_6). Heating the solution of hydrofluoric acid caused more rapid solution of the quartz. White lead (basic lead carbonate) was added to the solution in the required quantity. It dissolved rapidly and completely with effervescence, and any hydrofluoric acid which did not react with the silica formed an insoluble precipitate of lead fluoride which was filtered off. Lead fluosilicate is a very soluble salt. It dissolves in about 28 per cent. of its weight of water at 20° C. The crystalline salt has the composition ($PbSiF_6 \cdot 4H_2O$).

The solution was diluted so as to contain 17 grammes of $PbSiF_6$ and 7 grammes of free H_2SiF_6 in 100 cubic cm. solution. After adding 1 gramme of gelatine dissolved in hot water to 2,000 cubic cm. of solution, the electrolyte was rendered absolutely pure, in respect to metals which can deposit with lead, by electrolysing for several days, using electrodes of refined lead. The anodes were wrapped with two thicknesses of clean linen, so as to prevent the impurities from dropping off and floating in the electrolyte. The small amount of soluble impurities in the electrolyte was due principally to the impurities in the white lead used for making the solution. The electrolysis was continued for four days at temperatures between 17° C. and 57° C., using a current density at the electrodes of 10 to 12 amperes per square foot. A small amount of "anode sludge" remained behind, and in order to prevent it from being oxidised by the atmosphere and subsequently going into solution, melted vaseline was poured on the surface of the electrolyte. The deposit which formed on the cathode was smooth, dense and non-crystalline.

After purifying the electrolyte, about 800 grammes of absolutely pure lead was made by electrolysis, using ordinary refined lead, wrapped with clean linen, for the anodes. The refined lead which was deposited on the cathode was further refined by reversing the current and re-depositing it on new cathodes. The solution was protected from the atmosphere by a covering of melted vaseline. The purified lead was melted, cast into a thin plate and then rolled into sheets about ⅛in. to 1/16in. thick. The sheets were cut into strips of suitable size and used as anodes for the lead voltameter. No residue was left on dissolving the purified anodes by electrolysis.

The silver voltameter, which was used as the standard for comparison, was a glass beaker containing 500 cubic cm. of a 15 per cent. concentrated neutral solution of silver nitrate. The anodes were four rods of re-purified silver, ⅝in. wide by 1/16in. thick, and an average length of 4in., giving a total active surface exposure of 12 sq. in. (one side and two edges). The anodes were loosely wrapped with three thicknesses of clean linen, serving the double purpose of a porous compartment and to prevent any particles of silver from dropping off. The cathode was a sheet of platinum, having an exposure of 3in. by 3½in., or a total exposure, both sides, equal to 21 sq. in. The electrolyte at start and at finish of the experiments was neutral to fresh litmus paper.

The lead electrolyte used for the first series of experiments contained 13½ per cent. of lead fluosilicate ($PbSiF_6$) and 6½ per cent. of free hydro-fluo-silicic acid (H_2SiF_6). It was prepared by diluting the purified electrolyte and then precipitating the excess of lead by pure sulphuric acid. The anodes were strips of the purified lead. Two glass beakers, each containing 500 cubic cm. of the electrolyte, served as voltameters. (The action of the electrolyte on glass is

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* Paper read before Section C of the International Electrical Congress of St. Louis. Slightly abridged.

Table I.—*Lead Electrolyte contained 13·5 per cent.* $PbSiF_6$ *and 6·5 per cent. free* H_2SiF_6.

A. Experiment No.	B. Duration of experiment (hours).	C. Grammes of silver deposited.	D. Grammes of lead deposited.	E. Grammes of lead dissolved.	F. E.M.F. of silver cell (volts.)	G. E.M.F. of lead cells (volts).	H. C.D. per sq. ft. of lead cathode	I. C.D. per sq. ft. of lead anode.	J. Calculated amps. from silver deposits.	K. Calculated amps. from lead deposits.	L. Percentage error of lead voltameters.	M. Calculated electro-equivalent weight of lead.	Remarks on the lead voltameters.
1	1½	5·8958	A5·6221	5·6910	0·36	0·36	16·0	16·0	0·9765	0·9715	−0·512	102·90	One anode and copper cathode.
2	..	..	B5·6396	5·7002	..	0·14	8·0	9·0	..	0·9745	−0·205	103·24	Two anodes and lead cathode.*
3	1½	5·7663	A5·5246	5·5970	0·36	0·14	7·5	8·6	0·9583	0·9547	−0·375	103·04	Two anodes and copper cathode.
4	..	..	B5·5450	5·5840	..	0·36	15·0	15·0	..	0·9582	−0·010	103·43	One anode and lead cathode.*
5	2	7·8408	A7·5108	7·5758	0·36	0·36	16·0	16·0	0·9740	0·9734	−0·062	103·39	One anode and lead cathode.
6	..	..	B7·5168	7·5871	..	0·15	8·5	9·0	..	0·9741	+0·010	103·47	Two anodes and lead cathode.*
7	2	7·6253	A7·3191	7·3693	0·37	0·37	15·0	15·0	0·9472	0·9485	+0·137	103·59	One anode and lead cathode.
8	..	..	B7·3221	7·3855	..	0·15	7·5	8·5	..	0·9489	+0·168	103·62	Two anodes and lead cathode.*
9	1½	6·2287	A5·9600	6·0404	0·46	0·16	8·0	9·0	1·0316	1·0299	0·165	103·27	Two anodes and copper cathode.
10	..	..	B5·9605	6·0561	..	0·15	8·0	9·0	..	1·0300	- 0·155	103·28	Two anodes and lead cathode.*
11	4	16·6804	A15·9996	16·0720	0·47	0·14	8·0	9·0	1·0360	1·0368	+0·077	103·52	Two anodes and copper cathode.
12	..	..	B16·0011	16·0816	..	0·14	8·0	9·0	..	1·0369	+0·087	103·54	Two anodes and lead cathode.*
13	1½	6·8652	A6·5815	6·6421	0·48	0·27	27·0	10·0	1·1370	1·1373	+0·027	103·47	Two anodes and lead cathode.
14	..	..	B6·5812	6·6429	..	0·27	27·0	10·0	..	1·1372	+0·018	103·46	Two anodes and lead cathode†
15	1½	9·3253	A8·9390	9·0217	0·64	0·37	37·0	14·0	1·5444	1·5447	+0·019	103·46	Two anodes and lead cathode.
16	..	..	B8·9419	9·0114	..	0·36	37·0	14·0	..	1·5451	+0·045	103·49	Two anodes and lead cathode ‡
17	2	6·8566	6·5695	6·6445	0·42	0·14	10·0	8·0	0·8518	0·8514	0·047	103·41	Two anodes and platinum cathode.*
18	2	6·8754	6·5877	6·7097	0·43	0·14	10·0	8·0	0·8541	0·8538	−0·035	103·41	Two anodes and platinum cathode.*

Table II.—*Lead Electrolyte contained 8·5 per cent.* $PbSiF_4$ *and 2·5 per cent. free* H_2SiF_4.

A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.	Remarks.
19	2	9·0470	A8·6678	8·7618	0·45	0·32	9·0	10·0	1·1238	1·1233	−0·044	103·41	Two anodes and copper cathode.
20	..	..	B8·6663	8·7326	..	0·31	9·0	10·0	..	1·1232	−0·053	103·39	Two anodes and lead cathode.*
21	3	13·4113	A12·8607	12·9875	0·50	0·28	9·0	10·0	1·1107	1·1112	+0·014	103·49	Two anodes and copper cathode.
22	..	..	B12·8558	12·9543	..	0·27	9·0	10·0	..	1·1107	0·000	103·46	Two anodes and lead cathode.*
23	2	7·2780	A6·9716	7·0313	0·40	0·42	22·0	8·0	0·9041	0·9035	−0·066	103·39	Two anodes and lead cathode.
24	..	..	B6·9755	7·0272	..	0·41	22·0	8·0	..	0·9041	0·000	103·44	Two anodes and lead cathode.§
25	3	7·2738	A6·9695	7·0353	0·30	0·38	14·5	5·4	0·6024	0·6022	−0·033	103·41	Two anodes and lead cathode.
26	..	..	B6·9698	7·0468	..	0·38	14·5	5·4	..	0·6022	0·033	103·42	Two anodes and lead cathode.*
27	2	6·5278	6·2550	6·3494	0·41	0·24	10·0	8·0	0·8109	0·8107	−0·024	103·42	Two anodes and platinum cathode.*
28	2	6·4861	6·2168	6·2939	0·42	0·24	10·0	8·0	0·8058	0·8057	−0·012	103·44	Two anodes and platinum cathode.*

* Smooth, dense deposit. † Smooth, dense deposits, except on lower corners. ‡ Deposit formed very rough and warty on the edges. § Deposit was rough on edges.

small and the solution in a short time loses its originally small solvent action on glass. It may be kept in glass bottles.) The two lead voltameters were connected in series with the silver voltameter, and for convenience of approximately determining the current, an ammeter was also placed in the circuit.

The electrochemical equivalents of silver and lead which were used are those given by Carl Hering in the *Electrochemical Industry*, Vol. I., p. 170: Silver = 0·001118 grammes per coulomb, and lead = 0·0010717 grammes per coulomb. Compared with the atomic weight of oxygen = 16·00, the atomic weight of silver = 107·93, and that of lead = 206·92, which gives the electro-equivalent weight of lead = 103·46. These values give 4·025 grammes of silver and 3·858 grammes of lead per ampere-hour. The value for silver is that which was adopted by the International Electrical Congress of Chicago, 1893.

All the electrodes, except the silver anodes, were attached to a strip of hard wood by means of binding posts. This arrangement allowed of all the electrodes being placed in their respective electrolytes at the same instant, and also being removed and instantly submerged into beakers of distilled water (free from chlorides) which were placed directly back of the voltmeters. The cathodes were at once detached from the strip, rinsed with distilled water, then with alcohol, allowed to drain, and then carefully dried over a low Bunsen flame. They were placed in a desiccator over sulphuric acid, and as soon as cooled were weighed. The lead anodes were washed, dried and weighed in the same manner.

Voltameter A in experiments Nos. 1, 3 and 4 and voltameter B in experiment No. 2 contained one anode and one cathode, one side of each exposed to electrolytic action. The size of each electrode was 2¼in. by 4¼in.; the surface exposed to electrolytic action was 9 sq. in. The distance between electrodes was 1in.

In all the other experiments, two anodes and one cathode were used. The size of the anodes was 2¼in. by 4¼in.; the surface exposed to electrolytic action was 16 sq. in. The distance between electrodes was 1in.

The cathodes used in voltameter B in experiments Nos. 1 and 2, and both voltameters in experiments Nos. 3 and 4, were strips of lead, size 2½in. by 4½in. They were suspended in the electrolyte so that the active surface exposure on one side was 2½in. by 3½in., or 8¾ sq. in. At the surface of the solution, where the lead was exposed to atmospheric action, it was slightly etched. In the other experiments, Nos. 5 to 8 and Nos. 11 to 14, the cathodes were exactly 3½in. long, and were suspended ¼in. below the surface of the electrolyte by a thin strip of metal about ¼in. wide. This arrangement prevented the cathodes from being etched at the surface of the electrolyte, where oxidising action of the atmosphere takes place.

A thin sheet of copper, size 2½in. by 3½in., was used as cathode in the lead voltameter A in experiments Nos. 1, 2, 5, 6, 11 and 12. It was suspended below the surface of the electrolyte by a thin strip of sheet copper ¼in. wide. It was found that there is no action of the electrolyte on the copper so long as it is the cathode and a current is passing. The deposit of lead which formed on it was just as smooth and as dense as that which formed on a strip of lead. This indicates that the copper was not dissolved, which might be expected, as copper stands so much lower than lead in E.M.F. series. Copper, however, is dissolved by an acid solution of lead fluosilicate when the solution containing a piece of metallic copper is allowed to stand exposed to the atmosphere. The only advantage which the copper cathode possessed is that a much thinner strip of metal was used, thereby decreasing the weight, which, when using a delicate balance, was an advantage.

In all the experiments, except voltameter A, experiments Nos. 1, 2, 3 and 4, two anodes and one cathode were used. This arrangement was found to be the most satisfactory.

The cathodes used for experiments Nos. 7, 8, 13 and 14 were strips of thin sheet lead, size 1in. by 3in., giving a surface exposure (both sides) of 6 sq. in., or a current density of 15 to 37 amperes per square foot. They were suspended below the surface of the electrolyte by a thin strip of lead ½in. wide. The anodes for these experiments were strips of the purified lead, size 2¼in. by 3½in., giving a surface exposure of 16 sq. in.

In experiment No. 8, when a current density of 37 amperes per square foot of cathode exposure was run, the deposit was dense and smooth, except on the edges, where it precipitated as small warty formation. These lumps, however, were sufficiently coherent so as not to be detached during washing, drying and weighing the cathode.

When a current of 30 amperes per square foot of cathode exposure is passed through the stronger electrolyte, a smooth, dense non-crystalline deposit formed. A current density of 27 amperes per square foot was used in experiment No. 7, and the deposit was perfectly smooth and dense; only at the two lower corners was there any inclination to roughness.

An electrolyte containing 8½ per cent. of lead fluosilicate and 2½ per cent. of free hydro-fluo-silicic acid (6 per cent. SiF_4 and 5 per cent. lead) was used for experiments Nos. 11, 12, 13, 14, 15 and 16. In all these experiments, except No. 13, the deposit on the cathode was smooth, dense and non-crystalline. In experiment No. 13, when a current density of 22 amperes per square foot of cathode exposure was used, the deposit was smooth and dense, except on the edges, where it had a rough warty formation. This shows that the more dilute the electrolyte, the less is the upper limit of current density.

Platinum cylinders, 2in. high and 6in. circumference, were used as cathodes in the silver voltameter, and in the lead voltameter in experiments Nos. 9, 10, 15 and 16. The cylinders were flattened, forming a cathode measuring 8in. by 2in., or a surface exposure of 12 sq. in. The current used in both the silver and the lead voltameter for these experiments was about 10 amperes per square foot.

All the deposits of lead formed in all the experiments, except Nos. 8 and 13, were smooth, dense, coherent and non-crystalline. The deposits were not dissolved from the cathodes, but were formed one on top of the other.

It might be mentioned that the reason for being so particular about purifying the electrolyte previous to the experiments, and for using such pure lead for the anodes, was so as to be certain that any variation in the results would not be due to the impurities. Ordinarily, such care need not be exercised in securing such pure lead for the anodes. A good quality of refined lead is sufficiently pure for general purposes.

Conclusions.—The better form of voltameter is one with two anodes and one cathode. Suspend the cathode between the two anodes and below the surface of the electrolyte by means of a thin narrow strip of metal or wire, so as to prevent the action of the atmosphere on the lead at the surface of the electrolyte. This action may also be retarded by using an electrolyte which is less acid than that used in the experiments. Even with an almost neutral solution of lead fluosilicate its conductivity would be sufficiently high for a voltameter.

The deposit which forms, even with high current-densities (20 to 25 amperes per square foot of cathode exposure in a fairly strong electrolyte), is perfectly smooth, dense and non-crystalline so long as the electrolyte contains about one part gelatine by weight in 2,000 to 4,000 parts of solution. With age and by use the gelatine slowly loses its reducing property. The appearance of the deposit indicates when more gelatine is needed, so that as long as the deposit forms smooth and non-crystalline none need be added. The gelatine is added by dissolving a small quantity in hot water and adding it directly to the electrolyte. The moment it is added the crystallisation of the lead is prevented.

A glance at the tables shows that the current-density used within fairly great limits in the lead voltameter does not affect the results. In experiment No. 8 a current-density of 37 amperes per square foot was employed, and the results obtained agreed as closely with the silver voltameter as when lower-current densities were used. The limit of the current-density seems to be controlled by the strength of the electrolyte and by its circulation. The more dilute the solution the less is the limit of current-density which can be used. This is shown by the deposits which formed in experiments Nos. 7, 8, 13 and 14.

The lead voltameter is well adopted for obtaining electrochemical efficiencies of experiments which require long duration.

Of great importance is the fact that while an acid copper sulphate solution in contact with copper electrodes contains varying quantities of cupreous sulphate, lead exists in the solutions only as divalent ion. On this circumstance is founded our belief that the lead voltameter, properly used, will be found of extreme accuracy.

One advantage of lead over silver is its cheapness, so that with a small outlay a lead voltameter of any size may be constructed.

From an electrochemical point of view the lead voltameter also has an advantage over the silver voltameter in that lead stands very high in the E.M.F. series, so that the impurities which are ordinarily contained in refined lead will remain as "sludge" on the anode, whereas the purest silver is required for the construction of a silver voltameter.

The table shows that the lead voltameter compares very favourably with the silver voltameter, as the results are within sufficient limit of accuracy for most voltametric work. In the majority of the measurements the electro-equivalent weights of the lead are almost theoretical. According to the most recent tables, the atomic weight of lead is 206·92, which makes the electro-equivalent weight of lead equal to 103·46. These values in the table were obtained by the simple proportion: (Weight of deposited silver): (Weight of deposited lead) = 107·93 : x.

The difference in the amounts of lead dissolved from the anodes and deposited at the cathodes show that oxidation of lead took place to a serious extent, particularly when the solution had not had lead electrodes recently immersed in it.

For accurate work we recommend passing a current of pure carbon dioxide through the oxygen-free electrolyte in a covered receptacle. We do not think any further precautions will be necessary in washing and drying than we have used. It will be desirable to use fresh polished cathodes of lead or copper each time rather than re-deposit metal on cathodes which have already been used. Should any oxidation of lead during drying take place with the formation of lead oxide, for example, the error caused by dipping such oxidised metal into the acid solution would be increased to 13 times (or the atomic weight of lead 207 divided by that of oxygen 16), the error caused by the simple oxidation.

This Paper is far from complete. More work needs to be done in order to develop the possibilities of the lead voltameter, and to find out whether or not it is an accurate instrument.

USE OF ELECTRICITY IN FACTORIES AND WORKSHOPS.

The Home Office has sent out the following circular and draft regulations:—

SIR: I am directed by the Secretary of State to transmit to you the enclosed draft of Regulations which he proposes to make, in pursuance of sec. 79 of the Factory and Workshop Act, 1901, for the *use of electricity in factories and other places under that act.* For some years past certain requirements, directed to securing the safety of the public, have been imposed by the Board of Trade in all instances where undertakers have sought powers to supply customers with electricity at pressures exceeding 250 volts, and such supplies are now given to some thousands of factories under those conditions. Instances, however, have been brought to the notice of the Secretary of State in which failure to observe the conditions laid down by the Board has resulted in serious, and sometimes fatal, accidents to persons employed in places under the Factory Act, and he has considered it to be desirable to give to certain of the requirements of the Board the force of regulations under sec. 79 of the Factory Act, as a provisional measure pending the issue of a more complete code. The effect will be to make the occupier or consumer responsible for their observance.

The present draft regulations are based upon the requirements of the Board, without any addition except by way of relaxation. They will apply, however, not only to works now subject to those requirements, but also to the use of electricity generated on the premises or taken from an outside source not under Board of Trade control. The dangers in both cases are the same. The intended regulations are provisional only, and cover only part of the ground which will eventually have to be dealt with. They do not contain all the precautions which the Secretary of State is advised may be necessary, *nor do they apply at all to the generation or transformation of electricity.*

In accordance with the requirements of the Factory Act, the regulations are now published in draft, and are subject to further consideration. Any objections of substance, made by employers, workpeople or other persons affected, will be carefully considered by the Secretary of State, and will, if necessary, be the subject of full enquiry made by a competent person appointed by him. In that event, the owners, occupiers, employers, workpeople and all others concerned will be entitled to a full hearing at the enquiry, and the report of the person holding it will be considered by the Secretary of State before the regulations are made.

If, therefore, any person desires the Regulations to be further considered, he should lodge objection in accordance with sec. 80 of the Factory Act, and in pursuance of that section the Secretary of State gives the following notice:—

That he proposes to make regulations dealing with the use of electricity in factories and other places to which the Factory Act applies, in accordance with the enclosed draft, copies of which may be obtained on application to the Factory Department, Home Office, London, or at the local offices of the Inspectors of Factories; and that any objections with respect to the draft regulations by or on behalf of any person affected thereby must be sent to the Secretary of State within 40 days from this date. Every such objection must be in writing, and must state (*a*) the draft regulations, or portions of draft regulations, objected to; (*b*) the specific grounds of objection; and (*c*) the omissions, additions or modifications asked for.

(Signed) M. D. CHALMERS.

DRAFT REGULATIONS FOR THE USE OF ELECTRICITY IN FACTORIES AND OTHER PLACES UNDER THE FACTORY AND WORKSHOP ACT, 1901.

Whereas the generation, transformation, and use of electricity in electrical stations and in any factory, workshop, dock, wharf, quay, warehouse or other place to which sec. 79 of the Factory and Workshop Act, 1901, is applied by that act has been certified in pursuance of the said sec. 79 to be dangerous:—

I hereby in pursuance of the powers conferred upon me by that act make the following regulations, and direct that they shall apply to all places named above, other than electrical stations, in respect of the distribution and use of electricity where the normal working pressure is greater than 250 volts and less than 650 volts between any two conductors:

1. All wires in connection with the supply shall, where practicable, be completely enclosed in strong metal casing, and where this is not practicable they shall be so arranged that there shall be no danger of any shock or of fire.

2. All main and branch circuits shall be protected by switches and by fuses or other automatic cut-outs.

3. The supply to every motor or arc lamp shall be controlled by means of an efficient switch, so placed as to be easily handled by the person in charge of the motor or arc lighting, and connected so that by its means all pressure can be cut off from the motor or arc lamp and from any regulating switch resistance or other device in connection therewith: provided, however, that where the arc lamps are connected in series across the outer conductors of a three-wire system, and the pressure cannot exceed 250 volts from earth, it shall be sufficient if one such switch be provided for each series of arc lamps.

4. All switches and cut-outs shall be so enclosed and protected or be in such positions or of such construction that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

5. All metal holders for incandescent lamps, the frames of all motors, and the metal casings of all wires, switches, fuses and cut-outs, shall be efficiently connected with earth.

6. Where the electricity is derived from a public supply the following conditions shall be observed:—

(*a*) A suitable safety fuse or other automatic cut-out shall be inserted in each service line, as close as possible to the point of entry into the premises, and contained within a suitable locked or sealed receptacle of fire-proof construction, except in cases where the service line is protected by fuses in a street box, but no fuse or cut-out shall be inserted in the intermediate conductor of a three-wire system.

(*b*) All service lines and apparatus shall be highly insulated and thoroughly protected against injury to the insulation and against access of moisture, and any metal forming part of the electric circuit shall not, unless efficiently connected with earth, be exposed so that it can be touched. All electric conductors shall be so fixed and protected as to be free from risk of electrical discharge to any adjacent metallic substance.

Provided that in regard to service lines and apparatus under the sole control of a person other than the occupier of the premises to which the supply is given it shall be a sufficient compliance with regulation 6 on the part of such occupier if he obtains from such person in the month of January in each year a certificate that the regulation is fully observed in regard to the said service lines and apparatus. Such certificate shall be produced at any time when required by H.M. Inspectors of Factories.

These regulations shall come into force on the 1st day of January, 1906.

Home Office, Whitehall, 1904.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Wireless Telegraphy.—J. Zenneck discusses recent theoretical work in wireless telegraphy with a view to the practical application of its results. The difficulty of obtaining an agreement between the theoretical and actual frequencies of a transmitter lies in the unavoidable presence of wire ropes near the antenna, a difficulty which is increased tenfold on board men-of-war. But though it may be impracticable to calculate the frequency, the resonance method devised by Bjerknes enables us to measure it with ease and rapidity. As regards the merits of multiple antennæ, the author remarks that a multiple antenna has the same effect upon the wave-length as a single antenna of increased thickness, but without as much increase of weight. For equal lengths, the capacity of a multiple antenna is greater than that of a single antenna. Besides, the ratio of energy radiated to energy supplied is greater, so that multiple antennæ have a greater efficiency. The primary circuit of the Tesla transformer should have a high capacity and low inductance. It is best to let the primary circuit consist of a single turn of wire or several turns in parallel. The author differs from Drude as to the degree of coupling giving a maximum amplitude. Drude puts it at 0·6, but the author has obtained a maximum at 0·18, being a much looser connection. As regards the primary spark potential, the author shows that the maximum amplitude in the secondary system rapidly increases with the primary E.M.F. up to a sparking distance of about 4cm. In cases where the damping factor is to be determined, the method of Bjerknes has been found to work well. It is advisable to vary, not the inductance, but the capacity of the resonating circuit, and to measure the current by means of a bolometer affected by induction. The method yields the damping of the primary and secondary systems and the frequency of one system, when the frequency of the other is known, with sufficient accuracy.

[J. ZENNECK, *Physikalische Zeitschrift*, October 1, 1904.]

Radio-activity and Life.—J. J. Taudin Chabot makes some striking speculations on certain analogies shown by the phenomena of radio-activity with ebullition on the one hand and with the decompositions accompanying, say, the life of albumen, on the other. The atoms of radio-active substances are in a state of unstable equilibrium. Some of them, every now and then, pass abruptly into the next state. The passage amounts to an explosion although it differs from ordinary explosions in not necessarily tending to the simultaneous explosion of all the other atoms around. A somewhat similar phenomenon is presented by a boiling liquid, where certain portions of the gasified liquid suddenly burst out from the interior, producing vortices in the liquid and taking portions away with them in the form of spray. The vortices would correspond to the γ-rays, the gas and the spray to the β-rays and α-rays respectively. Some striking analogies to the behaviour of the emanations and the rare gases such as argon and helium are offered by nitrogen, which is a constituent of nearly every explosive substance. Among the compounds of nitrogen, cyanogen, CN, deserves special consideration on account of its importance in the decomposition of albumen. All the nitrogenous compounds resulting from the decomposition of albumen contain cyanogen. This has a high internal energy, and is therefore extremely unstable. Pflüger believes it to be a constituent of all living matter, and calls cyanic acid a "semi-living" molecule. The presence of oxygen increases the instability of the cyanogen compounds, so that, as in the case of the emanations, the least impulse suffices to make the living molecule "explode" and produce carbonic acid, as radium produces helium. The transformation of albumen under the influence of oxygen takes place according to an exponential law, as does the decay of radio-activity. Like the radio-active substances, albumen has a limited and predetermined life. The phenomena of life would thus become in principle identical with those of radio-activity, and an equally necessary result of known causes, but of a much wider scope in nature.

[J. J. TAUDIN CHABOT, *Physikalische Zeitschrift*, October 1, 1904.]

N-rays.—E. Salvioni gives an account of a laborious series of experiments made for the purpose of testing Blondlot's N-ray observations. As a general result, he is of opinion that there is some objective reality of the phenomena mixed up with a number of subjective elements. He is driven to this conclusion by the extreme clearness with which he observed a few of the appearances, such as the effect upon a line of calcium sulphide, and the maxima and minima from which Blondlot deduced the wave-length of the rays. On the other hand, he has failed in obtaining positive results by any of Blondlot's "objective methods," and has found that physiological and psychological elements have a considerable influence. Both he and his assistants worked themselves into a state in which a bewildering variety of luminosities appeared to them, but found that a few months' rest left them in a state less fit than ever to obtain positive results. The author points out that the phenomena, especially on the medical side, show a suspicious resemblance to "animal magnetism," though such resemblance should, of course, not prejudice truly impartial investigators.

[E. SALVIONI, *Nuovo Cimento*, August, 1904.]

Radio-active Gas from Crude Petroleum.—E. F. Burton has obtained a highly radio-active gas from petroleum obtained from a well in Petrolia, Ontario, where it occurs in the carboniferous limestone, although it probably has its origin in the underlying Trenton formation. Air was passed through the heated oil, and then in succession through concentrated sulphuric acid, a flask surrounded by ice, phosphoric pentoxide and glass wool. It was finally pumped into a cylindrical vessel of galvanised iron, containing an exploring rod connected to an electrometer. The cylinder was maintained at a potential of 168 volts by a battery of small storage cells, and the conductivity of the gas which it contained was determined by measuring the saturation current to the exploring electrode. On first introducing into the cylinder the air which had passed through the oil, the conductivity jumped up from 16·5 to 92 scale divisions per minute. Its conductivity steadily increased, after the cylinder was closed, for about three hours, when it reached a maximum value, after which it slowly decreased approximately in a geometrical progression with the time. This would mean, according to Rutherford's theory, that the air is charged with emanation, and its conductivity increases to a maximum, which is reached when the loss in the ionising power due to the decay of the emanation is just equalled by the gain contributed by the excited radio-activity produced in this process of decay. From this time the rate of change indicated gives the rate of decay of the emanation. The author finds that the radio-active gas decays approximately according to an exponential law, falling to half value in 3·125 days. It produces an induced radio-activity whose rate of decay is such that it falls to half value in about 35 minutes, that being the same value as that obtained in the case of Cambridge tap-water. The author concludes that the active gas obtained from crude petroleum is very probably identical with radium emanation, but admits that there are indications of the existence of a radio-active substance more persistent than radium emanation.

[E. F. BURTON, *Philosophical Magazine*, October, 1904.]

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UNDERGROUND ELECTRIC RAILWAYS.

The subject of underground electric railways just now occupies a very prominent position, both in this country and in the United States. Possibly within three months, and certainly within six, a service of electrically-propelled trains will be commenced on the much-abused Metropolitan District Railway, and in as many weeks a similar service will be running on the New Rapid Transit subway of New York City. The two articles which we publish this week permit a rough comparison of these two examples of engineering skill. The generating station which supplies the New York Rapid Transit subway is being equipped with reciprocating engines, while at Lot's-road turbo-generators are being erected. On the other hand, both works generate current at 11,000 volts three-phase, and the switch gear in the two stations possesses many points of similarity. The permanent way in both cases is not situated a great distance below the surface, like our "tubes," but while the New York line runs in a shallow subway, most of the constructional work of which is of steel, the London "underground" is chiefly in brick tunnels at a slightly greater depth.

When the New York scheme was first proposed there was considerable discussion as to the form which the railway should ultimately take, the plans for tube and subway construction being considered at great length. However, the latter was eventually chosen, chiefly because it was thought that it would tend towards greater expedition in travelling. Lifts were held to be a great obstacle, and there is much truth in the contention that they cause considerable loss of time. Moreover, the carrying capacity of the line is more or less limited by the carrying capacity of the lifts, and as New York is a city that is growing at a very rapid rate it was thought to be a difficult matter to provide the necessary lift capacity. In the deeper stations moving stairways, or "escalators," have been installed. That New York City is not built upon "London clay" may also have been a reason for the non-adoption of the Greathead tube system. On the line itself four tracks have been laid, the two in the centre being for express trains and those on the outside for slow trains. In a future issue we hope to publish more details of this railway, especially with regard to the permanent way and sub-stations. Concerning the London scheme, there is not the slightest doubt that the change will be welcomed by the thousands whose unpleasant duty it now is to spend a certain proportion of each day in an atmosphere that defies description. In the words of Mr. Yerkes, who presided at the company's second ordinary general meeting held on Tuesday, "it would shortly become a pleasure to ride in the Metropolitan District Railway carriages instead of a pain, as it was at the present time." There is thus a certain amount of consolation for passengers in the knowledge that the company sympathises with them, and is really doing something to improve matters.

Now, although this conversion from steam to electric traction promises a revolution in travelling conditions, and although it will probably be an excellent thing for the shareholders, there must be a feeling of regret that the scheme has not been carried out by Englishmen with English capital. American engineers have been responsible for the design of the station and the installation of the plant; a considerable portion of this plant is American, and the whole affair has been financed through American channels. Naturally, the public will not trouble itself about these matters so long as it gets increased travelling facilities, but the matter is hardly so satisfactory from the engineering point of view, especially when it is remembered that the pioneer electric underground railway, the City and South London, was entirely a product of British engineers and manufacturers. The single station at Lot's-road will supply no fewer than four London underground railways, three of which are constructed on the deep-level tube principle, and one surface line from Hampstead to Edgware. This will ensure a splendid load-factor, and since all the lines will be controlled by the same company ideal working conditions should be ensured. Thus it will be possible to effect additional economies over and above those which ordinarily attend the change from steam to electricity.

At the meeting referred to above, a shareholder asked whether any comparison could be made between the Mersey Railway and the "electrified" District Railway, the former not having been so successful as might be desired; but Mr. Yerkes replied to the effect that there could be no fair comparison between the two undertakings. In justice to his shareholders, we think that Mr. Yerkes might have amplified his statement, for the two lines have a very similar history. Both have been unsuccessful, from a financial point of view, as steam-driven lines; both waited far too long to adopt electrical equipment, gradually driving their long-suffering passengers away as the atmosphere in their tunnels got fouler and fouler; and last, but not least, both will have to pay their dividends on a far greater amount of capital than would have been expended on a modern line built initially for electric traction. Still, while not replying to the shareholder's question directly, Mr. Yerkes discreetly called attention to an article in *The Times* of Tuesday, which dealt with the relative costs of steam and electric traction on the Manhattan Elevated Railway of New York. This railway, having about 40 miles of line, was gradually converted between the years 1901 and 1904, the former being the last year of entire operation by steam, and the latter the first year of electrical working. The figures put forward are certainly very striking, and we trust that they may be taken as indicative of the future of the District Railway. Since the adoption of electricity on the Manhattan Railway the total working costs have fallen from 11·977 cents per car-mile in 1901 to 9·468 cents per car-mile in 1904, a reduction of about 2½ cents in two years. But this is only one result; the number of passengers carried on the same track-mileage increased from 248,587,022 to 286,634,195 in the same period. This brought the gross earnings up from $12,208,337 to $14,187,685, leaving a net increase of earnings for the year of $1,594,090. If these figures may be accepted as a criterion, then it would appear that the star of the District Railway is very much in the ascendant, and that there is a new period of prosperity in store for an undertaking which has rendered excellent service in the past but has been compelled to move forward with the great wave of progress. The inertia has, without doubt, been considerable, but it has eventually been overcome by force of public opinion, backed up by the Board of Trade and Parliament, the final "push" being administered by an American "Railroad King."

OBITUARY.

DESMOND G. FITZGERALD.

It is with sincere regret that we announce the death, on the 9th inst., of Mr. Desmond G. FitzGerald, at Clare, Suffolk, where, owing to declining health, he had gone to live after a long and busy life in the metropolis. Mr. FitzGerald inherited his literary ability, his father having filled important editorial and assistant-editorial positions in London daily journalism. After commencing his career at the War Office, where he held several appointments, Mr. Desmond G. FitzGerald gradually drifted into literary work, and took an early interest in scientific matters generally, and in electrical research work in particular. Early in 1861 it was decided to publish a weekly journal devoted to electrical subjects, and towards the end of that year *The Electrician* (first series) was founded, and was chiefly devoted to questions relating to telegraphy and electrical science. In the founding of this pioneer journal, Mr. FitzGerald was assisted by the late Mr. F. C. Webb and other colleagues as enthusiastic as himself; and although the publication of *The Electrician* had to be discontinued for a time, subsequent events have proved that Mr. FitzGerald's enterprise was not a mistaken one. During the period between the cessation of the first series of *The Electrician* and the inauguration of the present series, Mr. FitzGerald contributed largely to the more or less ephemeral publications which were issued from time to time dealing with electrical matters, and he ultimately took over the editorship of the *Electric Telegraph Review*. Soon after the beginning of 1878, when Mr. Julius Beer, who was then proprietor of the *Observer*, decided to re-establish *The Electrician*, Mr. FitzGerald became connected with the editorial staff of the paper, and for some years contributed largely to its columns. On the establishment of the School of Submarine Telegraphy at Hanover-square, Mr. FitzGerald was appointed director of the science classes, and continued to occupy this position for a long period. Electrochemistry, and in particular the electrical storage battery, was always a branch of electrical work in which Mr. FitzGerald was deeply interested, and amongst his other literary work his book entitled "The Lead Storage Battery," had a considerable sale, and is now out of print. We write with a full appreciation of Mr. FitzGerald's many excellent qualities. He was a very reserved man, and few of the younger electrical workers of the present day are acquainted with him even by name, as it is now some years since he took an active part in commercial matters. Those of us who knew him in the prime of life fully appreciated his many gifts, not the least of which was his unswerving friendship and geniality. Death has taken from us many of those associated with Mr. FitzGerald in the early days of *The Electrician*; but there are still some left who retain pleasant memories of him, and to whom his loss will be a cause of deep sorrow. Electrical science owes him a debt of gratitude.

CHARLES SELIM LEMSTRÖM.

We learn with deep regret of the death, on October 2nd, at Helsingfors, of Prof. C. S. Lemström, who, after an illness of several weeks and an apparent return to complete convalescence, suffered a relapse and finally succumbed to an attack of paralysis of the heart. When in London a few weeks ago, Prof. Lemström gave every appearance of being in perfect health, and his death was, therefore, quite unexpected here. Prof. Lemström was born at Ingå, Finland, in 1838, and was, consequently, in his 66th year. After studying at Helsingfors up to 1867, he commenced his first scientific researches at Stockholm under Prof. Edlund, who was then making his famous investigations at the Academy of Science in that city. In 1869 Prof. Lemström was appointed lecturer at the Helsingfors University, in 1874 he took his Ph.D. degree, and in 1878 became professor of physics at the University. While engaged in the Swedish Polar Expedition of 1868 he turned his attention to the study of the aurora, and continued these researches for a long period in Lapland. Subsequently he was appointed to lead the International Finnish Polar Expedition to Sodankyla and Kultala from 1882 to 1884. During his travels in the Polar regions he was much impressed by the fact that plants there, if they had resisted the disastrous effects of night frosts, subsequently showed a degree of development surpassing that of plants in more southern regions where the climatic conditions are more propitious. Deeming that this might possibly be due to the same electrical discharges which are made apparent by the aurora, he entered upon a long series of researches on the influence of electricity upon plant growth. He inaugurated experiments not only in his own country but also in other parts of Europe, the more recent ones being carried out in England at the Durham College of Science. Prof. Lemström recorded the results of his investigations and researches in "Electricity in Agriculture and Horticulture," a review of which appeared in our columns last August. We hope that research in this direction will be continued by other workers. Perhaps the next generation may find that they owe to Prof. Lemström more than we can now appreciate for his pioneer work in this direction.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

The Electric Furnace. By Henri Moissan. Translated by A. T. de Mouilpied. (London: Edward Arnold.) 1904. 10s. 6d.

Moissan's work is known to all students of his subject. It is classic in every sense. The French issue of 1897 contains all but a very little of what is now put forth. There is good reason to regret that so long a time should have passed before an English translation was published, and there is still more reason to repine at the quality of the translation now issued. Slavishly literal, ruining the spirit and often ignoring the sense, it is a travesty not a translation. We take a page at random. On p. 170 of the original work we have:

> Ce n'est pas sans une certaine appréhension que nous avons executé pour la première fois, cette experience; je m'étais demande s'il ne se produirait pas d'explosion au moment où l'on placerait dans l'eau un creuset rempli de fer liquide, porté à la temperature de 3,000°. En réalité, grace à la caléfaction, l'experience est sans danger. Nous avons pu préparer 250 à 300 culots de fer ainsi refroidis brusquement, et nous n'avons jamais eu d'accident. Avec d'autres métaux, et en particulier le bismuth, il n'en a pas toujours été ainsi.

The translation is as follows:—

> Not without a certain apprehension did we carry out this experiment for the first time. I wondered whether an explosion might not take place at the moment of placing in water a crucible full of molten iron at a temperature of 3,000°C As a matter of fact, the experiment is quite safe, thanks to the calefaction. We have prepared from 250 to 300 ingots of iron, suddenly cooled in this way, without accident. This has not always been the case with other metals, especially with bismuth.

Possibly this is sense, but it is certainly not English. To avoid any appearance of prejudice, we venture to translate the passage ourselves.

> The experiment involved a certain amount of risk; it was possible that an explosion might occur when a crucible full of iron at a temperature of 3,000°C. was plunged into water. As a matter of fact, nothing of the kind happens, because the transmission of heat to the water is gradual. Some 250 to 300 ingots were cooled in this way without accident. Other metals, notably bismuth, are more difficult to deal with.

There is undoubtedly a gain in space and, we think, in clarity. The phrase "grace à la calefaction" presents a little difficulty, but it is certainly not properly rendered by "thanks to the calefaction." To the indolent reader all this may seem jejune enough; to his faithful slave, the reviewer, it is very real. Here is a great work. It should be worthily translated—not word by word and line by line, but with appreciation of its sense and with an easy working knowledge of the two tongues.

Having disposed of the translation, we may come to the pleasanter task of commending the original unreservedly. All chemists know M. Moissan as a master; every electrochemist recognises him as a pioneer on one side of their work. His researches are set forth with the precision and lucidity of a learned and cultivated Frenchman. It is a delight to read what he has written, be it understood in his own graceful tongue. For the benefit of those who have not studied his work when it appeared we may be permitted to indicate its chief heads. By the aid of his own form of electric furnace, the device of which is in itself a considerable achievement, M. Moissan has been able to volatilise or reduce almost all known metals and oxides; he has succeeded in preparing a great number of novel products characteristically stable at colossal temperatures; he has, in short, added a new chapter to chemistry. It is needless to be specially concerned in electrochemistry; every chemist who is interested in his science and in the arts which arise from it, must master the principles which govern reactions at the temperature of the arc. For this purpose we suggest application to the original, even though French may not be facile.

Leçons sur L'Electricité By Eric Gerard. Vol. I. 7th edition. (Paris: Gauthier-Villars.) 1904. 12fr.

Some parts of this text book have been thoroughly revised and re-cast in the present edition, and it remains one of the best, if not the best, book of its nature published on the Continent. The present volume deals with electrical theory and also with the design of electric generators, other practical applications being left to the second volume. This separation of theory and practical application is, perhaps, wider than will be appreciated by some students, as the electrical engineering student is probably taken as far as he will ever want to go in general electrical theory before the various chapters on practice are commenced. It must not be forgotten, however, that the volume is intended to serve as a text book for students who are at the same time following a lecture and laboratory course of training, and that, therefore, as a book of reference for them a thoroughly systematic arrangement will probably be more useful than one representing more nearly the actual order of their studies.

ROTARY CONVERTERS AND MOTOR-GENERATOR SETS.*

BY WM. C. L. EGLIN.
(Delegate of Association of Edison Illuminating Companies.)

In the distributing systems of the electric supply companies in the United States, the demand for low-tension direct current service is usually of the first importance. The distribution is underground, by means of three-wire network, and fed from sub-stations located near the load centres; the sub-stations being connected by means of high-tension alternating-current feeders from the main generating station, which is located where the best facilities are available for economical operation. The sub-stations are usually provided with a storage battery, and in some cases with an auxiliary steam equipment, which is used in the event of emergency or for extraordinary loads during the winter months. In most cases, however, where auxiliary steam apparatus is used, it forms part of an old generating station which has been changed to a sub-station. The percentage of the total load converted for direct current varies widely in different localities, and in the larger supply companies it varies from 30 to 100 per cent. Some of the leading companies also supply power to the sub-stations of street railway companies, and others have a 500-volt power circuit, although most of the direct current is supplied on three-wire 230-volt systems. In all cases the percentage of the total load converted from alternating current to direct current is large, so that an effective, reliable and efficient means of transforming alternating current to direct current is essential. The three methods available for this purpose are rotary converters, motor-generator sets and rectifiers, the first two only of which are available at present for transforming large currents.

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* Paper read before Section E of the International Electrical Congress of St. Louis. Slightly abridged.

Rotary Converters.—In most of the larger rotary converters using three-phase currents, the phases are split so as to use six phases on the rotary converter, and in that way increase the capacity of the machine. The efficiency of the rotary converter is higher than the direct-current generator, for the reason that part of the current passes directly through the windings. The rotary converter may be either shunt wound or compound wound. The rotary may be started from either end, preferably from the direct-current side.

A method which has been used on large rotary converters is the starting motor, using an alternating-current motor of the induction type to bring the machine up to synchronous speed. When only one rotary converter is in use, and direct current is not available for starting, and the rotary is therefore started from the alternating-current side, care must be exercised to test the polarity, as it is very probable it may be reversed. This can usually be rectified by opening the switch on the alternating-current side, allowing the machine to slip a pole

The rotary converter meets all of the commercial conditions demanded of it, and is capable of delivering current on the direct-current side from 110 to 600 volts. It can be operated on varying frequencies from 25 to 60 cycles successfully. Rotary converters operate better at the low frequencies for reasons which will be discussed later.

In the early introduction of rotary converters difficulties were met which were principally due to hunting, usually caused by variations in the angular velocity of the generator. This caused a swing action of the revolving part of the rotary converter, which generally increased unless some means were provided to dampen this effect. The effect of hunting causes excessive sparking of the brushes, and when hunting becomes excessive the machine will flash over at the commutator and short circuit the direct-current side of the machine; and unless safety devices are provided the machine is liable to be destroyed. The difficulty of hunting has been overcome by the addition of bridges between the poles of the machine. The design of these bridges was capable of being varied so as to increase the dampening effect required. The first form was a copper bridge placed between the poles, but it was found that additional dampening effect was required. The poles were then undercut and copper bridges were extended under the pole tips. The most powerful form consisted of a copper bridge imbedded in the pole face. The addition of bridges usually reduced the efficiency of the machine, rarely, however, exceeding 1 to 1½ per cent. The proper remedy for hunting is naturally the removing of the cause by obtaining a uniform rotation of the generator, which can be accomplished by the combination of an effective governor and the necessary fly-wheel effect on the engine. Hunting does not seem to take place when the generators are driven by either steam or water turbines. A number of rotary converters have failed owing to the killing of the field, due either to the circuit being open or to the effect upon the field caused by disturbances on the alternating-current side, thus allowing the machine to exceed its normal speed, or, in other words, run away. These failures have required the installation of auxiliary apparatus and of safety devices, which are usually installed as follows:—

A circuit breaker on the direct-current side arranged to trip with excessive overload, which cuts out the rotary in the event of it flashing over at the commutator, and speed-limiting devices to trip the circuit breakers on the alternating-current and direct-current sides. In some cases the alternating-current side of the rotary is provided with an overload and reverse-current circuit breaker which trips when the current is reversed; or, in other words, when the rotary is running inverted, supplying alternating current to the line and taking direct current from the sub station.

There are a number of different forms of speed-limiting devices, both electrical and mechanical. One form of electrical device consists of a differential relay, one set of coils being connected to the alternating-current 'bus and the other set to the collector rings. In the event of the rotary exceeding its speed, the frequency at the collector rings will increase, causing an unbalance at the relay and tripping the circuit breakers. The mechanical devices usually consist of some governor attachments which make contact in the event of the shaft running above its normal speed and tripping the circuit breakers. Various arrangements of the field wiring so as to allow combination separate and self-exciting connections have been tried so as to prevent errors on the part of the operators.

The study of the rotary converter from an operating standpoint early indicated that the machine had a high inherent efficiency; that the voltage and load could be easily regulated and the power-factor adjusted to suit the best operative conditions of the system; and that the first cost of the outfit was comparatively low. For these reasons it was extensively used, especially for frequencies of 25 cycles.

Motor-generator Sets.—Before the rotary converter had been fully developed, a number of these machines were installed on systems with frequencies of 60 cycles; and at this frequency the difficulties due to hunting were greatly increased, and in some cases satisfactory operation could not be obtained. This led to the introduction of the motor-generator sets. The first motor-generator sets were installed so as to obtain the most reliable equipment irrespective of the cost or efficiency. These equipments consisted of a low-voltage multiphase induction motor, direct connected to either one or two direct-current generators mounted upon a common base. The motors were arranged with stationary coils and squirrel-cage winding on the rotor, and they were similar in most respects to the small motors which have been used successfully for a variety of purposes. The generators were of standard design, and the motors were built to suit the speed of the generator, the motor being supplied with low-voltage current from stepdown transformers.

The motor-generator sets can be started either from the direct or alternating-current side, by using the generator as a motor and placing a variable resistance in the armature circuit similar to the method used in starting the rotary converter. When the set is started from the alternating-current side, some current-limiting device is introduced in the alternating current leading to the motor. It has been found of advantage in practice to synchronise the larger motor-generator sets so as to prevent any sudden rush of current when throwing the motors on the system. As the usual methods of synchronising are not suitable for this purpose, a disc with white and black stripes is attached to the shaft, and with an arc lamp connected to the alternating-current 'bus the set can be readily synchronised, and at synchronous speed the black and white stripes are readily visible. By the attachment of mirrors to the pillow blocks of the various motors, each set can readily be synchronised by the switchboard attendant. Bringing the machine to synchronous speeds is not essential, although it is recommended for the larger size units; that is to say, machines of 400kw. or larger. It has been found advantageous to start both generators and rotary converters from the direct-current side with a starting bar operated by hand, thus reducing the amount of current required to overcome the friction of rest about one-half. This is often important when the sub-station is heavily loaded and the current is drawn from it to start additional machines. It also reduces the size of the starting resistance. For example, 400kw. motor-generator sets or rotary converters may require from 400 to 600 amperes to start them from rest, providing the machines have been standing for some time, and thus allowed the oil to squeeze out between the bearing and the shaft. With the assistance of the starting bar, this current can be cut down to 200, and not exceeding 250 amperes at 230 volts.

The operation of these motor-generator sets was all that could be expected of them, and was satisfactory in all respects; but, on account of their inefficiency and high first cost, improvements were demanded. A very rational step was the abolishment of step-down transformers and the substitution of a high-tension winding for the low-tension on the motors, the introduction of one 250 to 300-volt generator instead of two 125 to 150-volt generators, and, in some cases, the substitution of a synchronous motor for an induction motor.

Regulators on the alternating-current side were unnecessary—the voltage on direct-current generators being readily controlled by a rheostat on the shunt field—and the operation was simplified, allowing the equipment to be handled by the regular class of dynamo operators, this being of great importance in large systems, as it requires less time to train the operators. Disturbances on the alternating-current side of the system have little effect on the motor-generator sets, and are of such a character that they are easily provided for by protecting devices.

The objection to motor-generators, especially those of induction type, is the low power-factor, which increases the losses in the feeders. The losses in the feeders are usually a small part of the total loss, so that this in many cases is not important.

The first cost of motor-generator sets is usually somewhat higher than of rotary converters, particularly in the large sizes. The actual difference, however, is not so great as generally supposed. The relative costs of the various sizes are shown in the following table:—

Comparative Table of Costs.

Rotaries with transformers and regs.		25 cycle synch. motor-g'nerator	25 cycle ind. motor-g'nerator	60 cycle synch. motor-g'nerator	60 cycle ind. motor-g'nerator	Capacity Kw.
25 cycle.	60 cycle.					
1	1·05	1·05	1·10	1·03	1·08	1,000
1	1·00	1·05	1·05	1·00	1·00	500
1	0·95	1·00	0·95	0·95	0·95	250 to 300

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> Ce n'est pas sans une certaine apprehension que nous avons executé pour la première fois, cette experience; je m'étais demande s'il ne se produirait pas d'explosion au moment où l'on placerait dans l'eau un creuset rempli de fer liquide, porté à la temperature de 3,000°. En réalité, grace à la caléfaction, l'experience est sans danger. Nous avons pu préparer 250 à 300 culots de fer ainsi refroidis brusquement, et nous n'avons jamais eu d'accident. Avec d'autres métaux, et en particulier le bismuth, il n'en a pas toujours été ainsi.

The translation is as follows:—

> Not without a certain apprehension did we carry out this experiment for the first time. I wondered whether an explosion might not take place at the moment of placing in water a crucible full of molten iron at a temperature of 3,000°C As a matter of fact, the experiment is quite safe, thanks to the calefaction. We have prepared from 250 to 300 ingots of iron, suddenly cooled in this way, without accident. This has not always been the case with other metals, especially with bismuth.

Possibly this is sense, but it is certainly not English. To avoid any appearance of prejudice, we venture to translate the passage ourselves.

> The experiment involved a certain amount of risk; it was possible that an explosion might occur when a crucible full of iron at a temperature of 3,000°C. was plunged into water. As a matter of fact, nothing of the kind happens, because the transmission of heat to the water is gradual. Some 250 to 300 ingots were cooled in this way without accident. Other metals, notably bismuth, are more difficult to deal with.

There is undoubtedly a gain in space and, we think, in clarity. The phrase "grace à la caléfaction" presents a little difficulty, but it is certainly not properly rendered by "thanks to the calefaction." To the indolent reader all this may seem jejune enough; to his faithful slave, the reviewer, it is very real. Here is a great work. It should be worthily translated —not word by word and line by line, but with appreciation of its sense and with an easy working knowledge of the two tongues.

Having disposed of the translation, we may come to the pleasanter task of commending the original unreservedly. All chemists know M. Moissan as a master; every electrochemist recognises him as a pioneer on one side of their work. His researches are set forth with the precision and lucidity of a learned and cultivated Frenchman. It is a delight to read what he has written, be it understood in his own graceful tongue. For the benefit of those who have not studied his work when it appeared we may be permitted to indicate its chief heads. By the aid of his own form of electric furnace, the device of which is in itself a considerable achievement, M. Moissan has been able to volatilise or reduce almost all known metals and oxides; he has succeeded in preparing a great number of novel products characteristically stable at colossal temperatures; he has, in short, added a new chapter to chemistry. It is needless to be specially concerned in electrochemistry; every chemist who is interested in his science and in the arts which arise from it, must master the principles which govern reactions at the temperature of the arc. For this purpose we suggest application to the original, even though French may not be facile.

Leçons sur L'Electricité By ERIC GÉRARD. Vol. I. 7th edition. (Paris: Gauthier-Villars.) 1904. 12fr.

Some parts of this text-book have been thoroughly revised and re-cast in the present edition, and it remains one of the best, if not the best, book of its nature published on the Continent. The present volume deals with electrical theory and also with the design of electric generators, other practical applications being left to the second volume. This separation of theory and practical application is, perhaps, wider than will be appreciated by some students, as the electrical engineering student is probably taken as far as he will ever want to go in general electrical theory before the various chapters on practice are commenced. It must not be forgotten, however, that the volume is intended to serve as a text book for students who are at the same time following a lecture and laboratory course of training, and that, therefore, as a book of reference for them a thoroughly systematic arrangement will probably be more useful than one representing more nearly the actual order of their studies.

ROTARY CONVERTERS AND MOTOR-GENERATOR SETS.*

BY WM. C. L. EGLIN.

(Delegate of Association of Edison Illuminating Companies.)

In the distributing systems of the electric supply companies in the United States, the demand for low-tension direct-current service is usually of the first importance. The distribution is underground, by means of three-wire network, and fed from sub-stations located near the load centres: the sub-stations being connected by means of high-tension alternating-current feeders from the main generating station, which is located where the best facilities are available for economical operation. The sub-stations are usually provided with a storage battery, and in some cases with an auxiliary steam equipment, which is used in the event of emergency or for extraordinary loads during the winter months. In most cases, however, where auxiliary steam apparatus is used, it forms part of an old generating station which has been changed to a sub-station. The percentage of the total load converted for direct current varies widely in different localities, and in the larger supply companies it varies from 30 to 100 per cent. Some of the leading companies also supply power to the sub-stations of street railway companies, and others have a 500-volt power circuit, although most of the direct current is supplied on three-wire 230-volt systems. In all cases the percentage of the total load converted from alternating current to direct current is large, so that an effective, reliable and efficient means of transforming alternating current to direct current is essential. The three methods available for this purpose are rotary converters, motor-generator sets and rectifiers, the first two only of which are available at present for transforming large currents.

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* Paper read before Section E of the International Electrical Congress of St. Louis. Slightly abridged.

Rotary Converters.—In most of the larger rotary converters using three-phase currents, the phases are split so as to use six phases on the rotary converter, and in that way increase the capacity of the machine. The efficiency of the rotary converter is higher than the direct-current generator, for the reason that part of the current passes directly through the windings. The rotary converter may be either shunt wound or compound wound. The rotary may be started from either end, preferably from the direct-current side.

A method which has been used on large rotary converters is the starting motor, using an alternating-current motor of the induction type to bring the machine up to synchronous speed. When only one rotary converter is in use, and direct current is not available for starting, and the rotary is therefore started from the alternating-current side, care must be exercised to test the polarity, as it is very probable it may be reversed. This can usually be rectified by opening the switch on the alternating-current side, allowing the machine to slip a pole

The rotary converter meets all of the commercial conditions demanded of it, and is capable of delivering current on the direct-current side from 110 to 600 volts. It can be operated on varying frequencies from 25 to 60 cycles successfully. Rotary converters operate better at the low frequencies for reasons which will be discussed later.

In the early introduction of rotary converters difficulties were met which were principally due to hunting, usually caused by variations in the angular velocity of the generator. This caused a swing action of the revolving part of the rotary converter, which generally increased unless some means were provided to dampen this effect. The effect of hunting causes excessive sparking of the brushes, and when hunting becomes excessive the machine will flash over at the commutator and short circuit the direct-current side of the machine; and unless safety devices are provided the machine is liable to be destroyed. The difficulty of hunting has been overcome by the addition of bridges between the poles of the machine. The design of these bridges was capable of being varied so as to increase the dampening effect required. The first form was a copper bridge placed between the poles, but it was found that additional dampening effect was required. The poles were then undercut and copper bridges were extended under the pole tips. The most powerful form consisted of a copper bridge imbedded in the pole face. The addition of bridges usually reduced the efficiency of the machine, rarely, however, exceeding 1 to 1½ per cent. The proper remedy for hunting is naturally the removing of the cause by obtaining a uniform rotation of the generator, which can be accomplished by the combination of an effective governor and the necessary fly-wheel effect on the engine. Hunting does not seem to take place when the generators are driven by either steam or water turbines. A number of rotary converters have failed owing to the killing of the field, due either to the circuit being open or to the effect upon the field caused by disturbances on the alternating-current side, thus allowing the machine to exceed its normal speed, or, in other words, run away. These failures have required the installation of auxiliary apparatus and of safety devices, which are usually installed as follows:—

A circuit breaker on the direct-current side arranged to trip with excessive overload, which cuts out the rotary in the event of it flashing over at the commutator, and speed-limiting devices to trip the circuit breakers on the alternating-current and direct-current sides. In some cases the alternating-current side of the rotary is provided with an overload and reverse-current circuit breaker which trips when the current is reversed; or, in other words, when the rotary is running inverted, supplying alternating current to the line and taking direct current from the sub station.

There are a number of different forms of speed-limiting devices, both electrical and mechanical. One form of electrical device consists of a differential relay, one set of coils being connected to the alternating-current bus and the other set to the collector rings. In the event of the rotary exceeding its speed, the frequency at the collector rings will increase, causing an unbalance at the relay and tripping the circuit breakers. The mechanical devices usually consist of some governor attachments which make contact in the event of the shaft running above its normal speed and tripping the circuit breakers. Various arrangements of the field wiring so as to allow combination separate and self-exciting connections have been tried so as to prevent errors on the part of the operators.

The study of the rotary converter from an operating standpoint early indicated that the machine had a high inherent efficiency; that the voltage and load could be easily regulated and the power-factor adjusted to suit the best operative conditions of the system; and that the first cost of the outfit was comparatively low. For these reasons it was extensively used, especially for frequencies of 25 cycles.

Motor-generator Sets.—Before the rotary converter had been fully developed, a number of these machines were installed on systems with frequencies of 60 cycles; and at this frequency the difficulties due to hunting were greatly increased, and in some cases satisfactory operation could not be obtained. This led to the introduction of the motor-generator sets. The first motor-generator sets were installed so as to obtain the most reliable equipment irrespective of the cost or efficiency. These equipments consisted of a low-voltage multiphase induction motor, direct connected to either one or two direct-current generators mounted upon a common base. The motors were arranged with stationary coils and squirrel-cage winding on the rotor, and they were similar in most respects to the small motors which have been used successfully for a variety of purposes. The generators were of standard design, and the motors were built to suit the speed of the generator, the motor being supplied with low-voltage current from stepdown transformers.

The motor-generator sets can be started either from the direct or alternating-current side, by using the generator as a motor and placing a variable resistance in the armature circuit similar to the method used in starting the rotary converter. When the set is started from the alternating-current side, some current-limiting device is introduced in the alternating current leading to the motor. It has been found of advantage in practice to synchronise the larger motor-generator sets so as to prevent any sudden rush of current when throwing the motors on the system. As the usual methods of synchronising are not suitable for this purpose, a disc with white and black stripes is attached to the shaft, and with an arc lamp connected to the alternating-current 'bus the set can be readily synchronised, and at synchronous speed the black and white stripes are readily visible. By the attachment of mirrors to the pillow blocks of the various motors, each set can readily be synchronised by the switchboard attendant. Bringing the machine to synchronous speeds is not essential, although it is recommended for the larger size units; that is to say, machines of 400kw. or larger. It has been found advantageous to start both generators and rotary converters from the direct-current side with a starting bar operated by hand, thus reducing the amount of current required to overcome the friction of rest about one-half. This is often important when the sub-station is heavily loaded and the current is drawn from it to start additional machines. It also reduces the size of the starting resistance. For example, 400kw. motor-generator sets or rotary converters may require from 400 to 600 amperes to start them from rest, providing the machines have been standing for some time, and thus allowed the oil to squeeze out between the bearing and the shaft. With the assistance of the starting bar, this current can be cut down to 200, and not exceeding 250 amperes at 280 volts.

The operation of these motor-generator sets was all that could be expected of them, and was satisfactory in all respects; but, on account of their inefficiency and high first cost, improvements were demanded. A very rational step was the abolishment of step-down transformers and the substitution of a high-tension winding for the low-tension on the motors, the introduction of one 250 to 300-volt generator instead of two 125 to 150-volt generators, and, in some cases, the substitution of a synchronous motor for an induction motor.

Regulators on the alternating-current side were unnecessary—the voltage on direct-current generators being readily controlled by a rheostat on the shunt field and the operation was simplified, allowing the equipment to be handled by the regular class of dynamo operators, this being of great importance in large systems, as it requires less time to train the operators. Disturbances on the alternating-current side of the system have little effect on the motor-generator sets, and are of such a character that they are easily provided for by protecting devices.

The objection to motor-generators, especially those of induction type, is the low power-factor, which increases the losses in the feeders. The losses in the feeders are usually a small part of the total loss, so that this in many cases is not important.

The first cost of motor-generator sets is usually somewhat higher than of rotary converters, particularly in the large sizes. The actual difference, however, is not so great as generally supposed. The relative costs of the various sizes are shown in the following table:—

Comparative Table of Costs.

Rotaries with transformers and regs.		25 cycle synch. motor-generator	25 cycle ind. motor-generator	60 cycle synch. motor-generator	60 cycle ind. motor generator	Capacity.
25 cycle.	60 cycle.					Kw.
1	1·05	1·05	1·10	1·03	1·08	1,000
1	1·00	1·05	1·05	1·00	1·00	500
1	0·95	1·00	0·95	0·95	0·95	250 to 300

This is based on quotations by the same manufacturer of rotary converters and motor-generator sets of 25 and 60 cycles, with a 25-cycle rotary converter with transformers and regulators as a unit.

The following table shows the efficiency of a 400kw. 60-cycle rotary converter and a 400kw. 60-cycle motor-generator set with both high and low-voltage motors. These tests were made at the works of the manufacturers, and show that even at high frequencies the rotary converter is more efficient than the motor-generator set:—

2-phase 16 poles 400kw., 450 revs., 230 to 300 volts rotary.

2-phase 60 cycles, 5,000 volts primary, 210 to 160 volts secondary, static transformer.

Per cent. load.	Combined efficiency at 210 volts.	Combined efficiency at 160 volts.
100	89·6	90·5
75	88·0	88·9
50	84·3	85·5
25	73·0	75·3

Motor-generator Set:

D.C. 10 poles 400kw., 450 revs., 125 to 150 volts.

A.C. 16 poles 560kw., 450 revs., 280 volts.

Per cent. load.	Combined efficiency at 150 volts.
100	82·0

Motor-generator Set:

D.C. 10 poles 400kw., 450 revs., 230 to 300 volts.

A.C. 16 poles 560kw., 450 revs., 220 volts.

Per cent. load.	Combined efficiency at 300 volts
100	84·9

Motor-generator Set:

D.C. 10 poles 400kw., 450 revs., 230 to 300 volts.

A.C. 16 poles 560kw., 450 revs., 5,500 volts.

Per cent. load.	Combined efficiency at 300 volts.
100	86·9

After these machines were installed in the sub-stations, a series of tests were made, using the same observers and the same instruments (the instruments which were checked between tests), so as to obtain the all-day efficiencies when operating under commercial conditions, the rotary converters being placed in one sub-station and the motor-generators in another, but both supplied from the same generating station. It would appear from these tests there is no practical difference in the commercial efficiency between the high-voltage motor-generator set and the rotary converter, and, as was to be expected, the low-voltage motor-generator set was the most inefficient.

All-day Efficiencies under Commercial Conditions.

Type of machine.		Load.	H.P.	Eff.	Power-factor.		
					A Ph.	C Ph.	Av.
No 1	Ind. motor, Quarter phase, 560 H.P., 220 volts, 1,150 amperes	Empty	0	0	0	45·9	23·0
		¼	140	72·9	67·1	86·4	76·7
		½	280	82·1	83·6	92·8	88·2
		¾	420	85·3	86·4	90·4	88·4
		Full	560	85·4	88·7	92·1	90·4
No. 2	Ind. motor, Quarter phase, 560 H.P., 6,000 volts, 47 amperes	Empty	0	0	3·9	29·1	16·5
		¼	140	72·7	56·9	69·7	63·3
		½	280	81·2	77·4	82·5	80·0
		¾	420	84·7	82·5	86·2	84·3
		Full	560	85·9	85·[illegible]	88·9	87·3
No. 3	Rotary, Quarter phase, 400kw., 250 volts	¼	134	70·[illegible]	99·2	106·0	102·6
		½	268	77·2	100·5	105·1	102·8
		¾	402	80·4	97·4	102·4	99·9
		Full	536	84·1	97·6	98·0	97·8

Conclusions.—The type of machine to be installed in sub-stations depends principally upon the frequency of the system and the importance of reliable and continuous service. The frequency to be used depends upon other conditions which are outside the scope of this Paper. In cases where the largest percentage of the output of the generating station is to be transformed to low-tension direct-current, 25 cycle rotary converters should be installed on account of their higher efficiency and lower first cost. The very large number of these machines which are now in successful operation proves conclusively their reliability and effectiveness. In mixed systems, and where the percentage of current transformed for low-tension distribution is small, motor-generators are desirable. With higher frequency, particularly 60 cycles, it has been shown that motor-generators compare favourably in efficiency and are much more reliable and simple in their operation.

The Late Prof. Finsen.—An appeal has been issued in Copenhagen for contributions towards the cost of erecting a monument to the late Prof. Finsen, and also for the foundation of a fund to be devoted to scientific and humanitarian purposes. About 1,400 signatures are attached to the appeal, and these include those of all Ministers, members of the Rigsdag, editors of all Danish newspapers, and many patients who had been cured by the late professor.

SOME SINGLE-PHASE RAILWAY PROBLEMS.*

BY PAUL M. LINCOLN.

Up to the present time practically all long-distance power transmission has been carried on with three-phase currents on account of the obvious advantages due to its use. The use of single-phase currents, however, introduces practically no new elements into the transmission problem. Its effect is to simplify the arrangements both of the line and the translating apparatus at the ends of the line. On the line two conductors instead of three will be used with a corresponding reduction in the number of insulators. At the terminals one transformer will take the place of a group of three, and the switching apparatus is very greatly simplified.

One apparent handicap under which the single-phase line labours is the apparent fact that to transmit a given amount of power a given distance with a given loss requires more copper single-phase than three-phase in the ratio of 4 to 3. If we assume that the voltage between the single-phase terminals is equal to that between any two of the three-phase terminals, this apparent fact holds. Under normal conditions of operation, however, this assumption is not fair to the single-phase line. It is evident that, so far as the transmission line is concerned, the true criterion of voltage strain is that which exists between any conductor and ground and not the voltage between conductors. It is further evident that under normal conditions ground potential will exist at the geometric centre of the electric system. For instance, ground potential for the single-phase line will exist at a point midway between the terminals as shown at (*a*) Fig. 1, while in the three-phase system it will exist at the geometric centre of the triangle as shown at (*b*). With the same terminal voltage, therefore, the insulation strain between any terminal and ground will be the greater in the three-phase system in the ratio of 2 to $\sqrt{3}$. But if the terminal voltage be so adjusted that the insulation strains to ground be made the same, then to transmit a given amount of power a given distance at a given loss will require for the single-phase line an amount or copper no greater than that required by the three-phase line. In other words, for equal insulation strains on the line the terminal voltage of the single-phase system may be greater than that of the three-phase system in the ratio of 2 to $\sqrt{3}$.

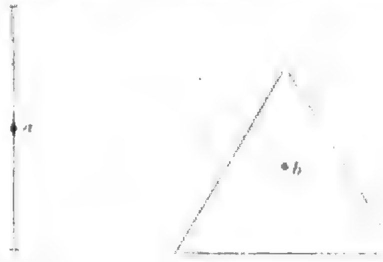

FIG. 1.

It may be well to draw attention to the fact that the above observation holds good only for the normal condition—that is, the condition that ground potential occurs at the geometrical centre of the system. If one of the conductors becomes grounded an abnormal conditon arises and the insulation strain becomes equal to the terminal voltage. Under this condition, however, the three-phase system suffers the disadvantage of having the insulation on two conductors subjected to a strain equal to terminal voltage, while in the single-phase system only one conductor is so subjected.

On account of the fact that a polyphase generator is for a given output much lighter and cheaper than a single-phase generator, it becomes of advantage, so far as the generating plant is concerned, to derive the single-phase currents necessary for operating a single-phase railway from polyphase generators. The saving in cost of generators thus effected amounts to approximately 30 per cent. In order to secure this advantage it is necessary to use a switchboard and transformer equipment which is somewhat more complicated and expensive than would be the case with single-phase generators, but as a rule not sufficiently so to prevent a greater economy in the use of polyphase generators over single-phase. For this purpose the two-phase generator is in general preferable to the three-phase, since it is easier, generally speaking, to divide a given amount of single-phase load into two parts than into three parts. Three-phase generators can, of course, be used, but a balanced condition of load is obviously more difficult to secure.

The use of single-phase current from two wires of a three-phase line also involves a tendency to produce disturbances in neighbouring telephone and other circuits, which is not apparent at first

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[*] Paper on the "Transmission and Distributing Problems Peculiar to the Single-Phase Railway" read before Section D of the International Electrical Congress of St. Louis.

thought. Under the normal condition of operation of a three-phase circuit the sum of the static potentials of the three phases is always zero at any and every instant of time. Therefore, static induction on neighbouring wires is due only to the fact that different distances necessarily exist between the disturbed circuit and each conductor of the three-phase circuit, and, therefore, is matter which can be corrected by proper transpositions. If, however, one of the three wires be taken away, as may be the case with a single-phase from a three-phase circuit, the sum of the static potentials no longer remains at zero, and static induction will take place on neighbouring circuits without the possibility of correction by any method of transposition.

In other words, two conductors of a three-phase circuit will, under normal conditions, give rise to an amount of static induction on neighbouring circuits equal to about one-half that which would be occasioned by the three conductors under the abnormal condition arising when one of them becomes grounded. Therefore, if there is any danger of disturbing neighbouring circuits by static induction, it is advisable on this account to use three distinct two-conductor circuits rather than the alternative of taking single-phase from the three conductors of a three-phase circuit. An alternative is to carry all three of the conductors to all points to be served. This often involves running three wires where two would carry the load simply for the purpose of obtaining the static influence due to this third wire. Since the static influence is independent of the material of the wire and also largely independent of the size of the wire, this third conductor need not necessarily be as expensive in first cost as the other two constituting the working circuit.

In general, therefore, the transmission problem is changed but little by the adoption of single-phase in the place of three-phase. But when we come to the problem of the distribution of alternating current to cars on trains along the line of a railway we find a material difference between this and its counterpart—the distribution of direct current to railways. In the following discussion it is assumed that the general arrangement of the typical alternating-current railway will be practically the same that is now followed in the typical direct-current railway. That is, the system will consist of a generating station sending out the required energy at a high voltage. At various points along the line this high-voltage energy will be transformed down to the voltage that has been selected as the trolley voltage and fed directly into the trolley. The general arrangement of the alternating and direct-current systems is, therefore, very similar. The main differences between the two systems are, first, the elimination of a trolley voltage limit except that set by considerations of insulation and safety; and second, the elimination of rotary converters from the sub-stations and the consequent elimination for the necessity of constant attendance.

Assuming that in any given case the trolley voltage is fixed, there will still remain two variables to be determined—first, the cross-section of the trolley copper, and second, the distance between transforming stations. These two quantities are evidently interdependent. That is, a variation in one requires, in order to render a given service, a variation in the other. For instance, if we increase the number of feeding points the cross-section of copper to convey a given amount of power with a given loss is decreased.

The considerations upon which these quantities should be determined may evidently be classed under the following heads:—

1. Maximum economy. 2. Voltage drop. 3. Insurance against accident. 4. Mechanical considerations. 5. Avoidance of undue multiplicity of stations.

Maximum Economy.—It is evident that a cross section of copper and a distance between transforming stations should be used which will give the maximum economy, provided the limit as thus set does not fall beyond that as absolutely fixed by other considerations. Kelvin's law gives us a basis for the calculation of the most economical cross-section of copper. As is well known, this cross-section is dependent only on the cost of power, the cost of conductors in place, the load-factor and the interest and depreciation on the investment for conductors. Knowing the above factors, we may derive at once the density of current per unit of cross-section of copper which will be most economical. This current density per unit of cross-section is entirely independent of the distance power is to be transmitted as well as the amount of power and the transmitting voltage. Once having derived the most economical density of current per square inch, it is easy, by making certain other assumptions, to fix the most economical distance between transforming stations as well as the proper size of copper. The most economical distance between stations is given by the formula: $D=0{\cdot}00314\sqrt{KVA/WP}$, in which D = distance between adjacent transforming station in miles, K = the cost of a single transforming station in dollars, V = trolley voltage, A = most economical current density in amperes per square inch as derived from the conditions mentioned above, W = average apparent kilowatts used per mile of road and P = price of copper in cents per pound.

This formula is simply another method of saying that to make first cost a minimum the cost of the transforming stations should be made equal to the cost of the trolley copper. Knowing the values of A, D and W, the cross-section (in circular mils) of the trolley is, of course, fixed by the expression $6{\cdot}35\times10^{4}DW/VA$.

To derive the above expression for distance between stations the assumption is made that the cost of a transforming station is independent of its capacity, an assumption which, of course, is not strictly true, but one which is not so far from the truth as appears at first sight. The total cost of a transforming station is made up of transformers, auxiliary apparatus and building. The cost of the building and the auxiliary apparatus will remain practically stationary for large variations of capacity. The cost of the transformer item, of course, decreases with decreased capacity, but decrement in cost is not nearly so great as the decrement in capacity. Further, the decrement in capacity to render a given service will be less than the decrement in distance between stations. For when a car or train is opposite a given transformer station practically all of the energy to operate it must come from that transformer station. Within wide limits, too, the maximum load on any transformer station will be that due to a single car or train. The maximum load on any transformer station is, therefore, within wide limits, independent of its spacing, and, therefore, independent of its capacity. Closer spacing only limits the element time during which the load pulls on a transformer station, and not the element of maximum load. Since the capacity of a transformer station should be adjusted to the root mean square load and not to the average load, it follows, as stated above, that the decrement of capacity in transformer stations is not proportional to the decrement of spacing.

As indicated above, however, the consideration of economy should be allowed to fix these quantities only when they fall within the limits as fixed by other considerations.

Voltage Drop.—It is, of course, essential that sufficient voltage exists at the car to operate it, and it is preferable that the fluctuation of voltage be within the limit of successful incandescent lighting; and in the spacing of transformer stations and the choice of trolley wire the dictation of economy may have to be modified by the dictation of allowable drop. In comparing the question of voltage drops in an alternating-current railway line with those of a direct-current railway line, two marked differences obtain, one an advantage to the alternating system of distribution and one a disadvantage. An advantage for the alternating system accrues from the general fact that alternating voltages are capable of being transformed with comparative ease and high efficiency. It is possible, therefore, to instal an apparatus on an alternating-current car whereby any voltage drop that occurs may be compensated for.

On the other hand, the alternating system labours under the disadvantage that inductive drops which are peculiar to the alternating system are added to the ohmic drop, which is the only element to be considered in the direct-current system. The amount by which the total drop is increased by this inductive effect is dependent, of course, upon the size of trolley wire, its distance from its return, the nature of the return, the frequency and the power-factor of the load. The general statement may be made, however, that with 25 cycles, the usual height of trolley wire, the usual power-factors that will be met in practice, and sizes of trolley wire not exceeding No. 4—the total drop in the trolley line will rarely be more than the ohmic drop increased by 50 per cent. This figure assumes that the term "ohmic drop" takes into consideration the additional loss that alternating current causes in the return rail circuit over that caused by direct current.

Insurance.—A second point which should be borne in mind when determining the size of trolley and the distance between stations, and which may require a modification of these quantities as fixed by consideration of economy, is the possibility of the temporary breakdown of any transformer station. These elements should be so chosen that in this event operation of cars or trains past the disabled station may be effected from adjacent stations. This condition may fairly be considered as an abnormal one, however, and so long as operation under this condition still remains possible the questions of economy and drop may be lost sight of in that section where the abnormal condition exists. An arrangement of transformer stations which may be suggested in this connection is one in which a reasonable amount of spare capacity is provided by making each transformer station a certain percentage larger than necessary to take care of its normal load, and only providing a single transformer in a station. In case of the disablement of any station, its load can be taken care of by the adjacent stations until such time as the transformer can be replaced.

Mechanical Considerations.—This point is sufficiently covered by the consideration that the trolley wire must be on the one hand of sufficient size to make a strong mechanical structure, and, on the other hand, not of so large a cross-section as to make the supporting structure unduly heavy. The size dictated by maximum economy must, therefore, be subject to the modification of mechanical fitness.

Danger of Multiplicity of Stations.—In viewing this problem from the standpoint of the high-tension line, it must be borne in mind that that every point at which it is necessary to tap the line and take power becomes a point of danger, a point where accidents may happen. And the higher the high-tension voltage the more difficult and expensive it becomes to take power from the line, and the greater becomes the liability of danger. This point becomes a good reason for reducing the number of transformer stations to a minimum.

It may be easily gathered from the above discussion that there is no golden rule for the determination of the spacing and capacity of transformer stations or the size of the conductor. It is, like most other engineering problems, a matter of compromise between various elements, some of which point in one direction and some in the other, and a matter which must be determined by engineering judgment rather than by any inflexible law.

THE CONDUCTION OF ELECTRICITY IN MERCURY VAPOUR.*

BY A. P. WILLS.

When a current of electricity is made to pass through a tube containing mercury vapour it may, or may not, encounter a large resistance at or near the junction of the vapour with the negative electrode. If an induction coil or a static machine be employed as a source of current supply, this large resistance invariably exists. But under certain conditions it disappears almost completely; in fact, it may so far disappear that, instead of a resistance of thousands of ohms, one of less than 1 ohm may obtain. Under such conditions, the current-carrying capacity of a tube may become enormous. In some cases a current of over 100 amperes has been passed through a tube containing mercury vapour.

The discussion in the present Paper is chiefly concerned with the experimental investigation of the conducting properties of the so-called "positive column." Before going into a detailed discussion of this matter, some general phenomena to be observed in a tube carrying large currents will be noticed.

General Phenomena.—Fig. 1 represents a tube exhausted save for mercury vapour. The positive electrode *a* is of iron, although by slightly varying the construction of the tube a positive electrode of liquid mercury might be used. In fact, any metal may be used as a positive electrode with good results, provided it does not undergo physical or chemical change under the conditions of use. The negative electrode *b* always consists of liquid mercury, because this material, although easily vaporised, soon condenses and falls to the bottom of the tube, thus becoming again part of the electrode; and this action has no deleterious effect upon the walls of the tube. Furthermore, it has been shown that electricity passes from a gas to a metal much more readily when the latter is easily capable of disintegration of some sort. When the tube is operating normally, there is about the anode a region extending to *c* which is practically non-luminous. At *c* the luminous column begins and ends at *d*. At *d* there is a narrow dark space, then a narrow luminous section, and following this a dark space, extending to the negative electrode but penetrated by a conical flame extending from a brightly-luminous spot on the surface of the electrode to the bright layer just mentioned. The anode, under normal conditions, presents nothing of particular interest in a casual observation of its action except a slight luminous protuberance, which projects out into the non-luminous region about it, and the electrode itself does not appear to be heated to any extent. But if the tube is made to carry an abnormal amount of current, the luminous column extends up to the electrode and joins with it, sometimes in one, sometimes in numerous bright spots, and at these spots the electrode itself is sometimes heated to a red or even a white heat and the tube is said to "arc." Under ordinary conditions, the current appears to be leaving the electrode over a considerable extent of surface. Again, under certain conditions, a blue velvety glow will appear over the entire surface of the electrode. When this is present, and likewise when arcing takes place, there is a large increase in the potential drop over the anode, and also in the temperature measured by a thermo-couple in the neighbourhood of the anode.

The bright spot at which the current enters the cathode indicates that the current must encounter considerable resistance just there. This bright spot does not remain stationary, but dances around over the surface in very lively fashion. This dancing effect can be made to disappear, as Dr. Hewitt has shown, by causing a platinum wire to protrude slightly above the surface of the mercury. When this is done, the current seems to prefer to enter the electrode where the wire emerges from its surface. At the point where the current enters the electrode there is a marked depression in the surface of the mercury. The depth of this depression is sometimes as much as 3mm. or 4mm.

The length of the first negative dark space seems to increase with the current and the diameter of the tube, and also depends upon the vapour density. The effect of increasing the density is to decrease the length of the dark space. The temperature in the dark space except near its junction with the luminous column, and possibly in the negative flame, is low in comparison with that in the luminous column; for, in this region, the vapour condenses readily upon the walls of the tube. The positive column, viewed from the side, usually appears uniformly luminous except in the neighbourhood of its extremities *c* and *d*; viewed from the end, it appears brightest at the axis of the tube; and at low vapour densities the luminosity falls off gradually towards the walls of the tube; but at high vapour densities the luminosity is confined to a small circular cylinder concentric with the axis of the tube. The cross-section of this cylinder increases with increase of current, and decreases with increase of vapour density.

The Electromotive Intensity and the Temperature along the Positive Column.—In order to find out how the temperature and the electromotive intensity vary along the length of the column, the tube shown in Fig. 2 was constructed. At *a*, *b*, *c* and *d* are thermo-couples serving also as terminals for an electrostatic voltmeter. The tube was 1·9cm. in diameter, and the distance between successive electrodes 38cm. The results contained in Table I. were found, the electromotive intensity being the average between the points indicated:—

Table I.

Current in amperes.	Electromotive intensity in volts per centimetre between			Temperature in degrees centigrade at			
	a—*b*.	*b*—*c*.	*c*—*d*.	*a*.	*b*.	*c*.	*d*.
1·25	0·645	0·660	0·641	123	83	106	134
1·75	0·612	0·612	0·590	143	88	143	160
2·25	0·580	0·585	0·557	172	125	175	200
2·75	0·552	0·559	0·537	200	123 (?)	205	241
3·25	0·535	0·548	0·561	243	167	242	297

The numbers in this table are for the case of the tube operating in air at the room temperature of about 20°C. The results given are typical of those which could be obtained from a tube of any diameter.

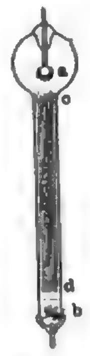

Fig. 1.

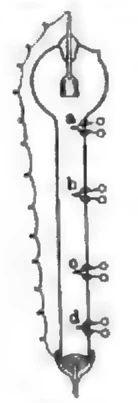

Fig. 2.

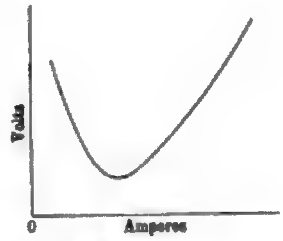

Fig. 3.

The Drop in Potential over the Anode.—By the phrase "drop in potential over the anode" is meant the difference in potential between the anode itself and a small wire (thermo-couple) sealed into the tube with its end about 1cm. in front of the anode. The following table gives the results obtained from a tube 1·9cm. in diameter: the temperatures given are those furnished by the thermo-couple, which at the same time served as one of the terminals for the electrometer:—

Table II.

Current in Amperes	1·25	1·75	2·25	2·75	3·25
Anode drop in volts	6·5	5·8	5·4	5·1	4·6
Temperature in degrees Centigrade	123	143	172	200	243

These figures were obtained while the tube was behaving normally at the anode—that is, there was no arcing and no bluish haze over the electrode. The effect of these is to greatly increase the drop in potential over the anode, and also to cause a large increase of the temperature. The anode drop may rise to 15 volts when the anode is behaving abnormally. Much larger currents than the last given in the table could not be used without producing arcing. It is noteworthy that the larger the current the less the anode drop. If the anode consist of liquid mercury instead of iron, the anode drop is considerably greater under similar circumstances. The current probably does extra work in vaporising the mercury.

The Drop in Potential over the Cathode.—From experiments upon a number of different tubes it appears that the drop in potential over the cathode is very nearly independent of the current, and about 5 volts in magnitude. Dr. Von Rechlinghausen has shown by using very short tubes of large diameter, so that the resistance of the vapour could be neglected, that the sum of the cathode and anode drops decreases slowly as the current increases. He employed in one instance a current as large as 100 amperes. The lowest value for the sum of the two drops which he obtained was 7·5 volts. From what has been said above, it is probable that this low value is due to the favourable action of large currents in decreasing the resistance encountered by the current at the anode.

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* Abstract of an article in the *Physical Review* of New York.

Suppose a tube to be operating, and let the current be gradually decreased. When the current reaches a certain value the tube suddenly ceases to operate; repeat the experiment, and the same thing happens at approximately the same value of the current. This value of the current is called the "minimum value," and is designated by I_m. Now I_m is a function of the external inductance and also of the external resistance, and, moreover, not only of the magnitude of the inductance, but also of the nature of the same. By this is meant, for instance, that an inductance with a closed iron core will have a different effect in determining the value of I_m than will an inductance of equal magnitude with a straight iron core. The latter determines a smaller value of I_m. The general nature of the functional relation between I_m and the inductance L is as follows:—When the inductance L is quite small, a few milli-henrys, say, and the resistance in series with the tube is not very large, say over 30 ohms, then I_m will be somewhere in the neighbourhood of 3 amperes. As the value of L is increased the value of I_m will decrease very rapidly at first, then more slowly. When L has a value of 1 henry, then I_m is about 0·5 of an ampere. An increase in L to 4 henrys causes but a slight decrease in I_m. In fact, if the functional relation be plotted, the curve appears to become asymptotic to a line $I_m = 0{\cdot}4$ approximately. The "minimum value" of the current seems to vary somewhat with the diameter of the tube, being smaller for tubes of smaller diameter. The increase of external resistance, the E.M.F. of supply being increased to correspond, effects a decrease in I_m. But in practice this is not so good a method of producing the desired result—namely, a small value of I_m—which means steadiness of operation.

Certain Voltage-current Relations.—Before proceeding to the consideration of the specific factors which determine the conductivity of a mercury vapour column, certain relations between the voltage over a tube and the current passing through it will be presented. The remarks immediately following apply to the case of a tube operating in air at ordinary room temperature. The diagrams comprehending the results are from a Paper already published by Dr. Hewitt. Fig. 3 shows the general nature of the relation between the voltage over a tube and the current passing through it. The form and position of this curve may easily be changed by altering the radiating power of the tube, and this is more especially true of the right-hand limb of the curve. This fact points towards the conclusion that the density of the vapour plays an important rôle in determining the conductivity of a vapour column.

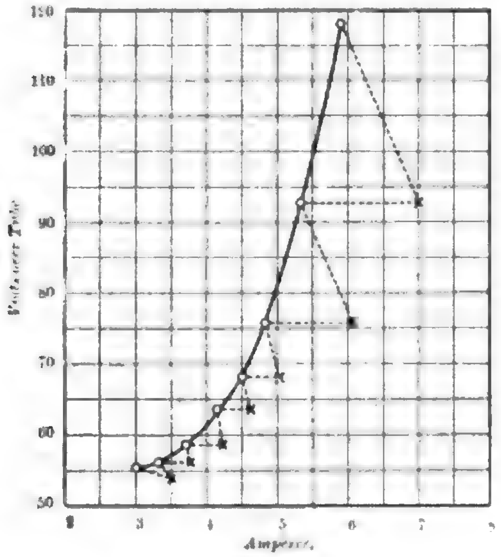


FIG. 4.

Fig. 4 is another diagram taken from Dr. Hewitt's earlier Paper. The currents employed and the diameter of the tube were such that the vapour density was an important factor in determining the conductivity of the vapour column. The points fixing the curve were obtained as follows:—The tube was started with a current of 3 amperes and the voltage over the tube taken, then the external resistance was suddenly decreased, causing an increase of current; the voltage did not immediately increase, but soon began to do so, and the current simultaneously decreased somewhat. In a few minutes the current and voltage became stationary; these were noted, and determine the second point on the curve. The other points were obtained in the same way. The points thus represent steady states. The interesting thing in connection with this experiment is the fact that considerable time is required to reach a new steady state after the current is changed. This is attributed to the sluggish variation in the vapour density following the increase in temperature due to the increase in current.

To discover experimentally the exact rôle which the density of the vapour plays in determining the conductivity of the vapour was difficult. Perhaps the most difficult thing of all was to discover what vapour density exists in a tube carrying a large current of electricity. Owing to large temperature differences between points along the axis of the tube and points near the walls, there is probably a very considerable variation in the vapour density over a cross-section of the vapour column. So far, what has been done is to find the effect of varying the mean density in a tube upon the electromotive intensity. The experiments about to be described show how this was accomplished. It was finally decided to adopt a method of experimentation which would ensure the vapour to be in a state of saturation at every point in the tube at any desired temperature while no current was flowing. Then, if the temperature corresponding to this state be known, the vapour pressure and the vapour density may be deduced with the aid of tables. Now, if a current be sent through the tube, and the drop in potential over a known length of vapour column be taken immediately, it will be that corresponding to a mean density of the vapour equal to the vapour density existing in the tube just before it was started, which is determined as described above. By repeating this procedure over a range of temperatures, the effect of variation of the vapour density upon the electromotive intensity may be found. In the application of this method it is assumed that a variation of the mean vapour density follows but slowly the introduction of the current. That this is the case has already been pointed out.

The tubes employed in the experiments to be now described were all about 60cm. in length. The diameters of these tubes varied from 1·25cm. to 5·08cm.

In making an experiment, the usual procedure was to raise the temperature to about 170 C., and to keep it stationary there for about 10 minutes before starting the tube. The desired current was started in the tube and a reading on the voltmeter taken as soon as possible, after which the current was turned off. Then the temperature was very gradually lowered and further readings taken at the temperatures selected and with the same current. The time occupied in making a set of experiments upon a given tube with a given current was usually about six hours. The vapour pressures corresponding to the temperatures selected were taken from a curve plotted from the experimental results given by Hertz. The galvanometer used in connection with the thermo-couple had a bad habit of changing its zero position in the midst of a set of experiments, and in spite of the care used to overcome this trouble it is probable that some slight errors crept in from this cause. The tubes used in the experiments vary in diameter from 1·25cm. to 5·08cm., the currents from 0·5 to 8 amperes, and the pressures employed were within the limits of 0·1mm. and 6·4mm. of mercury, corresponding to the temperatures 81·4°C. and 170·1C°. respectively.

It became evident from the numerous experiments carried out that, with the exception of values of the electromotive intensity corresponding to pressures less than ½mm. of mercury, the relation between electromotive intensity and pressure may be fairly well represented by two intersecting straight lines. The pressure corresponding to the point of intersection of these lines depends upon both the diameter of the tube and the current, and if Δ_Q be the pressure corresponding to the point of intersection, then approximately $\Delta_Q = 4\sqrt[3]{I}/\sqrt{D}$, numerically, wherein I stands for the current in amperes, and D for the diameter of the tube in centimetres. At a value of the pressure about equal to Δ_Q, the walls of the tube seem to cease to exert a restrictive action upon the conducting vapour column: the luminous column seems to leave the walls of the tube about this point and to grow less and less in diameter as the pressure increases. It appears then, that in considering the action of pressure, or rather of vapour density, in affecting the conductivity of the vapour contained in the tube, it is necessary to consider two cases—viz., case I., in which the walls of the tube exert a restrictive action upon the luminous column; case II., in which the luminous column is practically free of the walls of the tube. It was found that the results are represented with considerable accuracy by the empirical formula

$$X = a\left(b+\frac{1}{\sqrt{I}}\right)\left(c+\frac{1}{\sqrt{D}}\right)\left\{\Delta+\frac{2}{D}+\frac{1}{\sqrt{D}}\right\}+\alpha,$$

wherein X represents the electromotive intensity in volts per centimetre, I the current in amperes, D the diameter of the tube in centimetres and Δ the vapour pressure in millimetres of mercury; and wherein a, b, c and α are constants which suddenly jump in value when the pressure Δ_q is reached; the values of the constants which do not change in value when this point is reached are inserted in the formula. The numerical values of these constants are:—

	Below Δ_q.	Above Δ_q.
a	0·0545	0·150
b	0·775	0·398
c	1·71	0·122
a	0·100	0·370

The above formula gives fairly accurate results excepting in the case of the tube with the diameter 1·25cm. and current 0·5 ampere. In this case the values given by the formula are about 8 per cent too high. The formula does not represent the results for pressures below 0·3mm. of mercury. At about this pressure, the electromotive intensity assumes a value which remains nearly constant as the pressure is still further decreased. There is one objection to the method employed in the present investigation which applies particularly to small tubes, in that the method prohibits the use of very large currents, which would cause such rapid heating as to produce a considerable change in the vapour density existing in the tube before the necessary readings could be taken.

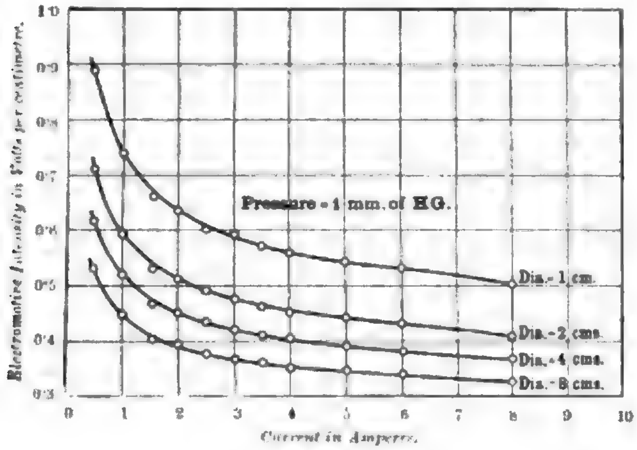


FIG. 5.

In order to exhibit the relation between electromotive intensity and current, the curves shown in Fig. 5 were plotted from the formula. The curves shown all relate to a pressure of 1mm. of mercury. The effect of current in increasing the conductivity of a tube is clearly shown. It would appear, however, as though this effect of the current may be largely due to a change in the distribution of the vapour density radially from the axis of the tube. For, as an increase in the current means more heating of the vapour in the path of the current and a consequent higher temperature, the vapour density in the path of the current will therefore be decreased, with the result that the conductivity of the tube is thereby increased. The current, as it were, throws the obstructing matter out of its path. This view seems to be supported by the fact that, when the current is small, the effect is greatest. For, in this case, there is more relatively non-conducting space near the walls into which the obstructing matter may be pushed without being still in the path of the current, which is for the most part in the neighbourhood of the axis of the tube, where the heating is greatest. As the current gets larger more and more of the available cross-section of the vapour column becomes conducting, with the result that the space into which the superfluous material may be thrust without interfering with the passage of the current becomes less. The effect of increasing the vapour density is to cause the current to become more concentrated in the neighbourhood of the axis of the tube, so the effect just described should be larger at higher densities. Another cause operates also to assist the action of the current in reducing the electromotive intensity namely, the increase in conducting area which follows an increase of current.

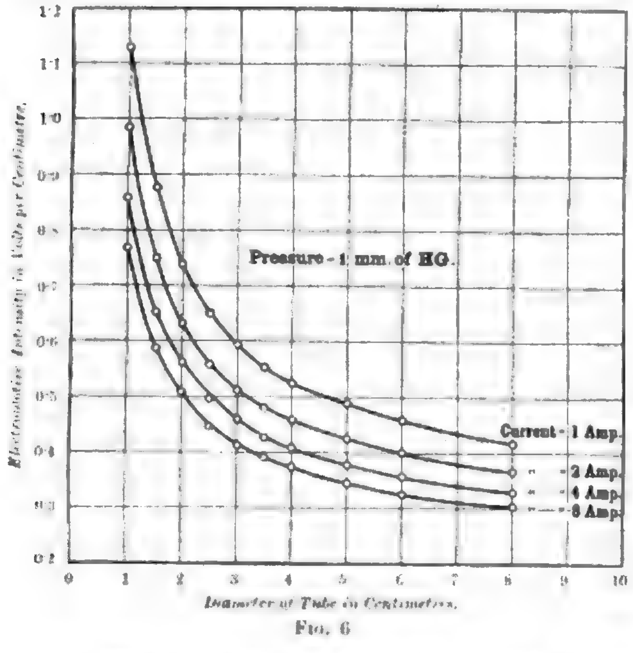


FIG. 6

The Relation between Electromotive Intensity and Diameter of Tubes.—This is exhibited in Fig. 6 for four different currents, the curves all corresponding to a pressure of 1mm. of mercury.

If the general empirical formula given above may be assumed to hold for very large currents and diameters, then the least electromotive intensity which will maintain a current in mercury vapour is somewhat greater than 0·1 of a volt per centimetre when the current is restricted, and somewhat greater than 0·37 of a volt per centimetre when it is unrestricted. It is questionable, however, if the formula be capable of such wide application. But it is most probable that a current of electricity may be maintained in mercury vapour under an electromotive intensity of less than 0·5 of a volt per centimetre.

The experiments described in this Paper were performed in the laboratory of Dr. Peter Cooper Hewitt, under his auspices, and at his instigation. I wish to acknowledge my obligations to Dr Hewitt for his cordial encouragement throughout the progress of the work.

REPORT ON HIGH-VOLTAGE TRANSMISSION LINES.

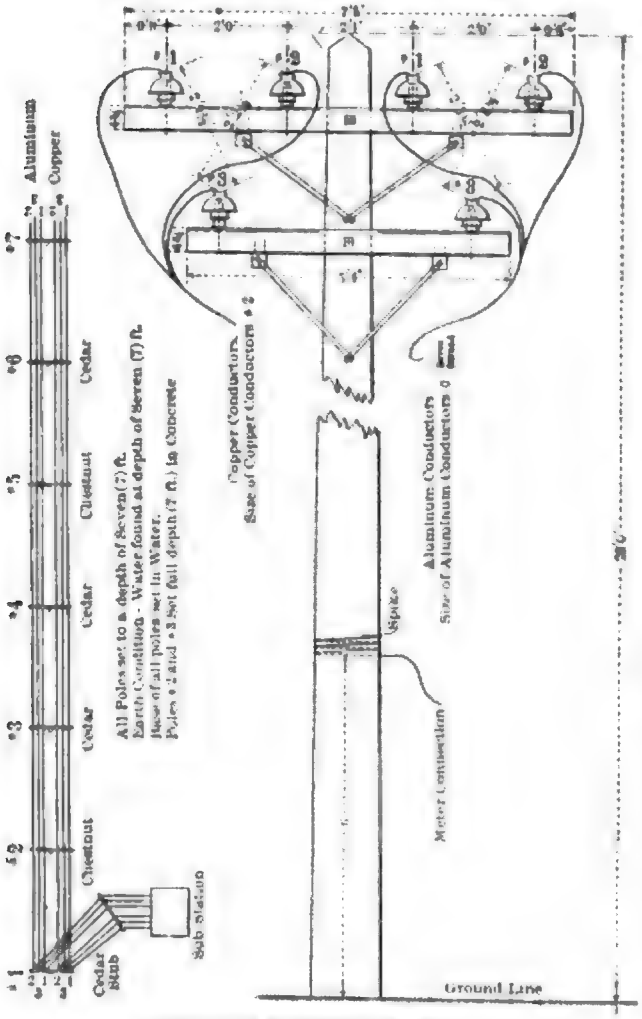
BY S. B. STORER, H. O. ROCKWELL AND R. E. DANFORTH.

The committee of the New York State Street Railway Association, appointed to investigate the dangers incident to high-voltage power transmission lines, have submitted the following report to the Association:—

The committee, in their investigations, have assumed that the principal objects to be attained were the determination of the conditions under which high-voltage power transmission lines become dangerous to the general public, and also to determine, if possible, the proper measures to be taken for the prevention of such dangers. With this end in view, and by the courtesy of Mr. C. Loomis Allen, general manager, and Mr. W. J. Harvie, Electrical Engineer, of the Utica and Mohawk Valley Railway Co., of Utica, N.Y., a short transmission line was erected and arrangements made to conveniently subject the conductors to the worst possible conditions that might arise in the operation of any high-voltage line. This experimental line was built on the railway company's property adjacent to their Frankfort sub-station, which is supplied with 20,000-volt three-phase 60-cycle alternating-current power generated at the Trenton Falls water-power plant of the Utica Gas and Electric Co. Poles Nos. 1, 3 and 6 are cedar, poles Nos. 2 and 5 are chestnut, and pole No. 4 is of iron, being a standard 4in., 5in., 6in. tubular type, 28ft. long. The wooden poles are 35ft. in length and set to a depth of 7ft. Poles Nos. 2 and 4 are set in concrete and the others set in earth in the usual way. For convenience the poles are numbered, beginning with the one adjacent to the sub-station.

A double set of cross-arms are provided, the upper one carrying four conductors and the bottom one two, arranged so that the wires on each side of the pole form an inverted triangle approximately 24in. on a side. The wires on one side of the poles were copper and those on the opposite side aluminium, all being mounted on Locke No. 100, chocolate-coloured, insulators. Tests were made, however, only on the aluminium conductors. The upper cross-arm was 7ft. 5in. long, and the lower one 5ft. 4in. long, both being 4¾in. by 4in. These cross-arms are set in gains and fastened on with a single bolt passing through the pole and supported by a one-piece galvanised iron brace which is lag-screwed to the pole, and bolted to a small angle iron attached to the arm. The above is the standard type of construction used by the Utica and Mohawk Valley Railway Co. The cross-arms on the iron pole were held in place by a collar and bolts, no braces being used.

In order to obtain the necessary high-voltage current without causing trouble to the main transmission system, two 330kw. oil-insulated, self-cooling transformers were supplied and connected so as to receive current at 360 volts, raising it to 20,000 volts for use on the experimental line. The transformers are V connected so as to transform from three phase to three-phase, giving regular working conditions. The switching of the current was all done in the low-voltage side of the transformers, in which there were also connected three alternating-current ammeters supplied by the Westinghouse Electric and Mfg. Co. for use during the tests. One meter was connected in each phase. The voltmeters used were of the Weston portable, alternating-current type and a Westinghouse static ground detector reading from 0 to 3,000 volts, all of which had been recently calibrated. One of the Weston meters had a double scale for either 150 or 300 volts and the other one a double scale for 300 or 600 volts. In order to approximate the conditions which might be met by a person leaning against a pole and receiving a shock, due to possible leakage through the pole or over its surface, an aluminium cable was wrapped around poles Nos. 2 and 3 about 6ft. from the ground, three turns being taken around each pole and a connection to the centre of the pole being made by a large spike driven into the pole and around which the ends of the aluminium cable were fastened. The difference of potential between this aluminium band around the pole and the ground would represent the maximum shock or voltage obtainable by any person leaning against the pole or coming in contact with it. With the line in normal operating condition, either wet or dry, it was impossible to find any difference of potential between these points as determined either by voltmeter or by personal contact nor could any be found when different wires were laid on cross-arms on adjacent poles until they were tied to the iron braces. With one conductor removed from the insulator and lying on top of the cross-arm, as well as being connected to the iron brace, no leakage was obtainable with the pole dry; with the pole wet after a 12 hours' hard rain, the Weston voltmeter showed a difference of potential of 90 volts. The shock obtained by personal contact was somewhat in excess of this amount owing to the higher resistance of the human body than that of the voltmeter. The closing of the voltmeter circuit between the aluminium band wire and the ground would materially reduce the shock.


7'8"
2'0"
2'0"
28'0"
Aluminium
Copper
Cedar
Chestnut
Cedar
Cedar
Chestnut
Cedar
Cedar Stub
Sub Station
All Poles set to a depth of Seven (7) ft.
Earth Condition - Water found at depth of Seven (7) ft.
Base of all poles set in Water.
Poles # 2 and # 3 Set full depth (7 ft.) in Concrete
Copper Conductors
Size of Copper Conductors # 2
Aluminium Conductors
Size of Aluminium Conductors 0
Spike
Meter Connection
Ground Line

DIAGRAMS SHOWING TEST LINE

In order to obtain severe conditions one of the other conductors was removed from its insulator on pole No. 3, laid on the cross-arm and connected to the iron brace exactly in the same manner as on pole No. 2. This arrangement gave a difference of potential of 20,000 volts between the two cross-arms on pole No. 2 and pole No. 3, and is the shortest path obtainable for the current flowing through the entire length of the poles and the intervening ground. Under these conditions, with both poles soaked after a 12 hours' hard rain, the difference of potential between the band wire on No. 2 pole and the ground was 270 volts, and that between the band wire on No. 3 pole and the ground was 170 volts. This difference was probably due to the fact that the one showing the higher difference of potential was set in concrete, while the other was in wet earth. This shows that the resistance of the concrete, even though wet, is considerably higher than that of wet earth.

As the worst possible conditions, the third wire of this line was removed from its insulator and laid on the cross-arm supported by the iron pole. It will be noted that this arrangement gave all three phases with conductors removed from their insulators and laid on the cross-arms of three consecutive poles—the two wires on the wooden poles being, in addition, tied to the iron braces—one of the poles of iron and the two wooden ones, water soaked after a heavy rain. Between the band wire on pole No. 2 and the ground the voltmeter indicated 320; between the band wire on pole No. 3 and the ground the voltmeter indicated 300; while between the iron pole and the ground there was no difference of potential—showing that although set in concrete its base probably extended through to wet earth, making a good ground.

The voltmeter was then connected in circuit between the band wire of pole No. 2 and that on pole No. 3, showing a difference of potential of 370 volts, which, by calculation from current and voltmeter resistance, shows a resistance of approximately 1,400 ohms between these two points. During a later test after several days of dry weather, the poles having been wet down with a hose, the resistance of pole No. 2 from the band wire to the ground was determined as approximately 1,780 ohms, a static voltmeter being used. This difference in resistance is due to the fact that in the later test the body of the pole contained less moisture than in the first test. The latter test also seemed to show that at least 75 per cent. of the total drop in potential occurred at the point of contact between the brace or lag screw and the pole. It should be noted that, as stated previously, the shock obtainable by a human being would be considerably in excess of that indicated by a Weston voltmeter, and would be correspondingly less than that indicated by a static voltmeter. The above results were obtained by using a line voltage of 20,000, but the effect of increasing or decreasing the line voltage would be to modify the results obtained in practically the same proportion.

The most interesting experiment performed was for the purpose of determining the possible danger to persons standing on the ground and holding a hose throwing a stream of water on either a trolley wire or a high-voltage transmission line. For the purpose of this demonstration a fire engine was secured from the village of Frankfort, and placed so as to take water from the Erie canal, which is within about 300ft. of the sub-station. A line of 3½in. hose with a 1⅛in. nozzle was carried to the experimental line, the nozzle being placed at an angle of about 60deg. and throwing the stream directly on the 600-volt trolley wire, and later on the 20,000-volt transmission wires. In neither case was it possible to obtain the slightest shock even while standing on the rail or the wet ground and holding the brass nozzle in bare hands. The length of the stream from nozzle to trolley wire was about 20ft., and about 30ft. to the transmission wires. It was also found that it was impossible to short-circuit the 20,000-volt line even by throwing the stream so as to strike two of the wires, which, as stated previously, are only 24in. apart; nor did any change in the ammeters in circuit indicate that any current passed between the two wires over the stream of water. The series of tests indicate that under certain possible conditions of high-voltage transmission, wooden poles may become sufficiently charged to render them dangerous. These conditions while possible are, however, extremely improbable, but it is, nevertheless, advisable that proper means be devised for affording necessary protection; and we therefore offer the following suggestions in relation to such protection.

It was shown that when the band wire which was wrapped around the wooden poles was grounded it was practically impossible to obtain a shock by standing on the ground and touching any portion of the pole below the band wire. We therefore suggest that all wooden poles in exposed locations, which are carrying high-voltage transmission lines, be supplied with a metal band placed tightly around the pole about 6ft. from the ground and permanently and durably connected to the ground. Where iron poles or towers are used, if they are merely set in earth no protective device of the above character is required. If they are set in concrete there might be a slight shock obtained if the concrete was very dry and covered every portion of the pole where placed in the ground. This condition can be avoided by having the pole project several inches through the concrete into the earth. Galvanised iron poles or towers set in earth without the use of concrete are, therefore, preferable as regards safety from accidental shock over any other type. For protection from possible danger due to wires carrying a high voltage breaking in and lying on the ground we would suggest that poles or towers in exposed places be fitted with thoroughly and permanently grounded iron shields or brackets which extend on each side of each pole and cross-arm to a sufficient distance and at a proper height, so that a break in the wire would cause the ends to come immediately in firm contact with the grounded shields by dropping upon them. In this case no one received a severe shock from the broken ends which might be lying on the ground or suspended within reach, as the wires would be at the same potential as the earth on which the person was standing. A grounded network suspended under the transmission wires, if properly installed, would accomplish the same results. The suggestions embodied above are the results of experiments conducted on three different occasions under widely varying conditions. The committee feels that this is a highly important subject, and demands further investigation before final recommendations are made.

EXPERIMENTS ON NERNST LAMPS.

Herr von Gaisberg has communicated to the *Elektrotechnische Zeitschrift* of October 13th the results of some life and efficiency tests on 110-volt Nernst lamps obtained by the Hamburg Inspectorate of electric lighting. The lamps were taken from stock, being of the type known as the "B pattern," with a straight filament stretched horizontally below the flat zigzag heater (illustrated in *The Electrician*, Vol. LI., p. 455). No trouble was experienced with the series resistances, which were designed for 15 volts. During the tests, the lamps were extinguished twice every 24 hours, but switched on again after having cooled down. They were equipped with globes of opal glass and the photometric measurements were made in the axis of the lamps. It is likely that the values obtained in the direction of the axis are not very different from those relating to any point within a cone with an angle of 90deg. at the apex.

Table of Results.

No. of lamps.	Hours of burning.	Mean pressure at the lamps in volts.	Consumption in watts.	Candle-power in direction of the axis. (Hefner units)	Consumption per Hefner c.p.	—
10	0	111·0	30·7	19·7	1·6	Pattern B, 0·25 a., 110 v.
10	25	109·3	29·8	14·4	2·1	
10	50	110·1	30·5	12·3	2·5	
10	75	109·9	30·0	12·4	2·4	
10	100	109·6	29·5	12·6	2·3	
10	200	109·9	29·5	12·2	2·4	
10	300	109·9	27·8	12·3	2·3	
10	400	110·0	26·7	9·4	2·8	
10	500	112·0	27·1	10·5	2·6	
10	600	110·1	22·3	7·0	3·2	
10	700	110·4	21·5	6·2	3·5	
10	0	110·5	57·4	44·4	1·3	Pattern B, 0·[illegible] a., 110 v.
10	25	112·0	57·4	29·7	1·9	
10	50	109·3	55·8	28·7	1·9	
10	75	110·3	55·5	26·5	2·1	
10	100	109·5	55·5	27·7	2·0	
10	200	109·1	54·6	27·9	2·0	
10	300	109·4	53·4	24·0	2·2	
9	400	110·4	53·7	23·6	2·3	
9	500	111·1	53·1	24·4	2·2	
7	600	111·4	49·3	19·6	2·5	
6	700	110·2	42·7	14·4	3·0	

Tramcar Collision at Halifax.—A serious tramcar collision occurred at Halifax on Friday last when a "one-man" car with "regenerative" control got beyond its driver's control, rushed down a steep gradient and dashed into a similar car just commencing the upward journey. The front of each car was smashed in and the runaway finally left the rails, overturning a waggon of the Health Department, and inflicting an injury upon the driver of the waggon. There were two passengers in the up-going car, one of whom was badly cut. The driver of the down-going car was slightly injured, but the man in charge of the up car escaped by jumping off before the collision. At the point where the car got beyond control the gradient is 1 in 12. No explanation has yet been offered as to the cause of the accident, but we are informed that the controller handle was found to have been left in the "off" position. The car was equipped with both slipper and wheel brakes.

CORRESPONDENCE.

WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to your editorial note in your issue of October 14th on the subject of a "loop" or "closed circuit" aerial wire or antenna, patented in 1903 by Mr. J. Nevil Maskelyne, I should like to draw your attention to a patent of mine, No. 14,449 of 1899, in which substantially the same arrangement has been described and claimed.—Yours, &c.,

London, E.C., Oct. 18. S. G. BROWN.

[The patent (No. 14,449 of 1899) to which Mr. Brown refers describes, among other things, the employment of two vertical wires, one attached to each side of the spark-gap in the transmitting apparatus, and one attached to each end of the coherer in the receiving apparatus. The specification proceeds: "The vertical wires may or may not be closed at the top or joined through a small capacity, and a rectangular or other shape may be given to the wires, and the rectangle may consist of more than one turn of wire, so as to enclose an area." Claim 5 of the patent is as follows:—"In wireless telegraphy the combination with a transmitting or receiving apparatus of two wires attached, one to each side of the spark-gap or coherer, and bent so as to enclose an area."—ED. *E.*]

LEGAL INTELLIGENCE.

Poole & District Electric Traction Co. v. Bournemouth Corporation.

ARBITRATION.

(Concluded from p. 1,041, Vol. LIII.)

The proceedings were concluded on Friday last, Oct. 14.

Mr. H. LLOYD, K.C., in handing in a revised list showing the weekly traffic receipts of the company from the commencement until Sept. 21, 1904, pointed out that during the last nine months of 1904 slightly less car-miles had been run than during the corresponding nine months of 1903, a few more passengers had been carried, and the receipts were slightly less. This result had been achieved during one of the best summers experienced for many years.

Mr. BALFOUR BROWNE, K.C., pointed out that although 1904 had been the best summer for many years from the point of view of weather, from the money-taking point of view this had not been so.

Mr. LLOYD replied that in Bournemouth their takings had been £1,500 in excess of the previous summer.

Mr. BALFOUR BROWNE then addressed the arbitrators on behalf of the company. In the first place he claimed that Mr. Lloyd had attempted to prejudice the case in the minds of the tribunal by his final remarks as to the number of years' purchase which, in his opinion, the sum claimed by the company would work out at. But there was really nothing in it, as the figures given did not relate to income alone, but to other rights where there was no income. Going back to the earlier part of Mr. Lloyd's speech, he said he was at once at issue with him as to the figures in the profit and loss account of the balance-sheet for 1901 not being solid figures. Mr. Lloyd had departed from the balance-sheet of 1901 in making up his estimates, despite the fact that it had been agreed between the parties that that balance-sheet was to be taken as the basis in arriving at a valuation. In effect, the Corporation claimed that the balance-sheet was not a solid figure, and although no charge was made that any of the items were untrue, yet the tribunal was asked to consider the receipts side as solid and the expenses side as unsound. It was one of the advantages which the company secured in having the balance-sheet of 1901 taken as a basis, because in that year the expenses were only 47·4 per cent. What was a solid figure? A fact; and the balance-sheet showed facts. The Corporation had all these figures before them when the agreement was sealed, yet no question was raised. Then it was claimed that something should be set aside for depreciation. He did not know why that should be. The company had 30 years unexpired of its term, and then only could the undertaking be purchased as a going concern. Therefore the company considered that they were in precisely the same position financially as a railway company, a gas company or a water company. He knew of no such company that allowed depreciation. The only depreciation that was allowed by a gas company was depreciation for works upon leasehold land, because a time must come when they came to an end. But the Poole Company never came to an end. Again, the Corporation knew that no depreciation had been allowed out of income during 1901, and yet they put their seal to the agreement. The allocation of the profits after they had been earned was a matter solely for the directors, and did not affect the profit and loss account at all. The £1,000 which Mr. Lloyd had tried to introduce was not in the balance-sheet at all, but was merely part of the distribution of the profits. Coming to the evidence, he regarded it as curious that in his speech Mr.

Lloyd had not once referred to his own witnesses, but from cross-examination it was quite clear that all their estimates had been made up irrespective of the existence of the agreement to take the balance sheet of 1901 as the basis of the valuation. Mr. Waller, for instance, had taken figures from the accounts of 1901 and 1903, whilst Mr. Baker and Mr. Hamilton had not taken a single figure from the 1901 balance-sheet. All this proved that the Corporation felt themselves in a hole and that the company had got the pull, although he would not go so far as to say that the Corporation, knowing this, had entered into an unfair agreement. Practically speaking, however, the injunction which the company obtained in 1901 affected the whole of the Corporation tramway system. And now, after entering into an agreement to purchase the Christchurch rights and the Poole extension, the Corporation said that they were worse than worthless to them. He contended that the arbitrators had no right to go into the balance-sheet except to find the multiplier to be applied in ascertaining the fair market value of the Poole undertaking as a going concern.

The UMPIRE: I want you to indicate, at some time or other, how you think our minds are to come to a conclusion as to the number of years to adopt.

Mr. BALFOUR BROWNE said that he thought the tribunal should deal with it from the point of view whether the profit of £5,622 shown in the balance-sheet of 1901 was absolutely well secured. This would be determined by the tenure, and no matter what number of years there were to run, the figure of £5,622 must be adhered to. This was how he read the section of the Act of 1902 confirming the agreement. To his mind the case was exactly the same as if the tribunal had been given the figure of £5,622 and then asked to fix the fair market value under the conditions obtaining. Supposing, for the moment, that the Corporation's view of the case that 16¼ years were sufficient, that would only give the fair market value of the existing undertaking. But the agreement expressly stated that the arbitrators should take into account the prospective increase of profits, besides the other rights and privileges of the company, as well as any other circumstances likely to be of benefit to the company during its unexpired term. That was the bargain. It might have been a bad bargain for the Corporation. No doubt it was; but it was what they had put their seal to, and it was not the case they had put before the arbitrators. Therefore, he asked that the arbitrators would address themselves to this aspect of the case, and not to the consideration of whether or no the company secured any advantage under the agreement.

Mr. LLOYD said he had just seen the traffic receipts of the company down to Oct. 13, and these showed that there was an increase of only £2. 19s. 7d. over the corresponding period of last year, and that in order to earn this extra sum 38,000 additional passengers had been carried.

The decision was reserved.

Wylie & Lockhead v. Wilkins & Bros.

At Liverpool County Court last week plaintiffs sought to recover from defendants (a firm of decorators) £5. 10s. for the use of certain electric fittings and decorations at a bazaar held at Glasgow in October, 1903. For plaintiffs, it was stated that they had been entrusted with the electric light installation at the Fine Art Institute, Glasgow, for a series of bazaars. Defendants had a contract for the installation for a three days' bazaar, to be held on dates intervening the plaintiffs' series. With a view to saving time and expense, an arrangement was come to by which, according to plaintiffs' contention, defendants hired the entire installation for a sum to be arranged. When an account was sent in for the use of fittings, defendants alleged that a sum of 20s. paid was to cover the whole.

For the defence, Mr. LORD said it was not until January that defendants knew that any further amount was claimed. Defendants had sent their electricians and all the necessary decorations and fittings to Glasgow, and only on the repeated requests of plaintiffs' representatives had they allowed their fittings to remain and be used for an agreed sum of 20s., which had been paid.

His HONOUR held that the balance of evidence was in favour of defendants, and he gave them judgment, with costs.

P.O. Telephone Wires.

At Brentford County Court, on Friday, Judge Shortt, K.C. (as arbitrator under sec. 3 of the Postal Telegraph Act, 1878), gave his award in the dispute between the Postmaster-General and Brentford District Council on the question of overhead or underground wires. The Postmaster-General intended to construct telephone lines along Ealing and Hanwell-roads, Brentford, but the local authority refused to sanction overhead wires. It was contended for the Postmaster-General that he was bound to make the service as cheap as possible in order that the lowest fees could be charged to the public, and he therefore proposed overhead wires, as the roads were rural in character and little populated. Overhead wires would cost £71. 4s. 7d., and an underground system £364. 5s. 6d.

For the respondents it was urged that the district was thoroughly served by the National Telephone Co. and that no extension was needed.

His Honour said he had visited the roads along which these lines were proposed to be run, and he was satisfied that, owing to their narrowness, they were unfit to have poles set up in them. He did not think the extra expense of putting the wires underground sufficient excuse to outweigh that view, and he therefore found for the Council. He was not satisfied that there was any pressing need for those new wires, but in any event they must be laid underground. Costs were given against the Postmaster-General.

Tramway Owners' Liabilities.

Messrs. Wild & Robbins, market gardeners, sued the London United Tramways (1901), Ltd., at Westminster (London) County Court last week for compensation for damages to a van. The evidence went to show that the van was being hauled by a traction engine, and suddenly turned on to the "off-side" track from behind another heavily-laden van too late for the motorman to avoid a collision. Plaintiffs' engine driver admitted that he had had several collisions with cars and that the one under consideration was the second on the day in question.

Judge WOODFALL found for defendants with costs, as he considered that, if he accepted the contention of plaintiffs' counsel, that the tramcar driver should have stopped when he saw the leading van, for fear something might come out from behind, it would be impossible to work tramways at all.

In another case against the same company, the Rev. M'Whatton sued for damages to a motor car. Plaintiff was driving the car at the time of the accident, and followed a van on to the "off-side" to avoid a stationary vehicle when an electric car approached. The van got clear, but plaintiff, being unable to turn in time, stopped.

Several witnesses said the motor car pulled on to the line too late for the tramcar driver to avert the accident.

In this case also the Judge found for defendants, on the ground of plaintiff's want of care.

National Telephone Co. v. Palmer.

At Haverfordwest County Court on Wednesday judgment was entered for plaintiffs in this action for breach of agreement. The facts were given in our issue of Aug. 26. It appeared that several Haverfordwest subscribers to the National Company's system alleged breach of agreement by the company, and declined to pay four years' rent at £8 per annum. The agreement stipulated that defendants would be given free use of the telephone in all towns that might be connected up in the Pembrokeshire exchange area, which embraced Milford, Neyland, Pembroke Dock and Pembroke. It was alleged by the subscribers that the company's agents represented that all those places would be joined up, but as a matter of fact neither town was connected. The claim against the present defendants was heard as a test case, and there was a counterclaim for damages caused by misrepresentation.

A verdict on the claim was agreed to, but the jury found there was a collateral agreement on the part of the company's agent by which defendants had been induced to enter into the contract, and they, therefore, found a verdict for the subscribers on the counterclaim.

His Honour held that the agreement entered into and signed by the defendants was explicit and could not be upset by anything the agent said contrary to its terms. Verdict was accordingly entered for the company on the claim and counterclaim, with costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Wolverhampton Lighting committee require a canvassing engineer, competent to prepare specifications and estimates for light and motor power installations. Particulars from the borough electrical engineer (Mr. C. E. C. Shawfield). Applications to the town clerk (Mr. Horatio Brevitt) by noon Oct. 31. See also advertisement.

An assistant electrical engineer is required by Erith District Council. Salary £150 per annum. Applications to the clerk (Mr. Chas. H. Fry), Council Offices, Bexley-road, Erith, by 10 a.m. Oct. 24.

Farnworth District Council require a chief assistant engineer. Salary £120. Applications by Oct. 31.

Applications are invited for the position of lecturer and demonstrator in electrical engineering at the school of engineering, electricity and technical science, Canterbury College, University of New Zealand. Salary £300 per annum, with saloon passage to New Zealand. Particulars of qualifications and forms of application from the Agent-General for New Zealand, 13, Victoria-street, London, S.W., to whom applications by Oct. 29. See also advertisement.

A lecturer in electricity and physics is required in January at the Municipal Technical School, Birmingham. Commencing salary £140. Particulars from the secretary, Mr. Geo. Mellor. Applications by Nov. 19. See advertisement.

A draughtsman used to transformer design and calculations is required. See advertisement.

An engineer's draughtsman, accustomed to high-tension switchboard design, is wanted in London. See advertisement.

An engine driver is required for a lighting and traction station in the Midlands. See advertisement.

Amalgamated Society of Engineers.—The proposed alteration of the rules of this Society has been approved:—

All the 64 amendments have been carried. The general effect of the changes is to weaken the power of the Executive Council, which now must give a detailed statement of its reasons for disapproving of District committee resolutions. A majority of three votes to two will be necessary before a general strike may be entered on, but a bare majority will be sufficient to reject or accept a settlement. A new clause in one of the rules stipulates that the Council may enter into conference with the Employers' Federation executive with a view to an amicable settlement of any dispute that may arise in any district of the society; but on no account shall they take any case from the district in which the dispute occurred to the Central Conference unless requested to do so by the local District committee, and then only after all local efforts have failed. The Executive Council, or any one acting on their behalf, shall not be allowed to complete an agreement with any employer or employers concerning wages, piecework prices, or system of working unless the terms of agreement are first submitted to the district or districts affected. In all cases of disagreement between the district or districts affected and the Executive Council the whole case shall be submitted to and decided by the vote of the whole society, to which both sides of the question may be put by each party concerned.

Armagh.—Mr. H. T. Harris has been appointed consulting electrical engineer to report upon electric lighting.

Australasian Preference.—The Commonwealth Government has decided, in connection with the tenders invited by the Deputy Postmaster-General of Melbourne for the supply of telegraphic and telephonic material, to allow on some of the items a preference of 15 per cent. in favour of the Commonwealth goods, and 10 per cent. in favour of those of British production or manufacture.

Bangor.—An inquiry was held last week into the application of the Council to borrow £2,300 for electric lighting extensions—viz., £1,000 for service cables, £1,000 for meters and £300 for new battery plates.

The borough electrical engineer (Mr. Price White) supplied technical details.

The Inspector (Mr. M. K. North) said he would have to inquire more closely into the item of £300 for new battery plates.

Mr. White said that when the batteries had been working for a year he discovered that the battery plates were "buckling," and it was absolutely necessary that they should be renewed. There had been two renewals of plates, the first costing £187. 19s. 6d. and the second £176 6s. 2d. There had not been a maintenance clause in the original contract, the committee having been advised that it would be cheaper to maintain the batteries themselves. In future they proposed to insist on a maintenance clause.

Bedford.—An unopposed inquiry was held on Friday into the application of the Council for sanction to borrow £39,950 for electric lighting extensions.

Bermondsey (London).—31,500 8 c.p. lamps have been applied for up to Oct. 18 by private persons (189 in number), or, including public lighting, 34,495.

Bexhill.—An inquiry was held here last week into the application of the Council to borrow £3,500 for electric lighting extensions.

Bishops Stortford.—The Council have resolved to apply for a provisional electric lighting order.

Bradford.—The annual report of the Tramways department was adopted by the Tramways committee on Monday.

Some minor extensions were made during the past year, and it is considered that nearly every part of the city is well served with tramways. The electrical equipment of new sections with direct labour has, the committee state, been again executed with satisfactory results. The route length of tramways worked by the Corporation has increased from 45 to 63 miles, which includes over 10 miles outside the borough boundary. The tram-cars carried the total population served (about 324,000) 134 times during the year. The car-mileage increased by 502,884 miles and the receipts by £29,353. On April 30 last the department took over the Shipley tramways, by arrangement with Shipley Council and the Mid-Yorkshire Tramways Co. On Dec. 19 the new section from Forster-square to the junction of Otley-road with Barkerend-road was opened, and some improvements had been made in the city termini. The new car shed at Saltaire had been opened. On land acquired at Bowling it was proposed to erect a permanent-way depot, car shed and apparatus for screening the material from the slag heap for use as "grit" on the track and for purposes connected with the permanent way department. There were 239 cars fully equipped, the whole of which had been in service. 100 cars had been fitted with covered tops and seem to have been appreciated by the travelling public. Whilst the car tops certainly increased the expenditure, it was hoped that the increase in revenue would more than counterbalance that. The committee, after considerable experience with chilled iron wheels, had decided to adopt steel tyres, and hoped in that way to effect considerable saving in car maintenance and repairs. No less than £28,526, or 1·48d. per car-mile, was spent during the financial year ending March in repairs, renewals, cleaning and inspection of rolling stock.

Correspondence has passed between the Board of Trade and the Tramways committee as to the regulation of the Board insisting upon a "headway" of 6 clear feet between the floor of the top deck of the tramcar and the arch of the railway bridge at Eccleshill.

There is little more than an inch less than this space, but by using the cars taken over from the Mid-Yorkshire Tramways Co., and certain others that the Tramway committee are running, the required space would be obtained, and the committee suggest to the Board that they should run none but those cars on the Greengates section.

With regard to standing in tramcars, the committee decided to adhere to their previous resolution that 10 persons should be allowed to stand inside a car, the total number not to exceed the number which the cars are certified to carry inside and out.

Bradford Education committee propose to add a textile department to their technical college at an estimated cost of £45,000. Electric driving will be adopted throughout.

Brentford.—Four companies have served notices upon the District Council of intention to apply for provisional orders, and negotiations have been opened with two of them. On the recommendation of the General Purposes committee, it has now been resolved "that the time has not yet arrived for the lighting of the town by electricity," and the Council are advised to withhold their consent to any scheme for at least 12 months.

Buenos Ayres.—Hitherto the mayor has claimed the right to levy 20 cents per lineal metre every time the tramway rails are changed, as a charge for the giving of the levels. The Council have now decided that once the level has been given, the rails can be changed without further payment of the tax.

Burslem.—The Council have been advised that authority to supply electricity in bulk to Tunstall Council cannot be obtained by provisional order, and a deputation has been appointed to meet representatives of Tunstall Council to discuss the question of promoting a bill in Parliament.

Canterbury.—An unopposed inquiry was held here last week into the application of the City Council to borrow £10,000 for additional machinery for the electricity works.

Carlisle.—Sanction has been obtained to a further loan of £5,000 for extensions of the electric lighting mains. The Council have secured the contract for the supply of electric current to the North British Railway Canal Goods Yard.

Cheltenham.—On the 13th inst. Mr. James Swinburne (who was nominated by the president of the Institution of Civil Engineers, at the request of Cheltenham Town Council, to investigate the working of the electrical undertaking and report as to its management) attended at the Town Hall for the purpose of hearing representations concerning the undertaking from ratepayers.

Mr. W. Ansell, appeared for the Ratepayers' Association, and in a lengthy speech, attempted to substantiate the truth of criticisms and allegations of mismanagement made by himself at a recent town's meeting. His criticism was levelled against the Electricity committee under Ald. Norman's chairmanship. He contended that this committee had never grasped the business side of the question, but had left matters mainly in the hands of Ald. Norman and the engineer (Mr. Hamilton Kilgour). He proceeded to mention instances in which amounts varying from £200 to £400 had been expended in making extensions of mains to private houses the annual receipts from which for the supply of energy fell short of the capital charge on the extensions.

Mr. Kilgour here pointed out that in several cases the amount sanctioned was more than that actually spent, and that the extension, once made, had been available for other customers.

Mr. Swinburne observed that the locality of the extensions had to be taken into account before the Council could be convicted of bad judgment.

Mr. Ansell argued that in more than 50 per cent. of the extensions outside the compulsory area loss had been incurred, and he blamed the Corporation for not safeguarding the interests of ratepayers in those instances by insisting on guarantees or contributions from customers towards capital outlay. He contended that the Corporation had supplied current to private consumers and for traction to the light railway company at unremunerative prices. He also referred to the absence of depreciation and machinery antiquation accounts, the neglect to ask for open tenders for plant and the policy of allowing the yearly deficits on the undertaking to accumulate instead of wiping them out year by year as the provisional order required.

Councillor Ley Wood stated in reference to this latter point that it was impossible, without fresh legislation, to make the ratepayers pay the £17,000 of accumulated deficiency, and that it would be hard on the present ratepayers if they were compelled to bear a burden which ought to have fallen on their predecessors.

Other prominent ratepayers addressed the inspector, who, in closing the inquiry, remarked that, so far, he had heard only one side of the matter; the other side would present their case in due course.

Church Lighting.—Electric lighting at St. Paul's Established Church, Perth, was inaugurated on Sunday last. A local firm (Messrs. McLeish, Morrison & Co.) carried out the wiring and fitting work.

Cottage Lighting.—Twenty additional cottages at Tooting will be handed over by the contractors to the London County Council in a few days. Each room in these houses is lighted electrically at 1d. (in the slot) per light for about six hours.

Croydon.—The Council have authorised application being made for powers to extend the tramway system to South Norwood-hill.

Darlington.—The charge for electric current for private lighting has been reduced from 5d. to 4½d. per unit for the first 1,000 units, to 4¼d. for the next 2,000 and to 4d. for over 3,000 units per annum.

Derby.—Messrs. J. G. White & Co. inform us that the question between the Derby Corporation and themselves of delay in execution of works has been amicably settled. It is understood that the work actually carried out was largely in excess of the contract requirements, and involved numerous changes in the specifications.

Devonport.—The Corporation have decided to apply for an additional loan of £7,958 for extensions of the electric lighting undertaking.

Dover.—The Rural District Council have consented to the application of the Corporation for a provisional electric lighting order for the rural parishes round Dover, including St. Margarets.

Dublin.—An inquiry was held on Tuesday into the application of the Corporation for permission to borrow £21,000 for their electric lighting scheme.

For the Corporation, Mr. O'Brien, K.C., said the necessity for the loan arose from the absolutely unexpected success of the electric lighting scheme. When the original estimates were prepared they were made on a certain anticipated demand, but they now wanted additional machinery, &c., as the demand had exceeded their most sanguine hopes. The Corporation were bound to supply electric current to everyone who demanded it in the electric lighting area under a penalty of £2.

Mr. F. J. Allan, secretary of the Lighting committee, gave evidence as to the progress made by the electric lighting in the city. On March 31, 1903, there were 319 consumers, but up to Oct. 13, 1904, the number of new agreements entered into numbered 580. Two of these were cut off and 35 were extensions of existing installations. The total number of equivalent 8 c.p. lamps was 79,042, but there were 8,440 lamps still awaiting connection.

The city electrical engineer (Mr. Mark Ruddle) stated that it was necessary to provide additional plant in order to meet the increased demand for electric lighting.

In cross-examination by Mr. Chambers (who represented opposing ratepayers), Mr. Ruddle stated that for the past 12 months it was arranged that Mr. Robert Hammond should have a salary of 1,000 guineas for supervising the works, but he did not know whether he had had it. He estimated the cost of production, including allowance to Mr Hammond, wages, coal, oil, &c., at 2·58d. per unit. With the amount needed for repaying loans the cost per unit would be 5·63d. The revenue derived from the public lighting he estimated at 4·41d. per unit.

The Inspector (Mr. Cowan): You are only getting 4d.; in that case you are losing?

Mr. Chambers: Taking interest and sinking fund at 3·1d. and the cost of production at 2·58d., if you are selling at under 4d., you must be losing?—That is, the average price for public as well as private lighting. The average price for public lighting was £22 per arc lamp. There were 456 arc lamps. Private lighting was, of course, on a higher scale than public lighting. The private lighting came to £15,514. The cost of private lighting was 4·4d. and of public lighting 2·05d. per unit. It would be necessary to spend £25,000 on the old lighting area to make the supply there proper and efficient under the new system. He estimated that in 15 months there would be an increased demand of 50 per cent., and the cost per unit would be reduced as the output grow.

Mr. J. Irwin, J.P., chairman of the Lighting committee, said a Corporation, unlike a company, was paying back its capital, and in the earlier years that was a heavy drain on the undertaking. The loss on the undertaking so far was £10,000 or £11,000 a year. The offers made by Mr. Hammond to take over the undertaking for a certain period would come up for consideration before the next meeting of the Council.

In cross-examination, with a view of showing that the present loan would would be inadequate to meet future developments, Mr. Irwin said the matter had been fully discussed by the committee. Notwithstanding a loss of £42,000 on the undertaking, he believed it would eventually pay. The total capital expenditure was £347,500, and the gross profit was £15,027, equal to 4½ per cent. on that capital.

The Inspector said it was true the ratepayers had to meet £17,847 a year more than they had to meet before the starting of the electric lighting, so that they were paying 5d. in the £, but they had for that a very much better lighted city.

Mr. Irwin said that was so, and the 5d. in the £ would be the most the citizens would be called upon to pay. He thought the provision for depreciation quite sufficient, and under careful management that 5d. in the £ could be reduced he felt satisfied.

Mr. R. Knowles, electrical engineer, said he had been superintendent of the works at the Pigeon House station. They were well designed and economically worked. There was no difficulty in running the condensers regularly, except occasionally at low tides, and, since the alterations, that would only occur once in six months.

Mr. Robert Hammond considered there was great misapprehension in saying that it required £25,000 to complete the scheme. He did mention that if another 1,000kw. supply was required they would have to spend another £40,000 in generating plant, but as far as the original scheme was concerned, he did not think it right that it should be added to as part of the original scheme by the expenditure of money on mains beyond those which the original scheme contemplated. Every yard of Prof. Kennedy's mains originally laid down was used by him. He was told he had to utilise the present distributing site in Fleet-street, and he quite concurred with that. Then he was asked to make an estimate for very largely extending the public arc lighting, and the result was that, in consultation with the city surveyor (Mr. Harty), he drew up a list of streets for that purpose. His further task was to devise a system of distributing mains outside the old area. The only proposal which was not carried out was the raising of the voltage in the old area. If it were decided by the Corporation to raise the voltage, they could do so; there was not the slightest difficulty. Mr. Hammond then dealt with the defects in the original plant. From time to time he had mentioned these things, but he had no power until he made the formal tests, and then, he was bound to say, that in some respects the plant was faulty. The day had not yet arrived for an official test of the new plant. He was pleased with the way the engines were working, but when he tested them he would reject them if they were not satisfactory. Mr. Ruddle had included in the cost his (witness's) 1,000 guineas for supervision, which was not to be paid to him every year. The operation of the new undertaking had convinced him of the soundness of his estimate in his original report of the possibility of generating and delivering electricity in the city at 3½d. per unit. They had agreed that the generating cost for the year ending March 31, 1905 would be 1·59d. unit. That was not an optimistic figure. It was with reference to the original plant and well within its capacity. So long as he was consulting engineer to the Corporation he was bound to fight the city's battle. He had said that he would be willing to take over the scheme. Well, he did not want to interfere with the city's control of its electricity undertaking, but if the city was afraid of it he would take the responsibility on his own shoulders.

The inquiry was adjourned.

Dunblane (Scotland).—The gas company have declined the Town Council's offer of £8,000 for the gas works, and the Council are now considering the desirability of adopting electric lighting.

Dunfermline.—Mr. W. B. Sayers has been called in by the Corporation to advise whether they shall proceed to negotiate with the Fife Electric Power Co. for the supply of electricity in bulk or construct and equip municipal works.

Electric Power in Docks.—At the new graving dock in the shipbuilding yard of Messrs. Robert Stephenson & Co., Hebburn-on-Tyne, there is a complete electric light and power plant, comprising two sets of 650 H.P. triple expansion engines, driving two Westinghouse dynamos, generating current at 250 volts. In the new platers' shed, as well as throughout the yard, the machinery is worked either electrically or hydraulically, nearly all the machinery having separate motors. There are also two large electric cranes. The dock has been constructed by Robert McAlpine & Sons, Glasgow, to the designs and under the superintendence of Thomas Meek & Sons, of Westminster.

Electrical Contractors' Association (Incorporated).—The first annual general meeting was held on Tuesday for the purpose of considering the report of the central board, and for the transaction of the ordinary business of the Association.

Mr. W. R. Rawlings (in the chair) welcomed the representatives from Ireland, Scotland and the provinces to London, and recounted the earlier history of the association. He referred to the negotiations and agreement with the manufacturing houses, and urged members to act loyally to this agreement. He eulogised the work of the joint committee and mentioned the opposition offered to Sheffield Corporation. After dwelling at length on the reconstitution and the incorporation of the Association, he explained the composition of the central board, sectional boards and local branches.

The Treasurer presented his financial statement, showing a deficit of £165. 10s. 6d. This, he said, was more apparent than real, as the subscriptions due May 1 last had not yet been called in. These would pay all outstanding accounts, and leave a balance of about £100.

Mr. Martin (Glasgow) moved the adoption of the balance sheet, and Mr. Wallis (Leeds) seconded, the motion being carried unanimously.

Mr. Steinthal proposed that the subscriptions for members of all classes should be £2. 2s. per annum, and that the entrance fee for members and fellows be £2. 2s., and for associates £1. 1s. The motion was carried, with two dissentients.

Mr. McDermot moved that the meeting accept the recommendation of the central board, and confirm the purchase of the "Electrical Contractor" for £200.—Carried.

Some further business, upon which some divergence of views was manifested followed.

Reports were received from the sectional boards for London, Manchester and Glasgow.

Mr. R. Tweedie Smith then gave an address on "Municipal Trading."

Mr. Woodward moved that the Association oppose municipal trading in so far as it affected the electrical profession.—Carried unanimously.

The President read a letter from the Manufacturers' Association giving notice to terminate the agreement on Dec. 31 next.

A vote of thanks concluded the proceedings.

Electrical Mining Machinery Contract.—Messrs. Scott & Mountain, of Close Works, Newcastle-on-Tyne, have secured a contract from the Alquife Mines & Railway Co. for a complete electrical plant for their mines in the South of Spain. This installation is of interest on account of water power being used. The Mining Company have secured the water rights of the Rio Alcazer, where, under the worst conditions, from 300 H.P. to 400 H.P., with a fall of 280ft., is available.

The electrical plant consists of a 300 H.P. double Pelton wheel with a special form of governor, the turbine being fitted with a heavy flywheel and directly coupled to a Scott & Mountain three-phase alternating-current generator of 250kw. capacity. This generator delivers three-phase current at an E.M.F. of 500 volts to a transformer, where it is transformed to 5,500 volts, and conveyed from the power station to the mine, a distance of nearly 10,000yds., by bare overhead cables. At the mine the current is again transformed down to 500 volts by step-down transformers for the power motors and to 250 volts for the lighting of the private houses, workshops and offices. There will also be installed at the mine two motors of 100 H.P. each for driving the briquetting machinery, six 15 H.P. motors for driving elevators, &c., and nine 5 H.P. motors for driving the feeding gear from the kilns, hoists, workshops, &c. About 275 incandescents will light the workshops, offices, &c.

Electrical Power Afloat.—Mr. Henry Burrell, of Glasgow, is the inventor of an electrical arrangement for handling cargo on board steam-driven vessels, and he informs us that the Clyde is about to assume the lead in the progress of ship equipment by the adoption of electricity as the prime mover for economically handling such cargo instead of the conventional steam winch. Under Mr. Burrell's method the usual derricks are to be dispensed with and in their place a complete system of electric cranes is to be substituted, fixed two abreast, and so placed that two pairs of cranes can work alternately into one hold, either with a port and starboard delivery, or into a double-tiered warehouse. Electrical energy is to be generated in a specially-provided room in the after end of the vessel by steam turbo-dynamo sets of large size. The vessel is to be provided with a common switchboard for power and lighting, each crane having a separate D.P. switch and fuse, power being carried to the crane by concentric cables. These cranes are not only to be well adapted for ordinary mixed cargoes, but are to be specially designed to withstand the heavy racking work of dealing with coal or ore by crabs, and it is considered that in this class of work their value is likely to be mostpronounced, owing to the avoidance of manual labour by their means. Provision is made in Mr. Burrell's scheme for night work by the electrical illumination of the working area of the cranes, cluster lamps being fixed on the jib. In an illustration which accompanies Mr. Burrell's particulars the general arrangement of turbos, cranes, &c., is shown.

Electricity Meter Litigation.—We recently announced that the British Westinghouse Co. were commencing an action against Ferranti Limited for infringement of meter patents. We have been asked to state that Ferranti Limited are defending this action, and are prepared to give indemnities to anyone using their meters who may consider this indemnification necessary.

Embankment Tramway.—At the meeting of the Court of Common Council (City of London) yesterday (Thursday), a letter was read from London County Council seeking consent to the proposal for connecting up the present tramway termini at Blackfriars and Westminster by the construction of tramways between those points, via Blackfriars Bridge, Victoria Embankment and Westminster Bridge. The communication was referred to the Streets and Bridge House Estates committee.

Exeter.—The total income of the electricity department for the year ended March 31 was £10,398. 16s. 11d. and the expenditure £6,252. 8s. 11d., leaving gross profit £4,070. 12s. 6d.

Interest required £1,832. 1s 2d. and sinking fund £1,120, leaving net profit £1,118. 11s. 4d. The capital expenditure was £82,279. 3s. 6d. 441,879 units were sold, including 361,028 to private consumers and 75,427 for public lighting. The total maximum supply demanded was 452kw.

Farnborough.—The Board of Trade propose to revoke the Farnborough Electric Lighting Order, 1899.

Fulham (London).—The electrical engineer (Mr. A. J. Fuller) reported at the Council meeting on Wednesday that of the £52,042 voted for extensions to the electricity undertaking work to the value of £10,242 was already in hand. He proposed to call for various tenders and to give orders for the remainder of the vote. Mr. Fuller described the various works and plant upon which expenditure was to be incurred, and the proposals were adopted.

Hackney (London).—For the year ended March 31 the total income of the electricity department was £26,692. 11s. 8d., and the total annual expenses £10,502. 8s. 10d., leaving gross profit £16,190. 2s. 10d.

Interest absorbed £6,577. 8s. 10d., redemption of loans £1,682. 8s. 5d., and reserve for accrued principal and interest £2,450. 17s. 1d., leaving a net profit of £5,546. The equivalent of 94,016 8 c.p. lamps (including 178 motors, with an aggregate of 614 H.P.) was connected to the mains. 2,548,083 units were generated. 582,475 were supplied for public lighting at 2d. per unit, and 1,598,916 to private consumers at an average of 3·28d. Works costs were 0·73d. per unit, a reduction of 0·06d. on the previous year. Total works costs were 1·04d., or an increase of 0·01d. The total maximum supply demanded was 1,479kw., and the load factor was 16·83, against 18·88. The total capital expenditure was £246,575. 14s. 9d., an increase of £31,344. 19s. 4d. during the year.

Halifax Tramways.—The Brighouse-Bailiffe Bridge electric tramway route is now open for traffic.

Hammersmith (London).—A statement as to extensions to the electric lighting plant was submitted to the Council by the Finance committee on Wednesday.

The sum voted was £40,000, which it was proposed to spend as follows:—Three boilers, including brickwork, feed-water heater, forced draught apparatus, economiser, pumps, piping, &c., £12,100 (total of contracts accepted to date £4,899); two 1,500kw. turbo-alternators, condensers, &c., £20,000 (total of contracts accepted £18,482. 10s.); ash conveyor, tank, battery, chimney, flues, extension of condensing main, buildings, &c., £5,900 (total of contracts accepted £2,067. 6s.); sundries, £2,000. The statement was approved.

Hanwell.—The Council have decided to ask Ealing Corporation and the Harrow Electric Light & Power Co. upon what terms they would be willing to supply electricity in bulk to the district, and, in the meantime, Hanwell Council are considering the advisability of appointing a consulting engineer.

Hastings.—At the last meeting of the Council it was reported that a communication had been received from the Local Government Board stating that the Board had had under consideration the report made by their inspector (Mr. Boulnois) after the inquiry held by him into the application of the Council for sanction to borrow £3,416 for electric lighting.

The Board observed that the accounts of the electricity department for 1900-3 inclusive showed a loss on each year's working, and only during the last year had any sum been raised by rate towards meeting those deficits, the deficits carried forward on Dec. 31, 1903, amounting to £4,468. 8s. 11d. The Board desired to know what steps the Council intended to take with a view of wiping out this deficit, and to prevent a recurrence of such deficits.

In reply, the Electricity committee informed the Board that, in addition to the provision of £1,500 made in the estimate for the current year, the committee intended to recommend the Council to raise and set aside a similar sum of £1,500 yearly until the deficiency had been wiped out, unless in the meantime, through more successful working of the undertaking, the revenue might be found sufficient to cover any then existing deficiency.

In a later communication the Board wanted a copy of a resolution of the Council undertaking to set aside a yearly sum of £1,500 for wiping out the deficit, and the committee accordingly recommended that the Council undertake to appropriate £1,500 yearly out of the general district rate for the purpose of wiping out the deficiency.

After considerable discussion, the recommendation was adopted.

Handsworth Tramways.—The Board of Trade inspection of the new route from New Inns to Kinver (14 miles) took place yesterday (Thursday).

Heywood.—The Council have paid £20,289 to the old tramway company as the Council's share of the purchase price of the company's undertaking, but have failed to come to a working arrangement with Bury and Rochdale, who ask 5d. per car-mile run in Heywood. Heywood offers 4½d.

Huddersfield.—The capital outlay on the tramways to date is £414,969. The receipts for the past six months were £37,371, and working expenses £19,199. The gross surplus was £18,171. £12,390 was required for interest and redemption of debt, leaving a net surplus of £5,781, but without provision for depreciation.

On the recommendation of the Electricity committee, sanction has been sought for a loan of £4,800 for giving a supply of electricity to Golcar.

Islington (London).—Estimates amounting to £668 for extensions of mains have been approved by the Finance committee.

Jamaica.—Electric lighting is, it is announced, to be installed at St. Ann's Bay.

Keighley.—For the year ended June 30 the total revenue was £2,922. 8s., compared with £2,102. 1s. 10½d. in 1902-3. The expenditure was £2,090. 14s. 9d., against £1,933. 19s. 6d., and the gross profit was £881. 13s. 9d.

After paying interest, sinking fund, &c., the deficit was £1,622. 10s. 2d., against £1,850. 12s. 8½d. Units sold amounted to 184,307, an increase of 46,586. Generation costs per unit were 1·41d., total works costs 2·40d., and the total cost (including interest and sinking fund) 5·60d. The maximum load was 140kw., and the average price obtained 3·61d. per unit. There were 176 consumers, and the motors connected represented 192 H.P. Total capital expenditure is £48,556. 9s. 3d.

The Board of Trade have approved the Council's proposed tramway scheme.

Leeds.—The accounts of the city tramways for the half-year ended Sept. 29 were submitted to the Tramways committee on Monday.

Receipts were £161,089 5s. 10d., against £151,367. 15s. for the corresponding period last year, an increase of £9,721. 10s. 10d. Working costs were £83,500. 6s. 2d., against £80,635. 5s. 10d., but in the last half-year upwards of £3,000 was spent on maintenance of permanent way. From the gross profit of £77,585 have to be deducted depreciation, interest and sinking fund, leaving an estimated net profit of £39,293. 15s. 5d., against £36,890. 6s.

The Corporation are recommended to give a supply of electric current in Kirkstall.

Liverpool.—At the final meeting of the Electric Power and Lighting committee on Wednesday the chairman (Mr. R. Dart) stated that the number of consumers of electricity in the city had increased during the year from 4,790 to 5,345.

The energy supplied for lighting and power showed an increase of 20 per cent. over last year, and for tramways 12½ per cent., the increase on the total output being 15 per cent. The new power station at Lister drive would be ready in a few weeks, and additional plant was being provided for sub-stations. The city was at present lighted by 18,312 electric and gas lamps.

The chairman of the Tramways committee (Sir Chas. Petrie) also gave an interesting account of the progress made during the year. During the nine months of the present year (he said) there had been an increase of 3¼ per cent. in passenger traffic and in receipts of 3½ per cent. The committee had for some time been considering the question of extending the tramways and had recommended the City Council to obtain Parliamentary powers to construct about 33½ miles of additional line. The fatalities in connection with the tramways continued to steadily decline, the ratio to passengers carried being 1 in 29,000,000, against 1 in 28,000,000 last year, and against 1 in 5,000,000 in the last year of horse traction. The committee had authorised 350 cars to be fitted with top covers, all of which would, it was hoped be in service before the end of the winter. After maintaining efficiently the whole system out of revenue, and providing for sinking fund, there was set aside £64,161 to reserve, renewal and depreciation fund, leaving a balance of £32,080, which was transferred to relief of rates. The question of the carriage of parcels and light merchandise had been receiving close attention, and it was thought that a scheme might be usefully propounded dealing with this phase of tramway work at an early date.

London County Council.—At Tuesday's meeting the Finance committee reported that the average price obtained for the issue of £1 463,000 required for the Marylebone electricity undertaking loan had been £96. 14s. 10d. per cent.

Electric Lighting.—It was resolved that the electrical staff of the Council should carry out the work of substituting electric lighting for gas at the tramway offices at Camberwell at an estimated cost of £350.

London County Council Tramways.—The Council have already parliamentary authority to double the track of and to convert to electric traction the Lewisham portion of the Catford—Greenwich tramways, and to construct electric tramways from Lewisham High-road, through Brockley to Park-road, from New Cross to Lewisham Obelisk, and from High-street, Lewisham, to Lee Green. Lewisham ratepayers have petitioned the Borough Council to endeavour to secure the extension of the Brockley and Park-road line, through Sydenham, and its continuation in a semi-circular route via Bell Green and Perry Vale back to Catford. It is also suggested that the Camberwell line should be extended on to Forest Hill, and that the Brockley line should further be linked up with Catford by a tramway through to Forest Hill.

London United Tramways.—A conference of local authorities through whose districts these lines run will be held at Ealing on Monday to discuss the question of the noises alleged to be caused by the tramcars, and the desirability of taking combined action on the subject.

Mexico.—Senor A. Lefebvre has made application to the Government for a concession for the utilisation of water power from the River Amacuzac, Tetecala (Morelos), for the production of electric power, &c.

Misdeclaration.—The subject of the misdeclaration of goods delivered to the railway companies at the different ports of entry into this country from the Continent and abroad has reached such a point that it has been stated to represent at some ports no less than 80 per cent. of the packages examined of late, and the various Chambers of Commerce are agitating this matter with a view to securing a more regular and exhaustive examination of goods at the ports of entry. It is said that freight advantages varying from 25 to 40 per cent. have been secured in this illegal and dishonest manner, to the detriment of the home trader. The agitation is likely to lead to an important conference between traders and the railway officials with a view to improving the present condition of affairs, and possibly amending the classification in such manner as to make it less unwieldy than at present.

Municipal Telephony.—A correspondent of the "Western Mail" contributed to the issue of that journal for Oct. 11 some comments upon the application of Swansea Corporation to borrow a further sum of £2,000 for telephonic extensions. The communication is a lengthy one, and the writer holds strong views on the subject of municipal telephony in general and the Swansea installation in particular. The communication would, we think, have carried more weight had the writer's name been appended thereto.

North London Tramways.—Stoke Newington Council have instructed their delegates to the forthcoming conference on the electrification of the above tramways to offer no opposition to the overhead system of traction for the Moorgate-street-Manor House route.

Paignton.—A site has been acquired for electricity works.

Panama.—It is announced that a contract has been signed with an American company for the establishment of a system of wireless telegraphy between Bocas del Toro and Colon on the one hand and Bocas del Toro and Port Limon (Costa Rica) on the other. A similar system is to be installed to connect Colon with Panama, and thence with several other districts in South America. The published particulars state that the first-named line is due to be opened within 12 months, the last-named in 18 months, and the continuation from Panama within two years. The system selected is not given.

The value of electrical apparatus imported into Panama for the year 1903 was £336, almost entirely of American manufacture, France standing for £40.

Perth.—On Thursday last the Council decided by 18 votes to 9 to proceed as soon as possible with the conversion of the existing horse tramways to electric traction. The estimated cost of the scheme is about £70,000. The burgh electrical engineer (Mr. John Lambert) has been instructed to report as to the additional plant required at the electricity works for supplying current to the tramways

Poplar (London).—The borough electrical engineer and manager (Mr. P. N. Hooper) has tendered his resignation and this has been accepted with regret by the Council, who have acceded to Mr. Hooper's application for a testimonial under seal. Advertisements are to be issued inviting applications for the vacant position at a commencing salary of £400 per annum.

Russia.—As the Archangel municipal authorities have failed to come to terms with any contractor, the scheme for the electric lighting of the town remains in abeyance, while the project for establishing an electric tramway has been abandoned. Large extensions of the coast telegraphs in this district have been made, the line now reaching within 75 miles of Cape Sweetnose, to which point it is to be extended in the near future.

Salford.—The traffic receipts of the tramways department for the past year were £198,422. 7s. 6d. With £161. 18s. 1d. received from Manchester Corporation as proportion of fares for working the Bury Old-road lines, and £68. 15s. 8d. recovered for damage to cars, the total was £198,646 1s. 8d.

Expenditure was £138,541. 6s. 4d., showing gross profit £60,106. 14s. 11d. Current cost £47,986. 10s. 2d.; traffic expenses were £57,508. 17s. 1d., of which £40,494 was for wages of motormen, &c.; £7,649 13s. 4d. was wages for cleaners, oilers, &c.; and £1,429 17s. 3d. wages of clerks and inspectors. £2,185 was paid to Manchester for hire of cars. After paying interest and sinking fund (£34,005. 14s. 2d.), rents of lines (£10,903. 4s. 5d.), providing for depreciation and renewals (£1,439 19s 1d.), the balance (£12,000) was transferred to the borough fund in aid of rates. The total capital expenditure was £160,807. 17s. 6d. The total liabilities at March 31 amounted to £612,892 10s. 9d., and the assets to £575,064. 17s. 6d. The report states that the high price paid for current (2d. per unit, less 2½ per cent.) has seriously hampered the Tramways committee during the year, and the charge has since been reduced to 1½d. net.

The accounts of the electricity department show total revenue £68,767. The expenditure was £25,907, leaving a gross profit of £42,860. After liquidating a deficiency of £2,394 on last year's account and paying £31,086 in interest and redemption of loans, &c., the committee placed £8,000 to depreciation and renewals fund, and the balance (£1,380) was transferred to the district fund in relief of rates. The capital expenditure for the year ended March was £48,233. The total liabilities amount to £521,537 and the assets to £563,693

School Lighting.—Finchley higher elementary schools, which were recently opened by Lord Stanley of Alderley, are lighted electrically, as is the four-dial clock in the tower above the building.

Scunthorpe.—Application has been made for sanction to a loan of £4,500 for electricity supply.

South Australia.—A bill has been introduced to authorise the Government to purchase certain tramways in and around Adelaide at prices to be fixed by arbitration (failing agreement), but giving the Government power to decline to carry out the purchase if the award is unsatisfactory to them. The Government will, however, be able to again exercise the right of compulsory purchase after two years. The bill further seeks power to lease the tramways to companies or to sell same to municipalities, to equip tramways electrically, and to re-acquire the undertakings from lessees after 14 years.

South Perth (W. Australia).—This rising residential suburb, which is at present without any system of public lighting, is shortly to have an electric light supply, the Council having granted a 21 years' concession to Messrs. J. Barre Johnston & Co., Perth. It is proposed to instal at the commencement a plant sufficient for about 1,700 8 c.p. lamps, including Babcock & Wilcox water-tube boilers, steam dynamos, balancer and switchboard. Distribution will be on the continuous-current three-wire system, at 460 volts between the outers, the mains being carried overhead on jarrah poles. It is expected that there will be a fair demand for energy for motors for deep well pumping. The contractors are allowed eight months to complete.

Spain.—Don José Xinxo has applied to the Spanish Government for a concession for an electric tramway from the Plaza Rovira (Gracia) to San Juan de Horta. More favourable terms than those offered by the applicant will receive consideration if lodged by Nov. 9 at the office of Public Works, Madrid.

The generation of electricity for industrial uses in Murcia and other towns from the waters of the River Segura at Rio Muerto is to be undertaken by Don José L. Gomes Navarro, the concessionnaire.

Stratford-on-Avon.—The Council have decided to enter into an agreement with the Birmingham Installation Co. for a transfer of the Council's provisional electric lighting order and for the erection, equipment and maintenance of electricity works.

Sunderland.—On Tuesday an inquiry was held into the application of the Council to borrow £25,000 for extensions of the electric lighting undertaking.

The acting town clerk (Mr. C. Bevan) said the loan was for extensions to buildings and machinery and for extensions to mains and services.

The borough electrical engineer (Mr. J. F. C. Snell) said the undertaking had been in existence for 10 years, and at the end of last year they had 950 consumers, with the equivalent of 197,683 8 c.p. lamps connected. The capacity of the generating plant was 5,539kw and the number of units consumed 3,508,139. The gross revenue for last year was £36,128, and the engineering and management costs £19,769, leaving a gross profit of £16,359, which was allocated as follows:—Interest £7,999, sinking fund £7,114, reserve fund £1,246. The total amount sanctioned to Dec. 31, 1903, was £288,635, and the actual amount expended £286,079. Of the £25,000 now applied for, £8,668 was for buildings, and in connection with that item work costing £2,006 had already been done.

Switzerland.—The Federal Assembly has issued a decree granting a concession for the construction and working of a narrow-gauge electric railway from Sierre to Indin or Rumeling. This concession has been granted to a syndicate comprising MM. O. Zan Ruffinen and H. Gentinette, of Louèche, and three others, the syndicate's capital being about £80,000 (2,000,000fr.).

Tariff Changes.—The new tariff proposals of the Norwegian Customs include the imposition of 5 per cent. ad val. duty on machinery.

Taunton.—A reduced scale of charges for electric current came into force on 1st. inst.

Telegraphic Feat.—In the issue of the "Daily Telegraph" (London) on Thursday, last week, there appeared a despatch 11 columns in length from the redoubtable war correspondent Mr. Bennet Burleigh. This message, dated Liao Yang, Sept. 4, was telegraphed from Vancouver on Oct. 12, appearing in the issue of the "Daily Telegraph" for Oct. 13. The successful work of the Commercial Cable Co. is mentioned in the "Daily Telegraph" for the 14th in the terms following:—"It is due to the Commercial Cable Co. to say that the despatch of over 20,000 words was telegraphed from Vancouver to our London office with remarkable rapidity and accuracy—indeed, almost without a slip."

Tewkesbury.—The Council have decided to apply for a provisional electric lighting order.

Theft.—At Chelmsford Petty Sessions a labourer named Runcieman was sentenced to two months' hard labour for stealing a quantity of copper and other metals from Messrs. Crompton & Co.

West Fife Tramways.—Cowdenbeath Town Council expressed approval of this scheme on Friday. The consulting engineers are Messrs. Bramwell & Harris, and the tramway is to be laid first of all from Dunfermline to Lochgelly and Kelty, via Crossgates and Cowdenbeath. The estimated initial cost is £130,000.

West Ham.—The Education committee decided on Monday to obtain quotations for incandescent electric lamps of 8, 16 and 32 c.p., to be supplied in quantities of 1,000.

Whitehaven.—The electric lighting mains are to be extended to Kells.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Whitby District Council invite tenders for the supply and erection of one 200kw. direct-current dynamo, coupled to a high-speed engine (reciprocating or turbine type); and one water-tube boiler, fitted with chain grate mechanical stoker. Specifications from the electrical engineer (Mr. L. H King), to whom tenders by 5 p.m., Nov. 21. See also advertisement.

Swansea Corporation invite tenders for the removal, alteration and re-erection at a new station of one 450 I.H.P. modern type triple expansion engine and of a 225kw. continuous-current dynamo; also the supply and erection of an 8-ton travelling crane. Specifications from the borough electrical engineer (Mr. C. A. L. Prusmann). Tenders to the town clerk (Mr. John Thomas), by noon Nov. 12.

The Visitors committee of *Cumberland and Westmorland Lunatic Asylum*, Garlands, Carlisle, invite tenders for two Lancashire boilers, feed pumps, steam exhaust and water pipes and valves; two 50kw. and one 30kw. steam dynamos, and a 5-ton travelling crane; economiser; underground bitumenised cables and boxes; wiring of buildings, switchboards, motors, fans, &c. Specifications from and tenders to Mr. C. W. Allan Hodgson, The Courts, Carlisle, by Nov. 1.

Sunderland Corporation invite tenders for two 300kw. three-phase generators (5,500 volts) to couple to existing Belliss engines, and two 300kw. synchronous three-phase motors (5,000 volts) to be coupled to existing multipolar Silvertown dynamos. Tenders (addressed chairman of Electricity and Lighting committee) to the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon 28th inst.

Tamworth Corporation are prepared to consider offers for the construction and maintenance of electricity works. Particulars from the town clerk.

Preston Tramways committee invite tenders for motors and tramway boosters. Tenders to engineer and manager by Nov. 9.

Tenders are invited by noon 27th inst. for the steel work of a bridge at the Sculcoates-lane electricity works, *Hull*.

Shanghai Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlements of Shanghai. Alternative proposals are desired for single-trolley and double-trolley lines. Copies of pro forma contract, &c., from the Council's agents, Messrs. John Pook & Co., 63, Leadenhall-street, London, E.C., or from Messrs. Fearon, Daniel & Co., 90, Wall street, New York, from whom further information may be obtained. Tenders to the secretary, Municipal Council, Shanghai, by March 31, 1905.

TENDERS RECEIVED AND ACCEPTED.

In connection with Whitehaven Harbour lighting the Council have accepted the tender of the Gilbert Arc Lamp Co. for arc lamps, and that of the British Insulated & Helsby Cables for cables.

The following tenders have been received by London County Council in connection with the construction of the Greenwich tramway power station:—

Steam Exhaust and other Piping.

John Spencer (Ltd.) *(acceptd)*	**£9,785**	E. Le Bas & Co.	£10,598
J. Fraser & Son	15,468	T. Piggott & Co.	10,560
J. G. Moore	11,941	Aiton & Co.	10,581
Hefford & Shuttlewood	11,513	Foster Bros.	10,146
T. Potter & Sons	11,247	S. Russell & Sons	10,086
J. Musgrave & Sons	11,242	Meehan & Sons	9,884
Westwood & Wrights	10,801	Stirling Boiler Co.	9,793

Condenser and other Piping.

James Oakes & Co *(acceptd)*	**£6,419**	Holwell Iron Co.	£6,975
Clayton, Goodfellow & Co.	11,668	Aiton & Co.	6,911
Westwood & Wrights	8,473	John Spencer Limited	6,725
Sheepbridge Coal & Iron Co.	8,014	Sir Hiram Maxim Electrical & Eng Co	6,487
E. Le Bas & Co.	7,430		
J. Musgrave & Sons	7,365		

Pumping Plant.

Electric Construction Co. *(accepted)*	**£8,083**	W. H. Allen, Son & Co.	£9,800
		Bruce Peebles & Co.	9,795
Andrew Barclay, Sons & Co.	10,500	Entwisle & Gass	9,105
Electrical Co.	10,319	Ditto	9,050
Johnson & Phillips	10,229	Vickers, Sons & Maxim	9,071
Ernest Scott & Mountain	9,921	Gwynnes Limited	8,675
British Westinghouse Co	9,807	John Cochrane	8,500

The tenders of John Thom and the Mirrlees Watson Co. were incomplete.

Three Electric Car Travellers.

C. & A. Musker *(acceptd)*	**£1,458**	**10**	Heenan & Froude	£1,872	0
J. M Henderson & Co.	2,406	0	J. Hitchin & Son	1,856	0
J. Buchanan & Son	2,300	0	Ditto	1,774	0
Ransomes & Rapier	2,006	0	Brush Co.	1,850	0
Ditto	1,766	0	Dick, Kerr & Co.	1,828	0
Cowans, Sheldon & Co.	1,955	0	Hurst, Nelson & Co.	1,643	0
R. W. Blackwell & Co.	1,950	0	Jessop & Appleby Bros.	1,534	0

Messrs. W. F. Jones & Co., 50, Cannon-street, E.C., have secured a contract from Brussels Corporation for 500 iron clad three-wire house-service fuse boxes.

BUSINESS NOTICES, &c.

Messrs. Robson & Coleman, electrical engineers, 5, St. Mary's-place, Barras Bridge, Newcastle-on-Tyne, have taken over the electrical contracting business of Mr. Thompson Gradon, jun., 181, Barras-bridge, Newcastle.

Mr. A. S. E. Ackermann has removed to 25, Victoria-street, London, S.W.

Messrs. A. C. & G. Hands (trading as Hands Bros.), electrical engineers, &c., 30 and 34, Snow-hill, London, E.C., have dissolved partnership. Debts by Mr. A. C. Hands.

Messrs. G. A. Smith & G. H. Hontsworth, electrical engineers, 180, Regent-road, Liverpool, have dissolved partnership. Debts by Mr. Smith.

Messrs. Geo. Becker & Otto Bohndel (trading as Schoen Bros.), electrical fittings agents, 29, Cock lane, London, E.C., have dissolved partnership. Debts by Mr. Bohndel.

The German Steelworks Union Agency (Ltd.), who have been appointed sole agents for the United Kingdom of the Stahlwerks Verband A.G., have opened offices at 13 and 14, Abchurch lane, London, E.C. The company, which is composed of 14 firms, is divided into three departments—viz., the rail, the joist and the half-products departments. Mr. A. Reichwald is chairman.

BANKRUPTCIES, LIQUIDATIONS, &c.

In the bankruptcy of James Marsden, electric fittings manufacturer, 39 and 40, Woodcock-street, and 4, Grove-road, Sparkhill, Birmingham, the first meeting of creditors will take place on Oct. 21 at 174, Corporation-street, Birmingham, and on Nov. 21 at the County Court, Birmingham.

G. W. G. Booker, formerly electrical fittings maker, &c., Regent-parade and Vyse-street, Birmingham, has been adjudicated bankrupt.

Claims against Thos. Hyom, electric light fitter, &c., 139, Fawcett-road, Southsea, by Nov. 1 to Mr. E. H. Hawkins, 3, Barbican, London, E.C.

Claims against the Bath Electric Mfg. Co. (Ltd.) by Nov. 30 to Mr. A. C. Comley, Albion-chambers, Bristol.

A meeting to receive an account of the winding-up of the London Telegraph & Steam Gauge Electric Co. (Ltd.) will be held at 4, Romford-road, Stratford, Essex, on Nov. 21.

The Electrical Bleaching Co. (Ltd.) is to be wound up voluntarily. Mr. W. B. Winnicott, Queen-street, Nottingham, is liquidator.

The Traction Development Co. (Ltd.) have decided to wind-up voluntarily, with A. P. Ibbott, 9, Throgmorton-avenue, London, E.C., as liquidator. Claims by 19th inst.

Winding-up Petition.—A petition for the winding-up of the Elmore Trust (Ltd.), presented by Alice Jane Reynolds, will be heard in the High Court on 25th inst.

Plant for Sale.—A six-pole compound-wound dynamo of 150kw. (230 v., 612 amp., 145 revs.) for direct-coupling to engine is advertised for sale, owing to alteration of original scheme of driving. Applications to Messrs. Andrew Handyside & Co., Britannia Iron Works, Derby, or to Messrs. Greenwood & Batley, Leeds. See also advertisement.

Electric lighting plant, consisting of two 80-unit Willans-Mather & Platt sets, is for sale. Address, "Engineer-in-chief," Messrs. A. Guinness, Son & Co., Dublin. See also advertisement.

Carbons for Sale.—Mr. N. Cohen, of 3, Peter-street, Wardour-street, London, W., advertises for sale 18,000 carbons of various sizes.

Motor Wanted.—An electric motor about 85 B.H.P. is required for direct coupling, also starting switch. See advertisement.

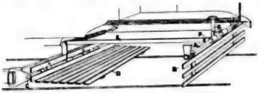
Premises to be Sold and Let.—The 40 years' lease of Crown Works, Bancroft-road, Mile End-road, London, E., is to be sold on Friday, 28th inst. There is 34,000ft. of working space on two floors, a yard, stables, offices, &c., with option of purchasing freehold. Particulars from the auctioneers (Messrs George W. Dawes & Co.), 12, Basinghall-street, London, E.C. See advertisement.

A warehouse or factory is to be let at Lewisham, close to main road and within 2 minutes of station. Floor area about 6,000 sq. ft. Applications to Mr. Wm. Jerrard, 40, Loampit-vale, Lewisham, London, S.E. See advertisement.

A well lighted factory is advertised in another column to be let. Applications to 469, Hornsey-road, Holloway.

A well-equipped factory of four floors, 11,300 sq. ft., is to be let at 558, Holloway-road, London, N. Applications to Mr. A. Monk, 558, Holloway-road, N. See advertisement.

Tramway Life-guards.—The increased speed of electric over horse-drawn tramcars has led to the adoption of a life-guard on the faster vehicles, and the most efficient of these guards have come into extensive use. In our description of the Leicester Corporation tramways (*The Electrician*, May 20, 1904) we referred to the life-guard adopted on these lines. This form of guard is manufactured by Hudson-Bowring (Ltd.), of Manchester. The accompanying illustration gives a sketch of Style A of the Hudson-Bowring life-guard, of which over 2,000 are now in daily use. Besides Leicester, these guards are employed at Manchester, Southport, Glasgow, Ilford, Stalybridge, Bath, Wellington (N.Z.) and other places. From the shaft A is suspended a swing-gate, B. Upon a shaft, C (carried by the pilot board), is a cradle, D, held up (so long as the gate is vertical) by a bar, E, and a "toggle" or knuckle lever, F. When the gate swings inwards it breaks the "toggle," and allows the cradle to fall and gather up the obstruction. The foot rod G re-sets the "toggle." Compressed steel is used in the manufacture of all the mechanical parts of these guards, which are made in various patterns to suit the requirements of tramway owners, the chief points of difference being that woven wire is employed in some styles in place of the wooden lathes adopted in other forms of the guard, and the re-setting gear is varied. In each style the "gate" is free to trail in the event of the rear of the car being depressed owing to uneven distribution of the load on the car.



The Hudson-Bowring Tramway Life-guard.—Style A.

Mathematical Instruments.—We have received from Mr. W. J. Brooks, 33, Fitzroy-street, London, W., specimens of flexible and parabola curves. These admirable devices are made of celluloid and are invaluable to students and draughtsmen. Every student, at some time or other, has felt the need of an inexpensive reliable flexible curve which will enable him to draw a curve approximating to points obtained experimentally, and although there are several of these on the market, that designed by Mr. Brooks undoubtedly possesses advantages. It is made in four patterns, the first (A) consisting of a flexible strip of celluloid or steel, provided with tabs along its length. Up to the 8in. size, this curve can be held down in position by placing the fingers of one hand on the tabs. In the larger sizes the tabs are secured by weights or drawing pins, and the ruling pen is not obstructed by these. Pattern B is a steel strip, and any shape given to it is retained by means of a stiff-hinged link-work attached to the tabs. The parabola curve is very accurately cut in transparent celluloid by specially-designed appliances, and its axis, focus and latus rectum are engraved upon it. It is of considerable use to draughtsmen and teachers of mathematics. Used in conjunction with squared paper it effects a great saving in time in the graphical solution of quadratics.

New Switches.—We have received from Mr. A. P. Lundberg, 477-487, Liverpool-road, London, N., samples of two switches which he has recently placed upon the market. It is claimed for these that the "Pivot Intermediate" switch (Fig. 1) is the first switch of tumbler action on a single base ever produced for "intermediate wiring" (controlling lamps from any desired positions in a circuit). Previously turn-type switches have been employed or tumbler and turn-type combined. Occasionally, when tumbler-type switches were specified for use throughout, it was necessary to couple two 2-way switches together for the intermediate positions, which necessitated the employment of an ugly fitting and more complicated circuit connections. The diagram of connections (Fig. 2) shows how the new switches can be arranged. The "Pivot Intermediate" switch, although a little higher, is of the same diameter as standard single or two-way switches of the tumbler type, and covers, &c., used with these switches are interchangeable with it. It has a patent variable-leverage action which is very definite. The patent locked type of cover can be fitted, and large size loop-in terminals are arranged. It can be supplied for flush work (see Fig 3) and all types of standard fronts, &c., are interchangeable; or it may be used as a reversing switch. Another application is its use as a parallel series switch in hospital wards, &c., the removal of one of the copper contact pieces on the rocking contact arm being the only alteration necessary to convert it for this purpose. The second switch is an improved "Bowspring" pear switch (Fig. 4). The current-carrying parts of this switch are mounted on a vitreous porcelain base, and a wider break than in previous patterns is arranged, in addition to improved terminals. The porcelain base is easily lifted from its containing case to facilitate wiring up, and the appearance and design is admirable in every respect.

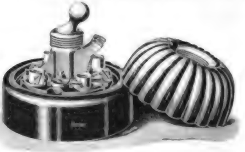


Fig. 1.

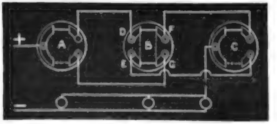


Fig. 2.

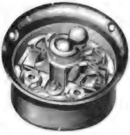


Fig. 3

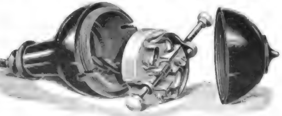


Fig. 4.

Electric Radiators.—The names of Mr. H. J. Dowsing and the Dowsing Radiant Heat Co., 24, Budge-row, London, E.C., are inseparably associated with the development of the luminous electric radiator, and in a new list which the company are now issuing some fine examples of this apparatus are listed and described. We have selected from a large number of illustrations two examples, one plain and one ornamental. Fig. 1 is of a light portable type, coppered all over except the back, and specially designed for waiting rooms, offices, &c., where a portable heater of good appearance is required. The overall dimensions of this radiator are—height 21½in., width 16in., depth 6in. Fig. 2 is fan-shaped, patent coppered reflector, with fancy brass frame, adapted for drawing rooms, bedrooms, boudoirs, and wherever a handsome type of radiator is required. Overall dimensions—height 29in., width 25¾in., depth 10½in. Both these radiators are, as shown, fitted with two switches, enabling one-half the current to be shut off when not needed The circular list contains much information regarding Dowsing radiators, which are coming into general use.

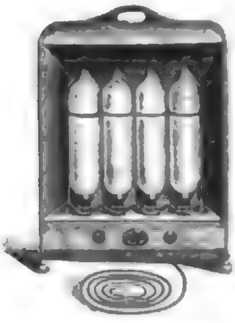


Fig. 1.—Dowsing Radiator.

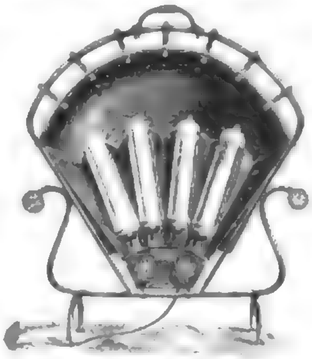
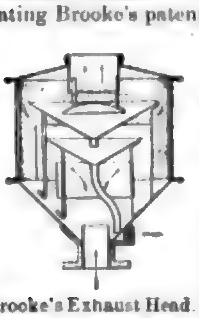


Fig. 2.—Dowsing Radiator.

Catalogues.—The India Rubber, Gutta Percha & Telegraph Works Co. have just issued several sheet lists dealing with (1) Rymer-Jones testing keys, (2) Rymer-Jones universal shunt, and (3) Rymer-Jones patent connectors. In the first-mentioned list illustrations and particulars of discharge, reversing and short-circuit keys are given. These keys have spiral wires to ensure perfect metallic connection between the contact arms and their terminals, so that the bearings may be well lubricated to secure free movement. Friction between the rubbing contact surfaces keeps them clean, and, as one is of gold and the other of platinum, there is no tearing action. In the second list a universal shunt, which can be used for all the tests for which the Wheatstone bridge and the Kelvin and Varley slides are suitable, is illustrated. This shunt is made on the same principle as the larger pattern shunt which has been employed in the India Rubber Co.'s works for the past eight years, and has been found to be in every way satisfactory. Instead of the instrument being contained in two large and separate cases, as hitherto, both parts are now made in a single case, measuring 13in. by 7in. by 8½in. In this way the smaller pattern shunt is particularly suitable for use on board ship or in cable huts, where space is limited, and enables effectual insulation to be provided, besides reducing the cost of the instrument. The third list illustrates several forms of connectors for electrical testing.

Messrs. Holden & Brooke issue a new list describing and illustrating Brooke's patent exhaust head, of which a section is shown in the accompanying illustration. These heads are constructed on an improved principle and break the beats and muffle the noises caused by exhaust steam; and, further, catch hot and greasy condensations, and prevent the distribution of greasy spray. The internal areas are arranged to avoid back pressure



Brooke's Exhaust Head.

The Stern-Sonneborn Oil Co., 57, Gracechurch-street, London, E.C., have prepared a circular relating to a special class of lubricating oil which the company has placed upon the market for use in turbine lubrication, and of which the company offer samples free to interested parties. This company's "Occentoline" oil, a cylinder oil for superheated steam cylinders, is also dealt with in a circular now available.

Particulars and illustrations of further examples of telpherage installations made by the United Telpherage Co., Westfield, New Jersey, U.S.A., are to hand.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Oct. 12 to 18, with the ports of destination:—

Africa—Alexandria, £169; Beira, £269 (including £238 telegraph apparatus); Cape Town, £192; Chinde, £16 (telegraph material); Durban, £1,952 (including £1,479 telegraph material); East London, £99; Port Elizabeth, £396. *Argentina*—Buenos Ayres, £258 (including £165 telegraph material); *Australasia*—Adelaide, £15; Auckland, £125; Brisbane, £35; Fremantle, £192 (including £172 telegraph material); Lyttelton £20; Melbourne, £223; Napier, £57; Otago, £20; Perth, £21 (telegraph material); Sydney, £2,501 (including £158 telegraph material); Wellington, £164. *Belgium*—Antwerp, £558; Ghent, £48; Ostend, 141 cwt. (telegraph wire). *Brazil*—Rio Janeiro, £68 (including £16 telegraph material). *Canada*—Halifax, £36,329 (telegraph cable). *Ceylon*—Colombo, £117. *China*—Shanghai, £516 (including £300 telegraph material). *Cyprus*, £15 (telegraph material). *France*—Boulogne, £347; Paris, £3,335 (including £3,240 telegraph material). *Germany*—Hamburg, £102. *Gibraltar*, 16 cwt. and £40 (telegraph material). *Holland*—Amsterdam, £35; Flushing, £112. *Hong Kong*, £435. *India*—Bombay, £4,330; Calcutta, £400; Madras, £212. *Russia*—St. Petersburg, £407 (including £295 telegraph paper). *Spain*—Cadiz, £10. *Straits Settlements*—Penang, £58; Singapore, £127. *Sweden*—Gothenburg, £46 *West Indies*—Trinidad, £13. Total, £54,357, against £13,725 in the corresponding week last year (Oct. 14 to 20).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Lectures Scientifiques: A French Reader for Science Students." By W. G. Hartog. (London: Rivingtons.) 5s.

"First Stage Magnetism and Electricity." By R. H. Jude. New edition. (London: W. B. Clive.) 2s.

"The Higher Text Book of Magnetism and Electricity." By R. Wallace Stewart. (London: W. B. Clive.) 6s. 6d.

"The Law and Practice relating to Letters Patent for Inventions." By Nicolas Vale. (London: Butterworth & Co.) 15s.

"Notices sur L'Électricite. By A. Cornu. Extraites de l'Annuaire du Bureau des Longitudes." (Paris: Gauthier-Villars.) fr.5.

"The Electric Tramcar Handbook." By W. A. Agnew. (London: Alabaster, Gatehouse & Co.) 2s. 6d.

"Elektrolytisches Verfahren zur Herstellung parabolischer Spiegel." Monographien über angewandte Elektrochemie. No. XIV. By S. Cowper-Coles. Translated by Dr. E. Abel. (Halle: Wilhelm Knapp.) 1m.

"Künstlicher Graphit." Monographien über angewandte Elektrochemie. No. XV. By F. A. J. FitzGerald. Translated by Dr. Max Huth. (Halle: Wilhelm Knapp.) 3m.

PATENT RECORD.

The following List of Application for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

September 6, 1904.

19,198 J. N. Fidler and S. W. Fidler. Manchester. Life-guards.
19,232 A. Blondel. Arc lamps. (Date applied for, Sept. 9, 1903, date of application in Belgium.)*
19,242 H. Lea and S. Mitchell. Electric light fittings.
19,243 A. Dickinson and J. Mannheim. Electric generator locomotives and the like.
19,245 R. P. Wilson and A. C. Marshall. Automatic signalling for electric railways or tramways.*
19,265 R. Hornischke. Indicating devices for electrical fire-alarms.*
19,266 R. Ziegenberg. Galvanic cell.*

September 7, 1904.

19,305 E. M. T. Boddam. Electric interlocking apparatus for electric signals and points.
19,326 J. F. Janes. Electric hand switches for motor cycles, &c.
19,333 J. Young. Eliminating the effects of induction in telephone systems and the like.
19,334 Firm of Reiss & Klemm. Liverpool. Electric motors. (Date applied for, Oct. 12, 1903, date of application in France.)*

September 8, 1904.

19,341 T. Haynes. Birmingham. Bearing for motors, dynamos, &c.
19,343 J. Murphy, J. Murphy and P. Goodier. Birkenhead. Regulating trolley head.
19,364 L. W. Branston. Bath. Combined driving gear and brake for electric cranes.
19,365 W. H. Isherwood. Leeds. Metallic conduits for wires and cables.
19,419 W. H. Chapman. Removing static electricity from paper, yarn, power belts, &c.*
19,422 H. J. Haddan (Allgemeine Beleuchtungs- und Heizindustrie A.-G. Germany). Regulating mechanism for arc lamps.*

September 9, 1904.

19,423 T. Taylor. Birmingham. Internal insulation of tubes and fittings for electric conduits.
19,440 W. H. Isherwood. Leeds. Switches.
19,475 O. Imray (Siemens Schuckert-Werke, G.m b.H., Germany). Electric cranes or the like.
19,477 Warwick Machinery Co. (G.E. Co., U.S.). Emergency governors.
19,478 B.T.-H. Co. (G.E. Co., U.S.). Regulators for electric circuits.
19,479 B.T.-H. Co. (G.E. Co., U.S.). Electricity meters.
19,482 G. P. Finnigan. Electric automatic block signal and safety systems.*
19,500 A. Wright. Electricity meters of the mercury electrolytic type.
19,502 A. Wright and H. Flaxman Reason. Electrolytic meters for alternating currents.

September 10, 1904.

19,506 G. E. Fletcher. Manchester. Wall sockets and switches.
19,525 A. Baumann. Electromotors. (Date applied for, Sept. 12, 1903, date of application in Germany.)*
19,540 J. Dixon and T. O. Dixon. Combined rail and road electric tramway system and vehicles therefor.
19,561 J. Honnette and H. Gerhardi. Trolleys for electric tramways.*
19,571 A. G. Bloxam (Société Anomyne d'Etudes Electro-Chimiques, Switzerland). Lead peroxide.
19,572 B.T.-H. Co. (G.E. Co., U.S.). Controlling circuit breakers.
19,573 B.T.-H. Co. (G.E. Co., U.S.). Train control systems.
19,574 B.T.-H. Co. (G.E. Co., U.S.) Motor control systems.
19,580 T. Duncan. Electricity meters. (Date applied for, Dec. 29, 1903, date of application in U.S.)*
19,590 M. MacDonald McHardy. Casing or conduit.

September 12, 1904.

19,609 A. G. Seaman. Kingston. Electro-magnetic variable-speed gear.
19,611 J. Klinkenberg. Glasgow. Controlling apparatus for electric motors.*
19,612 A. Duncan. Terminal for electric conductors.
19,646 Bastian Meter Co., C. O. Bastian and C. H. Churchill. Electrolytic electricity meters.
19,647 F. C. Smith and F. H. Davis. Birmingham. Chain for pendant electric light fittings.
19,651 J. Clarke. Electric railways and tramways.
19,665 H. Hawthorn. Automatic transmitters for electric fire alarm or other signals.

September 13, 1904.

19,686 J. Schofield. Manchester. Trolley poles.
19,748 and 19,749 A. F. Berry. Apparatus for distribution of alternating electric current.
19,758 M. Wildermann and R. L. Mond. Thermopiles.
19,762 R. Ames. Points for electric tramways and light railways on the conduit system.

September 14, 1904.

19,822 M. Latour. Starting resistances for electric collector motors. (Date applied for, Sept. 16. 1903, date of application in France.)*
19,823 J. J. Hobson. Protecting "live" rails on electric railways.
19,826 F. W. Howorth (A. Hommel, Switzerland). Magnetic inductors.
19,833 W. J. Davy. Arc lamps.

September 15, 1904.

19,838 T. Miller. Glasgow. Operating points of an electric railway or car line from an approaching car.
19,848 A. G. Hyslop. Glasgow. Electric conduit systems.
19,883 E. Eisemann. Liverpool. Electric igniters.*
19,885 B.T.-H. Co. (G.E. Co., U.S.). Electric controllers.
19,886 B.T.-H. Co. (G.E. Co., U.S.). Electric railway systems employing sectional conductors.
19,887 B.T.-H. Co. (G.E. Co., U.S.). Safety devices for electric signalling systems.
19,888 B.T.-H. Co. (G.E. Co., U.S.). Signalling systems.
19,889 B.T.-H. Co. (G.E. Co., U.S.). Electromagnetic mechanism.
19,890 B.T.-H. Co. (G.E. Co., U.S.). Systems of signalling.
19,891 B.T.-H. Co. (G.E. Co., U.S.). Protective devices for signal systems.
19,898 H. E. Blackburn. Barnes. Primary batteries.
19,917 E. G. Harcourt. Push buttons and the like.
19,923 A. Hommel. Electromagnets having polarised armatures for apparatus operated by reversals of electric current. (Date applied for, Dec. 21, 1903, date of application in Switzerland.)*

September 16, 1904.

19,953 E. E. Clark. Manchester. Third-rail systems of electric traction.
19,961 H. V. James. Manchester. Electrically-controlled driving gear.
19,976 W. R. Everett and E. J. Newton. Electrical propulsion of vehicles.
19,979 W. R. Everett and E. J. Newton. Magnetic wheels.
19,993 Evershed & Vignoles and E. B. Vignoles. Shunts for electrical instruments of the moving coil type.
19,997 H. R. Stuart. Apparatus for regulating the voltage of electrical circuits. (Date applied for, Sept. 25, 1903, date of application in U.S.)*
19,938 K. F. Elers. Current collecting devices for electric generators and motors. (Date applied for, Sept. 26, 1903, date of application in U.S.)*
19,999 C. le G. Fortescue. Electrical transformers. (Date applied for, Sept. 30. 1903, date of application in U.S.)*
20,000 C. le G. Fortescue. Coils for electrical apparatus. (Date applied for, Sept. 30. 1903. date of application in U.S.)*
20,001 P. M. Lincoln. Systems of electrical distribution. (Date applied for, Sept. 30. 1903. date of application in U.S.)*
20,003 K. Birkeland and S. Eyde. Process and furnace for subjecting solid materials to the action of the electric arc. (Date applied for, Sept. 19, 1903, date of application in Norway.)*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

19,251 Brown. Telegraphy.
19,341 Hayes. Laying pipes for electric light and other mains.
21,227 Turner and Turner. Life-guards for electric vehicles.
21,315 Cable. Steps for electric and other vehicles.
21,980 Hulsart and Adams. Arc lamps.
23,359 Veuille. Sparking plugs and the like for electric ignition.
23,540 Adams and Curtis. Resistance boxes.
23,636 Brown. Raising and lowering arc lamps.
25,022 McMurrike. Couplings for electrical conduits. (Date applied for, Nov. 21, 1902.)

1904.

7,980 Mercadier. Fuses or cutouts. (Date applied for, April 7, 1903.)
8,540 Swift. Printing telegraph receivers.
10,688 Bohm. Device for grinding commutators.
11,023 Horsburgh. Polar plotting paper.
12,268 Mariage. Automatically putting alternating-current transformers in or out of circuit.
14,221 Darinholz. Galvanic batteries.
14,366 Latour. Starting resistances for electric motor commutators. (Date applied for, June 27. 1903.)
15,043 Lake (Submarine Signal Co.). Electric telephonic transmitters and like instruments.
15,203 All. Electric burglar and fire alarms.
15,296 Phillips (Vogel). Electric elevators.
15,457 Kruh. Vapour electric conductors. (Date applied for, July 11, 1903.)
15,699 Boehm. Electrical resistances.
15,874 Ruppert. Electrical fire extinguisher.
15,981 Brownell. Telephone directories.
16,179 Peck and Fortescue. Electrical transformers. (Date applied for, Aug. 8, 1893.)
16,294 Dickinson. Electric lamp guards.
17,190 Gimingham. Manufacture of glow lamps to represent candles.

COMPANIES' MEETINGS AND REPORTS.

Edison & Swan United Electric Light Co. (Limited and Reduced).

The twenty-first ordinary general meeting was held on Monday, under the presidency of Mr. Henry Wolfenden.

The SECRETARY (Mr. H. Charles Gover) read the notice convening the meeting.

The CHAIRMAN said: In the concluding part of my speech last year I remarked, "We are making steady progress." I may now claim that that remark has, so far, been justified—we have made progress. Both our sales and our earnings show an increase compared with the previous years. The quality of our manufactures and the costs are alike favourable, and our financial position continues to improve. We have still, however, to contend with active competition, which we are quite prepared to meet, and our confidence in the future remains unabated. Taking the accounts as they stand, you will see that in the net revenue account the balance brought from profit and loss is £42,603 against £30,834 last year, an increase of £11,768. This is not the result of higher prices, as we have to recognise the tendency of the times and to study the interests of our customers. With regard to our stocks, we have priced these in our usual conservative manner. After providing for interest (£18,760) we appropriate £5,000 to depreciation on freehold and leasehold property, and allocate also £5,000 to depreciation on plant, or about 6¼ per cent. upon the sum standing against this item in our books at the commencement of the year, and we put £1,000 to tools account. The stocks are depreciated by £1,442, and we have provided the usual £1,000 for future stock depreciation. This reserve now amounts to £3,488, and must be regarded as an insurance fund. £1,508 is reserved for bad and doubtful debts. This leaves the result of the year's trading with a credit balance of £8,891, which in the ordinary course would have been available for dividend. The cost of establishing the business, goodwill, &c., remains unaltered, but we have reduced the debt of the Altrincham Company by £1,466—that is to say, that company have paid us in cash during the year not only the interest on their debenture debt and on the amount they owe us on open account, but also a sum of £1,466 in reduction of their past indebtedness to us. Of course, the goods which we supply to them regularly from time to time are being regularly paid for in addition. Adverting to the auditors' note with reference to our method of dealing with the interest accrued during the year on the Altrincham Company's debt, we think we are acting in a perfectly correct manner. We have no reason to assume that the Altrincham debt is not a good one, but, on the contrary, there is every indication of its being gradually paid off with interest. Our freehold and leasehold property (£82,101) is reduced, not only by the £5,000 written off as depreciation, but also by a further £2,140 reserved for redemption of leases. Our stocks and plant (£234,091) show a reduction of £11,423, sundry debtors (£47,003) show a slight increase on last year, accounted for by the fact that we are doing a larger turnover. Investments at cost and loans on security (£26,857) contrasts with £7,000 last year, and, therefore, shows an increase of £19,857. This is easily realisable at short notice, and is perfectly good. On the other side you will note that sundry creditors and credit balances stand for £16,974, a reduction of £9,129 from last year and of no less than £29,071 compared with 1902. The resolution approved last May sanctioning the writing down of the capital of the company was duly confirmed by the Court, and its effect is shown in the balance-sheet. The amount cancelled does not, however, suffice to extinguish the debit balance by £3,589, and this amount, therefore, falls to be deducted from the credit balance brought from net revenue account leaving £5,302 to be carried forward to credit of the current year. I abstain from discussing the details of the working of our business, as I hold that a public meeting is not the place where that should be done; but if any shareholder desires information upon any point I shall be pleased to see him at the offices. As to the future, symptoms seem to point to an improvement in the general trade of the country, and doubtless we shall participate in this. I now move the adoption of the report and accounts.

This was duly seconded and carried unanimously. The remaining routine business having been completed, the usual vote of thanks terminated the proceedings.

Cuba Submarine Telegraph Co. (Ltd.)

The sixty-sixth ordinary general meeting was held on Wednesday, Mr. Charles W. Parish presiding.

The SECRETARY (Mr. James Scott) read the notice convening the meeting, and also the auditors' report.

The CHAIRMAN said: The accounts are for the six months ended June 30 last, and the traffic receipts amount to £16,526, while last year they were £17,244, a falling off of £718, which arose in the month of June, when the Manzanillo-Santiago cable became interrupted; but our interest receipts were rather larger, and the total income comes out £18,715 this year, as compared with £19,325 in 1903, or an actual reduction of £610. Expenses were £6,369, or £303 more than last year, due to additional expenses at the stations. Besides our usual working expenses, we have had to write off the special cost of the attempted repair, during January, February and March last, to the Cienfuegos-Santiago 1875 cable, amounting to £7,670. I referred to this matter at our meeting last May, but the payments in connection with the hire of the repairing ship are included in the accounts before us. The expenses of £6,369 and this special outlay of £7,670 amount to £14,039, which, deducted from the £25,686 we have to the credit of revenue, including £6,970 balance from the previous half-year, leaves £11,647 to deal with. The preference dividend requires £3,000, and we propose to pay a dividend at the rate of 5 per cent. per annum on the ordinary shares and carry forward a balance of £4,647, which I think we may consider a satisfactory outcome of rather an unfortunate half-year. Our last report informed you that we had contracted for a new cable to be laid from Cienfuegos to Santiago. The manufacture of this cable has made good progress, and I hope, if all goes well, we may have it working before the end of the year. Unfortunately the Cape Cruz-Santiago section of the Manzanillo and Santiago cable beame interrupted on June 14, the date of the great storm which fell upon the south-eastern portion of the Island of Cuba. This particular length of cable was the one laid nearest to the shore. The depth of water is very great in places, and there is an uneven bottom with banks of rocks which makes it most difficult to successfully repair breaks. The West India & Panama Co.'s steamer, the "Henry Holmes," has tried to repair the break, but, after working on the spot for some time and finding the cable could not be recovered near the break, we came to the conclusion that it would be necessary to change its position and take a considerable part of it further out to sea, away from the rocky and uneven bottom. We are sending out some extra cable, which will enable the position of part of this broken cable to be diverted into a better one, and where we may expect it will work for many years without any interruptions. In the meantime we are working under some difficulties, and until our new cable is laid I fear we must expect a decrease in our traffics. We are still waiting news of our applications to the United States Government for payment of the expense we were put to by the cutting of our cables during the Spanish-American war; also our representative in Cuba has not yet succeeded in obtaining from the Government the subsidy due to us under our concessions for the coast cables, but we are still working away at these two matters, and trust in time to receive a satisfactory settlement, although these continual delays are most disheartening. I move the adoption of the report and accounts.

The motion was carried unanimously, and the dividends being approved and the retiring directors and auditors having been re-elected, a vote of thanks terminated the proceedings.

MONTE VIDEO TELEPHONE CO. (LTD.)—The directors' report for the year ended July 31 states that the net profit was £13,527. 3s. 2d. By adding £1,783. 11s. 11d. from last year, the available balance is £15,310. 15s. 1d. After putting £2,000 to a reserve for renewal of plant and transferring £5,000 to reserve, the directors recommend payment of the full preference dividend at the rate of 5 per cent. and a dividend of 3 per cent. on the ordinary shares, leaving £1,805. 15s. 1d. to be carried forward. During the recent civil war telephonic communication in the provincial districts of Uruguay was much interrupted. The number of subscribers and revenue in Monte Video continues to improve.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—At the meeting on Tuesday the Chairman (Mr. Chas. T. Yerkes) said the power house at Chelsea was very nearly finished. Its capacity would be more than sufficient to give power to all the companies which were to derive energy from it, including the Metropolitan District, the Great Northern, Piccadilly & Brompton, the Baker Street & Waterloo, and the Charing Cross, Euston & Hampstead Railways. Those companies were compelled to take their power from the company's power house, thus ensuring that all the power which they would generate would be sold. At the same time it gave to those companies their electric power at a much lower price than they would be able to generate it for themselves. The electrification of the District Railway had been delayed somewhat by manufacturers of material, and there would be some delay by the car builders. While the directors expected to have electric trains on the route by Jan. 1, the whole of the railway would not be running electrically by that time. It was impossible to take off the steam trains one night and commence with electric trains the next morning. It must be done gradually, for several reasons, the main reasons being that the men were not educated to the new system, and that the signals could not be worked properly. The Baker Street & Waterloo Railway was progressing rapidly, but they would be a little late there owing to the laying of the permanent way and the building of the street stations. The Great Northern, Piccadilly & Brompton and the Charing Cross, Euston & Hampstead Railways were going on very well. The London United Tramways, in which they had a controlling interest, were doing a good and constantly increasing business.

In reply to a query, the chairman said they should probably run the first electric train from Ealing to the Mansion House. If precedents were anything to go by, electric working would be much more economical than steam. In the first place, by electricity they operated more cheaply; secondly, they could run more trains, and thirdly, travelling was more comfortable.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

GARCIN RENAULT ELECTRIC CARS & ACCUMULATORS (LTD). (82,298.)—Reg. Oct. 15, capital £20,000 in £10 shares, to adopt an agreement with P. Verhaeghe and to carry on business of dealers in and factors and vendors of motors, ships, accumulators, cycles and other vehicles, electrical, mechanical and general engineers, manufacturers of motor accessories, &c. The subscribers are P. Verhaeghe, engineer, G. Droulle, merchant, A. Renault, merchant, L. Garcin, engineer, E. Guilbert, M. Duboys and A. Bosquet, merchant.

MUIRHEAD & CO. (LTD.) (82,270.)—Reg. Oct. 12, capital £50,000 in £10 shares, to acquire business carried on at Elmer's End, Kent, under style of Muirhead & Co., to adopt an agreement with A. Muirhead and F. L. Muirhead, and to carry on the business of electrical, mechanical and telegraph engineers and contractors, engine builders, boiler makers, electricians, manufacturers of and dealers in dynamos, telegraphic instruments, wires, cables, insulators and any apparatus and things required in connection with the generation, distribution, supply, regulation, accumulation and employment of electricity, heat, steam or other power, iron, brass and metal founders, launch and ship builders, machinists, fitters, millwrights, tube makers, iron and steel converters, smiths, metallurgists, &c. The subscribers are: A. Muirhead, D.Sc., F.R.S., H. J. Muirhead, F. L. Muirhead, M.A., LL.B., Mrs. E. M. Muirhead, Mrs. G. J. Muirhead, Mrs. E. E. Muirhead and G. J. B. Porter. No initial public issue. First directors, A. Muirhead, H. J. Muirhead and F. L. Muirhead. Qualification £500.

WESTON, CLEVEDON & PORTISHEAD DOCKS RAILWAY CO. (LTD.) (82,275.)—Reg. Oct. 12, capital £120,000 in £1 shares, to carry on business of railway and tramway proprietors, carriers of passengers and goods by land and water, constructors and workers of underground, surface or overhead railways and tramways, owners of power stations and suppliers of electricity, &c.

STATUTORY RETURNS.

CONDUIT & INSULATION CO. (LTD.)—Return to Sept. 8 gives capital as £40,000 in £1 shares, of which 33,878 have been taken up. £1 per share has been called up on 15,878, and £15,878 has been received, including £7 paid on seven forfeited shares. 18,000 shares are considered as fully paid. Mortgages and charges, nil.

GENERAL ELECTRIC CO. (LTD.)—In return to Aug. 10 the capital is £800,000 in 40,000 preference and 40,000 ordinary shares of £10 each, of which 25,000 preference and 30,180 ordinary have been taken up. £10 per share has been called up on 18,000 preference and 5,180 ordinary, and £231,800 has been received. £320,000 is considered as paid on 7,000 preference and 25,000 ordinary. Mortgages and charges, £200,000.

GORSEINON ELECTRIC LIGHT CO. (LTD.)—The return to July 8 gives capital as £1,000 in £1 shares, all of which have been taken up. £1 per share has been called up and £990. 10s. received. Mortgages and charges, £800.

NEWTONS LIMITED.—According to return to Sept. 29 the capital is £40,000 in 4,000 shares of £10 each, of which 3,265 have been taken up. £10 per share has been called up on 1,865, and £18,650 has been received. £14,000 is considered as paid on 1,400. Mortgages and charges, £10,000.

ERNEST SCOTT & MOUNTAIN (LTD.) In return to Oct. 4 the capital is £150,000 in 100,000 ordinary and 50,000 preferred ordinary shares of £1 each, of which 97,790 ordinary and 28,700 preferred ordinary shares had been taken up. £1 per share has been called up on 75,790 ordinary and 28,700 preferred ordinary, and £104,240 has been received. £4. 10s. has been paid on one forfeited share of £10 nominal value, and £22,000 is considered as paid on 22,000 ordinary shares. (Capital was originally £70,000 in £10 shares, and was increased to £100,000 in £10 shares in 1897. 50,000 new shares of £1 each were created in March, 1904, and the existing £10 shares were subdivided into £1 shares). Mortgages and charges, £20,100.

YALE ELECTRIC POWER CO. (LTD.)—The return to Oct. 7 gives capital as £20,000 in 800 shares of £25 each, of which 605 have been taken up. £25 per share has been called up on 537 and £13,375 has been received, leaving £50 in arrears. £1,700 is considered as paid on 68 shares. Mortgages and charges, nil.

MORTGAGES AND CHARGES.

ELECTROLYTIC ALKALI CO. (LTD.)—Issue on Sept. 12 of £10,350 debentures, part of series created July 9, 1904, to secure £50,000, charged on company's undertaking and property for time being, including uncalled capital. Trustees, Liverpool Mortgage Insurance Co.

MEXICO ELECTRIC TRAMWAYS (LTD.)—Trust deed dated Sept 21, 1904, to secure £500,000 second debentures, has been registered. Property charged, certain ordinary shares and second mortgage debentures held by company in Cia de los Ferrocarriles del Distrito Federal de Mexico and company's general assets. Trustees, L. Breitmeyer and C. Rube.

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—Issue on Sept. 22 of £10,000 and on Oct. 6 of £700 mortgage debentures, part of series created Feb. 18, 1904, to secure £100,000. Property charged, company's undertaking and property, present and future, except uncalled or unpaid capital. Holders, York City & County Banking Co., H. Cleveland, W. W. Whytehead, H. E. Cradock, R. G. H. Boulton and W. W. Boulton. No trustees. Previously issued of same series, £66,100.

PERTH (W.A.) ELECTRIC TRAMWAYS (LTD.)—Issue on Oct. 6 of £500 6 per cent. debentures, part of a series created Dec. 22, 1903, and covered by trust deed of Dec. 30, 1903, to secure £50,000, charged on company's undertaking and property, present and future, including uncalled capital, benefit of certain agreements, tramways in Perth, &c. Trustees, Lord A. Butler and J. S. Austen. Previously issued of same series, £35,000.

ROYCE LIMITED.—Issue on Oct. 7 of £1,900 debentures, part of series created March 27, 1903, to secure £25,000, charged on company's undertaking and property, present and future, except uncalled capital. Trustees, Law Guarantee and Trust Society. Previously issued of same series, £23,100.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO. (LTD.)—Issue on Sept. 23 of £53,292 debentures, part of series created by resolutions of July 3, 1900, and May 6, 1904, to secure a sum not exceeding in aggregate amount of share capital paid up for time being. Dates of trust deeds, Aug. 3, 1900, and June 8, 1904. Property charged, company's undertaking and property, present and future, including uncalled capital (as floating security except as to freehold or leasehold hereditaments for time being comprised in said trust deeds). Trustees, H. R. Beeton and W. R. Davies. Previously issued of same series, £120,000.

CITY NOTES.

MEMORANDA (Oct. 20).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26$\frac{11}{16}$d. per oz. Consols 88$\frac{7}{16}$—88$\frac{9}{16}$ for money, 88$\frac{5}{8}$—88$\frac{3}{4}$ for account; 2½ per cent. annuities 87$\frac{3}{4}$—88$\frac{1}{4}$. Consols Pay Day, Nov. 4; Stocks and Shares Continuation Days, Oct. 25 and Nov. 9; Ticket Days, Oct. 26 and Nov. 10; Pay Days, Oct. 27 and Nov. 11; Mining Share Carry-over Days, Oct. 24 and Nov. 8.

CALLENDER'S CABLE AND CONSTRUCTION CO. (LTD.)—The directors have declared an interim dividend of 5s. per share (10 per cent. per annum) on the ordinary shares. Sir J. Fortescue Flannery, M.P., has been elected a director in place of the late Lieut. Col. G. A. Elliot.

ELECTROLYTIC ALKALI CO. (LTD.)—The net profit for the year ended Aug. 31, after ample expenditure in keeping up buildings, works, plant, machinery and tools in an efficient state, and making adequate allowance for depreciation, is £521. 18s. 9d., making, with £852. 10s. 7d. from last year, a total of £1,374. 9s. 4d., which the directors recommend should be carried forward. To the great depression of the market price of bleaching powder throughout the year the unsatisfactory results of the year's working are attributed.

EASTERN TELEGRAPH CO. (LTD.)—This company announce the payment by warrants on Nov. 1 of interest for the half-year ending Oct. 31 on the 4 per cent. mortgage debenture stock. The transfer books will be closed from Oct. 25 to 31 inclusive.

EASTERN & SOUTH AFRICAN TELEGRAPH CO. (LTD.)—It is announced that the payment by warrant on Nov. 1, 1904, of interest on the 4 per cent. Mauritius subsidy debentures will be made on Nov. 1. The transfer books will be closed from Oct. 25 to 31 inclusive.

GLOBE TELEGRAPH & TRUST CO.—A quarterly interim dividend of 3s. per share on the preference and of 2s. per share on the ordinary shares has been declared.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—The following dividends have been declared for the current year:—An interim of 3 per cent. on the 6 per cent. cumulative preference shares (less tax) and an interim of 3 per cent. on the ordinary shares (tax free), payable 31st inst.

SOUTH LONDON ELECTRIC SUPPLY CORPN. (LTD.)—During the first nine months of the year 6,590,572 units were sold, against 2,788,400 units for the corresponding period of last year, giving a gross revenue of £51,009, against £27,065.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have appointed Oct 26 a special settling day in £200,000 4½ per cent. first mortgage debentures and a further issue of 16,000 £5 ordinary shares of the *Urban Electric Supply Co. (Ltd.)*

WEST AFRICAN TELEGRAPH CO. (LTD.)—An interim dividend at the rate of 4 per cent. per annum for the six months ended June 30 has been declared.

WESTERN TELEGRAPH CO. (LTD.)—The directors (after transferring £22,000 to general reserve and £18,000 to maintenance ship's reserve) recommend a final dividend of 3s. per share (making 6 per cent. for the year to June 30), and a bonus of 2s. per share (both tax free), payable Nov. 3. The register of transfers will be closed from Oct. 25 to Nov. 2 inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Oct. 15	1,754	+ 42	20	31,709	+ 5,686
Airdrie	,, 7	214	...	35	7,046	...
Ayr Corporation	,, 15	198	− 2	22	8,838	+ 466
Barnsley	,, 7	165	− 18	40	6,821	− 494
Barrow	,, 7	190	...	36	6,990	...
Bath Electric Trams, Ltd.	,, 14	641	...	41	[illegible]	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	...	...	...	...	...	...
Birmingham Corporation	,, 15	337	...	41	12,569	...
Birmingham Tramways Co.	,, 15	5,456	+ 304	15	81,784	+ 2,506
Blackburn Corporation	,, 14	869	+ 58	29	28,401	+ 2,677
Blackpool Corporation	,, 13	668	+ 140	28	39,761	+ 5,619
Blackpool and Fleetwood	,, 15	340	+ 22	15	18,994	+ 208
Blackp'l, St. Anne's & Lytham	,, 13	308	− 75	50	20,643	+ 7,166
Bolton Corporation	,, 16	1,701	+ 99	29	64,752	+ 406
Bournemouth Corporation	,, 12	1,009	+ 10	†28	33,686	+ 1,901
Bradford Corporation	,, 15	4,437	+ 681	28	134,859	+ 23,767
Brighton Corporation	,, 16	988	+ 44	28	31,565	+ 3,165
Brisbane Tramways	...	...	...	...	...	...
Bristol Trams & Carriage	,, 14	4,816	− 200	10	112,472	+ 874
Buenos Ayres & Belgrano	...	...	...	...	...	...
Burnley Corporation	,, 15	1,143	+ 238	3	3,307	+ 787
Burton Corporation	,, 16	325	− 36	¶28	10,471	+ 1,756
Calcutta Tramways Co.	,, 15	r42,549	+ r10,915	16	r560,879	+ r69,226
Camborne-Redruth	,, 11	108	− 9	24	2,886	− 114
Cardiff Corporation	,, 16	1,922	− 40	29	60,040	+ 1,731
Carlisle Tramways Co.	,, 15	182	10	41	8,990	+ 249
Central London Railway	,, 15	6,780	+ 337	15	90,561	− 744
Chatham & Dist. Lt. Rys.	,, 13	577	+ 7	41	24,522	+ 2,130
City & South London Rly.	,, 16	2,538	− 226	16	39,746	− 1,367
Colchester Corporation	,, 15	235	...	11	3,678	...
Cork Electric Trams Co.	,, 12	479	− 15	41	19,506	− 2,478
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 7	[illegible]	− 31	40	21,710	+ 3,286
Dover Corporation	,, 16	202	− 6	29	7,069	− 212
Dublin & Lucan Railway	,, 14	182	+ 10	15	2,145	− 20
Dublin Southern District	,, 14	932	+ 63	} 15	61,983	− 3,412
Dublin United	,, 14	[illegible]	− 8			
Dudley—Stourbridge	,, 7	850	+ 9	40	35,470	+ 1,400
Dundee Corporation	,, 12	921	− 18	...	...	...
East Ham Council	,, 15	645	+ 56	29	31,639	+ 1,470
Gateshead & Dist. Trams	,, 7	946	− 61	40	36,569	+ 1,486
Glasgow Corporation	,, 15	14,564	+ 484	†20	290,475	+ 16,018
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 7	229	− 47	40	10,474	+ 601
Gt. Northern & City Rly.	,, 15	1,190	...	36	34,130	...
Greenock & Port Glasgow	,, 7	640	+ 25	40	23,461	+ 1,216
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 7	290	− 2	40	12,073	+ 1,080
Huddersfield	,, 15	1,269	+ 69	29	[illegible]	+ 2,758
Hull Corporation	,, 15	3,344	+ 784	29	64,787	+ 8,894
Ilford District Council	,, 15	390	+ 47	¶29	[illegible]	+ 607
Ilkeston Corporation	,, 13	128	− 20	2	254	− 57
Ipswich Corporation	,, 15	417	...	28	15,166	...
Isle of Thanet Co.	,, 15	431	+ 39	2	975	− 133
Kidderminster & District	,, 7	117	− 3	40	5,370	+ 33
Kirkcaldy Corporation	,, 12	215	− 23	41	9,423	...
Lanarkshire Trams Co.	,, 13	469	+ 43	41	26,651	...
Leeds Corporation	,, 15	5,613	+ 416	28	173,013	+ 10,520
Leicester Corporation	...	...	...	...	...	...
Liverpool Corporation	,, 8	10,794	+ 250	41	436,197	+ 12,850
Liverpool Overhead Rly.	,, 16	1,453	141	†16	26,090	− 1,064
*London County Council	,, 8	13,048	+ 2,492	‡27	352,347	+ 72,091
Lowestoft	...	...	...	...	...	...
Maidstone Corporation	,, 13	131	...	13	2,306	...
Manchester Corporation	,, 15	12,149	+ 694	28	353,075	+ 14,678
Mersey Railway	,, 16	1,513	+ 196	15	21,531	+ 1,739
Merthyr	,, 7	204	− 7	40	8,146	+ 108
Metropolitan Elec. Trams	,, 14	1,794	+ 630	15	20,219	+ 7,376
Middleton	,, 7	200	+ 19	40	13,415	+ 109
Nelson Corporation	...	...	...	...	...	...
Newcastle-on-Tyne Corp.	,, 15	3,964	+ 62	15	55,993	+ 3,740
Newport (Mon.)	,, 15	487	+ 25	2	946	+ 66
Oldham, Ashton & Hyde	,, 7	513	− 29	40	22,213	− 961
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams	,, 14	1,247	+ 96	41	53,336	+ 6,176
Peterborough	,, 7	208	36	40	6,275	− 189
Poole and District	,, 7	364	− 15	40	12,567	45
Portsmouth Corporation	,, 15	1,740	+ 267	‡28	61,400	+ 6,116
Potteries	,, 7	1,760	+ 22	40	69,563	+ [illegible]
Reading Corporation	,, 12	620	+ 67	2	1,260	+ 86
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 7	63	+ 8	40	6,542	+ 18
Salford Corporation	,, 17	[illegible]	+ 35	29	[illegible]	+ 7,526
Sheerness	,, 5	69	− 1	40	[illegible]	− 404
Sheffield Corporation	,, 16	[illegible]	− 250	§29	[illegible]	+ 2,670
Southampton Corp'ation	,, 13	940	− 31	28	29,211	− 1,951
Southend Corporation	,, 12	296	+ 39	28	11,903	+ 1,275
Southport Tramways	,, 7	309	− 12	40	13,585	+ 546
S. Staffordshire Trams.	,, 7	840	− 127	41	30,917	− 5,198
Stockport Corporation	,, 14	488	+ 159	28	17,103	+ 6,951
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	,, 7	586	− 8	40	22,171	+ 1,018
Taunton Trams	,, 7	68	+ 12	40	2,237	− 222
Tynemouth and District	,, 7	229	49	40	[illegible]	715
Tyneside Trams Co.	,, 12	[illegible]	+ 72	41	[illegible]	+ [illegible]
Wallasey District Council	,, 15	710	+ 23	‡28	[illegible]	+ 1,377
Walsall	,, 15	[illegible]		40	[illegible]	...
Warrington Corporation						...
West Ham Corporation	,, 13	[illegible]	...	31	[illegible]	...
Weston-super-Mare	,, 5	[illegible]	+ [illegible]	40	[illegible]	+ 482
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 7	342	− 1	40	[illegible]	− 41
Worcester	,, 7	307	− 178	35	11,437	+ 5,626
Wrexham	,, 7	103	− [illegible]	40	[illegible]	− 739
Yorkshire Woollen District	,, 7	[illegible]	− [illegible]	40	21,014	+ [illegible]

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., Oct. 19	Rate per Cent. Yielded.	Dividend Due.	Business Week to Oct. 19. Highest.	Business Week to Oct. 19. Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	3/0	Anglo-Argentine Ordinary Shares	6¾—7	4 5 8	April, Oct	6¾	6⅝
5	2 6	Do. 5% Cum. Pref.	5½—5¾	4 8 10	..	5⅝	5½
St.	6%	Do. Permanent 6% Deb. Stock	139—142	4 4 10	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	103—105	4 16 9	—	104½	104
10	6%	Barcelona Tramways Ord.	9—10	5 0 0	—	9¾	..
10	5/0	Do. 5% Cum. Pref.	9—10	5 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91—96	4 14 0	..	..	..
100	5%	Do. 5 per Cent. Debs.	98—101	4 19 5	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	⅛—⅜	..	..	..	..
1	..	Do. 5% Cum. Pref.	⅞—1¹⁄₁₆	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1¾—2¼	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 8	—	4⅛	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	98—101	4 9 3	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19—20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10—10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106—108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	99—102	5 17 8	..	..	..
St.	5%	Do. Pref. Ord. Stock	100—103	4 13 0	—	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10—10½	4 15 3	..	..	..
50	4½%	† Do. 4½ per Cent. 1st Mort. Debs.	102%—104%	4 6 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	97—100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	9¾—10¼	5 17 8	..	10⅛	9¾
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾—11¼	5 6 7	Feb, Aug	11⅛	..
St.	5/0	Do. 5 per Cent. Perpetual Debs	116—118	4 4 7	—	117½	..
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	95—98	..	..	97	96½
5	1/6	Buenos Ayres and Belgrano Ord.	3¾—4¼	5 9 3	..	4⅛	3¾
5	2/0	Do. 6 per Cent. "A" Cum. Pref.	5¾—6¼	5 4 4	—	5⅞	5¾
5	3/0	Do. "B"	5¼—5¾	5 11 6	—	5⅝	5½
St.	5%	Do. 5 per Cent. Debs.	105—108	4 13 8	—	107½	106½
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	102—105	4 16 3	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. 5% Deb. Stk.	96—99	5 2 6	..	97	96½
5	3 0	Calcutta Tramways	7¼—7¾	4 2 9	—	7½	7⅜
100	4½%	Do 4½% 1st Deb. Stock (red.)	106—108	4 4 0	..	106½	..
1	1/0	Cape Electric Tram Shares	1½—1¾	5 14 5	..	1⅝	1½
St.	4%	Central London Ordinary Stock	89—91	4 9 0	June, Dec	91½	89½
St.	4%	Do. 4 per Cent. Pref. Stock	100—102	3 18 8	..	100½	..
St.	4%	Do. Deferred Stock	79—81	4 18 9	..	80½	80½
100	4%	Do. 4 per Cent. Debs.	107—110	3 12 4	..	..	..
5	2/6	†City of Birmingham Trams. 5% Cm. Prf.	4¾—5	5 0 0	..	4¾	..
100	4%	† Do. 4 per Cent. 1st Mort. Debs.	98—101	3 19 3	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	47—49	4 10 10	Feb, Aug	48	47
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122—125	4 0 3	Feb, Aug	123½	..
St.	5%	Do. (1896)	117—120	4 3 0	..	..	..
St.	5%	Do. (1901)	113—117	4 6 0	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106—109	3 14 7	May, Nov	108	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	101—104	4 16 0	..	..	..
10	6 0	Dublin United Trams. (1896) Ltd., Ord.	13—14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15—16	3 15 0	..	..	..
10	3 0½	Gt. Northern & City Rly. Prf. Ord. (4%)	5¼—6¼	..	—	6¼	5¾
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9—10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19—20	4 10 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—14¾	4 1 4½	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109—111	4 1 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	3¾	3½
St.	4%	Do. 4 per Cent. Deb. Stock	88—91	4 7 11	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3¼—3¾	3 15 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10—10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10¾—11	4 10 11	..	10¾	10⅝
St.	4%	Do. 4% 1st Mort. Deb. Stock	103—106	3 16 4	..	104½	104¼
St.	..	Madras Elec. Trams 5% Deb. Stk.	102—106	..	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6—9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12—15	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅛—⅜	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1	5 0 0	—	..	..
St.	13/7	Do. 4½ Deb. Stock	101—103	..	..	101½	100½
100	5%	Montreal St. Ry. St's 5% Mrt. Dbs. (1908)	100—103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103—105	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—1½	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	102—105	4 16 6	..	..	..
10	10/0	Potteries Electric Traction Ord.	8—9	5 11 2	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	8¾—9¼	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101—104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	86—89	3 7 5	June, Dec	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	½—¾	6 14 2	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	½—¾	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5¾—6	6 13 4	July, Feb	5¾	12½
5	3 0	Do. 6 per Cent. Pref.	5¾—6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101—104	4 6 7	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	100—103	4 8 6	..	..	..
5	3/0	British Westinghouse 6% Pref.	2¾—3¼	9 4 6	..	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	87—90	4 10 2	..	..	..
1	..	Brush Electrical Engineering	¼—½	..	March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1—1½	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	93—96	4 14 6	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	70—75	6 0 0	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9¾—10¼	5 14 3	Jan, July	9¾	9¾
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5¼	4 10 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	102—105	4 5 8	Nov, May	104½	103½
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	⅞—1	4 11 6	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	95—98	4 16 10	..	..	..
1	0/9	†Chadburn's (Ship) Telegraph Ord.	¾—1¼	8 17 6	..	..	..
2	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—2	3 15 0	Jan, July	1⅝	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	90—95	5 6 5	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	7—7½	6 13 4	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	5¾—6¼	5 4 4	Sept	6⅛	5¾
St.	4½%	Do. 4½% Deb. Stock	103—106	4 5 9	..	..	..
5	..	Edison & Swan United ("A" sh.) (£3 pd.)	½—1	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1—2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	78—83	4 17 9	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79—84	6 0 6	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6¼—6¾	5 9 10	H'lf-yearly	6½	6⅜
5	3/0	Do. 6 per Cent. Cum. Pref.	6¼—6¾	4 14 0	..	6⅜	6¼
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	105—106	4 3 10	..	107	105½
2	1/7½	Electric Construction Co.	1—1½	6 8 0	July	1¼	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2—2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97—100	4 0 0	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90—96	5 4 2	..	—	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9—9½	5 5 3	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91—96	4 3 4	..	..	..
5	5 0	Henley's Telegraph Works Ord.	10¾—11¼	6 1 9	Feb, Aug	10¾	..
5	2 3	Do. 4½ per Cent. Pref.	5—5½	4 1 10	Feb, Aug	5⅛	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108—111	4 1 5	Feb, Aug	..	..
10	6 0	India Rubber, Gutta Percha, &c., Wrks.	19—20	5 0 0	Feb, Aug	19½	19
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99—102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾—11¼	4 5 10	Mar, Sept	..	..
12	2/0	Telegraph Construction & Mainten'ce.	36—39	6 3 1	Mar, July	38	37
100	5%	Do. 5 per Cent. Deb. Bonds, 1909	101—104	5 17 6	Jan, July	..	..
5	..	Willans and Robinson Ord.	1—2	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2—3	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs	78—80	5 1 0	May Nov	..	..

Share.	Last Dividend.	Name.	Price Wed., Oct. 19.	Rate per Cent. Yielded.	Dividend Due.	Business Week to Oct. 19. Highest.	Business Week to Oct. 19. Lowest.
		ELECTRICITY SUPPLY.		£ s. d.			
..	..	Blackheath & Greenwich Dist. El. Lt.—See South Metropolitan Elec. Lt. & Power Co. below	..	..	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11¾—12¼	6 5 0	..	12⅛	12
10	4/6	Do. 4½ per Cent. Cum. Pref	9¾—10¼	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10¾—11¼	5 4 4	..	11¼	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103—106	4 5 0	..	..	..
5	..	Bromley (Kent) El. Lt. & Power Shares	5¼—5¾	..	..	..	..
St.	4½%	Do. Do. 1st Debs	102—106	4 7 9	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10¼—10¾	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7½—8	4 7 6	..	7¾	7⅝
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106—109	3 14 6	..	107	106½
5	4/0	Charing Cross & Strand Electric Sup.	8¾—9	4 5 9	Feb, Aug	9	8¾
5	2/3	Do. 4½ per Cent. Pref.	5¼—5½	4 1 10	Feb, Aug	5⅜	5¼
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	—	..	..
5	2/3	Do. Do. (1903)	4¾—5	..	..	4⅞	4⅞
St.	4%	Do. 4% Deb. Stock (red.)	103—105	3 17 8	..	..	..
5	2/3	Chelsea Electric Supply Ord.	6½—7	4 2 2	March	6⅝	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108—111	4 1 9	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	10½—11	4 10 11	Feb, Aug	10¾	10⅝
10	6/0	Do. 6 per Cent. Cum. Pref.	13—14	4 5 9	Jan, July	13⅝	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122—126	4 0 3	Jn, Dec	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	103—106	4 5 9	..	..	..
10	4/0	County of London Elec. Supply Ord.	8¾—9¼	4 4 8	..	8¾	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾—12¼	4 18 0	Mar, Sept	12⅛	11¾
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106—109	4 3 9	..	107½	107
St.	4½	Do. Second Deb. Stock Prov. Certs.	102—105	4 7 5	..	104½	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88—93	5 7 6	..	..	..
5	2 0	Folkestone Electricity Supply Co. Ord	5¼—6	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101—104	4 7 6	..	..	—
10	..	Havana Electricity Co. Shares	9¾—10¼	..	..	..	—
5	3 6	†Hove Electric Lighting Ord.	7¾—8¼	5 0 0	..	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St (red.)	101—103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf	⅛—⅜	..	—	..	..
5	5/0	Kensingtn & Knghtsbdge Ord	12—13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101—104	3 17 8	..	..	..
5	..	London Electric Supply Ord.	1¾—2¼	..	..	..	..
5	3/0	Do. 6 per Cent. Pref.	5¾—6	5 0 0	..	5⅞	5⅞
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96—99	4 2 0	Mr, Jn, S, D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	16¾—17¼	5 10 5	April, Oct	16¾	16½
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼—5¾	4 1 10	Jan, July	5⅝	5½
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	113—117	3 18 0	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.	96—99	3 10 6	..	..	..
100	4½	Midland Elec. Corp. for P.D. 1st Mort. Db.	93—96	4 13 9	..	..	—
10	6 0	Notting Hill Electric Ord.	14¾—15¼	3 17 6	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	99—102	3 18 6	..	..	..
5	2/6	Oxford Electric Ord.	5¾—6¼	5 4 0	March	6⅛	6
St.	4%	Do. 4% Deb. Stock	98—101	4 0 0	..	..	..
1	..	Rand Electric	1⅛—1⅜	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mt. Deb	98—101	4 9 0	April, Oct	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	14—15	4 16 8	Feb, Aug	14⅜	14⅛
5	3/6	Do. 7 per Cent. Pref.	8—9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98—101	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¾—3¼	6 3 1	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83—87	4 12 6	..	..	..
5	3/0	South London Electric Supply Ord.	4¼—4¾	3 3 1	..	4½	4⅜
1	..	South Metrop'n Elec. Lt. & Power Ord.	¾—1	..	—	..	..
1	0/8½	Do. 7% Cum. Pref.	1¼—1½	4 13 4	—	1⅜	..
St.	4½	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	105—109	4 3 0	—	107½	106½
5	2/0	Urban Electric Supply Ord.	4¾—5	5 0 0	..	4⅞	..
5	2/6	Do. 6% Cum. Pref.	4¾—5	5 0 0	..	..	..
St.	..	Do. 4½ 1st Mort Deb.	100—102	..	..	101½	..
5	6/6	Westminster Electric Supply Ord.	12¾—13¼	5 0 0	Mar, Sept	13⅛	12⅞
5	2/6	Do. 5 per Cent. Cum. Pref.	6¼—6¾	3 14 0	..	6⅜	6⅜
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.	99—102	3 19 0	Jan, July	..	..
10	..	Amazon Telegraph	2¾—3¼	..	Jn, Dec	..	..
St.	12/6	†Anglo-American	49—52	5 6 6	F, My, Ag, N	50½	..
St.	25/0	† Do. Preferred	92—93	5 12 8	F, My, Ag, N	97	96
St.	2/0	Do. Deferred	7¾—8¼	1 2 9	F, My, Ag, N	8¼	7¾
100	$2	Commercial Cable Capital Stock	170—190	4 4 2	Ju, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93—96	4 3 6	Jn, Ap, Jy, O	91½	91¼
10	5/0	Cuba Submarine Ord.	7—8	7 10 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15—16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2¾—3¼	5 11 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7—8	6 6 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98%—101%	4 9 2	Jan, July	..	..
20	3/0	*Direct United States Cable	10¼—10¾	5 11 8	Ja, Ap, Jy, O	10⅝	10½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.	100—102	4 9 6	Jn, Dec	..	..
St.	25/0	†Eastern Ordinary	131—136	5 2 9	Ja, Ap, Jy, O	136	133½
St.	17/6	† Do. 3½ per Cent. Pref. Stock	86—89	3 18 9	Ja, Ap, Jy, O	88½	87½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.	106—109	3 14 3	May, Nov	107½	106½
10	2/6	†Eastern Extension	12½—13	5 7 9	Ja, Ap, Jy, O	12¾	12⅝
St.	4%	Do. 4 per Cent. Deb. Stock	105—108	3 14 3	Feb, Aug	107½	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1908	100—103	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.	101%—104%	3 18 3	May, Nov	101½	101⅛
10	3/0	Gt. Nrthn. (of Copenhagen)	28¾—29¼	5 1 9	Jan, July	..	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.	100—102	4 9 6	June, Dec	..	..
25	37/6	Indo-European	44—47	5 6 4	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97—100	4 0 0	June, Dec	..	..
10	6/0	West African Telegraph Shares	6—7	5 14 3	..	6½	..
2½	..	West Coast of America	¼—¾	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97—100	4 0 6	Jan, July	..	..
10	..	West India and Panama	½—1	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6½—7	5 11 5	May, Nov	6⅝	..
10	..	Do. 6 per Cent. 2nd Pref.	5—6	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	100—103	4 17 10	Jan, July	..	..
10	3/6	Western Telegraph	12½—13	5 7 9	Mr, Jn, O, D	13	12¾
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101—104	4 16 3	June, Dec	..	..
St.	4	Do. 4% Deb. Stock (red.)	101—104	3 17 6	—	..	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid)	5—5½	6 7 3	August	5½	5⅜
1	0/7½	Monte Video Telephone Ord.	½—⅝	..	..	..	..
St.	6%	National Co. Pref. Stock	106—108	5 11 0	..	107½	106½
St.	6%	Do. Def. Stock	92—94	5 6 5	..	93	92½
10	6/0	Do. 6 per Cent. Cum. 1st Pref	13—14	4 5 8	Feb, Aug	13½	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12—13	4 12 4	Feb, Aug	12½	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5¾	4 15 0	Feb, Aug	5⅝	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97—99	3 [illegible] 5	June, Dec	97½	97¼
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104—106	3 15 9	..	105½	104½
..	5/9	Do. Do. Prov. Certs. 35 [illegible] pd.	67—69	..	..	..	..
1	0/8½	Oriental	1⅛—1³⁄₁₆	6 6 8	April, Oct	1¼	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 [illegible] 0	..	..	..
5	3/0	United River Plate	6¼—6¾	5 18 6	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 8	June, Dec	5⅛	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103—106	4 14 4	June, Dec	..	—
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5¼	5 11 4	—	..	..
10	2/0	Globe Telegraph and Trust	9¾—9⅞	5 12 5	Ja, Ap, Jy, O	9⅞	9¾
10	3/0	Do. 6 per Cent. Pref.	13¾—14¼	4 4 3	Ja, Ap, Jy, O	14	13¾
100	4%	†Submarine Cables Trust (Cert.)	117—122	4 15 4	April, Oct	119½	..
..	30/7	Underground Elec. Rys. Co. of London 5% Profit Sharing Secured Notes	98½—99½	..	..	99¼	98½

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

THERE is an article abstracted in this issue which touches a great subject. The author, Mr. EDSTROM, rightly realises that the fixation of nitrogen in a form competent to be utilised is of high industrial importance. The most obvious method is to burn air. This has been done by chemists for many years, and within the last ten has been used by Lord RAYLEIGH to isolate argon. As energy has to be imposed on the elements to be united, direct burning must be performed in such a way that particles, or even molecules, are heated to the necessary temperature and at once are able to escape. The notion has been put into working form by BRADLEY, who employs a number of very thin arcs. Now, BIRKELAND and EYDE attempt the same thing by causing an arc to oscillate. The principle in each case is the same; energy must be poured into the mixture of gases, and as soon as the desired combination has occurred, it must be turned into another field. The difference lies in the size of the apparatus and the method of directing the energy. There is no quantitative side yet put forward for these experiments—a matter of regret, because success must be adjudged on that. Everybody knows that nitrogen can be burned to useable compounds; we want to know what is the cost. There is plenty of nitrogen in a combined state obtainable from gas producers, and by bacterial action from waste materials, and although both these methods draw on existing stores, yet one must be convinced that these are approaching exhaustion before welcoming synthetical methods unreservedly.

◆

ANOTHER Paper read before the Electro-Chemistry Section of the St. Louis Congress has been receiving some attention. It is one by Messrs. A. G. BETTS and E. F. KERN, and sings the praises of the lead voltameter for absolute measurements. We published it in full in our last issue. The point of interest in the Paper is that lead can be deposited from a solution of its fluosilicate in a coherent and weighable form. This discovery has been turned to account in the refining of lead, and the suggestion has naturally resulted that lead should be used as a standard material for measuring current. Lead has some advantage in cheapness and in its high equivalent; further, any exact method of checking accepted values by a new mode of deposition must be welcomed. The precise degree of accuracy which may be secured by the use of lead can be ascertained by an examination of the tables which we print. The discrepancy in the results is too large for a method worthy of being used for absolute measurements, if we assume an extreme degree of accuracy in the silver voltameter observations. There is, of course, just a possibility that errors in the silver determinations may account to some extent for the discrepancies in the figures, and to have made the investigation quite complete the authors should have measured accurately by other means the *relative* values of the currents used in each experiment. On chemical grounds, however, the lead voltameter must stand inferior to the silver voltameter. There is a risk of oxidation of lead which does not occur with silver, and there is no corresponding increase of the equivalent to compensate for this. Moreover, silver has the considerable advantage of remaining monovalent whenever it can; sometimes it may slip, but on the whole its behaviour is quite as virtuous as one can expect.

◆

THE extent to which the newly-discovered properties of radium are likely to revolutionise our views of the universe is strikingly exemplified by the calculations of Herr LIEBENOW, of which we give an account in another column. Following on the suggestions put forward by Prof. RUTHERFORD at the

Royal Institution last May (*The Electrician*, Vol. LIII., p. 212) he shows arithmetically that the whole of the internal heat of the earth may be accounted for by the very natural supposition that radium is uniformly distributed throughout the mass of the earth in quantities of about one-thousandth of what is known to occur in pitchblende. The heat known to be given out by the whole earth is sufficient to heat some 50,000 tons of water from freezing point to boiling point in one second. The occasional displays of volcanic activity are insignificant beside that constant stream of energy, and can be easily thrown in. Now, there are many indications to show that radium occurs more frequently than this in all known rocks, and the irresistible conclusion is that its occurrence is more frequent near the surface of the earth than in the interior. This demolishes at a blow all our conceptions of a liquid interior at the tremendous temperatures implied by a uniformly rising gradient. The fact that the gradient of temperature does not rise uniformly in the deepest mines has been known for some time, but it has, of course, been entirely unexplained, since no theory of a cooling earth could account for a cool nucleus and a hot intermediate layer. It now becomes quite permissible to assume that the temperature rises towards the centre, but attains a maximum at no very great depth, and that the interior beyond that point is at a uniform and comparatively low temperature.

IN view of the recent demonstrations of the value of wireless telegraphy in naval warfare, the delay of Admiral ROJDESTVENSKY in communicating with the Russian Government after his bombardment of British fishing boats in the North Sea is inexplicable, and his report published yesterday in no way explains this delay. We know that the flagship, and presumably all the other ships of the Baltic fleet, are equipped with wireless telegraph apparatus, and in spite of the credible reports as to the general state of non-repair of the vessels, the wireless apparatus was in order, as the flagship is said to have spoken the North Foreland by wireless telegraphy. There are several points on the North Sea and the Channel at which the Admiral's messages could have been received, and if he did not avail himself of this facility of sending an immediate report to his Government, it is evident that the reason was a desire for delay. The Russian Admiralty circulated a statement on Tuesday that they had no means of communicating with the squadron, a statement which is clearly incorrect for the reasons we have stated. It would, in fact, have been quite possible for the Russian Government to have been in continuous communication with the Fleet from within a few hours of the incident until its arrival in the Atlantic.

MUCH sound and practical advice concerning extra-high-tension transmission schemes is given by Messrs. KELLY and BUNKER in their Paper read before Section D (Electric Power Transmission) of the St. Louis International Electrical Congress and published in abstract in this week's *Electrician*. American engineers have done much pioneer work in long-distance high-tension transmission, and it would be unwise of us in this country, who are to all appearances on the eve of similar work, to ignore the difficulties they have encountered and the way in which these difficulties have been overcome. The authors record the tendency of American engineers to substitute iron towers for wooden poles. In this they are in agreement with the other American electricians who spoke at St. Louis on the same subject. This substitution does away with burning or charring effects; it allows longer spans, conduces to longer life of the line construction and facilitates in some cases the transport of the line material. Of the relative cost of iron towers and wooden poles, the authors unfortunately say nothing, but since the former are being substituted in cases where wooden poles were originally erected, it may be expected that the higher first cost of steel towers over wooden poles is more than off-set by the advantages gained. But iron towers have also some drawbacks, the principal one mentioned by the authors being the necessity of shutting down the transmission line at once should a wire come in contact with the ironwork. The authors, apparently, have been troubled with wooden pins charring, owing to continual leakage of current over dust-coated insulators. But it must be noted that dust does not always lead to such detrimental effects as in the author's case. In the Paper by Mr. L. M. HANCOCK on the Bay Counties power transmission, for instance, which was also read before the St. Louis Congress, it is stated, that little or no trouble was experienced from dust, except near cement mills. The nature of the country traversed in this particular instance may have something to do with this result; perhaps, too, the insulators were of a different design. It emphasises once more, however, the maxim, announced by most writers on high-tension power transmission, that it is absolutely necessary to investigate local conditions thoroughly before embarking on high-tension power schemes. The necessity of properly transposing the power wires in cases where a telephone circuit is strung from the same poles is forcibly brought home to the reader by the figures quoted by Messrs. KELLY and BUNKER. It will surprise many, no doubt, that the voltage induced in a telephone circuit hung below the non-transposed wires of a 40,000-volt power transmission was, in certain instances, as high as 2,000 or 3,000 volts.

EVERYONE who has followed the career of the Hargreaves-Bird process will feel regret that the report of the Electrolytic Alkali Company, published elsewhere, is not more satisfactory. The Company, as we know at first hand, has in use a sound and practical method. It has operated in a thorough and business-like way. Examination of the works has shown that the situation has been sensibly chosen, that the plant is good, and that adequate capital has been expended with a courage not always characteristic of English manufacturers. In spite of all this, the Company has to acknowledge that its situation is not free from difficulty. Knowing the process as we do, we are compelled to attribute this difficulty to the commercial situation. It must be remembered that, until electrolytic processes for making chloride of lime came into use, the Leblanc manufacturers were resting comfortably. When their chlorine monopoly was successfully attacked, they changed their methods, and prices for bleach fell with a bump. The history of the economics of the alkali trade has yet to be written. In the hands of a real romancer—we should prefer Mr. H. G. WELLS—it could not fail to be entrancing.

It would appear that the difficulties in connection with the conversion of the horse tramways in the north of London to electric traction are not smoothing themselves out in a manner likely to lead to a speedy and satisfactory settlement of the grievances of the three parties concerned. To the credit of the London County Council, be it said, however, it is quite evident that they take a common-sense view of the situation—viz., that the overhead system should be adopted for the tramways in North London, rather than the more expensive and complicated conduit system. In this, of course, the North Metropolitan Tramways Co. quite naturally concurs; but the real stumbling block is the existence of sec. 23 of the London County Council (Electrical Powers) Act, 1900, which provides that in no Borough may the overhead system be adopted without the consent of the Borough Council. But for this it is possible that effect might have been given to a compromise, which it was stated a short time ago had been arrived at between the County Council and the Company now working the horse cars on lease. In our issue for July 22nd we gave a report of a Conference of the local authorities north of the Thames, and we understand that a similar Conference is again to be held. In the meantime, the date of expiry of the Company's lease (1910) becomes less distant, but we fail to see that the County Council will be in any better position even at that date. So long as the Borough Councils insist on the conduit system, and the County Council refuses on the score of capital expenditure, there is a deadlock. An indication of the views of a responsible section of the Council is given in a report of the Finance Committee mentioned on another page of this issue. Owing to the difficulties in connection with the reconstruction of the existing northern lines, the construction of certain other new lines has been delayed, and the powers for the construction of a line along Rosebery-avenue expire next year. In order to avoid the lapse of the powers and the consequent expense which would be entailed in applying to Parliament again, it is recommended that the construction of this short line upon the conduit system be proceeded with at once, but that it should be worked by horses by arrangement with the North Metropolitan Company until the conversion of the entire tramways in the north. In advising this course, however, the Committee points out that this decision must not commit the Council to the adoption of the conduit system for the whole of the lines in the north.

◆

Electric condensers, while one of the oldest electric apparatus used, are amongst those pieces of electric machinery which are least understood and which have undergone but little improvement during the past. They have acquired the reputation of being unreliable—at least, when used for storing considerable quantities of electric energy at high pressures—and their employment for results which can be obtained by other means is studiously avoided. But there are many occasions where their employment, if only they were cheap and reliable, would conduce to a decided betterment of things. This is notably so in alternating-current installations, where condensers might advantageously be used for rectifying phase differences, or for creating phase differences, as the case may be. But we are yet far from adopting condensers as a standard piece of apparatus with the same confidence as we would use, say, a choking coil. As Mr. Swinburne said in his Presidential Address to the Institution of Electrical Engineers two years ago: "Bringing the poles of a large station within a small fraction of a millimetre over an enormous area with nothing but a few thicknesses of paper between them does not appeal to an engineer." A step towards the realisation of a cheap high-tension condenser for considerable power has been made by Herr Moscicki, whose investigations are recorded in another part of this week's paper. As will be seen, the pattern of condenser finally adopted by the experimenter closely resembles the old Leyden jar, but with the all-important difference that the dielectric is thickened at the edges of the coating, thus rendering these critical places as puncture-proof as any other part of the jar. Since the energy which can be stored in a condenser is in proportion to the square of the potential employed, it is obvious that the higher the voltage the smaller will be the capacity of the condenser required to produce the same effect. As Herr Moscicki claims that his condensers will stand extremely high voltages, he therefore proposes, where the voltages are not already very high, to connect them through transformers across the circuit in which an alteration in phase is to be obtained, placing the primary of a step-up transformer across the circuit and connecting the condenser to the secondary terminal.

◆

A peculiar coincidence occurred in the Old Kent-road, London, on Monday. A fire (not "due to a defective electric circuit") broke out on the premises of a tailor, and the fire brigade was called to extinguish the flames. Whilst they were at work one of the London County Council electric tramcars came up, and the fuse in the plough blew. This, as occasionally happens, set fire to the preservative compound in which the ploughs are dipped periodically, and flames were seen to issue from beneath the car. An intelligent fireman immediately directed his hose upon the car and extinguished the flames. The coincidence of the two occurrences and the fact that the fire brigade was on the spot when the flare-up happened underneath the tramcar, must be the reason for the peculiar report which was published in Tuesday's *Times*, from which it would appear that the serious fire occurred on the tramcar and that the fire brigade was called to extinguish this, while no mention of the fire brigade is made in connection with the tailor's shop fire. The report reads as follows:—

> One of the London County Council's electric trams caught fire last night in the Old Kent-road. The passengers hastily left the car, and firemen extinguished the flames. A defective electric circuit was the cause of the mishap.—A fire broke out last night at 510, Old Kent-road, S.E., on the premises of a tailor named Posiler. The shop and house were severely damaged.

It would appear, however, that there is need for a non-inflammable preservative compound for "dipping" the ploughs.

◆

Bequest to Cardiff University.—It was announced by Principal Griffiths at the annual meeting of the University College, Cardiff, on Friday, that, under the will of the late Dr. Isaac Roberts, the college would become the recipient of nearly £15,000. This was under the condition that two scientific research scholarships, open to graduates or non-graduates, of the value of £50 a year each, be established. It is understood that University College, Liverpool, and Bangor College will also benefit under the will.

Standards for Bull-headed Railway Rails.—The Engineering Standards Committee has issued its report on the standard specification and sections of bull-headed railway rails. The standard specification relates to questions of chemical composition, manufacture, permissible variations in weight, templates, length of rails, branding, tests and so on. It is followed by an illustrated description of forms of British standard tensile test pieces. This is succeeded by a series of tables containing the principal dimensions and areas of standard bull-headed rails and nine full-sized dimensioned sections of rails, ranging—in steps of 5lb.—from 60lb. to 100lb. per yard.

Cable Interruptions and Repairs.

	Date of Interruption.		Date of Repair.
Cayenne—Pinheiros	**Aug. 18, 1902**	..	—
Beissi-Issa (Yemen)—Camaran	**Oct. 22, 1902**	..	—
Tarifa—Tangier	**Jan. 18, 1904**	..	—
Cayenne—Paramaribo	**July 13, 1904**	..	—
Cap Haitien—Mole St. Nicholas	**Aug. 20, 1904**	..	—
Bundaberg—Gomen (New Caledonia)	**Aug. 30, 1904**	..	**Oct. 21, 1904**
Cap Haitien—Puerto Plata ..	**Sept. 26, 1904**	..	—
Trinidad—Demerara	**Oct. 11, 1904**	..	—
Bolama—Bissao	**Oct. 13, 1904**	..	—
Jupiter Inlets (Florida)—Nassau (Bahamas)............	**Oct. 20, 1904**	..	—

Electrical Indication of Fire in Edinburgh Theatre Royal.—An outbreak of fire occurred in the Edinburgh Theatre Royal on Tuesday during a rehearsal. The fire originated among some wood shavings and packing in the basement under the stage, but it was almost extinguished by the time the fire brigade arrived on the scene. In addition to the ordinary hand alarm to the fire station, the Edinburgh Theatre Royal is equipped with the May-Oatway automatic alarm device, and this was instrumental in turning out the brigade. We are informed that there are only four theatres in the United Kingdom equipped with combined hand and automatic alarm devices, and all these theatres are in Scotland. The damage at the Theatre Royal did not exceed £5.

Magnetic Alloys of Non-magnetic Metals.—According to the *Western Electrician* of Chicago, successful experiments have recently been conducted with a view to the production of magnetic alloys from non-magnetic metals. With the same manganese that obtained a practically non-magnetic iron alloy a magnetic copper alloy may be produced. The non-magnetic metals, copper, aluminium and manganese, combined in certain proportions, produce an alloy having considerable magnetic properties. No combination of copper and aluminium produces a magnetic alloy; hence, the presence of magnetic properties must be ascribed to the manganese. The manganese was submitted to the temperature of liquid air; but no change was found to occur, the metal remaining non-magnetic. This was found to be the case with the copper and aluminium.

A New Engineering Society.—A society known as "The Wolverhampton and District Engineering Society" has been formed at Wolverhampton. The officials are as follows:—

President, Sir Alfred Hickman, Bart., M.P. *Vice-presidents*—Councillor Berrington, Messrs. W. Buchan, P. M. Baker, Joseph Evans, George Green, E. S. W. Moore, A. J. Robinson, C. E. C. Shawfield, H. Stubbs, John Thompson. *Secretary*, Mr. T. Smith. *Hon. Members*—His Worship the Mayor (Ald. Levi Johnson, J.P.) and Councillors Corbett, Weaver and White.

Visits will be paid to works and Papers will be read before the society once a month. The programme for the session includes the following:—

"Steam Engine Packing," A. McSwiney; "The Parsons Steam Turbine and some of its Applications," Jno. D. Bailie; "A New Type of Reversing Rolling Mill Engine," H. Stonewall Jackson; "Electricity Switch Gear and Transmission," Leonard Andrews; "Pumping Machinery," E. C. R. Marks; "The Lanchester Car," F. W. Lanchester; a Paper by C. E. C. Shawfield; "Boiler Construction," S. J. Thompson.

The Electric Lighting of London.—An American paper publishes the following wonderful information concerning the electric lighting of the City of London:—

"I was in London a few months ago, and paid a visit to the lighting plant there. It is one of the most complete in the world. It is located in the East End, and, with some smaller stations, furnishes electricity for 4,500,000 arc lights. The lighting costs the municipality about $50,000,000 a year, or slightly over $11 a lamp. The main plant consumes about 2,000 tons of coal a day in the summer and three times that during the longer winter nights. Coal is bought in instalments of 60,000 tons. Storage bunkers holding nearly that amount always are kept filled in view of possible strikes or other emergencies. There are 40 boilers with a capacity of 1,000 H.P. each, supplying power to operate half a dozen 3,000 H.P. dynamos and one 6,000 H.P. dynamo. Sufficient voltage is carried by the main cables to kill an army of 90,000 men. There are 3,000 miles of cable in the city connected with the electric lighting plants. The sum of $50,000,000 for lighting each year seems pretty large. But when you consider the average cost per light, it is cheaper than you find in American cities."

Electrolysis of Water Mains.—The *Electrical Review* of New York states that in the last report of the Metropolitan Water and Sewerage Board of Boston it is alleged that on 90 linear ft. in a 48in. pipe in Cambridge (U.S.A.), 5,225 pittings were observed, varying in depth from $\frac{1}{16}$in. to $\frac{5}{8}$in. In parts of two lines of 36in. cast-iron pipe under the Charles river 11 pittings from 2in. to 6in. in diameter and $\frac{3}{8}$in. to $\frac{3}{4}$in. in depth were found. The pipes in the river are being destroyed very rapidly. At other river crossings damage was noted. In the city of Chelsea a 24in. cast-iron pipe line in 280 sq. ft. of pipe surface showed 250 pittings from $\frac{1}{16}$in. to $\frac{7}{16}$in. deep. In Lynn, on 175 sq. ft. of the surface of a 12in. pipe were found 387 pittings from $\frac{1}{32}$in. to $\frac{7}{16}$in. in depth, and at another place over an area of 44 sq. ft. were found 200 pittings. The deepest of these was 0·45in. with but 0·24in. of the original thickness of the pipe left. A large portion of these pipes will have to be replaced. An insulating joint with a connection made of a rubber gasket 0·5in. in thickness placed between two flanges, has been found helpful in preventing the flow of a large amount of electricity from the Metropolitan pipes to those of the city of Cambridge.

Wireless Telegraph Notes.—It is stated in a consular report that while submarine telegraphic communication between Martinique and the outside world was interrupted for over 12 months in 1902-3, owing to the terrible volcanic disaster in the neighbourhood of the island, a system of wireless telegraphy was established between Martinique and Guadeloupe. As communication was frequently interrupted by atmospheric and other causes, the experiment was not an unqualified success. During the first four working months of the wireless system an average of 10 messages of 10 words each per day were sent. Now that the French company's cable, which alone serves Martinique, has been repaired the wireless system is to be discontinued.

While on a recent visit to America, Mr. Marconi, it is stated by the *Western Electrician* of Chicago, made the following statement:—

Though thus far the experiments have been imperfect, they have mainly failed because of lack of power. I purpose to increase that of the Cape Breton station, and I have new appliances for a more perfect radiation for the electric waves. I believe that I can overcome the long distance with more power. The Cunard steamships now get their bulletins readily and accurately when 1,500 miles from shore. With sufficient power the remaining distance across the sea can be overcome, I believe. Recent experiments in Italy developed curious phenomena which distance only cannot explain.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, October 28th.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Physical Laboratory, Royal College of Science, South Kensington, S.W. Agenda: (1) "An Interference Apparatus for the Calibration of Extensometers," by J. Morrow and E. L. Watkin. (2) "A Sensitive Hygrometer," by Dr. W. M. Thornton. (3) "Note on a Property of Lenses," by Dr. G. E. Allan.

SATURDAY, October 29th.

JUNIOR INSTITUTION OF ENGINEERS.

3 p.m. Visit to the National Physical Laboratory, Bushy House, Teddington.

TUESDAY, November 1st.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Address by Sir Guilford L. Molesworth, the President. The medals and prizes awarded by the Council will afterwards be distributed.

THURSDAY, November 3rd.

TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

8 p.m. Meeting at the Society of Arts. Paper to be read: "Notes on Permanent Way," by A. N. Connett.

RUGBY ENGINEERING SOCIETY.

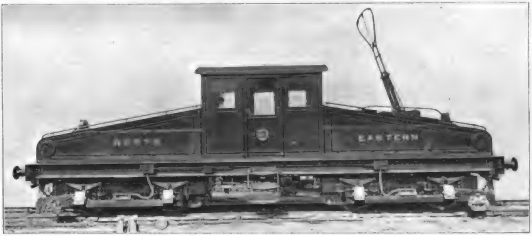
8 p.m. Meeting at the Benn Buildings, High-street, Rugby. Paper to be read: "Permanent-way for Tramways," by C. T. Taylor.

RONTGEN SOCIETY.

8.15 p.m. Meeting at 20, Hanover-square, when Mr. C. Thurston Holland will deliver his Presidential Address.

NORTH-EASTERN RAILWAY ELECTRIC GOODS LOCOMOTIVES.

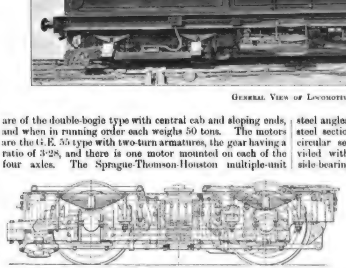
The electric locomotives which we illustrate herewith are said to be the largest ever built in the United Kingdom. They are of the double-bogie type with central cab and sloping ends, and when in running order each weighs 50 tons. The motors are the G.E. 55 type with two-turn armatures, the gear having a ratio of 3·28, and there is one motor mounted on each of the four axles. The Sprague-Thomson-Houston multiple-unit system has been adopted, this being similar to that used on the passenger trains. Some of the principal dimensions are given below:—

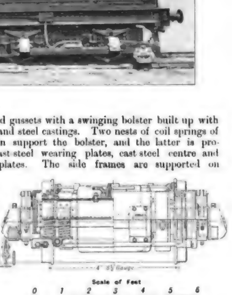


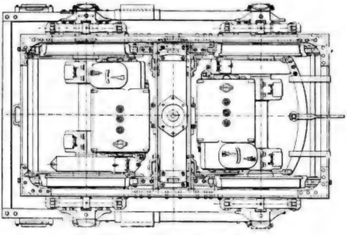
General View of Locomotive.

Gauge, 4ft. 8½in.; length over central cab, 9ft. ¼in.; length over headstocks, 35ft.; length over buffers, 37ft. 11in.; pivotal centres of trucks, 20ft. 6in.; wheel base of each truck, 6ft. 6in.; width over cab, 7ft. 6¾in.; width over side soles, 7ft. 10⅝in.; width over-all, 8ft. 8in.; height from rails to top of cab, 11ft. 9in.; height from rails to top of floor, 4ft. 3¾in.; diameter of wheels, 3ft.; diameter of axles at centre, 6⅝in.; diameter of axles at journals, 6in.; length of journals, 10in.

The trucks are of the steel plate frame type, built in accordance with English railway practice, and strengthened with steel angles and gussets with a swinging bolster built up with steel sections and steel castings. Two nests of coil springs of circular section support the bolster, and the latter is provided with cast steel wearing plates, cast steel centre and side-bearing plates. The side frames are supported on the axle boxes by laminated springs of heavy design, while the axle boxes themselves are of cast steel machined to work in the horn plates, which are also of steel and machined, and are riveted to the side frames, which are cut out to receive them. Wings are fitted to the axle boxes to take the shoe beams, and heavy brasses, babbitted, are employed in them, ample provision being made for lubrication and exclusion of dust. Owing to the important part that the brake gear plays in the work that the locomotive has to handle, which is chiefly on heavy grades, a specially heavy design has been got out, blocks being fitted to each side of each wheel and all gear being made heavy enough to stand operation by air pressure. The wheels are of the cast-steel disc type, balanced, and fitted with rolled steel tyres 5½in. wide by 2½in. deep on tread, held in place by retaining rings and also by eight set screws; the motors are carried on the transoms by means of cast-steel brackets in which the nose on the motor rests and is held there by a forged strap. Oak shoe beams are bolted to the axle boxes, the shoes being hung outside the wheel base as shown on the drawings. All holes are drilled, edges of plates planed and rivets hand riveted.







Bogie Truck for Electric Locomotive.

The underframe is constructed of steel sections and ballasted with cast iron blocks to bring it up to the weight desired. Each side sole is formed by a girder 12in. by 6in., weighing 54lb. to the foot and of I section; there are also two centre longitudinals, each 8in. by 3½in. by ⅜in., of channel section, these four longitudinals being connected at their ends by headstocks 15in. by 4in. by ½in. of channel section, and to the front of these are bolted oak headstocks 15¾in. by 8in. The whole frame is firmly riveted together with steel angles and gussets, all holes being drilled and edges of plates machined. The underframe bolster is formed by two girders, each 6in. by 5in. by ⅜in. of I section, held together on the top by a plate 3ft. wide and ¾in. thick, while on the lower side there is a plate 17in. wide by ¾in. thick. Between the bolsters, evenly spaced, there are five cross girders, each 8in. by 3½in. by ⅜in., of channel section, backed with a plate 15in. wide by ¼in. thick, and on the top of the frame is a floor of fireproof wood 1⅞in. thick, fixed transversely with a top or lining floor of ⅞in. thickness laid longitudinally. The draw gear, side couplings and buffers are of the standard English pattern.

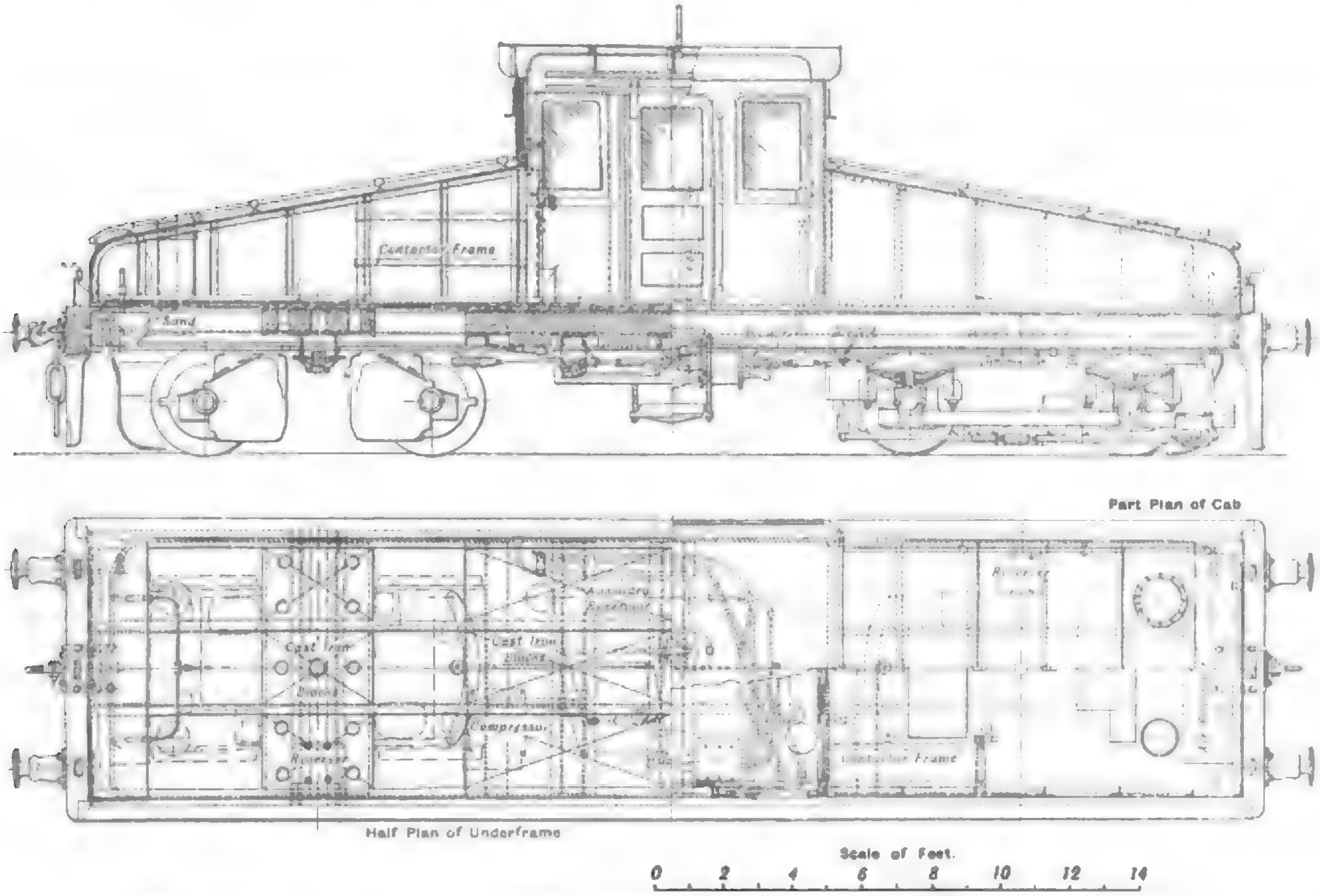
The centre cab is constructed of ⅛in. steel plate and angles and is quite separate from the sloping ends, which are also constructed in a similar manner, all three portions being bolted to the underframe. Two side windows are provided on each side, those at the driving corners being arranged for lowering. A sliding door constructed of ash is fitted on each side, and is glazed at the top and paneled at the bottom, bearing on the outside the arms of the company in transfer. The doorways are 2ft. 4in. wide and 6ft. in the clear. At the ends of the cab are two windows arranged to slide transversely. Arrangements are made for driving the locomotive from either end of the cab, and it is, therefore, fitted in duplicate with master controller, air brake, and sand and whistle valves. In the centre of the cab is fitted a cast-iron column to carry the hand-brake gear, and on each side is a panel for the control and pump circuit accessories with a main panel at one end for main and control switches, &c. Air gauges and ammeters are also fixed in each driving position. Under the sloping ends are fixed the contactors, reversers and rheostats. The apparatus for each two-motor equipment is fitted in its own end of the cab, the four-motor equipment being thus split up into two equipments as regards location. An angle-iron framing built on the floor of the cab supports the contactors, the reversers and resistances being bolted to the floor, but raised above it so that the cable runways may go underneath them. The air brake is of the quick-acting pattern, air being supplied by a B.T.-H. electrically-driven compressor of the C.P. 14 type, which is hung underneath the frame. This compressor will work against a pressure of 90lb. per square inch with a cylinder displacement of 20 cubic ft. per minute. The air reservoirs are fixed in the end of the sloping cabs, as are also the sand hoppers, the sand being carried by flexible tubes to the fixed pipes on the trucks, while the air-operating pipes are connected to them at the base of the hoppers.

A shaded lamp is fitted in each driving corner, with three lights in each of the sloping ends and a headlight on each end. All lamps are 32 c.p. and arranged for working six in series on a 600-volt circuit; two portable lights are also provided.

As the locomotives have to operate over sections fitted both with overhead line and third-rail, a sliding bow trolley has been provided of special design, which automatically reverses itself according to the direction of travel of the locomotive, and is also capable of being reversed and lowered from the cab by a hand-wheel actuating a worm and wheel device when not in use.

All cables are asbestos-covered and are run either in wood troughing lined with uralite or in steel tubing. Besides being fitted with the nine-wire coupler at each end for the control circuit, 'bus or main line and pump line couplers are also provided, so that two locomotives can be coupled together for dealing with heavier loads, and operated by one man.

Each locomotive, when operating on a 600-volt circuit, is capable of handling a 300-ton train on the level at a speed of



Plan and Elevation of Electric Locomotive. Brake leverage = 10·16 to 1 = 34·9 tons = 70 per cent. of total weight.

14 miles per hour and of starting with a train of 150 tons on a grade of 1 in 27 under all conditions of weather, running up this grade at a speed of 9 to 10 miles per hour. They were supplied by the British Thomson Houston Co., the trucks and bodies being built by the Brush Electrical Engineering Co. to the specification of Mr. C. H. Merz, consulting electrical engineer to the line.

CHRISTCHURCH (N.Z.) ELECTRICITY SUPPLY WORKS ACCOUNTS.

The accounts for the first financial year's working of this undertaking have just reached us. Supply was commenced on August 1, 1903, on the continuous current two-wire system. The installation, we are informed, is the only one in Australasia consisting of a combined refuse destructor and electricity works, the former being a four-cell Meldrum destructor which is rendering a very satisfactory account of itself. Coal is used merely for the purpose of assisting the destructor on the peak, and the total consumption for the month of August, 1904, was only 39 tons, no fewer than 26,880 units of electricity being generated. At the present time the plant is working non-condensing, and it is anticipated that when condensers have been put down even this low coal consumption will be reduced. From the copy of the accounts, which only deal with the first eight months' working, it appears that nothing is paid for steam supplied by the destructor, and although the two undertakings work in conjunction with each other, yet the accounts are kept entirely separate, the destructor having been in existence before the electricity works.

During the eight months ended March 31, 1904, the units sold numbered 39,423 and the actual maximum demand was 92kw. There are no public lamps and the number of power consumers at the end of the period numbered 15. The capacity of the plant is 200kw. and the number of consumers 60. A total capital of £12,142, averaging £60·7 per kilowatt, has been expended, of which £6,226 was for plant, £3,833 for mains, and £2,083 miscellaneous. The revenue for the eight months was £945, which works out at 5·76d. per unit sold. The total costs being £475 (2·89d. per unit), there remains a gross profit of £470. Of this, £158 has been set aside for depreciation, and, as the interest amounts to £317, there is a deficit of £305. However, as the figure set aside for depreciation represents 5·7 per cent. of the capital, calculated for eight months, and as that for interest represents 3·9 per cent., calculated for a similar period, the omission of any provision for a sinking fund can hardly be regarded as very serious. The following tables give the cost per unit sold under the usual headings. It may be pointed out, however, that the expenditure on distribution is not given, the reason being that it is probably so small as to be included under "Repairs." Apparently, too, the undertaking is free from all rents, rates and taxes, while stationery and law expenses are too insignificant to be set forth as separate items. Under "Salaries" there is only the small sum of £74, and even the wages amount to no more than £216. Thus, for eight months' work the entire staff has received only £290; we can only wonder what the chief engineer's salary may be.

Expenditure.

WORKS COSTS—		
Fuel	0·45d.	per unit.
Stores	0·39d.	"
Wages	1·30d.	"
Repairs	0·22d.	"
Distribution	—	
Public lighting	—	
Total works costs	2·36d.	"
MANAGEMENT—		
Rents	—	
Rates and taxes	—	
Salaries	0·44d.	"
Stationery		
Establishment, &c.	0·09d.	"
Law	—	
Total costs	2·89d.	"

In order to show that the undertaking is rapidly achieving better results, Mr. Lawrence Birks, the engineer, has sent us an analysis of the accounts for the month of August, 1904, and this we give below:—

Destructor.

REVENUE—		EXPENDITURE—	
Refuse destroyed	£3 19 0	Wages (five weeks)	£71 15 2
Ashes sold	1 14 6	Repairs	6 7 6
Refuse sorters	4 0 0		
	£9 13 6		£78 2 8

Net working cost.............. £68 9 2

Total quantity destroyed, 1,041 loads—*i.e.*, 19·8 loads per eight hours' shift, or 232 loads per week (12 shifts)

Working costs, 1s. 6d. per load gross, 1s. 3¾d. per load net.

Standing charges—Interest, £13,700 at 4 per cent., £46; sinking fund, at ½ per cent., £6—£52.

Concerning the electrical plant, there were 115 consumers who took 18,436 units, for which they paid £316. 2s. (4·11d. per unit). The total costs were £151. 9s. 11d. (1·97d. per unit), leaving a gross profit of £164. 12s. 1d. Calculating interest at 4½ per cent., depreciation and sinking fund at 5½ per cent., the standing charges amount to £104. 6s. (1·36d. per unit), and thus there is a net profit for the month of £60. 6s. 1d., which practically offsets the cost of working the destructor.

NOTES ON THE ELECTRICAL EXHIBITS AT ST. LOUIS.

BY OUR SPECIAL CORRESPONDENT.

The utility of an international exhibition must always be a difficult matter to gauge, especially with reference to a particular industry. If each country were to make a point of sending machinery and appliances illustrative of its high-water mark of development, the result would be a collection of exhibits worthy to be called international, and of its utility there could be no doubt. There are many obstacles to be met in order to achieve this end, the chief of which are the selection of a suitable situation for the exhibition (to make international co-operation possible) and the apathy of manufacturers in placing their products on view where no immediate benefit to their business can be easily discerned.

It may be stated at once that both these aspects of the question are strongly brought out in the electrical section at St. Louis and the character of its exhibits. In the first place, its situation is too far from Europe to make it an easy matter to transport large machines, and, further, the possibility of acquiring new business in that class of goods in face of a high protective tariff is an exceedingly remote one. The Palace of Electricity, although full of machinery and apparatus meriting the most careful study, has drawn its contents almost entirely from the manufacturing houses of the United States. European countries are represented practically only by instruments of precision, telegraphic apparatus, electrochemical appliances and special testing plant.

The cost and trouble of transport of this class of goods is not prohibitive, and, in addition, the more enterprising manufacturers of Great Britain and other countries are not wholly unsuccessful in selling their specialities, even against high tariffs and home competition.

Naturally, the space alloted to European countries was but a small fraction of the whole, but, bearing in mind the restricted character of the exhibits, they deserve considerable attention. Great Britain, in the group of scientific apparatus, was well represented by nearly all the best-known instrument makers, while the Post Office had sent some fine examples of their latest telegraphic practice. The Duddell oscillograph, which was on view, worked admirably—no small credit to the British Commissioner, as it is the kind of instrument often apt to be very unresponsive to anyone but an expert. Illustrative of quite a different field was the working model of Behr's mono railway, the demonstrations of which were conducted by the enthusiastic inventor himself and drew large crowds.

Germany was conspicuous by the attractive and orderly manner in which its exhibits were arranged, but, like those of the British section, they comprised almost solely electricity measuring instruments, with the addition of apparatus for research in electrochemistry and its industrial applications

Italy was represented by but little in the way of manufactured articles. There were, however, a few well-designed instruments and some specimens of cable on view. The numerous photographs and drawings of the great water-power stations in Lombardy for the production of electricity showed the importance of the advances that had been made in this industry, which means so much to a country without coal.

France, in her exhibits, was somewhat more ambitious in heavy machinery than the other countries, and sent a 700kw. three-phase set by the Société Alsacienne de Belfort. The Gramme Company also had a series of generators and motors, but the interest in them was mostly historical. In the fine collection of fittings and electroliers there was abundant evidence that on the artistic side France holds a high position. The rest of her exhibits fall into much the same category as those of Great Britain—*i.e.*, measuring instruments, electricity meters, telegraph apparatus and small accessories.

Coming now to the bulk of the native products it was hardly to be expected that there would be many startling novelties, seeing that the present Fair follows so shortly after the Paris Exhibition of 1900. Most of the machinery on view was, in fact, of standard design, and probably familiar to most European engineers. It was noticeable that almost all the smaller American firms were represented, but throughout the whole Electricity Building there was a pervading sense of the magnitude of the two rival organisations, the General Electric and the Westinghouse Companies.

In the history of electrical enterprise in America the influence of Edison is of paramount importance. The services he rendered to the development of the incandescent lamp, and to the idea of the central station generally, are forcibly indicated in the remarkable collection of his earlier machines and apparatus, which has been arranged under the auspices of the Association of Edison Companies. The existence and continued prosperity of these companies to-day are the best exemplification of the high standard to which central station distribution had reached before our legislature had begun to give facilities for a similar development in Britain. In the model of an early Edison station we have an illustration of all the essentials of a modern installation, including the feeder and mains system, three-wire distribution and the extensive use of the glow lamp. Among the Jumbo dynamos and other machines that tradition has made familiar, we find the less-known model of what is claimed to be Edison's invention of the electric tramcar.

In the department of polyphase machinery there are only two active exhibitors—the Westinghouse and the G.E. Companies. This dominating position is not due only to their size and power, but to the fact that they are the only licensees under the Tesla patents, which in America appear to control the whole field of polyphase working. One or two other firms show three-phase machines, but that is merely to educate the public in advance, pending the expiry of the patents.

For the provision of light and power to the whole exhibition a complete central station of 14,000 H.P. had to be designed, and this work, carried out by the Westinghouse Company, constitutes one of the most imposing features of the machinery building adjoining the Palace of Electricity. The plant consists of four Westinghouse Corliss engines coupled to three-phase generators, two of the latter built by the G.E. Co. and two by the Westinghouse Company. These furnish current at 6,600 volts and 25 periods. They have not, however, the distinction of being the largest generators in the Fair, this being held by an engine and generator set of 3,500kw. made by the Bullock Mfg. Co. This runs at 85 revs. per min. with the same voltage and frequency as the service plant.

The Westinghouse Company have running a Parsons turbine of 400kw. capacity, and they show another of the same size in detail to make its construction clear. In their guide-book they are half-apologetic for its size, as they have now in hand some machines of 8,000 H.P. The revolving field of the generator consists of a solid steel cylinder milled out to form the poles in which there are deep slots for the windings. Special precautions have to be taken for ventilating, but this type of construction is well adapted for the high speed of 3,600 revs. per min. and the consequent magnitude of the centrifugal stresses.

Among the Westinghouse machinery are found several types of three-phase motor, most of them, even when of 200 H.P. or 300 H.P., having squirrel-cage armatures which are started under load by a regulating transformer. Others are provided with the more common slip-rings and resistance to be inserted in the armature circuit. The single-phase railway motor, which has already been described, is also in evidence, together with a multiple unit system of train control. One of the most attractive features of this section of the exhibition is the auditorium in which are shown cinematograph pictures of the Westinghouse workshops in operation, taken by the light of the Cooper-Hewitt lamp.

As is now pretty generally known, these lamps possess great actinic power, enabling instantaneous photographs to be taken in dark rooms or shops, with only a small number of them in use. A good deal of general illumination throughout the buildings was done with this type of mercury vapour lamp.

Of the large machines made by the G.E. Co., the most conspicuous was the 2,000kw. Curtis turbine, which runs at the comparatively low speed of 750 revs. per min. It forms an auxiliary to the lighting service plant.

This company has brought together a very complete range of its manufactures, including the new commutator single-phase motor for railways, the development of which has been already touched upon. At its principal stall are seen at work large transformers, rotary-converters, a special design of motor-controlled high-tension oil switch, switchboards and their accessories. The operating electric car equipment is well arranged, the design of the controller requiring little responsibility on the part of the motorman. Its working is almost automatic, it being merely necessary for the handle to be placed full on, when the proper sequence of switching operations will be performed with sufficient time intervals. Should the motorman leave hold of the handle it at once flies back to the initial position, and shuts off the current. This exhibit in detail is worthy of the position which this company occupies in the province of car controller development.

One of the curiosities of the G.E. Co.'s stall is a type of single-phase motor frequently pointed out as a possibility to "third-year students," but which one rarely sees in this practical world. This machine of 7½ H.P. derives its rotating field partly from a condenser in series with a special induced circuit. This condenser serves the purpose not only of providing the requisite phase difference for self-starting, but also of compensating for the wattless current when the machine is running. The condenser, formed of tinfoil and paraffined paper, is conveniently placed in the base of the motor.

Amongst the newer methods of illumination this company is not behind in its experiments, and has already developed its own type of mercury vapour lamp, many of which were in actual service in the exhibition. In the field of arc lighting there was also on view Steinmetz's magnetite and copper arc.

In purely single-phase working a good deal is now being done in America with the repulsion motor principle. One of the firms best identified with it is the Wagner Mfg. Co., which has designed a motor that finds a ready market for use not only on single-phase networks, but also on three-phase systems where it is connected to one phase. The motor is provided with a commutator and starts first as a repulsion motor, but when the speed nearly reaches synchronism, a centrifugal apparatus short-circuits the commutator segments and it then runs as an induction motor.

A very noticeable feature of most of the machinery exhibits was the almost universal application of the direct-driving motor. Especially was this the case with the heavier machine tools, where the natural advantages of the electric motor were fully recognised. Not only were shafting and belts dispensed with, but the more distinctive features of the electric motor such as the regulation of speed, the possibility of reversal and quick-return motion, were brought into play.

In the division of measuring instruments the collection of the National Bureau of Standards overshadowed all the others. Not only was the apparatus of the most complete kind, but it was in active operation for carrying out the work of comparison of standards, and thus rendered more highly educative. As before pointed out, the instruments and equipment will all be removed to the new National Bureau Buildings at Washington, now being got ready for them, when the exhibition closes. Those now in charge of the exhibit were most courteous in explaining the apparatus and methods to any engineer who cared to inspect it.

At the Weston Company's stall one naturally sought for apparatus possessing accuracy and beautiful finish, and was not disappointed. The range of types is not perhaps very wide, but the evolution of the Weston instruments forms an excellent instance of what has been accomplished by painstaking experimenting and specialisation—after the so-called American method.

The progress in wireless telegraphy has been greater than in most branches of the science during the last five years, and the names of inventors and rival systems are now almost inconveniently numerous. At St Louis, however, the one most conspicuous is that of De Forest. In the exhibition grounds are erected a tower 300ft. high and a mast 220ft. high at the two transmitting stations, which are in constant use. From one of these messages have successfully been sent as far as Chicago.

After this the wireless telephone, which is worked by the simple device of a buried coil influencing a small coil held in the hand looks somewhat paltry. Although the Westerner is pleased with the apparent mystery, most central station men had already used the same device when "fault finding" on mains.

Admitting that the scope of the electrical section is something distinctly short of international, it forms a good landmark in the development of the industry. The features it will be associated with in the minds of most electrical engineers will probably be: the magnitude of its electric lighting effects, the size of the modern electricity generators and engines, the recognition of the steam turbine, the mercury vapour lamp, wireless telegraphy, and (more prosaic, but not less useful) the extended employment of direct driving motors.

THE SUPERIORITY OF ALTERNATING CURRENT FOR THE SUPPLY OF CURRENT TO LARGE CITIES.*

BY DR. GOTTHOLD STERN.

The production of continuous current by steam-driven dynamos in large cities requires only short treatment in view of our experience to date. The necessity of sub-dividing the service between several small central stations built on expensive real estate and the difficulty of supplying them with coal and water in the midst of streets crowded with traffic, has led all modern electrical engineers to abandon this oldest method of current supply, even such as, until recent years, wished to have nothing whatever to do with alternating current. Moreover, continuous-current dynamos cannot be constructed of the capacities now required by large central stations, and such continuous-current stations are, therefore, equipped with a number of smaller units. Very few of the continuous-current dynamos in Europe have a capacity greater than 1,000kw.; the average capacity of the dynamos in operation in the largest 15 Continental continuous current stations is 320kw. It is evident that steam engines adopted to such capacities are far from being as economical as larger units of the same quality; moreover, the labour required by a number of smaller units is greater, their first cost is higher and the space required greater. It will be contended that smaller units could be *apportioned* more readily to the variable load created by the varying demand on an electric light station; but on drawing the load curves of a characteristic summer and winter's day and circumscribing them by a broken-line diagram indicating the units in operation, it is evident at once that even in the largest stations a sufficient relation between engines in operation and the load on the station can be secured by 6 to 8 units, including the reserve; this number is still further diminished in the case of continuous current if the load is equalised to a certain extent by batteries. Practically, therefore, in stations of the same size, continuous-current dynamos should be selected in units of even larger capacities than alternators. However, in spite of this requirement, difficulties in manufacture of continuous-current units of large size compel the selection, in a large city, of continuous-current dynamo units of a smaller capacity than would be dictated by the selection of the most favourable size of unit.

In the present period of transition to the steam turbine there is added another difficulty. At the high rotative speeds of these turbines there results such a high number of pole reversals in the case of continuous-current dynamos as to make commutation extremely difficult. It is difficult enough to construct the commutator with sufficient safety mechanically for the high speeds, and the tendency to sparking is greatly increased at the higher differences of potential resulting from the higher number of pole reversals between adjacent commutator bars. The wear on the commutator and the brushes is enormous, and although methods have been suggested for eliminating the sparking by special windings, this difficulty will always stand in the way of the application of large continuous-current dynamos to steam turbines. Some of the lesser difficulties in the station incidental to continuous-current working need not even be cited in the comparison. We shall, for instance, ignore the difficulty of handling the continuous-current commutator in contrast with the ease of maintenance of the contact rings of the alternator. We must not forget, however, that alternating-current working has also its inconvenience; the separate exciter in the case of the alternating-current generator is a certain complication, and the paralleling of alternators undoubtedly requires somewhat more practice than paralleling of continuous-current dynamos.

Finally, we must not leave out of consideration the advantages inherent in the continuous current in connection with the possibility of its storage in storage batteries. If this possibility were coupled with smaller losses and if storage batteries had greater durability, there would be established a preference which for many purposes would outweigh many other disadvantages. Unfortunately, however, both conditions have not been fulfilled. The real purpose of a storage battery should consist in changing the variable load on the central station machinery to a more uniform load—*i.e.*, to almost integrate the daily load curve. We should then reach a steady loading of the engines and boilers and they would operate continually at highest efficiency. The increased safety attained by the application of storage batteries is certainly very valuable as the batteries can take up at once the supply of current should an accident occur to the machinery.

But with what losses and costs is coupled the operation of storage batteries. It appears from statistics of the "Association of Central Stations" in Germany that in cities with a population of over 200,000, in which storage batteries are used, the losses occurring in the batteries amount on the average to 33·5 per cent. The first cost of the storage batteries for each kilowatt-hour supplied through them amounts to 98pfs. (24·5cts.), and as interest and depreciation at the longest life of the cells—10 years—must be reckoned as at least 15 per cent. per annum, they increase enormously the cost of the current passing through them. If the cost of production of the kilowatt-hour at the dynamo terminals be 10pfs. (2·5cts.), it is increased by the losses in the storage batteries to 13·35pfs. (3·337cts.); and on account of interest and depreciation on the invested capital by 14·7pfs. (3·675cts.) additional, a total of 28·05pfs. (7·01cts.). Of course, the increase of price applies only to that part of the output which has passed through the storage batteries. In the cities above referred to this amounts on the average to 12 per cent. of the total energy produced, so that the storage batteries cause an actual increase of 21·6 per cent. in the price of the total production of current. And notwithstanding this, it cannot be denied that storage batteries present a considerable advantage on account of the increased safety and better equalisation of the service. This advantage cannot be realised, however, until such time as a good storage battery may be available—a time unfortunately not yet at hand.

The comparison will not be complete if the losses in the transformers are not considered also. The capacity of the transformers in well-planned alternating current stations is less than the number of connected lamps; their efficiency is up to 99 per cent. at full load, and even at half load, and, in good construction, not under 97 per cent. Of course, the iron loss of the transformers is continuous while the transformer is in circuit. This circumstance was formerly considered to be the weakest point in alternating-current service. Under the most unfavourable conditions this loss is calculated about as follows: The total transformer capacity is sufficiently valued at 80 per cent. of the connected installation of the station; for 100kw. of connected installation, representing in the station of a large city an annual consumption of 60,000 kw.-hours, there would be, therefore, 80kw. of transformers whose iron loss, if of good construction, is about 1 per cent. or 0·8kw. In the whole year there would be a loss in the transformers of 7,000 kw.-hours, or about 11·7 per cent. of the energy consumed. If the proper number of transformers is selected in the sub-stations, and those not required for the demand at the time are cut out of circuit by hand or by automatic switching apparatus, this loss can be considerably reduced. Apparatus of this kind has been continually improved from time to time, and it has also given good service for single

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[*] Abstract of Paper read before Section E of the St. Louis International Electrical Congress, 1904.

transformers. The copper loss in good transformers is very small and proportional to the momentary load.

It is important not only to manufacture the commodity cheaply and of the most satisfactory quality, but it must be transported cheaply and delivered cheaply to the customer at his residence. In the case of a large city with a diameter of about 5km. (3·1 miles), if it is desired to limit oneself to a single station—and it is desirable to do this for many reasons—it becomes necessary to use high tension, to avoid the expenditure of unheard-of sums for copper conductors, and the enormous loss of energy in the cable network. If some measure of importance is attached to uniformity in the pressure furnished to the consumer, the demonstration of this statement by actual figures need hardly be required at this time. Continuous current can hardly be seriously considered for high tension; first, because it is almost impossible to maintain high-tension continuous-current dynamos in operating condition; secondly, because high-tension continuous current can be transmitted by cables only with great difficulty; and thirdly, because the pressure of continuous current can only be converted by rotating machinery. Operating at the same pressure, conductors for alternating current are superior to those for continuous current as regards safety and durability, for, in the case of continuous current, in addition to the E.M.F., which constantly tries to effect an equalisation between the conductors of different potential, thereby tending to break down the insulation, there is added thereto the electrolytic effect which exerts a destructive action, not only on the conductors but, under certain conditions, on neighbouring metal parts also. This is particularly the case with underground cables, and probably no manufacturer has yet given a guarantee for an underground cable for continuous current at over 1,000 volts. As a matter of fact, cables which have been underground approximately 15 years subjected to 2,000 volts alternating current are not noticeably affected, as shown by lengths of cable in the Vienna cable system. Of the Vienna 2,000-volt alternating-current network which was begun in 1889, which had 75km. (46·4 miles) in 1892 and to date has increased up to 400km. (248 miles), there have been replaced during the whole time only 340 metres (1,120ft.), or less than 1 per cent., on account of failures, and the insulation resistance per kilometre has the same value to-day as at the time it was laid. Of course, failures in the cable network occur also with alternating current due to mechanical injury, &c., and we shall examine now the manner in which these show themselves. For simplicity's sake, let us consider a two-wire system. If one of the alternating-current conductors is damaged at one point, so as to become earthed, the service is in no way affected; even a second damage to the same conductor, by which a part of the current finds a return path through the earth, is without any particular harmful effect. With continuous current, on the contrary, the passage of the current to earth gives rise to an electrolytic action, which not only destroys in a short time long stretches of the conductor itself and its metallic sheathing, but also causes serious chemical decomposition in its passage from the metal parts of water and gas pipes, street-car rails, &c. If the second conductor also is completely earthed, a short circuit results, which, in the case of continuous as well as alternating current, can be productive of disastrous consequences, if provision is not made for switching off at the right time by properly proportioned safety catches. It is different with the "sneaking" earths when there is no complete earthing, but only a lowering of the resistance. In this case also, with the defect on one pole, a part of the current is diverted through the earth, and but a few amperes of continuous current, which are thus shunted around the cable, cause an electrolytic action, which results in damage to the whole length of the cable from the beginning of the first fault to the end of the last.

If a "sneaking fault" of this kind appears on both poles, it has frequently happened in the case of continuous current that one of the conductors was completely destroyed over a considerable length, in which the former current had not previously completely fused the place [illegible] already reduced in its cross-section. An alternating-current network, even for high-tension current, is not in the least affected by earths in a single pole even if they appear in considerable lengths and at different points; in failures on both poles no serious results are experienced at first until the current has found the weakest point of the faulty piece and caused a complete breakdown at this point. The fault is, however, confined to this one spot, and can easily be repaired by a simple splice. Cable faults are certainly not pleasant with any system, but the practical station operator will prefer the energetic manifestations of breakdown in a high-tension alternating-current cable to the lurking danger of the continuous-current corrosion.

Alternating-current high-tension cables are, of course, subject to many dangers not present with continuous-current cables; there are breakdowns caused by oscillations in pressure which arise with certain relations of self-induction and capacity favoured by the appearance of harmonic waves. Since these phenomena have become better known, it is not so difficult to provide protection against the consequences, and disturbances from these causes are avoided by the application of devices protecting against excessive tension and spark-gaps. High-tension alternating current cables are always so constructed that the several conductors are enclosed under the same sheath and iron armour. This is necessary to avoid inductive effects. This is readily possible only because comparatively small copper sections are necessary. In this way self-induction in the cables is prevented, and there is also no disturbing effect to neighbouring telephone and telegraph wires. The absence of lurking defects in insulation in the case of high-tension cables, and the small currents carried by them, prevent telephone disturbances from stray currents, and these occur with much less frequency than with low-pressure conductors as used for continuous current. In addition, the alternating current has an inherent characteristic, by which the high tension at which it can be generated can readily be practically utilised—*i.e.*, the possibility of conversion in transformers. Not until this characteristic became a practical possibility, through the efforts of Zipernowsky, Déri and Blathy, could the alternating current begin to conquer its territory. It is, of course, also practicable, in the case of alternating current, to transform from high tension to the distributing voltage by rotary converters. The advantages of transformers as compared with rotary converters are so numerous that they could be left out of consideration on other grounds. First, their cost is about one-half; second, the weight of a 100kw. transformer is only 0·6 the weight of a rotary converter of the same capacity and 0·4 that of a motor-generator of the same capacity, quite aside from the fact that often in the case of motor-generators—and always in the case of rotary converters—transformers are required in addition. Transformers require no constant attendance, they occupy less space and their efficiency is higher. It is not difficult to construct transformers having 99 per cent. efficiency. Rotary converters with over 95 per cent. efficiency have probably not been constructed, and at partial loads the difference in favour of transformers increases, especially if the comparison is made between smaller types. All of these circumstances lead to the fact that it is possible with transformers to increase notably the number of sub-stations without sacrifice in economy of cost of installation or of operating. In such cases the sub-stations supply only a small area of the city, and the influence this has upon the cost of the secondary network is clearly apparent. In the case of rotary-converter installations, in order to secure larger units and a smaller operating force, and because it is difficult to obtain suitable real estate for sub-stations, it is desirable to limit the sub-stations to the smallest possible number; the primary circuits are, in consequence, somewhat shorter, but the increased cost of the secondary net is many times this saving. It is desirable then to select as high a secondary pressure as possible, not forgetting, however, that by so doing the mistake which it is desired to avoid becomes emphasised—the delivery to the consumer of a less valuable kind of current.

We have now touched upon the second question which I advanced: Which kind of current is of more value to the consumer? In connection with the house wiring there appears at once a great difference. The same conditions which appear to make the continuous-current conductors in the street inferior as regards durability and safety hold in a still higher degree in favour of the alternating current in residences. The insulation of continuous-current house wiring at the same pressure must be better on account of the more severe requirements imposed by the electrolytic effects; they are on this account dearer for the same safety, or at the same installation cost are less safe. Furthermore, the distributing pressure in the case of continuous current must be higher on account of the greater distance between sub-stations, causing an additional difficulty in this direction. Finally, it appears that, on account of the secondary network with widely-ramified branches, every lack of insulation at every point, either in the street cables or in any house installation, causes an undesirable disturbance in the installation of every consumer connected to the same sub-station. The most desirable from the standpoint of the consumer is, therefore, an alternating-current service with house-to-house transformers at low secondary pressure. I believe I am not saying too much when I maintain that the consumer will also prefer the alternating-current meter to the continuous-current in the long run. Without the commutator or brush contacts common to most continuous-current meters, it is a simpler instrument and subject to fewer troubles. The clock meters of the American type are constructed for both systems, and the electrolytic meter has been abandoned for many years.

The consumer in a large city uses electricity primarily for lighting, and usually with incandescent lamps; arc lamps and motors occupy a second place; and, finally, we may consider several special applications for medical purposes, &c., which, however, would not determine a preference in the selection of the type of current. After a careful reflection, I have not put motors in the first place in the consideration of central-station service, as is generally the case, and my decision is based upon the following considerations:—The price of electric current for motors must be considerably cheaper than for lighting in order to compete successfully with other motor powers. There is really no other reason why central stations sell current for motors so much cheaper than for lighting. The supply of current for electric railways is not here considered because they usually have separate stations. According to the statistics of most of the large cities, the average use of current for motors is not greater than current for lighting. During the hours of maximum lighting load in the European Continental cities the motor load does not fall off; in the winter months, in average latitudes, the heavy lighting load begins at 4 o'clock and reaches a maximum at 5 o'clock, but the motor load does not cease until 6 o'clock. Even the fact that the maximum demand of the current for lighting does not show the same number of average hours' use per year as current for power does not strongly modify this conclusion; for, although it is difficult to obtain exact data on the maximum demand of this or that service, it can be stated with some certainty that current for motors will not show any sensibly better load-factor than current for lighting in the large Continental cities. There remains but one reason for the cheaper prices for motor current—expediency. Current for lighting must be considered, therefore, as that for which the highest price is paid and from which the station receives the best returns, and should be considered, therefore, as of first importance. The value of power supply should not be left out of sight, however, for it represents about 35 per cent. of the connected load in large Continental cities, and because it increases the hours of service, although to an extent which is overrated. Furthermore, the distribution of energy is a great national economic advantage in the development of cities, which sections operated by municipalities will not leave out of sight. Although the question as to which form of current is best adapted for motor service should not alone determine the choice of the system, it is, nevertheless, a factor which must be considered. Until several years ago the majority of electrical engineers recognised only the continuous-current motor; since the discoveries of Ferraris and Tesla in connection with the concatenation of alternating-current circuits, all this has gradually changed, and to-day the polyphase motor is no doubt superior to all others. In large cities it is largely a question of application to industries of a character in which the motor will receive but little attention—small factories, private establishments, bakeries, butcher shops, &c., services which require that the motor should operate as soon as the switch is thrown. The commutator is an obstruction for such service; it is often neglected and then gives rise to disturbances; even the rheostat which must be switched in is too complicated.

In the case of the polpyhase motor, particularly if for service of this kind it is equipped with short-circuited armature, these difficulties do not appear; it is necessary only to open or close a three-pole switch. The polyphase short circuited is to be preferred, particularly for service in which the motor receives no attention for long periods. This would be the case also in the application, sought for by central-station technologists, of electric motors to the driving of small ice machines, which, of simple construction, could be introduced in the large cities in great numbers, giving a welcome summer load for the central stations. The polyphase motor is of a type which, of all electrical machines, has the least mechanical workmanship, possesses the fewest number of parts subject to wear, requires least repairs, and approaches most nearly the ordinary machine construction. As regards efficiency, it is the equal of the best continuous-current type, and, produced in quantities, its cost of production is less than continuous-current motors. Even the constructions with contact rings are characterised by their simplicity as compared with continuous-current motors, and possess all of the characteristics through which the shunt continuous-current motor secured its extensive introduction for steadiness of running, regulation of speed and large starting torque.

Of late, single-phase motors, the shortcomings of which constituted for a long time a hindrance to the extension of the single-phase system, have entered a new stage of development. The series and repulsion motors for alternating current, known for a long time, had the defect that it was hard to prevent sparking at their commutators, and their speed varied considerably with variable load. The types of Lamme, of the Wagner Company, of Déri, of Finzi, of Eichberg, of Latour and of the General Electric Co. and others, have so far overcome this difficulty that to-day it is adopted for that most difficult application of the electric motor, the electric railway. It is to be expected that these methods will be still further developed in the near future and that then the single-phase alternating-current system—the simplest of alternating-current systems—will receive the appreciation which it really deserves.

One of the most important applications of the electric motor in large cities is the driving of elevators. In the Continental cities of Europe this part of the service is not very lucrative for the central station, as the average use is very small and is contemporaneous with the lighting maximum; however, the elevator service is the best means of securing the introduction of electric lighting in a house. In this service also, the polyphase motor has surpassed the continuous-current elevator; it has a steady speed; it can be arranged for equally large starting torque; it is reversible with equal ease, and much less sensitive as to its windings, which in the case of shunt continuous-current motors, particularly for 2 × 200-volt systems in which the motors are wound for 400 volts, are easily burned out by careless switching, and in other respects is subject to greater repairs than the polyphase motor. There is hardly a service which cannot be undertaken with polyphase motors more rationally and economically than with continuous-current motors, and even if the motor service is considered of the greatest importance to the central stations in large cities, the alternating current supply is to be preferred to continuous-current supply in this respect also.

As regards the utilisation of the electric current for incandescent lamps, the two kinds of current have for a long time been considered as of equivalent value. This is really the case at the same pressure; but the fact is becoming more recognised that the filament incandescent lamps are more advantageous at low than high pressures. But the continuous-current stations have a tendency, in order to utilise their networks to best advantage, to raise the pressure, while in the case of alternating current, especially with house-to-house transformers, the service pressure can be chosen almost as low as may be desired. The 200-volt incandescent lamp, according to exhaustive tests, consumes 20 per cent. more current with the same life or at the same efficiency; it has 20 per cent. shorter life than the 100-volt lamp, while the cost is 15 per cent. greater. 200-volt lamps of less than 10 c.p., or less than 2½ watts per candle power, cannot be produced as yet. Extensive tests have shown that in order to operate filament incandescent lamps most economically, it is necessary to go below 100 volts and down to 50 and 25 volts. The newer types of incandescent lamps, like the Auer-osmium lamps with their wonderful efficiency, cannot be advantageously manufactured above 35 volts. Such tensions it is possible to obtain very readily through appropriate transformers, on account of the extraordinary flexibility of the alternating current. In the case of continuous current, on account of its rigidly fixed pressure, it is necessary in such cases to have recourse to connecting the lamps in series, thereby losing the most valuable characteristic of incandescent lighting, the independence of the individual lamps. Again, other types of lamps require higher pressure, such as the Nernst lamp, which at 200 volts gives more satisfactory results than at 100 volts. In the case of alternating current it is possible to obtain at once this higher pressure even in the case of a 100-volt system, so that each type of lamp can be supplied with the pressure best adapted to it. The latest and apparently most economical type of lamp, the Cooper-Hewitt lamp, has not yet received a practical test on the European Continent and even in its native land it must no doubt be further perfected ere it can be considered adapted to general practical use. As far as known here, its adaptability for three-phase currents is the same as for continuous current, and in addition it affords a good method of securing an equal loading of the three legs of a polyphase system.

The alternating-current arc lamp was for a long time considered of less value than the continuous-current arc lamp. As a matter of fact, with the same consumption of energy at the lamp terminals, the usefully developed light is about 20 per cent. greater for continuous-current than for alternating current. This relation changes at once, however, if account is taken of the fact that about 20 per cent. of the energy necessary for a lamp is expended without utilisation as a steadying resistance, and this loss can be reduced to a minimum in the case of alternating current by economy coils and inductive resistances. With the alternating current there is secured at the same time the independence of each lamp, while with continuous current only two or three lamps can be simultaneously operated on 110 volts and four or five lamps on 220 volts. Enclosed arc lamps of the Jandus type which require higher pressures do not give the light output which is the advantage of the continuous-current lamp, and they require still greater steadying resistances. The alternating-current arc lamp has lately reached the same value as the continuous-current arc lamp, as regards the production of light per unit of energy at the lamp terminals, since chemicals have been added to the carbons, increasing the lighting effect. Thus the alternating current gives better results than the continuous current in similar lamps, using economy coils and resistances, as every increasing loss can be obviated. The lighting effect is the same in both lamps and the alternating current arc lamp has the advantage in construction on account of the inclined carbons, which in these lamps are of the same size and are less likely to cause unequal consumption than the carbons of different diameters in the continuous-current lamp. With this construction the inherent defect of alternating-current arc lamps of a lesser lighting of the ground disappears. Outside of lighting and motors the electric current is used for only a few special purposes, but they are of so little importance that the special adaptability of a type of current to one of these seldom-used applications should not be the deciding factor in the selection of the system.

In proposing a new plant for a large city I would proceed as follows, and the reasons are to be found in the requirements of a good current distribution previously outlined: At each of two points located about diametrically opposite in the periphery of the city—I assume about 12km. (7·5 miles) distance—there would be located, on cheap ground, with convenient access for coal and water, a large central station, each station containing six to eight large generating units. The dynamos would be built on a principle somewhat similar to the monocyclic system, so that with a heavy single phase winding there would be combined a correspondingly weaker auxiliary winding in quadrature, with and connected to the middle point of the main winding, thereby giving exactly three phase alternating current. The number of periods would be 50 cycles per second, and the voltage about 3,000 volts, so that a single transformation could safely be made to 100 volts. The cables would have three strands, to consist of two heavy and one lighter strand, under a common metallic sheath. At the points of heavier load, particularly for large power demands, single transformers would be installed; for districts in which the demand is more distributed, transformer sub-stations would be used, from which would go out secondary circuits of a similar construction to the primary circuits. In the suburbs and where there was only a small load, a four-conductor cable for 2 × 100 volts, with a smaller neutral conductor, might be used. The transformers would normally be single phase, and three-phase transformers would only be connected in case of power load, one phase to be connected in parallel with the former. The transformers could be cut in and out by automatic primary switches, particularly in cases where a single transformer would not carry the load. In the larger transformer sub stations the switching would be done by hand before and after the maximum load. The lighting load would be supplied from the main winding of the dynamo through the single-phase transformers, at a pressure of 2 × 100 volts, and the auxiliary winding need only have capacity enough to supply the power load. Only the lighting phase would be regulated; the motors would not be affected by the small departures from the normal phase shifting and the variations in the pressure which might result in the auxiliary winding. The primary cables of both stations should meet at as many points of the city as possible, avoiding the laying of both sets of cables in the same trench, particularly in the centre of traffic, where theatres and important installations require special security of current supply. In case the current in one of the circuits should fail for any cause, the second station could be called up for the supply. It would be expected that in such a system the use of the auxiliary winding for operating the three phase motors would grow less and less. The progress made in the construction of single-phase motors is so great that the above plan is no doubt the most practicable at this time, but in a few years it will surely be superseded by the pure single-phase system with its simplicity of construction and operation, to which then it can be changed over without any change in the dynamos or cable network. The tremendous development of alternating-current technology has thus resulted in an important change in the fundamental principles for the distribution of current in large cities. If during the infancy of our profession many electrical engineers held fast to the continuous-current because its laws were more familiar to them, and because its operations appealed to them on account of their having occupied themselves with galvanic batteries, they have become converted, however, in the course of time to the view that the alternating current represents a step forward, and that they were in the right who would not give up their enduring faith in the ultimate victory of the alternating-currrent system.

ELECTRICAL EXTRACTION OF NITROGEN FROM THE AIR.*

BY J. SIGFRID EDSTROM.

One of the most important minerals ever discovered is the Chile saltpetre. The saltpetre earth "Caliche" is found in northern Chile in layers of from ½ to 4 metres deep. It contains between 15 to 65 per cent. nitrate of soda ($NaNO_3$) and is changed in a number of factories in Chile into the so-called "raw saltpetre," which contains about 95 per cent. nitrate of soda, and is shipped in this form all over the world. The Chile saltpetre is chiefly used for manufacturing nitric acid and fertilisers. In the year 1901 the consumption of Chile saltpetre in Germany alone was 500,000 tons. Of this quantity 75 per cent. was used for fertilisers, 20 per cent. for the manufacture of nitric acid, 3 per cent. for the manufacture of nitrate of potash and 2 per cent. for the manufacture of sulphuric acid.

The demand for Chile saltpetre is increasing and the consumption growing heavier every year, in spite of the rapidly rising prices. We may well ask if the saltpetre mines in Chile are inexhaustible. Several investingtions have been made as to the extent of the saltpetre deposits in Chile, and the reports vary from 30 to 125,000,000 tons. We will probably come very close to the truth if we calculate that 100,000,000 tons still exist. When answering the question how long the deposit in Chile will continue to last, we must take into consideration two factors which primarily affect the life of the mines. First, the consumption, and second, the possibility of finding new saltpetre mines or means of manufacturing substances of equal qualities.

If we assume that the export of Chile saltpetre will develop at the same rate in the future as it has during the last 10 years, we can easily calculate how long the supply of the present mines will last. Fig. 1 shows graphically the report of Chile saltpetre during the years from 1880 to 1900. The export during the year 1900 was 1⅓ million tons, and the yearly average increase during the last 10 years about 50,000 tons. Basing the future consumption on the figures given above, the saltpetre mines would be exhausted somewhere about 1940.

Many efforts have been made to discover new deposits, but so far without success. Another way of counteracting the shortage of Chile saltpetre has been to substitute other chemicals, such as sulphate of ammonia, for fertilisers, but this material is not to be had in sufficient quantities. Some years ago experiments were made to produce the required nitrogen from the air by the application of bacteriology. The artificial production of an excess amount of bacteria in the earth and seeds tends to increase the power to absorb nitrogen from the air. The experiments have, however, not lead to any rational and economical application of this method. Under these circumstances it is not to be wondered that in several ways other means of producing compounds of nitrogen have been sought. The nitrogen which is contained in the air has been the source which has most naturally been turned to in seeking to produce a commercially useful article.

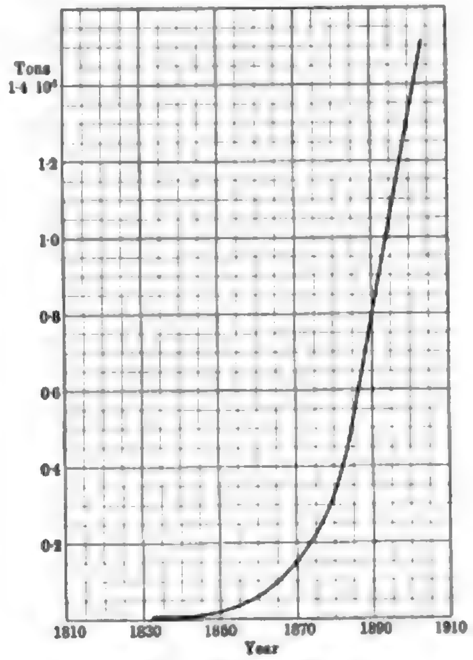

FIG. 1.—CHILE SALTPETRE.

The Siemens and Halske Company, of Berlin, investigated a method invented by Dr. Frank for manufacturing cyanamide of calcium ($CaCN_2$). Originally carbide of calcium was heated and treated by a current of nitrogen. The nitrogen was received by carrying a current of air over glowing copper. The copper unites with the oxygen of the air, and the nitrogen remains. Later, the same results were obtained by carrying the nitrogen over a heated mixture of chalk and carbon in the same proportion as used in making calcium-carbide. The cyanamide of calcium has been tried as a fertiliser with good results. The method of Frank is as yet, however, only in its experimental state.

Most of the experiments for the manufacture of compounds of nitrogen are based on a compound with oxygen. Owing to the inert character of nitrogen it has been very difficult to bind and utilise the nitrogen of the air. As long ago as 100 years physical science knew, through the investigations of Priestley and Cavendish, that electric sparks through air caused the nitrogen and oxygen of the air to unite, and that nitric acid would be obtained as a product by this process. Toward the end of the last century this process was furthermore investigated by Wills, Plücker, Dewar, Lord Rayleigh and others, but it has been during the present century that investigations have pointed to a practical solution of the problem.

It was principally through the immense development of electricity that means have been provided for the solution of the problem. The first results from the experiments of oxidising the nitrogen of the air were published by the Atmospheric Products Co., whose method was invented by Bradley and Lovejoy (*Electrical World and Engineer*, August 2, 1902).* The apparatus used in carrying out this method consisted chiefly of a solid drum or cylinder with a large number of platinum points placed inside the drum. Within the drum another cylinder is placed with points outwards. When the outer or inner drum is rotating the points come close to each other. The drums are connected to opposite sides of a high-tension direct-current system (8,000 to 10,000 volts). When the distance between the points is small, electric arcs are formed between the points. Through the motion of the drums the arcs lengthen the break. As each arc under these circumstances naturally offers an exceedingly variable resistance, an inductive resistance is placed in series to regulate the current. Through the space between the two drums a current of air is sent, part of which is oxidised through the contact with the arcs. The fundamental idea of this invention is to obtain an electric arc of maximum length and minimum cross-section, in order to bring the largest possible volume of air into contact with the surface of the arcs. This determines the efficiency of the system, as the energy consumed in the arc is proportional to its volume. It is evident that this effort of sub-dividing the arc results in a device in which the multitude of arcing points required for large capacities forms an objectionable feature in practical application. The efficiency of the Bradley and Lovejoy system has been said to be 1 ton of 70 per cent. nitric acid per kilowatt and year. This corresponds to about 700kg. of 100 per cent. HNO_3. Any further developments of this system have not been published, so far as I know.

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* Paper read before Section C of the St. Louis Congress.

* *The Electrician*, Vol. XLIX., p. 684.

Another method has been proposed by de Kowalski and M. Moscicki. According to the publication in the *Bulletin* of the Société Internationale des Electriciens, June 3, 1903, the method consists of exposing the air to an oscillating electric arc with a pressure of 50,000 volts and a frequency of several thousand periods per second. The method uses the well-known combination of self-induction and capacity. Its efficiency is said to be 1kg. if HNO_3 per 15 kw.-hours, which corresponds to 580kg. HNO_3 per kilowatt and year. Also in this method the amount of energy needs to be largely split up, thus complicating the apparatus in order to get good efficiency, when applying large amounts of energy.

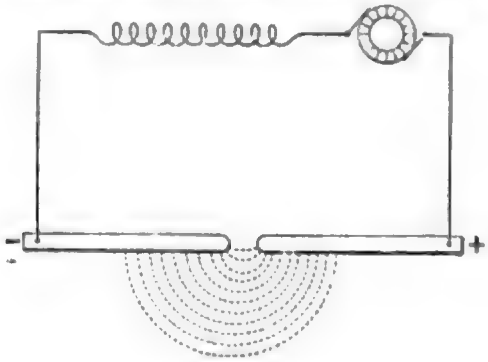


FIG. 2.

A new method for the solution of the problem was invented about one year and a half ago by Prof. C. Birkeland and Mr. S. Eyde, of Christiania. As far as now can be seen, this method should give comparatively good results. Prof. Birkeland and Mr. Eyde based their arrangements on the well-known fact that the electric current in the arc, and with it the arc itself, can be deflected by a magnetic field, the deflection being at right angle to the lines of force.

Based on this fact, Prof. Birkeland and Mr. Eyde proposed a large number of arrangements, of which I will describe the one which seems to give the best results. In Fig. 2 are shown two electrodes, E and E_1, which are connected to the poles of the electric generator G. The points of the electrodes are at such a distance that the pressure of the generator can maintain an arc between the electrodes. If a strong magnetic field is applied near the electrodes and at right angles to the direction of the electrodes, as shown in Fig. 2, the arc between the electrodes will momentarily be carried upward or downward, the direction of the current being for the moment from right to left or opposite.

For several reasons (one of which being the loss of pressure in the resistance L connected in the circuit) the pressure will fall between the electrodes at the moment the arc is formed. The arc will be carried outward by the magnetic field and grow longer as indicated by the dotted lines. Its resistance, consequently, rapidly increases until the pressure between the points is sufficiently high again to cause another arc between the electrodes. This arc having a lower pressure than the first one, the current will all pass through it, and the first one is extinguished. The speed of the arc is so rapid, however, and the formation of the new arc so instantaneous, that the arc can be formed several thousand times in a second. In the practical form of the ovens only some hundred arcs per second are used. These arcs are formed, carried outward and extinguished so rapidly that to the eye they appear as a disc of arcs.

If the magnetic field is excited by a direct current, and the generator delivers direct current for the arc, a continual series of arcs will be formed. These arcs move radially with a speed corresponding to the strength of the magnetic field. The striking points of the arc along the surface of the electrodes are also moving away from the points at the same speed. Thus the phenomena appear to the eye like a disc of arcs with the shape of almost a complete semicircle. The movement of the arc near the electrodes is usually more rapid at the negative than at the positive electrodes, shifting the centre of the circular disc somewhat to one side of a line joining the electrodes. If the magnetic field is excited by alternating current and the arc is fed by direct current, the arcs will vibrate between opposite sides of the electrodes. This will also be the case if the arc is fed by alternating current and the magnetic field by direct current, in which case the phenomena will appear as indicated in Fig. 3. It is principally this arrangement which has been used.

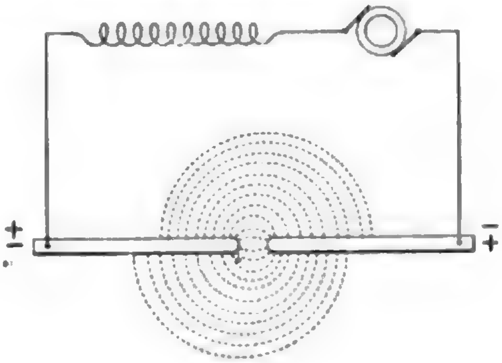


FIG. 3.

Fig. 4 shows the electric oven complete in a vertical section at right angles to the electrodes. The air that is to pass the oven is forced through the channels A and from them into the arc-chambers of the oven B, around and in the neighbourhood of the electrodes E. Having passed this space from the centre, and coming into the most intimate contact with the disc of arcs, the air passes out into the channel C and leaves the oven mixed with a certain percentage of oxidised nitrogen. If we look closer at this oven and the principles according to which it works, we may easily discern the chief difference between this invention and the methods described before. The difference will be most strongly marked by quantitative results.

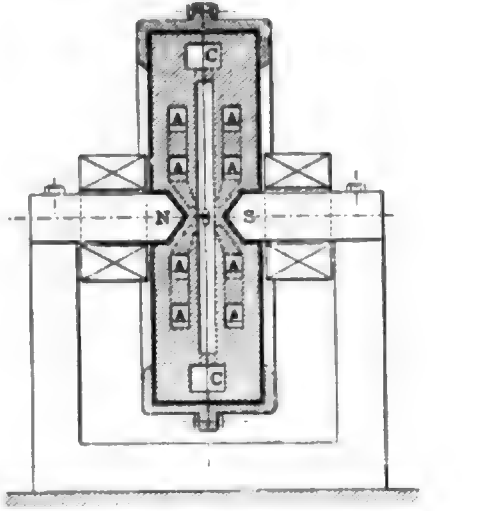


FIG. 4.

While, with Bradley and Lovejoy and de Kowalski's methods, the energy in every arc must be lowered to the least possible in order to obtain an economical system, the method of Birkeland offers no objection to employing large amounts of energy in the disc of arcs. On the other hand, experiments have proved that the economical efficiency increases with the amount of energy employed at the electrodes.

One of the ovens, which is still in operation, has consumed from 75kw. to 200kw. in the disc of arcs between one single pair of electrodes, and lately an oven with a disc of arcs for 500kw. has been built. The 200kw. oven has been fed with alternating current of 50 cycles frequency and 5,000 volts pressure. From this will easily be seen that the amount of energy employed, and the class of current in the arc, can hardly be compared with the current that may be used by other methods.

In spite of the large amount of current the electrodes in Birkeland's oven have, up to the present, been used without interruption for several hundred hours. Owing to the fact that the striking points of the arc move along the electrodes, the destructive influence of the arc is inconsiderable. The electrodes can, for this reason, be made of very cheap material, such as copper or iron, and have such dimensions that they can easily be cooled by means of air or water, keeping their temperature within reasonable limits. The oven of Birkeland and Eyde is, consequently, a very simple, strong and easily-operated piece of apparatus, even when working with a large amount of energy. Electric current from any ordinary standard machinery can be used for its operation. In the oven of Birkeland and Eyde, which was built about a year and a half ago, a small amount of energy was used in the disc of arcs only 7kw. to 10kw. The efficiency of this apparatus was at first only 400kg. HNO_3 per kilowatt and year. The next ovens were constructed for an increased consumption of energy, and have now, through continual improvements, reached an efficiency of 900kg. HNO_3 per kilowatt and year. The energy referred to is the amount of energy in the disc of arcs itself.

This result has, of course, been gained after numerous difficulties and with many obstacles to overcome. I will not enter into the details of this work, but will only mention some of the factors that have been considered in connection with the improvement of the oven as follows: The degree of moisture in the impressed air, its temperature, its amount of oxygen, its amount of air impressed per kilowatt-hour, the different amounts of electric current used, the voltage of the electric current, the frequency, the ovens arranged in series and parallel electrically as well as with regard to the impressed gases, the strength of the magnetic field, the insulation of the oven to prevent the loss of heat, the introduction of various contact substances. The air coming from the oven contains about 2 or 3 per cent. of nitric oxide (NO). In order to be utilised it must be transformed into nitrogen peroxide (NO_2). This is done in a reaction tank of thin sheet iron enamelled on its inner side.

From the reaction tank the gases go through an exhauster of clay, where they come into contact with drips of thin nitric acid. From here the gases pass on through the absorption system, consisting of four towers for water and one tower for a solution of caustic soda. In each tower the fluid is sent through the tower several times. The strongest acid runs always through tower No. 1, where the gases first pass, the next strongest through tower No. 2, and the weakest through tower No. 4. When the desired concentration is reached in tower No. 1 the acid is removed. The acid from tower No. 2 is then put into No. 1, from tower No. 3 into No. 2, from No. 4 into No. 3. Through tower No. 4 new water is passed. The process thus works according to the counter-current principle. The alkali tower contains, as previously noted, a solution of caustic soda. The gases from No. 4 pass through this tower. The remainder of the gases is absorbed here, and a mixture of nitrate and nitrite of soda is formed. From this pure nitrite of soda is manufactured. The acid taken from tower No. 1 is either concentrated by use of Valentiner apparatus and shipped, or is turned into nitrate of calcium or nitrate of potassium (potash).

The Birkeland process has been put into actual operation, and compounds of nitrogen are being manufactured. It is to be hoped that the process will prove economical, and thus one of the greatest needs of the present time—cheap nitrogen in bound forms—will be introduced on the market. The need of fertilisers is unlimited. Some years ago, when calcium carbide was invented, numerous factories were built, and a great boom was given to the electrical industry. The market, however, proved too small, and the enterprise has languished. This can never occur with respect to the nitrogen industry, as the market is unlimited. Thus, if the industry is pushed forward, the electrical industry will benefit immensely. Moreover, all sources of energy will increase in value; waterfalls, situated in uninhabited parts of the earth, will be utilised, and great central stations in cities will, in many cases, obtain a profitable load now lacking. The immense water powers being all utilised, power will become cheap, which again will benefit industry in general. Thus, if the process proves to be an economical success, the entire world of agriculture and industry will profit—and the process thereby will be a benefit to all mankind.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Medical Electricity." By Dr. H. Lewis Jones. 4th edition. (London: H. K. Lewis.) 12s. 6d.

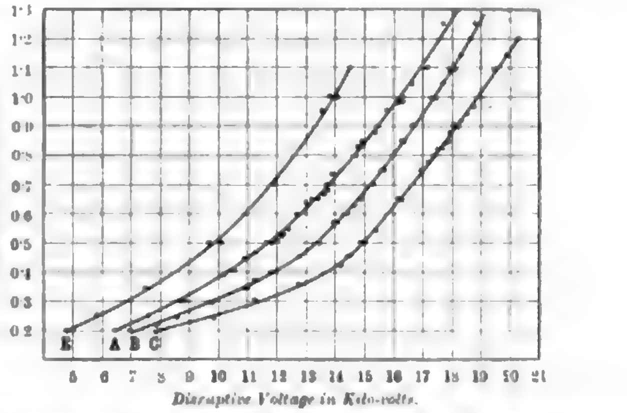
"Handbook on Cable Break Localisation." By Edward Raymond Barker. (London: Alabaster, Gatehouse & Co.) 1s. 6d. and 2s.

"Telegraphie und Telephonie ohne Draht." By Otto Jentsch. (Berlin: Julius Springer.) 5m.

HIGH-TENSION CONDENSERS.

The following article describes the principal features of a new type of high-tension condenser, designed by Herr J. Moscicki, of Freiburg (Switzerland), primarily for chemical purposes.

Before carrying out investigations of his own, Herr Moscicki had experimented with two-plate condensers bought from two firms of repute. But these condensers were not satisfactory, as every one of them finally broke down when worked at pressure of about 12,000 volts. Although many of the weak points inherent to plate condensers became apparent during the tests, Herr Moscicki, nevertheless, designed the first of his own condensers on the same lines. After trying various materials, glass was definitely found to be the most suitable dielectric. Plates of ordinary window glass, 2mm. by 200mm. by 285mm. (0·08in. by 8in. by 11·2in.) were coated with tinfoil 225mm. by 165mm. (8·85in. by 6·5in.), and 21 plates thus prepared were placed into a tinned sheet-iron box which was subsequently filled up with an insulating material made up of four parts of resin, one part of mineral wax and one part of vaseline. Seventy-two boxes were completed, each box being 3·74in. high and having a section of 9·1in. by 13·8in. Each complete box weighed a little over 33lb. Turpentine was employed for applying the tinfoil to the glass. Six boxes, connected in series, formed a 3 kilo-volt-ampere set at a frequency of 50 ~ per second. These sets were suitable for working at 50,000 volts, but only for eight hours at a stretch; after this time the condensers became so warm as to melt the filling. With 5,000 volts (corresponding to less than half the energy losses), however, the condensers could be run for any length of time. During the whole of the period these condensers were employed no short-circuits occurred, but as they conduced to losses of the order of 3 per cent., Herr Moscicki tried condensers of a tubular type. As subsequent results proved, this change was most fortunate, as condensers of this form were found to be superior to the old type in every respect. The greatest advantage of the tubular form of dielectric lies in the possibility of employing very thin glass. In fact, glass of a thickness of 0·5mm. (0·0197in.) successfully withstands pressures up to 67,100 volts, although, at the edges of the coating, disruptions occur at a voltage of only 11,700 volts. But this peculiarity is easily overcome by making the glass increasingly thick towards the open end of the tube. A second point in favour of the tubular form is its greater power of cooling. At a frequency of 50 ~ per second the losses of this latter type were always found to be below 1 per cent. A large series of interesting experiments were undertaken by Herr Moscicki to determine the relation existing between the disruptive strength of glass and ebonite and the thickness of the material tested. As alluded to above, two cases of electric puncture have to be considered; ordinarily the disruption takes place at the edge of the coating, but if the dielectric at these places is strengthened, then the disruption takes place at the weakest point within the coating. Small tubes were used in these experiments, the outer coating being of chemically-deposited silver, the inner coating consisting of mercury. The tube was immersed in oil, and the voltage gradually increased until rupture took place. Fig. 1 shows the results in graphical form for disruptions at the edge of the coating. For the second case the following approximate empirical formula was found: Disruptive strength of ordinary glass in volts $= 13 \times 10^4 \times t$, t being the thickness of the glass in millimetres. No empirical formula is given for ebonite, but here, too, the tension required to puncture the ebonite plate in the middle of the coating was very much larger than that necessary for disruption at the edge of the coating. The experiments so far described related to a frequency of the alternating voltage of 50 ~ per second. At frequencies between



A, Ordinary alkali glass. B, Glass without alkali. C, Boron-silicate thermometer glass. E, Ebonite.

8,000 and 9,000 ~ per second the dielectric broke down at much lower voltages. With regard to the percentage losses in condensers, it was found by the experimenter that they increased with the voltages and frequencies employed, but decreased with the thickness of the dielectric (glass). A definite formula connecting these variables is not offered, but Herr Moscicki promises to publish some further data on the subject in the near future.

Of practical interest is the information that a commercial ½ kilo-volt-ampere condenser of the tubular type is made up of five glass tubes of a thickness of 0·5mm. (0·0197in.), assembled side by side, within a cylindrical receptacle having a diameter of 8·54in. and a height of 18·5in. The complete condenser weighs from 6·7lb. to 7·8lb., and the cost of manufacture (material and working costs), according to Herr Moscicki, come to about 10s. per kilo-volt-ampere.

TRANSFORMER WITH A LARGE ELECTROSTATIC CAPACITY.

Herr L. Lichtenstein describes in the *Elektrotechnische Zeitschrift* of October 6th the following experiment on a high-tension transformer of the Siemens-Schuckert type, which was accidentally discovered to possess quite a considerable amount of capacity. The primary winding had 2 × 80 turns of copper strip of a section of 42 sq. mm. (0·065 sq. in.), the resistance of each coil being 0·0006 ohm, while the secondary winding consisted of 2 × 80,000 turns of copper wire of a diameter of 0·25mm. (0·0985in.), the resistance per coil being about 12,150 ohms. The primary coils of this 10kw. transformer were permanently connected in series, but the secondary coils could be either connected in series or parallel. Since the primary is designed for a pressure of about 100 volts, it follows that the maximum secondary pressure is about 200,000 volts. Figs. 1, 2, 3, 4A and 4B represent the various ways in which the secondary windings were successively connected up for the tests, and the table below gives the results obtained. The capacity current in the secondary was measured by a milli-ammeter with an internal resistance of 10,000 ohms. Since the capacity current—as in the case of an open cable—varies in value according to the place of measurement, the ammeter was inserted at that point of the secondary winding in which the capacity current was a maximum. In Figs. 1 and 2 the secondary winding is connected to earth as shown, while in the cases of Figs. 3, 4A and 4B the secondary terminals are isolated. The ammeter could not be inserted into the secondary in the cases of Figs. 4A and 4B, as the points of maximum current lie in the middle of the winding.

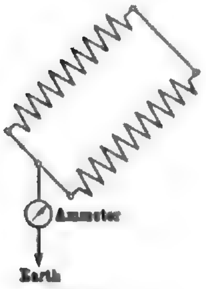


FIG. 1.

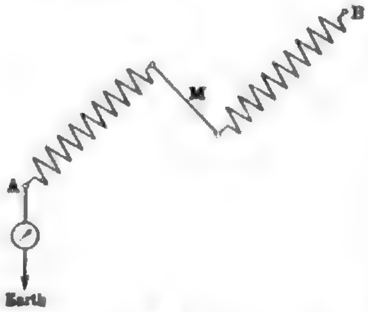


FIG. 2.

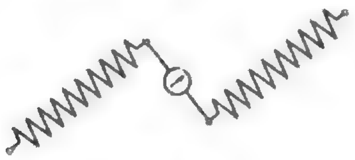


FIG. 3.

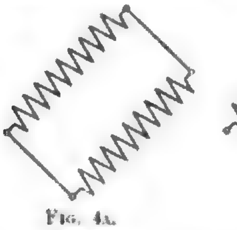


FIG. 4A.

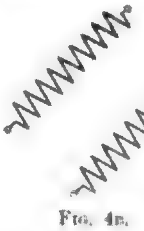


FIG. 4B.

Table of Results.

Primary pressure. Volts.	Primary current. Amps.	Secondary pressure. Volts.	Secondary current. Amps.	Primary power-factor.	Connection of secondary.	Remarks.
45·2	8·78	45,200	0·00844	0·858	Fig. 1	Primary current lags behind the pressure.
45·0	13·88	90,000	0·0133	0·686	„ 2	Primary current leads.
46·0	8·65	90,000	0·00496	0·852	„ 3	Primary current lags.
45·2	10·4	45,200	..	0·634	4A & 4B	„ „ „

The remarkable results obtained may be explained by assuming that the secondary contains a distributed capacity, the charge for a length of wire equal to dx being

$$de = cE\,dx, \qquad (1)$$

where c is the capacity per unit length (assumed to be constant) and E is the potential. E varies not only with the time, but also with the distance from one of the terminals.

In the case represented by Fig. 2, the terminal A is earthed and has the potential zero. The potential at B, therefore, is equal to the secondary voltage, which may be called E_l. At any intervening point D, at a distance x from A (Fig. 5), the potential at a given time, t, is

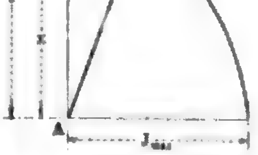


FIG. 5.

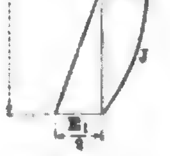


FIG. 6.

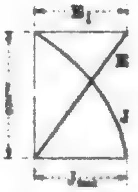


FIG. 7

$$E_t = E_l\sqrt{2}\,\frac{x}{l}\sin(\omega t), \qquad (2)$$

where $\omega = 2\pi\sim$, and the charge at this moment is, in accordance with equation (1), $de_t = cE_l\sqrt{2}\frac{x}{l}\sin(\omega t)dx$. The increment in the time dt is

$$\frac{\partial de_t}{\partial t}dt = cE_l\sqrt{2}\,\frac{x}{l}\,\omega\cos(\omega t)\,dx\,dt.$$

By dividing this increment by the time (dt) in which it takes place, we get the corresponding charging current,

$$di_t = cE_l\sqrt{2}\,\frac{x}{l}\,\omega\cos(\omega t)dx. \qquad (3)$$

The total current flowing through D is obtained by summing up all elementary currents (equation 3) between D and B,

$$\therefore\quad J_t = cE_l\sqrt{2}\,\frac{\omega}{l}\cos(\omega t)\int_x^l x\,dx = cE_l\frac{\sqrt{2}}{2}\frac{\omega}{l}\cos(\omega t)(l^2 - x^2).$$

The effective value of this current at D is

$$J = cE_l\omega\frac{l^2 - x^2}{2l}. \qquad (4)$$

It is thus seen that no charging current manifests itself at B, and that the maximum is attained at A (Fig. 2), being, in fact,

$$J^{II}_{max} = cE_l\omega l/2. \qquad (5)$$

The phase of the charging current is, of course, the same at any point of the secondary winding, the current leading the voltage by 90deg.

The case of Fig. 3 is diagrammatically represented by Fig. 6, and the maximum current in this case is $J^{III}_{max} = cE_l\omega l/8$.

Fig. 7 represents in form of a diagram the case of Fig. 1, and it is found that $J^{I}_{max} = cE_l\omega l/2$.

For Figs. 4A and 4B, finally, we have $J^{IV}_{max} = cE_l\omega l/8$.

The total capacity C, which is equal to cl, may be obtained from equation (5), and is $C = 2J^{II}_{max}/E_l\,.\,\omega$.

Inserting the figures given in the table above, it is found that $C = (2 \times 0{\cdot}0133) \div (90{,}000 \times 314)$ farad or $= 0{\cdot}000945$mfd.

THE UNOBTAINED WAVE-LENGTHS BETWEEN THE LONGEST THERMAL AND THE SHORTEST ELECTRIC WAVES YET MEASURED.[1]

BY PROF. E. F. NICHOLS.

We are accustomed to the use of two methods of producing transverse wave trains in the ether: Molecular or atomic vibrations under the action of heat energy and the oscillation of an electric charge on conductors of sensible mass at rest. It is doubtful whether the same wave frequencies will ever be obtained for direct comparison by both methods, nor is it any longer necessary to the electromagnetic theory that they should be, for nearly all known properties of light waves, except, perhaps, the magnetic rotation of the plane of polarisation,[2] have been experimentally proved for electric waves, and certain properties first recognised in electric waves have been similarly established for waves excited by the agency of heat. Yet, if for no other reason than that of continuity, further effort to possess a part of the unexplored region between the longest thermal and the shortest electric waves would be well spent. After a brief survey of the limits of our present knowledge, several experiments directed toward the production and measurement of short electric waves are suggested.

Present Boundaries.—Growing out of the discovery of a region of metallic reflection in quartz[3] in the infra-red spectrum, a new method of isolating heat waves of great wave length by successive reflections from crystalline surfaces has been developed,[4] and by its aid the bounds of the known heat spectrum have been extended sixfold. After five reflections on sylvine surfaces waves 61μ in length have been isolated and measured.[5] In character these longer waves already resemble electric waves more closely than they do light waves. All metallic surfaces reflect them about equally, and almost totally.[6] The necessary theoretical relations between reflecting power and electric conductivity[7] and between refractive index and dielectric constant[8] are more clearly manifested in them than in light waves. They can be polarised by gratings,[9] and it has been possible to demonstrate with conducting areas of suitable dimensions the same laws of resonance for heat waves which were known previously only for electric waves.[10]

It is, however, a question how much further the method of isolation by multiple reflection which has yielded so much can be carried. Several substances are known which, according to the Ketteler-Helmholtz law, should have regions of absorption and metallic reflection beyond 60μ; but the difficulty of working beyond this limit is of another sort. Rubens[11] has made computations from Wiens' law governing the distinction of energy in the spectrum of a black body at a temperature of 2,000°C. The results show that the intensity of radiation at a wave-length of 1·5μ is 800,000 times greater than at 60μ, and if the total energy between wave-lengths 50μ and 60μ be taken as a unit, the total energy between 60μ and 100μ will be 0·7 and between 100μ and 1,000μ about 0·2. While Wiens' formula may not hold rigorously for very long waves, yet the outlook for a further extension of the known spectrum by this method is at least discouraging.

In the electric spectrum, beginning with Hertz 60cm. waves, the wave-length has been successively reduced by Righi, Lebedew[12] and Lampa.[13] Lampa with apparatus differing in no essential respects from the infra-red grating spectrometer, was able to obtain and make measurements with waves 4mm. long.

Our present knowledge of the spectrum, as a whole, may be summed up in the terms of the wave-frequency intervals familiar in music as follows: Beginning with Schumann's[14] and Lyman's[15] short ultra-violet waves of the order 0·1μ, we know about two octaves in the ultra-violet, one in the visible and six in the infra-red spectrum, making nine in all. Here the unknown region begins and the shortest electric waves yet obtained lie about six octaves lower in the scale.

Possible Future Experiments.—The conquest of the unexplored spectrum seems at present more hopeful from the electric than from the thermal side, as the difficulties encountered so far in the electric experiments are to some extent mechanical and depend less upon natural limitations. But to accomplish this extension new methods must be devised. The short-wave electric experiments have so far been made with a vibrator, the thermal analogue of which corresponds theoretically to the isolation of a single molecule or atom forced to vibrate in a single plane. Limitations in the available quantity of energy with the diminishing capacity of the vibrator have not unnaturally been encountered, and in all cases a form of radiation has been dealt with which is unknown to our optical experiments.

I hope sometime to undertake some experiments with a vibrator consisting of a very great number of small conducting spheres submerged in oil on the bottom of an insulating tray. Suitable electrodes will be introduced at the ends of the tray and the discharge from an induction coil driven either directly through the layer of spheres, or the equilibrium of the spheres disturbed inductively, while the tray is constantly agitated. If the spheres can thus be made to vibrate individually, the radiation from such a vibrator should be powerful and very complex because of necessity highly damped. The radiation would probably not be wholly plane polarised, for not only would the discharge follow a zigzag path, but spheres lying off the line of any one discharge would have their electrical equilibrium disturbed along diameters inclined to the direction of the main discharge. A radiation might, therefore, be expected not wholly different in character from the emission of a very thin layer of a heated solid or liquid. It should be a continuous spectrum between broad limits, containing some shorter waves than the natural frequency of a single sphere acting independently. It is also not unthinkable that some interesting relations between the distribution of energy in this spectrum, could that be determined, and the energy of discharge might be found. With some form of single-contact coherer, similar to the one used by Herr Lampa, combined with a transmission grating, it is possible that this spectrum could be explored and the distribution of its energy roughly determined. Herr Lampa's progress toward shorter waves was stayed by the difficulties of construction and failing energy of his single vibrator rather than from any lack in the receiver employed.

Prof. Nichols also suggests a new radiometric receiver, whose action is based on the electrostatic and electrodynamic action between equal resonators.

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[1] Abstract of a Paper read before Section A of the St. Louis International Electrical Congress, 1904.

[2] A Righi, *Beiblätter*, 1895, p. 357; also A. Lampa, *Wiener Berichte*, 105, Ia., p. 1,049, 1896.

[3] E. F. Nichols, *Phys. Rev.*, 4, p. 297; also *Wied. Ann.*, 60, p. 401, 1897.

[4] H. Rubens and E. F. Nichols, *Phys. Rev.*, 4, p. 314, and 5, pp. 98 and 152; also *Wied. Ann.*, 60, p. 418, 1897.

[5] H. Rubens and E. Aschkinass, *Wied. Ann.*, 65, p. 241, 1899.

[6] H. Rubens and E. F. Nichols, *loc. cit.*

[7] E. Hagen and H. Rubens, *Phil. Mag.*, 38, p. 157, 1904.

[8] H. Rubens and E. F. Nichols, *loc. cit.*; also H. Rubens and E. Aschkinass, *loc. cit.*

[9] H. E. J. G. du Bois and H. Rubens, *Wied. Ann.*, 49, p. 593, 1893; also H. Rubens and E. F. Nichols, *loc cit.*

[10] H. Rubens and E. F. Nichols, *loc. cit.* Electrical resonance also affords a possible explanation for certain peculiar phenomena observed in films of condensed sodium vapour in the visible spectrum by Prof. R. W. Wood.

[11] H. Rubens. *Rapports* au Congrès Internat. de Physique, 2, p. 157. Paris, 1900.

[12] Lebedew, *Wied. Ann.* Bd. 56, 1895.

[13] A. Lampa, *loc. cit.*

[14] V. Schumann, *Wiener Sitzungsberichte*, 102 pp. 415 and 625, 1893.

[15] Theodore Lyman, *Astrophys. Jour.*, 19, p. 263, 1904.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

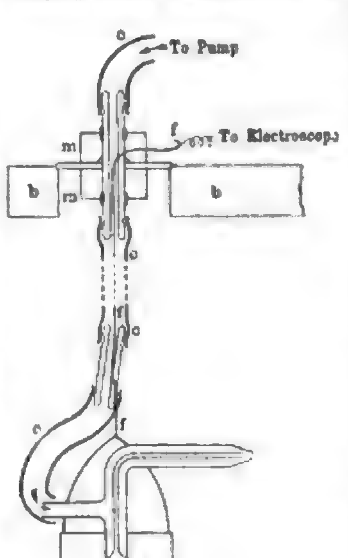
N-rays.—A. Broca reviews the present state of our knowledge with regard to the N-rays. He refers to the numerous controversies with regard to them, and says they are only equalled by those which attended Pasteur's discoveries. The author mentions that it took him six weeks of work before he saw the first N-ray phenomena. The methods are still very rudimentary and beset with numerous errors. One of the main difficulties lies in the very occurrence of N-rays in unexpected places. The author proceeds to give an account of the various ways of observing the rays, following upon the lines of Blondlot and his successors. He describes the precautions to be observed at every stage. Thus, the points between which the sensitive electric spark passes must be clean, sharp and carefully centred. The calcium sulphide should be kept in a sealed tube until required, and should be covered with a collodion film and not with gelatine. Observations cannot be made immediately after insolation. A minute is about the best interval. The effects of heat can be determined by observing the surface at an angle of 45deg., at which neither N-rays nor N'-rays have any effect.

[A. BROCA, *Archives d'Electricité Médicale*, October 10, 1904.]

Ionisation of Very Dense Gases.—It was shown by C. T. R. Wilson that the spontaneous ionisation of gases is approximately proportional to the pressure, except at high pressures. At the same time the relative ionisation of different gases is nearly proportional to the density of the gas, so that the highest spontaneous gaseous ionisation would be obtained by compressing the greatest mass in a given volume. As it seemed of interest to try whether this proportionality still holds for a gas of very high specific gravity and complicated structure, G. Jaffe undertook to measure the spontaneous combustion of nickel carbonyl, $Ni(CO)_4$. The apparatus used was a gold-leaf electroscope, and differed only in minor details from that used and described by Wilson. Most of the experiments were executed in glass bulbs of various sizes, thinly silvered internally, and some in brass vessels of cylindrical shape. A quartz rod, attached by sealing wax, was substituted for the sulphur bead used by Wilson, on account of the action of nickel carbonyl on sulphur, and the supporting rod was kept at a high potential by a set of very constant storage cells. In experiments with air at ordinary pressure, the accuracy attainable in the readings was unusually low, and the author was driven to the conclusion that the ionisation is influenced by unknown local causes. Neither light, heat, moisture, nor weather conditions could be identified as the disturbing elements. The glass bulbs had from 50 to 100 cubic cm. internal capacity. The number of ions per cubic centimetre per second varied between 41 and 68. Both these values are higher than Wilson's (39), but the latter used a larger vessel. Experiments at lower pressures make it probable that the ionisation is at least partly due to a radiation from the walls which is not of a uniform type. The variations in small vessels are bigger than those in large vessels, and sometimes amount to as much as 40 per cent. On introducing the nickel carbonyl, the author obtained much more consistent results. The spontaneous ionisation was 5·1 times greater than that of air. Since the density is 5·9 times as great, there is a fair proportionality between the density and the ionisation

[G. JAFFE, *Philosophical Magazine*, October, 1904.]

A Rapid Water Collector.—For measuring the electric field in balloon voyages it is usual to employ either radio-active substances or freshly amalgamated zinc plates. The former do not permit a simultaneous measurement of the ionisation, and the latter fail at night. Ordinary water-spray collectors are too slow, but D. Smirnow has designed one which is rapid in its action and quite satisfactory. It acts three or four times more quickly than a candle flame, and just about as rapidly as 5 milligrammes of radium bromide. Its construction is shown in the diagram, where *a* is a water-spray bottle of the ordinary construction, *c* a rubber tube into which dry air is pumped with an ordinary bicycle pump, *f* a copper wire connected to the electroscope, *b* a wooden board, and *m* a brass cap. The rubber tube is 8in. or 10in. in length, and hangs down from the car of the balloon.



[D. SMIRNOW, *Physikalische Zeitschrift*, October 1, 1904.]

Quantity of Radium in the Earth.—A calculation of exceptional interest is made by C. Liebenow in connection with Himstedt's suggestion that the radio-active constituents of the earth should be taken into account in explaining the temperature of the earth's interior. He shows that all the heat given out by the earth may be accounted for by radio-activity. Denoting the average specific conductivity for heat of the earth's crust by λ, the temperature gradient per centimetre by τ, and the circumference of the earth by u, the quantity of heat w given out by the earth per second is

$$w = \frac{\lambda \tau u^2}{\pi} = \frac{0{\cdot}006 \quad (4 \times 10^9)^2}{3{,}000 \quad 3{\cdot}14},$$

which comes to about 10^{13} gramme-calories per second. This quantity of heat is to be furnished by radium, and since, according to Paschen's latest determinations, 1 gramme of radium generates 226 gramme-calories per hour, 16 grammes of radium would generate 1 gramme-calorie per second. Hence, the earth can only contain some 2×10^{14} grammes of radium, since, otherwise, its temperature would be constantly increasing. If that quantity were equally distributed throughout the mass of the earth, 1 cubic metre would contain $\frac{1}{5000}$ milligramme of radium. Now the "fango" and other earths examined by Elster and Geitel contain about 1,000 times that amount. If, therefore, Himstedt concludes from the radio-activity of thermal springs that there are greater masses of radium in the depths of the earth, the radium cannot possibly be uniformly distributed throughout the earth, but must be confined to the strata nearest the surface. But even then the accumulation of radium cannot be very great. The author shows that a layer of Joachimsthal pitchblende 6cm. thick would supply the whole of the heat. In any case, the temperature need not be considered to increase up to the centre of the earth, but only within the limits of exploration hitherto attained.

[C. LIEBENOW, *Physikalische Zeitschrift*, October 15, 1904.]

Dimensional Formulæ.—Two years ago L. Gorczynski urged the necessity of an entire revision of the dimensional formulæ of physical quantities. K. R. Johnson now expresses a doubt as to whether such a revision would lead to any results worth having. The chief objection is to the conception of force, represented by the formula LMT^{-2}. Kirchhoff denies the necessity for the conception altogether. If the dimensions of force are left undetermined, and force is put as a quantity of dimensions X, work will become XL and power XLT^{-1}. Magnetic quantity becomes $X^{\frac{1}{2}}L$ in the electromagnetic system, resistance LT^{-1}, inductance L and capacity $L^{-1}T^2$. It is, therefore, seen that the last three quantities are quite independent of the dimensions of force. The author points out the possibility, but not the desirability, of deriving the dimensions of force from the law of gravitation, which would give $X = L^{-2}M^2$, and would get rid of fractional powers. This would, however, be a reversion to the conception of action at a distance.

[K. R. JOHNSON, *Physikalische Zeitschrift*, October 15, 1904.]

The Passive State.—A. L. Bernoulli makes a further contribution to the optical investigation of the passive state of metals. Micheli found that when iron became passive its principal angle of incidence diminished from 74 to 69deg., and its principal azimuth increased from 28 to 29deg. From this he concluded that the modified layer was solid and had a considerable thickness. The negative results of Müller and Konigsberger are due to their faulty method. In chromium, Micheli failed to obtain any visible modification of the optical constants on acquiring the passive state, but Bernoulli now shows that such a modification may be obtained on producing the passive state, not with nitric acid, but by a boiling solution of quinone in benzol. The active and passive states had to be produced alternately several times before a measurable effect was produced. The author produced such an alternation eight times in succession, boiling the mirror in salt solution to make it active, and using either the chinone or simply the prolonged action of air to make it passive. The E.M.F. varied by about one-fifth volt, and the principal angle of incidence by about 5deg., as in iron. The author found an explanation for the constancy of the optical constants when the passive state is produced by nitric acid by showing that the chromium so treated absorbs oxides of nitrogen, which neutralise the passive effect. The author believes that the passivity is due to a surface layer of some compound of chromium, as was originally supposed by Faraday. He further believes that this compound is nothing but "chromic chromate" $(Cr_2O_3)_2CrO_3$, that singular body which at ordinary temperatures is only soluble in hydrofluoric acid, and yet absorbs oxygen with great ease from the atmosphere, and gives it up again with equal readiness.

[A. L. BERNOULLI, *Physikalische Zeitschrift*, October 15, 1904.]

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ALTERNATING *v.* CONTINUOUS CURRENT FOR LARGE CITIES.

Although this matter has been discussed and re-discussed times without number, yet a considerable amount of interest attaches to a Paper on the subject read by Dr. GOTTHOLD STERN before the St. Louis International Electrical Congress, an abstract of which appears in another column of this issue. The author is obviously possessed of a strong bias towards alternating current, and some of his arguments are open to criticism. In this country, there is, at the present moment, a movement in favour of the substitution of alternating for continuous-current generation in very large undertakings, but this fact only applies to cases in which the area of distribution is great. On the other hand, where a densely populated area is supplied from a station near its centre, there is a tendency to replace alternating by continuous current. The City of London Electric Lighting Co. is an excellent example of this second case, for all extensions of plant are continuous current, and it is by no means unlikely that all the alternators will eventually be replaced by continuous-current machines. The Charing Cross and City undertaking, on the other hand, has had to erect its generating station at Bow, as no good site was available near the City, and, therefore, alternating-current generation has been adopted. Hastings, again, may be taken as another example of the variation in practice. A continuous-current station was first erected. After a few years an alternating-current system was put in as being more modern, but now there is no doubt that according to the latest practice a direct continuous-current three-wire supply would be far more economical.

Dr. STERN divides his consideration of the subject into two distinct parts. First, he discusses the relative merits of the two systems as far as production and transmission are concerned; and, second, he considers the relative values of the two kinds of current to the consumers. As might be expected, he enlarges upon the commutator difficulty, and expresses the opinion that "this difficulty will always stand in the way of the application of large continuous-current dynamos to steam turbines." It is true, of course, that the question of sparking does present serious difficulties in the case of continuous-current dynamos driven at high speeds by steam turbines, and although it is announced that this difficulty is being overcome by the use of compensating windings, there are still some examples of sparking turbo-driven machines to be seen. Those who claim to have overcome this propensity of continuous-current turbo-dynamos are loth to publish an account of the means they have employed to this end. Regarding Dr. STERN'S admission that the separate exciter in the case of an alternator is a complication, and that the paralleling of alternators is more difficult than the paralleling of continuous-current machines, little need be said. As a matter of fact, the complication involved by the excitation of alternators is negligible, and it is now practically as easy to parallel alternators as it is to parallel continuous-current dynamos, since the introduction of various kinds of synchronisers renders the operation a purely mechanical one requiring a very small amount of skill. His attack on the storage battery is, however, quite unwarranted, and cannot be allowed to pass without comment. It is safe to say that the much-maligned storage battery is the greatest friend the station engineer ever had, and yet it invariably receives the worst treatment of any plant in the station. It has no equivalent in a purely alternating current installation, and since continuity of supply is an essential in successful working, it constitutes a feature whose value cannot be compared with that of the rest of the plant in £'s per kilowatt. The author's chief complaints are that the battery is very inefficient and is not at all durable; but its efficiency is not important if it is only to equalise the load and act as an emergency unit, while its durability depends entirely upon the treatment which it receives at the hands of those responsible for its maintenance. The assertion that a good storage battery is not available does not enhance the value of the Paper, and it is to be regretted that Dr. STERN has not found time to visit several English generating stations in which storage batteries have been installed for many years and are still rendering excellent service. It is sought to compare the transformer losses in an alternating current system with the battery losses in a continuous-current system, but the comparison is evidently based on the enormous batteries used as a stand-by in some of the older Continental stations, and is hardly a fair one. Moreover, Dr. STERN'S figure for the cost of battery maintenance is excessive; manufacturers in this country are willing to undertake maintenance contracts at from 5 to 7 per cent. per annum The author further recommends the adoption of automatic devices in substations for switching transformers on and off as the load increases or decreases, devices which have on many occasions been tried and found wanting. They are, moreover, hardly necessary with modern transformers, whose efficiency at one-tenth load is almost as high as at full load.

Regarding transmission, it cannot be denied that alternating current is superior for obvious reasons, but it does seem that the author attaches too much importance to the possibility of electrolysis effects in connection with continuous-current cables. He quotes the case of Vienna, where it has been necessary to replace only 1,120ft. of cable carrying alternating current at 2,000 volts, the network having a total length of 240 miles, of which 46 miles were laid in 1889. Moreover, the insulation resistance per kilometre has, it is said, the same value to-day as it had when the cable was first laid. Now, this is a record of which any cable manufacturer might be proud, but it says more for the excellence of the cables than it does to prove that cables deteriorate less rapidly with alternating currents than with continuous currents.

The author then proceeds to dilate on the superiority of stationary transformers as compared with rotary converters or motor-generators, but as these machines perform totally different operations the comparison is inadmissible. He quotes 99 per cent. as the efficiency of stationary transformers and 95 per cent. as that of rotary converters, and then goes on to show that because of the superior efficiency of the former it is possible to have more sub-stations and a consequent better and cheaper secondary network. But if an efficiency of 99 per cent. is assumed, then the size of the transformer is fixed at a fairly large minimum, and, consequently, the number of substations depends simply on the connections to the mains. Later on, too, he advocates a house-to-house transformer system, when, of course, the transformers would not have an efficiency of 99 per cent. In this line of argument he ignores the motor load altogether; in fact, he apparently doubts the advisability of a power supply altogether, assuming that tariffs for motive power are lower than those for lighting simply because it is desired to compete with other forms of power, and not because of the high load-factor of a motor load. He reasons as if everything were to be determined by the lighting load of the station, and this is almost sufficient in itself to show that Dr. STERN'S arguments are fallacious.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Elements of General Radio-therapy for Practitioners. By LEOPOLD FREUND, Vienna. Translated by G. H. LANCASHIRE, Assistant Physician to the Manchester and Salford Hospital for Skin Diseases (with an Appendix entitled "Notes on Instrumentation," by CLARENCE WRIGHT). (London: Rebman Limited.) 1904. 21s. net.

Although the application of heat and of light to medical uses can be traced back to early ages, the real commencement of the scientific study of this subject is a matter of the last 10 years. In 1893 Finsen wrote on the influence of red light in small-pox, and commenced the investigations which were finally crystallised out in his famous Paper on the use of the concentrated chemical rays of light in medicine. Kellogg, of Battle Creek, in 1894, described his method of applying the light and heat of incandescent electric lamps for therapeutic purposes. Tesla and D'Arsonval were publishing the results of their investigations into high-frequency electrical discharges at about the same date, and other observers here and there were conducting isolated researches of value. Five years later, in 1899, we may consider that radio-therapy formally took its place among the medical sciences. That was the date of publication of Finsen's Paper. The first accounts of the use of X-rays in therapeutics were coming to hand from Schiff and Freund in Vienna and from Stenbeck and Sjögren in Stockholm, and the first investigation of the physiological effects of Becquerel rays were being done by Giesel. As an outward and visible sign of the times, we may incidentally refer to the publication in that year of the first volume of a work by Dr. Solis Cohen under the title of "A System of Physiologic Therapeutics: A Practical Exposition of the Methods, other than Drug-giving, Useful in the Treatment of the Sick." The scope of this work embraces electro-therapy, hydro-therapy, thermo-therapy and photo-therapy, and it also deals with treatment by climate, diet, inhalations and other cognate therapeutic subjects.

Dr. Freund's book is divided into five parts. The first part treats of the elements of electricity in a somewhat diffuse manner. The other parts are devoted to high-frequency currents, X-rays, Becquerel rays and radium, and light and heat rays respectively. All are treated from the medical point of view. The book is nicely got up, and its compilation must have entailed much labour, as copious references are given to nearly all previous writers upon the various branches of the subject dealt with. These references will render Dr. Freund's book very valuable to future writers on radio-therapy.

The question of the value of high-frequency discharges for medical purposes has been very much discussed. The striking physical phenomena exhibited by a large high-frequency apparatus in action are calculated to appeal to the vulgar, and its capabilities as a means of imposing upon credulous persons have made the high-frequency apparatus a welcome instrument in quack institutes and such like quarters. The methods of applying high-frequency discharges can be arranged in two main divisions. In the one the apparatus is made use of to generate brush discharges and these are brought to bear upon the surface of the patient by means of suitable electrodes. These may take the form of bare metallic points, or there may be an arrangement of a dielectric such as an exhausted glass tube or a tube filled with salt solution with an internal metal coating. In the latter arrangements the alternate charging and discharging of the inside of the glass is accompanied by an equal and opposite charging and discharging at its outer coating, and this shows itself as a violet flow or brush discharge passing between the outer surface of the glass and the patient's skin. If the potential at the extremities of the solenoid connecting the outer coatings of the Leyden jars are insufficient for the case, either a resonator or a step up arrangement of primary and secondary coils can be used to raise it. Very powerful brush discharges can be obtained in this way, and there is no room for doubt as to the good effects produced by these brush discharges in many forms of disease affecting the surface of the body. Chronic eczema, indolent ulcers and tubercular affections of the skin (lupus) can be much benefited by their employment. It is needless to add that the treatment of disorders such as those mentioned should be in the hands of a properly qualified medical man.

In the other division of high-frequency therapeutics the currents of the solenoid are caused to traverse the patient directly. Several arrangements are in use. In the simplest, the electrodes leading to the patient are connected to the ends of the solenoid which joins the outer coatings of the Leyden jars, and are applied to the body so as to include a particular limb or region. The patient is therefore in shunt to the solenoid; or, again, the patient is connected to one end of the solenoid while the other is led to a large sheet of metal placed beneath his chair or couch, and by reason of the augmentation of his capacity produced in this way currents of large magnitude can be set in motion, surging to and fro between the patient and solenoid. Readings on a hot-wire instrument up to ½ ampere are not uncommonly obtained. This method is spoken of as treatment by auto-condensation or by the condenser couch. Finally, the solenoid connecting the Leyden jars may be made so large that the patient can be enclosed in it, and his body is then the seat of eddy currents, a method known as "auto-conduction."

These modes of application differ from those in which the brush discharge is employed. It has been claimed that the large currents which are set in motion by them are able to exercise a powerful influence upon the nutrition of the body and to arrest various morbid processes. It is not yet established beyond doubt that such applications have any great value, and Dr. Freund is clearly of this opinion, as he only devotes 10 pages to this part of his subject.

Treatment by X-rays has been much in evidence in recent times in connection with cancer and other forms of malignant disease. Although its success in these complaints is by no means achieved, yet X-rays have decidedly gained a place in medical treatment for less serious disorders. In the healing of ulcers and many chronic affections of the skin a course of X-ray applications produces a marked change for the better in the affected area, and a permanent cure can often be secured in this way.

In the disease known as rodent ulcer, which has some of the attributes of a cancerous disease, X-rays have proved a genuine success. In lupus X-rays appear likely to supersede the treatment by concentrated arc light to a considerable extent. By the use of X-rays a much larger area can be irradiated at one time, and so the length of time which is required to complete a cure is reduced. In certain cases of lupus the large Finsen arc lamp may continue to hold its own as a means of finishing off any persistent foci of growth which may have resisted the effect of the X-rays. It is also quite likely that for this special purpose radium may find a useful field of application.

The introduction of the milliampere-meter into X-ray practice is certain to improve its quality. By the use of the valve-tube suggested by Villard, one component of the alternating current of the induction coil or high-potential transformer can be arrested, while the semi-phases which are useful for exciting the X-ray tube are allowed to pass and can be measured with a direct-current instrument if its insulation be good. By this device it has been shown that the production of X-rays in a tube is proportional to the current. Suitable "galvanometers" are now manufactured and are destined to come into general use. The current through a high or "hard" tube is less than 1 milliampere. A low or "soft" tube carries twice or thrice that current.

The applications of radium in medicine have not yet made any great advance. For superficial ulcerations, such as those of lupus and rodent ulcer, the employment of radium has certain advantages as a substitute for X-rays when the lesions are of small extent. Its action appears comparable to that of X-rays, but it is too soon as yet to assume that the actions are identical. Recent observations seem to suggest that differences may in time be found between their physiological actions.

In the radio-therapeutics of light and heat not much progress of prime value has been made except that of Finsen, who has completely demonstrated the effect of concentrated arc light upon lupus.

Something may yet come from the proposed methods of sensitising the tissues of the body by a preliminary administration of quinine or fluorescent chemicals internally before exposure to light rays. In the case of uni-cellular organisms, the presence of a fluorescent material such as eosin in minute amount seems to augment the effect of light rays very largely.

The heat radiations from incandescent lamps have been much vaunted in recent times as a panacea. Their application will probably settle down gradually into the position of an agreeable adjunct in the treatment of minor ailments, much in the way in which the Turkish bath is now used. There is very little evidence to support the view that such heat radiations possess therapeutic properties of great importance.

H. LEWIS JONES.

A SCIENTIFIC INVESTIGATION INTO THE POSSIBILITIES OF GAS TURBINES.[*]

BY R. M. NEILSON.

This Paper is written with the object of expressing and comparing as concisely as possible the advantages and possibilities of gas turbines worked on different cycles, and the difficulties to be overcome to make these turbines a success. Carnot's formula for the efficiency of an ideal heat engine, $E=(T_1-T_2)/T_1$, is well known, but its real meaning is sometimes forgotten; and it may not be out of place here to put in a reminder that, in Carnot's cycle, *all* the heat is put in at temperature T_1 and *all* the heat withdrawn at temperature T_2. We must therefore strive not so much to get the maximum and minimum temperatures respectively as high and as low as possible, but to get the mean temperature at which heat is given to the gas and the mean temperature at which heat is withdrawn from it respectively as high and as low as possible. Of these two temperatures the lower one is usually by far the more important. An ideal gas engine working on Carnot's cycle between the limits of temperature 2,000° C. (3,632° F.) absolute and 300° C. (572° F.) absolute will lose as much by an increase of 100° C. to the lower temperature as it will by a decrease of 500° C. from the higher temperature.

Coming now to discuss more particularly gas turbines, there are four cycles on which it seems to the author that these could be worked with the possibility of good results. Two of these are what Mr. Dugald Clerk designates type 2 and type 3.[†] The author will call them cycle I. and cycle II. respectively.

A pressure-volume diagram of an engine working on cycle I. is shown in Fig. 1, and an entropy-temperature diagram in Fig. 2. The working fluid is compressed adiabatically from A to B. Heat is then supplied by combustion at constant pressure from B to C.

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[*] Abstract of a Paper read before the Institution of Mechanical Engineers last Friday.

[†] "The Gas and Oil Engine." By Dugald Clerk. (Longmans & Co.) Chap. III.

The gas then expands adiabatically from C to D. The fluid is then cooled at constant pressure from D to A. Reciprocating gas-engines have been worked on this cycle by Brayton and others, but have never come into common use. (The Diesel engine may be considered to belong to this class, although no decided constant pressure line is discernible on indicator diagrams taken from the engine.)

It has been proposed for gas turbines to cause air and fuel to unite in a nozzle which thereafter diverges, with the idea that the air and fuel will combine on meeting each other and the hot products of combustion then acquire a high velocity in the divergent nozzle, with which velocity they will enter the turbine buckets. The author doubts if the combustion would be quick enough to give a good efficiency. If, however, a combustion chamber of ample size were provided in which the burning gases could rest a short interval before passing to the turbine, better results could, in the author's opinion, be expected. The air and fuel would be separately pumped into the chamber from which the products of combustion would flow continuously and uniformly by one or more passages into the turbine. If a mixture of air and fuel be always supplied to the flame with a velocity greater than the velocity of propagation of the flame, there can, of course, be no firing back, and this result can be obtained without the use of a wire gauze screen. The strength of the mixture of air and fuel should be kept constant.

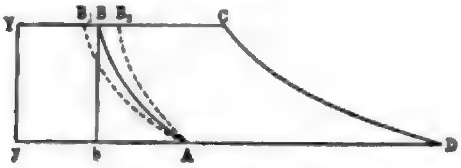

FIG. 1.—PRESSURE-VOLUME DIAGRAM.

This cycle allows of a fairly high ideal efficiency being obtained with a moderate maximum temperature. Now a moderate maximum temperature is of the utmost importance in the case of a turbine of the Parsons type. A Parsons turbine with steel blades could probably be designed without any great difficulty to stand a temperature of about 700 C. (1,292 F.) without any water jacketing or cooling devices of any sort (except for the bearings). With temperatures above this, the blades would need to be cooled.

It had better be stated here that the author has made several assumptions with regard to the working fluid or fluids. These assumptions are as follows:— (1) That the specific heats of gases dealt with are constant at all temperatures and pressures and are as follows:—

Specific heat at constant pressure or $K_p = 0·238$.
Specific heat at constant volume or $K_v = 0·17$.

2. That weight per cubic foot of gases dealt with = 0·0777lb. at a pressure of 15lb. per square inch abs. and a temperature of 17 C.

3. That PV/T = a constant for all pressures and temperatures.

4. That PV = a constant for isothermal expansion and compression at all temperatures and pressures.

5. That combustion produces no change of volume except that due to change of temperature.

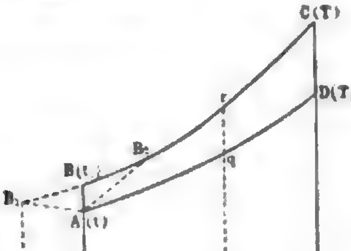

FIG. 2.—ENTROPY-TEMPERATURE DIAGRAM.

The numbers on the diagrams representing pressure and temperature are all representative of absolute pressures in pounds per square inch, and temperatures on the absolute centigrade scale.

Referring to Fig. 2 the heat absorbed by the fluid is represented in this figure by the area $aBCd$, and the heat abstracted or discarded by the area $aADd$. The heat converted into work is represented by the area ABCD, and, consequently, if E represents the ideal efficiency of an engine working on this cycle, $E = \frac{\text{area ABCD}}{\text{area } aBCd}$.

Now it can be proved that $AB/aB = DC/dC = qr/pr$ where pqr is any ordinate cutting the lines ad, AD, and BC, which are all constant pressure lines,

therefore $$E = AB/aB = DC/dC \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Let t represent the temperature before compression.
Let t_c represent the temperature at the end of compression.
Let T represent the temperature at the end of combustion.
Let T_1 represent the temperature at the end of adiabatic expansion.

Then from equation (1) and referring to Fig. 2, $E = \frac{t_c - t}{t_c} = \frac{T - T_1}{T}$.

It it important to consider the amount of negative work done and the ratio of this to the total or gross work. The negative work is the work of compressing the gas and delivering it in its compressed state. In a reciprocating gas engine in which the gas is compressed in the motor cylinder, the only negative work (ideally) is that of compressing the charge; and, even when a separate cylinder is used for the compression, the work of delivering might be avoided. With a turbine, however, the fluid cannot be compressed in the motor: and, whatever arrangement is adopted, the compressed fluid will have to be delivered after compression. The author has therefore considered it better in all cases to include in the negative work the amount required to deliver the compressed gas. The motor proper, of course, gets the benefit of this work.

In Fig. 1 the work to compress the gas is represented by the area AbB, and the work to deliver it in a compressed state by the area $yYBb$. The total negative work is therefore represented by the area $yYBA$. The gross work of the motor is represented by the area $yYCD$, of which the part $yYBb$ represents the work done before expansion, and the part $bBCD$ the work done during expansion. By deducting the negative work from the gross work the net work is obtained; this is represented by the area ABCD. This net work is the same as that represented on the entropy-temperature diagram, Fig. 2, by the area ABCD on that diagram.

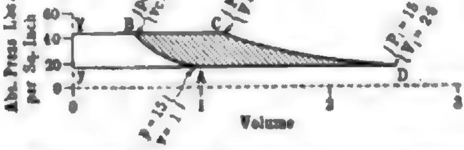

FIG. 3.—CYCLE 1, CASE 1, PRESSURE-VOLUME DIAGRAM.

Cycle I., Case 1.—A case with a maximum temperature of 700 C. (1,292 F.) will be considered:—

In all cases let t and p represent respectively abs. temp. C. and abs. press. (lbs. per square inch) before compression; let t_c and p_c represent respectively abs. temp. C. and abs. press. (lbs. per square inch) after compression; let T and P represent respectively abs. temp. C. and abs. press. (lbs per square inch) after combustion; let T_1 and P_1 represent respectively abs. temp. C. and abs. press. (lbs. per square inch) after expansion to atmospheric pressure; let v represent 1 cubic ft. of the fluid at temperature t and pressure p; and let v_c, V and V_1 represent the volume of the same at t_c, p_c; T, P and T_1, P_1 respectively.

Suppose that in all cases $t = 17$° C. (290° abs. C.) and the corresponding pressure = 15lb. abs. Let us first try compressing to 42lb. abs.: t_c will then be 389° abs. C. This compression is shown by the line AB on the pressure volume diagram (Fig. 3), and on the entropy-temperature diagram (Fig. 4). Let heat now be supplied and the gas expand at constant pressure along the line BC till the temperature is 973° abs. C. Let the gas now expand adiabatically along the line CD till the pressure falls to 15lb. abs. The fluid is now exhausted into atmosphere, and, as the new charge is taken at the same pressure and at temperature t, we can assume that the discharged gas is cooled at constant pressure and used over again. We can, therefore, complete both diagrams by the constant-pressure line DA. The heat absorbed by the fluid is represented by the area $aBCd$ in Fig. 4, and the heat rejected by the area $aADd$. The heat converted into work is represented by the area ABCD and

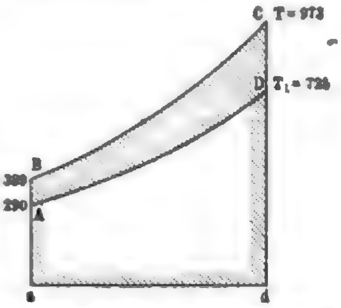

FIG. 4.—CYCLE 1, CASE 1, ENTROPY-TEMPERATURE DIAGRAM.

$$E = \frac{\text{area ABCD}}{\text{area } aBCd} = \frac{t_c - t}{t_c} = \frac{389 - 290}{389} = 0·25.$$

The negative work is represented in Fig. 3 by the area $yYBA$, the gross work by the area $yYCD$, and the net work by the area ABCD

$$\therefore \frac{\text{Negative work}}{\text{gross work}} = \frac{\text{area } yYBA}{\text{area } yYCD} = 0{\cdot}4.$$

The expansion line is carried right down to atmosphere. It should be possible in practice without difficulty to very nearly do this in a turbine although the volume at D is 2½ times the volume at A.

Cycle I., Case 2.—We can employ a much higher temperature than 700°C. (1,292°F.) if we use cooling arrangements. It has been proposed by Mr. Parsons and others to circulate water or other cooling fluid through the actual blades of a turbine, these being formed hollow. It has also been proposed to keep the blades of a single-wheel turbine cool by causing the actuating fluid to act only at one point of the circumference of the wheel, while a cooling fluid is projected on to the blades at another point.

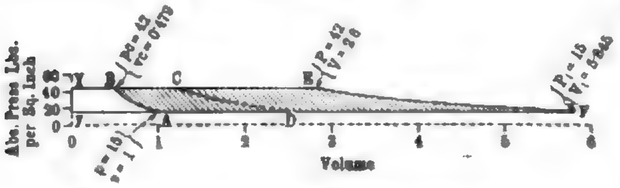

FIG. 5.—CYCLE 1, CASE 2, PRESSURE-VOLUME DIAGRAM.

By the employment of cooling devices we might possibly get a turbine to stand a temperature of 1,500°C. (2,732°F.) or even 2,000°C. 2,000°C. is a very high temperature, and there would be great difficulty in devising and constructing cooling arrangements that would keep the blades in good working order when acted on by gas at a temperature approaching this. Let us assume, however, that 2,000°C. is allowable for our maximum temperature; then, if we keep the same compression as in case 1, our ideal pressure-volume and entropy-temperature diagrams will be as shown in Figs. 5 and 6. In these figures the line CD has been reproduced from Figs. 3 and 4, and is shown in dotted lines in order that the two cases may be readily compared.

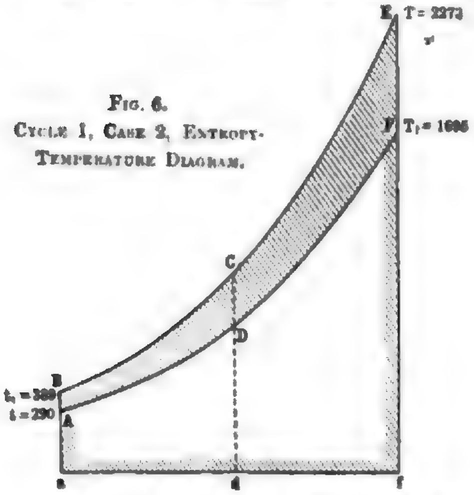

FIG. 6.
CYCLE 1, CASE 2, ENTROPY-TEMPERATURE DIAGRAM.

Referring to Fig. 6 the heat absorbed by the fluid is represented by the area $aBEf$, the heat rejected by the area $aAFf$, and the heat converted into work by the area ABEF. Therefore,

$$E = \frac{\text{area } ABEF}{\text{area } aBEf} = \frac{t_c - t}{t_c} = \frac{889 - 290}{889} = 0{\cdot}25.$$

The increase in the maximum temperature has, therefore, added nothing to the efficiency, and this will always be the case if the initial temperature and pressure are unchanged and we compress to the same amount. That is to say, as long as we start the constant pressure lines from the same points, A and B, we can extend them as far as we like to the right and connect them by any adiabatic line we please; E will remain unchanged.

The negative work (in case 2) is represented in Fig. 5 by the area $yYBA$; it is the same as in the last case. The gross work is represented by the area $yYEF$, and the net work by the area ABEF, therefore

$$\frac{\text{neg. work}}{\text{gross work}} = \frac{\text{area } yYBA}{\text{area } yYEF} = 0{\cdot}171.$$

We have, therefore, very considerably diminished the ratio of negative work to gross work.

Cycle I., Case 3.—In case 1 it was necessary to have a low compression because a high compression with a maximum temperature of only 700°C. would have given an impractically high value to the ratio of negative work to gross work. In fact, this ratio was high even with the low compression adopted. With the maximum temperature raised to 2,000°C., however, a much higher compression can be adopted. Suppose a compression to 300lb. per square inch absolute is adopted. This will make t_c 682·5 abs. C. The pressure-volume and entropy-temperature diagrams will then be as shown in Figs. 7 and 8.

Referring to Fig. 8, it is seen that

$$E = \frac{\text{area } AGHK}{\text{area } aGHk} = \frac{t_c - t}{t_c} = \frac{682{\cdot}5 - 290}{682{\cdot}5} = 0{\cdot}58,$$

which is more than double that in cases 1 and 2. There is, however, the inconvenience of a high compression, and, compared with case 1, more heat is likely to be lost through radiation owing to the higher average temperature.

The negative work is represented in Fig. 7 by the area $zZGA$, the gross work by the area $zZHK$, and the net work by the area AGHK.

$$\therefore \frac{\text{neg. work}}{\text{gross work}} = \frac{\text{area } zZGA}{zZHK} = 0{\cdot}3.$$

Cycle I., Case 4.—It will be interesting to find what efficiency can be obtained with a maximum temperature of 2,000°C. by increasing the compression till the ratio of negative work to gross work is 0·4—the same as in case 1. This ratio will be attained when $t_c = 909$ abs. C., which corresponds to a pressure of 818lb. abs.

Then

$$E = \frac{909 - 290}{909} = 0{\cdot}68.$$

In every case it has been assumed that the compression is adiabatic; it is usually important that it should be at least nearly so. If, for example, in Figs. 1 and 2 the compression, instead of being along the adiabatic AB, had been along the line AB_1, which is below the adiabatic line—that is, if heat had been allowed to escape during the compression, the heat absorbed by the fluid for the same value of T would have been increased by the area b_1B_1Ba in Fig. 2, while the heat converted into work would have been increased only by the relatively small area AB_1B. E would, therefore, have been reduced.

If, on the other hand, the compression had been along the line AB_2, which is above the adiabatic—that is, if heat had been put into the fluid during compression, the heat absorbed and the heat converted into work would both have been reduced by the same amount—namely, the area ABB_2. E would, therefore, obviously be reduced in this case also, assuming that the heat put into the fluid during compression is obtained by the combustion of fuel.

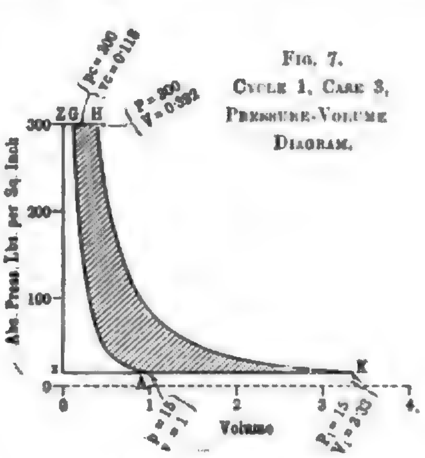

FIG. 7.
CYCLE 1, CASE 3, PRESSURE-VOLUME DIAGRAM.

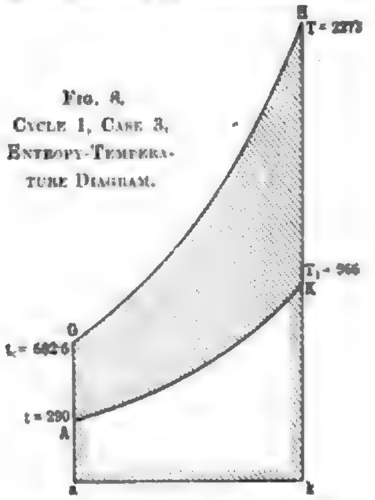

FIG. 8.
CYCLE 1, CASE 3, ENTROPY-TEMPERATURE DIAGRAM.

If, however, the heat put into the fluid during compression is obtained for nothing—if, for example, it is heat that would otherwise be radiated away or carried away by convection—the effect on E is not obvious.

A compression along the line AB_2, Figs. 1 and 2, will give a higher value to E than a compression along the line AB if the heat absorbed during the compression AB_2 is got for nothing, and if the two cases are otherwise the same; but a compression along the line AB_2 produces a higher ratio of negative work to gross work. This will be clear from Fig. 1. Now, with this ratio of negative work to gross work a still higher efficiency could be obtained by keeping the compression adiabatic and continuing it further. A hot compression, such as along the line AB_2 when the heat is got for nothing, may be advantageous in a few cases—viz., when T_1 is low compared with t_c; but, generally, such a compression will be harmful. It is in general disadvantageous to heat the air or fuel before compression, no matter what be the source of heat.

If gas is allowed to enter a water-cooled turbine at a high temperature, such as 2,000°C., there will necessarily be a great amount of heat carried away by the water. The heat lost through the walls and carried away by the cooling medium will probably be much greater with a turbine actuated by gas entering the turbine casing at about 2,000°C. than in a reciprocating engine in which the maximum temperature is 2,000°C.

(To be continued.)

THIRTY-THOUSAND-VOLT TRANSMISSION.*

BY J. F. KELLY AND A. C. BUNKER.

In discussing the conditions which affect and limit the constants and operation of high-tension lines, pressures of over 30,000 volts and lines of over 50 miles in length only will be considered.

The difficulties of taking care of lightning discharges increase much more rapidly than the line pressure, for the reason that any disturbance or change in circuit conditions, produced by getting rid of or dissipating a charge in a circuit having high voltage and high inductive and capacity reactances, may set up oscillations which, if not serious to apparatus, are disastrous to regulation and service. Various combinations and multiples of low-voltage types of arresters have been used, but where these have not had the proper addition of a resistance, they have seldom failed to be completely destroyed when the particular stroke or circuit change occurred. It has been clearly shown that the same arrester could not, without special adjustments, be used on all parts of the circuit, and that arresters performing their function for a lightning stroke, or taking the kick-back from a short-circuit opening, when a given number of generators, length of line or transformers were in circuit, would not so operate for another number of generators, transformers or length of line. This may have been due to the increased inductance in circuit obtained from a smaller number of generators or transformers, to a longer length of line, to the nature and duration of the arc in opening the short-circuit, or to any number together of these conditions. Where a resistance is used with any type of arrester, in order to keep the value of current which would flow over the arresters to a given percentage of the load current, the amount should be such that five or six times the normal impressed voltage can be taken care of.

A modified form of the Siemen's arrester has been used on circuits up to 50,000 volts with a fair degree of success when they were correctly adjusted for the different positions of the circuit, and, where a resistance was placed in series, the voltmeter cards were not painted badly when lightning or a short-circuit occurred. This design can be greatly improved, and no doubt would give very good results and thoroughly protect connected transformers. The low cost, ease of construction and their outdoor service ability are points in their favour. Perhaps the most reliable arrester is one consisting of an inductance and capacity in parallel, so that any frequency variation from the normal would cause a certain value of current to flow. This type, immersed in oil, would be rugged, and could easily be adjusted for any position of the circuit.

One of the best means of dissipating an induced charge or stored energy in a line is by having a distributed load along the circuit. If this load has a grounded neutral, the effect of a lightning stroke will be greatly reduced and more easily taken care of by the regular arresters. The star-connected line with grounded neutral has, however, some disadvantages of equal importance, which should be carefully considered before being adopted.

When a line is short-circuited from any cause, there is a rush of current, the value of which depends upon the impressed voltage and the impedance of the circuit up to the point of the short-circuit. When this current is suddenly interrupted, the voltage induced depends upon the constants of the circuit and increases in value with the length of circuit, distance between wires, the amount of inductance of the connected apparatus, the inductance of the rupturing arc and its duration, the impressed voltage and the instantaneous value of the current when the short-circuit is opened. This induced voltage will be small or of little importance if the short-circuit is opened at or near the zero value of the current. In operation, induced voltages have been observed when opening a 40,000-volt 100-mile line when short-circuited, of from 2½ to six times the normal voltage, as measured by the length of air-gap broken down by the kick-back.

The troubles from the charring of wooden pins were due to the continual leakage of current over dust-coated insulators. In some localities pins would last only from one to three months. This was entirely corrected by placing a metal short-circuit around the pin. Moulding at the thread, which is often noticed where the line passes through a marsh, can be prevented only by the use of a metal pin. Several lines have now been equipped with steel pins, and no new troubles have developed. It would seem that for large high-pressure lines steel pins should be used exclusively. Their initial cost is from 1½ times to twice the price of wooden pins, though cheaper in the end. Soft lead gives better results for the thread than any composition. The moulds should be made so that enough lead can be used to extend a little way below the bottom of the thread, as this will give a good bearing to the insulator over and above that obtained from the thread. This will greatly add to the mechanical strength of the insulator and of the line, as, with the ordinary pin, the insulator is the weakest element of the line. Precaution should be taken to have the thread portion short enough so as not to come in contact with the top of the insulator. This will prevent the tops being forced off when the insulators are put on the pins, and will allow a firm seat at the other end of the thread.

The idea that poles of the right kind of wood for the soil can be placed in the ground and last for 10 or 20 years has been the cause of many and costly repairs. One six-year-old redwood line, with butts treated before raising, had to have 33 per cent. stubbs. Another redwood line, untreated, had to have 10 per cent. stubbs in three years. Another line of untreated cedar poles required 35 per cent. stubbs in six years. In long lines, and even in some short ones, soils may be found that have an entirely different effect upon the life of the same wood.

The burning of the poles at the ground has been the cause of interruptions even when the line was patrolled twice a day, but the remedy is simply a question of persistence and expense in keeping the right of way cleared of all growth. It might be noted here that, even with a generous right of way kept cleared, the wind may carry the heat from a fire toward the line.

One case is known where some dried hay was carried up into a 40,000-volt line, with the result that it was set on fire and produced an arc that shut off the power. The burning hay, being carried on by the wind, did considerable damage. On another line, a flock of pelicans flew into the telephone circuit, which was strung several feet below the power wires. The span was something over 600ft., with a sag of 19ft. The telephone wires were struck so hard as to wrap them around the power-circuit. In another case a long piece of light bark was blown across a 42in. line, with the usual result. On the same line, during one season, there were three interruptions, in one locality, caused by large birds getting across two of the wires.

One of the principal advantages of wooden poles is that, in case an insulator is broken, allowing the wire to come against the arm or pole, the burning which takes place almost immediately in most cases may continue for several minutes before a blaze is started which will short the circuit. Several times it has been observed that from 20 to 30 minutes elapsed from the time trouble was first noted by the ammeters or telephone until it was necessary to shut off the circuit. In one case a 40,000-volt (grounded neutral) wire lay on a dry cross-arm for several hours before the circuit could be shut off, and at the end of the time the arm was not badly charred. With a duplicate line, ample time would in most cases be given for changing from one circuit to the other, or to cut out the affected circuit, providing the telephone line was operative or the men at both ends recognised the difficulty. For the past four years, engineers have tried to adopt, where possible, steel towers, instead of wooden poles, as a means of correcting a large number of line troubles.

At first thought, towers would seem to solve all difficulties previously experienced and certainly do eliminate a great many. The spans can be increased, so that as low as eight towers per mile can be used with safety. This would greatly reduce the number of insulators, which can be larger, and the means for their attachment to the towers can be quite elaborate without exceeding the cost of the other construction. The height of towers can be greater, which will decrease troubles from wires, branches and other material being thrown or blown across the circuit and reduce the breakage of insulators from the heat of forest or grass fires. If galvanised, or painted occasionally, their life would be greater than could be expected of wooden construction. Towers can be erected in places even more difficult of access, since they can be taken apart in pieces of lighter weight than a wooden pole. They would offer a more or less good lightning path to ground which would help to prevent the injury to connected apparatus, but will no doubt subject each insulator to greater strains. Any leakage around, or puncturing, an insulator will mean the immediate shut down of the circuit, and, in order to prevent the shut-down of the entire system, overload and reverse circuit breakers of the best possible design will have to be used.

The distance between wires is usually determined from the highest voltage which can reasonably be expected as a limit, as determined above. The rule that the distance between wires in inches equals 1½ times the number of thousands of volts is safe so far as the striking distance is concerned, though to correct for arcs holding on for a time after once established would be impossible. Where the cost of erected poles is high, or the right of way expensive, two circuits per pole line should be used, and, with good wooden construction, mechanical difficulties would limit the distance between wires to at most 60in., which would allow a line voltage of, say, 50,000 or 60,000. This distance between wires is for spans not over 150ft. to 200ft. A number of spans over 600ft. in length have been in operation for two or three years. These have been closely watched during wind storms to see what deflection would be given to the wires. Three aluminum cables ⅝in. in diameter, 600ft. span, 19ft. sag, were deflected from 30 to 45deg. from the vertical by a wind that was estimated to be 70 miles per hour. All three conductors kept their relative position when deflected, and there were no perceptible waves or vibrations in the cables.

It is claimed by some who have had the opportunity to notice, that in longer spans there is less tremor, vibrations or waves passing over the span when there is a wind than when there is none. All observations of the writers show that, for spans of 600ft. at least, there is no tendency of the wires to swing together in ordinary storms. Where possible the frequency of the current transmitted should not exceed 30 cycles per second. With the general use of alternating-current railway motors, 15 cycles or less may be advisable. With two circuits, one should be transposed in the opposite direction to the other, although there is one double circuit line operating satisfactorily as far as the telephone is concerned, with one of the circuits run straight through. Experiments made with a power line without transpositions and a telephone transposed every fifth mile placed 5ft. below the power wires, gave a pressure to ground of from 2,100 to 2,800 volts when the line pressure was 40,000 volts. With 30,000 volts the telephone voltage to ground was reduced in the same ratio. By giving the power wires two-thirds of a rotation between power taps and talking points, this voltage was not readable on a Weston or hot-wire 150-volt voltmeter. The induced voltage was due to capacity, and in none of the tests was there any measurable electromagnetically-induced voltage. The large number of fatal accidents which have occurred in the past from the telephone circuit being placed on the same poles with and under the power wires, would warrant a separate pole line, even if the service were no better.

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* Abstract of a Paper on "Some Difficulties in High-tension Transmission and Methods Mitigating them" read before Section D of the International Electrical Congress of St. Louis.

A telephone is most needed at times of line disturbances, and at such times it is rarely of service. The induced voltage on a telephone circuit, even where power-line transpositions are made, when one or more of the power wires are out or grounded, is high enough to be dangerous to life and to set fire to adjacent woodwork. The distance between the two circuits should be at least 6ft., and 8ft. would be better. In stringing the telephone wires, the same sag should be given as to the power wires. For lines over 50 miles in length, copper or aluminum should be used. All breakers and switches should be provided with cut-out switches on each side, so that they can be taken out of a *live* circuit for repairs.

THE MEASUREMENT OF THE POTENTIAL OF THE ELECTRODES IN STATIONARY LIQUIDS.[*]

BY HENRY J. S. SANDS, PH.D., M.SC.

In recent electrochemical investigations accurate data are, as a rule, to be found regarding current-density, voltage, temperature and concentration of liquid taken, and very often also regarding the potential of one of the electrodes, defined as the drop of potential on the boundary between it and the electrolyte. The actual concentration of the electrolyte in contact with the electrode is, however, very often uncertain, owing to the removal of substance by electrolysis. Some years ago I was able to demonstrate the great importance of this factor in connection with the electrolysis of acid solutions of copper sulphate.[†] When small current-densities were employed in a stationary solution, it was possible to show, with a fair amount of accuracy, that evolution of hydrogen only took place after the complete removal of copper salt from the liquid in contact with the electrode. On the other hand, when large current densities were employed, this local depletion took place so rapidly that even the most vigorous stirring could not prevent it. The result obtained in this research could be predicted theoretically when the assumption was made that the process occurring at the electrode itself was of a reversible nature; that is, that on the boundary between electrode and electrolyte, chemical equilibrium must be supposed to remain continually established. The matter may also be stated in the following manner, corresponding to a form in which it has recently been put forward by Nernst[‡] as a general principle: Differences of chemical potential cannot exist for a finite period of time on the boundary of two phases, that is, "between infinitely near points," as this would lead to infinitely great forces and reaction velocities. According to this assumption, the actual velocities of electrochemical reactions, and of all others which occur on the boundary of two phases, are infinitely great as soon as conditions of equilibrium have been overstepped by a finite amount, the observed velocities being simply limited by the rate with which diffusion and convection renew the material removed by the reaction. As conditions of equilibrium in electrochemical reactions are determined by the electrode-potential, by which name I propose to indicate the drop of E.M.F. on the boundary between electrode and electrolyte, and the rate of these reactions is proportional to the current strength, this may be expressed in the following manner:—"When the electrode-potential at which a reaction begins has been exceeded by a finite amount, the current strength becomes independent of it, being only limited by the velocity of convection and diffusion. The instance just referred to of the deposition of copper conforms to this rule, for it seems very probable that when a sufficient drop of potential is maintained on the boundary between electrode and electrolyte, the rate of deposition of copper only depends on the rate of renewal of the metal-salt at the electrode. Examples of a similar kind have been studied by Brunner[*]—viz., the rate of reduction of iodine to hydriodic acid with definite cathode potentials and the rate of liberation of hydrogen from weak solutions of acids under similar conditions.

As has already been indicated, Nernst and Brunner are plainly of opinion that all cases of electrochemical action may be ultimately considered from the same point of view. It is not the object of the present Paper to enter very fully into a thermo-dynamical discussion of the principle involved. It will suffice to point out that the latter seems sufficiently invalidated for *à priori* application to actual cases owing to the impossibility of stating that the atoms chemically reacting on the boundary of two phases are in infinite proximity.[†] In fact, the results of several recent researches, notably those of Haber,[‡] stand in opposition to conclusions drawn from the principle under discussion. The object of all these researches is the investigation of the dependence of electrode-potential as defined above on current-density. In Haber's work the reduction of nitrobenzene is examined, but instead of finding the current-density to be independent of the potential of the cathode, his results point to a logarithmic dependence of the latter on the former. In fact, he has partially explained his results, starting from the not improbable assumption that the variations of potential are brought about by the absorption in varying concentrations of hydrogen, or other reducing material, by the electrode. In the further elaboration of this view his results may all be foretold if we adopt as an empirical fact that the velocity of reduction at the electrode v depends on the concentration of hydrogen c in it according to the relation $v = \kappa c^{\gamma}$, in which κ and γ are constants depending on the conditions of the experiments. In contradiction to this, as will be understood from what has already been said, Nernst's view would require that once the conditions of equilibrium have been overstepped, the above velocity should be infinitely great. As a matter of fact, Haber's results have been doubted by Brunner, who believes that changes of concentration in the liquid adjoining the electrode may be partly responsible for them. To this Haber and Russ have replied, stating reasons for the correctness of the results obtained by the former.[§] In view of the fact that the investigation of the dependence of electrode-potentials on current-density seems one of the most important problems of contemporary electrochemical research, it appears very desirable to have independent methods for the determination of the rate at which changes of concentration occur in the layer of electrolyte adjoining the electrode.

When the diffusion coefficients required for calculating these changes of concentration are not known, it would seem that the most reliable method for arriving at an estimation of their rapidity is afforded by the investigation of the behaviour of stationary liquids free from convection currents. This was the method adopted by me for the examination of copper solutions. When hydrogen began to be evolved owing to complete depletion of the copper salt at the electrode, a sudden very large fall of cathode potential took place, which caused a corresponding increase of voltage between the two electrodes that could be easily observed. This method is only applicable where very sharp breaks of potential occur, and the anode is not polarisable in the liquid employed. Another method has since been described by Cottrell.[‖] In it a constant E.M.F. is maintained between the electrodes; the current, however, must remain so minute, or the resistance of the electrolyte be so small, that practically no E.M.F. is required to overcome it according to Ohm's law.

It is the object of the present Paper to describe a method which will allow the electrode potential in stationary liquids of the most varying kind to be measured, when very much larger currents are employed than those which can be made use of according to Cottrell's method, and at the same time to indicate the nature and the scope of the conclusions that can be drawn from the results obtained.

Description of Apparatus and Electrical Arrangements.—It was necessary that the apparatus should fulfil the following conditions: (1) The electrode under examination must be placed horizontally either at the top or at the bottom of the apparatus. It should be readily interchangeable and accessible to observation during an experiment, and allow the current to have uniform density. (2) The electrode not under examination should be as non-polarisable as possible, and no gases must be evolved which might stir the liquid. (3) The difference of potential between the electrode and the layer of electrolyte in contact with it must be capable of continuous measurement during the course of an experiment. (4) It was found desirable to have the apparatus arranged so that several successive determinations could be carried out without taking it to pieces. Figs. 1 and 2 serve to illustrate the apparatus that was designed to meet these requirements. For the sake of brevity we shall call the electrode under observation the cathode, the other electrode through which the working current enters or leaves the liquid the anode, although there is no reason why our cathode should not be used as anode and vice versa. Making use of these abbreviations, Fig. 1 shows the apparatus with the cathode at the top—that is, for liquids that become specifically lighter during electrolysis. In Fig. 2 the cathode is at the bottom, as used for liquids that become specifically heavier during electrolysis. The positions of the anode are indicated in both figures by A. The current passes up the wide tube B, and then enters the long straight tube C of about 1cm. bore. The cathode is approached through a hole, D, in the glass plate D, as shown in Fig. 1. The E.M.F. between the cathode and the part of the electrolyte on the other side of the glass plate D is determined, a liquid connection being tapped off here through the annular space E and the tubes F to the non-polarisable standard electrode G. We shall indicate by T the place in the electrolyte between the glass plate D and the tube C, where the liquid connection is tapped off to the standard electrode. The E.M.F. actually measured on the potentiometer is that between the cathode and the standard electrode, and this is composed of the following parts:—(1) The drop of E.M.F. due to polarisation between the cathode and the layer of liquid in contact with it. (2) The difference of potential between the cathode and T calculated according to Ohm's law as the product of the resistance between the two and the current strength. (3) Any small E.M.F. brought about by contact of the electrolyte examined with the decinormal potassium chloride solution of the standard electrode. (4) The constant E.M.F. of the standard electrode.

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[*] Paper on "The Measurement of the Potential of the Electrodes in Stationary Liquids; the Determination of Changes of Concentration at the Cathode during Electrolysis" read before the Faraday Society on Tuesday.

[†] *Phil. Mag.*, 6th Series, Vol. I., p. 45.

[‡] *Zeitschrift Phys. Chem.*, Vol. XLVII., p. 52 (1904).

[*] *Zeitschrift Phys. Chem.*, Vol. XLVII., p. 56 (1904).

[†] Nernst himself points out that the boundary of two phases is not to be considered mathematically discontinuous, but apparently attaches little importance to this fact.

[‡] *Zeitschrift Phys. Chem.*, Vol. XXXII., p. 193 (1900), also Russ, *Zeitschrift Phys. Chem.*, Vol. XLIV., p. 641 (1903).

[§] *Zeitschrift Phys. Chem.*, Vol. XLVII., p. 260 (1904).

[‖] *Zeitschrift Phys. Chem.*, Vol. XLII., p. 385 (1903).

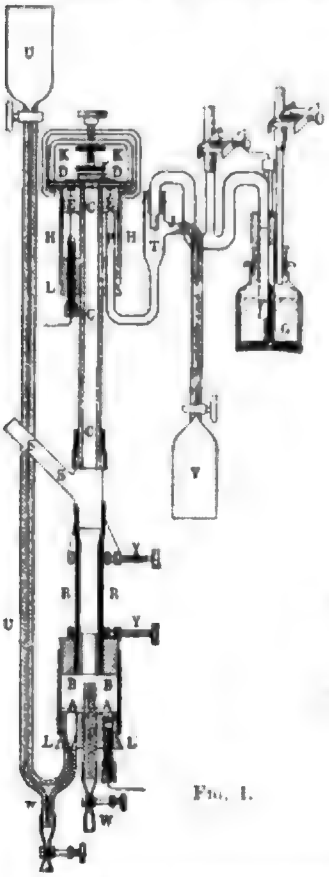

Fig. 1.

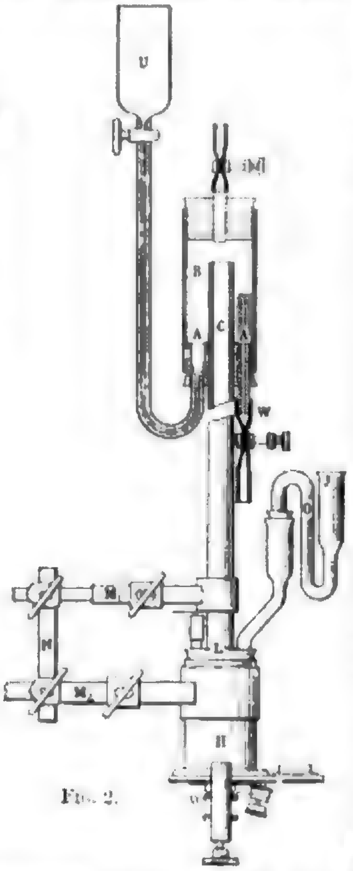

Fig. 2.

The first of these quantities is the one which it is desired to measure, the third was always assumed to be zero, as has been done by other investigators. The fourth may be taken according to Ostwald and Wilsmore to be 0·615 volt for the standard so-called decinormal electrode composed of mercury in contact with a decinormal solution of potassium chloride saturated with mercurous chloride. Being constant for all experiments it need, however, not be taken into consideration. The second difference of potential mentioned, may, as a rule, be calculated when the specific resistance of the electrolyte is known. It is better, however, actually to determine the resistance between the cathode and T during the course of an experiment, more especially when there is a possibility of an increase of resistance at the electrode, owing to the formation of badly-conducting deposits, gas bubbles, &c. The electrical method required for this purpose had to be devised in such a manner that no false connections should be ntroduced and that it should at th same time be independent of the polarisation of the electrode. As far as I am aware the only method suitable for this purpose is one described several years ago by Nernst and Haagn.* It consists of a modification of the Wheatstone-bridge method for alternating currents, two resistances being replaced by standard condensers, and rough condensers being interposed wherever a false connection would otherwise be made. Its application to the present case is shown diagrammatically in Fig. 3. The two resistances compared are the resistance from the anode to T, and the resistance from T to the cathode, plus a known variable resistance m. These formed two arms of the Wheatstone bridge, the other two being the standard condensers a and b (Fig. 3). A special box was made up for this determination containing capacities varying from one-thousandth of a microfarad to half a microfarad. In order to form the bridge containing the telephone between the junction of the two condensers and T, a second auxiliary electrode P is required in the liquid contained in the annular space e (Fig. 1). It was found that an electrode of ordinary smooth platinum answered perfectly well for this purpose. The current for these measurements was derived from a small induction coil, a rough condenser being interposed between it and one of the junctions. The method of working consisted in giving the two standard condensers a and b suitable values, say 500 and 20 millimicrofarads, and finding the value m_1 of the variable resistance m_1 taken from a dial-resistance box that produced a minimum in the telephone. The smaller of the two condensers b—*i.e.*, the one on the anode side—was then altered to its r-fold value $20r$ millemicrofarads, the other condenser being left unaltered. The new resistance m_2 was now determined, which produced a minimum in the telephode. The required resistance x from the cathode to T is then manifestly derived from the equation $(x+m_1)/(x+m_2) = 1/r$, its value being $x = (m_2 - rm_1)/(r-1)$.

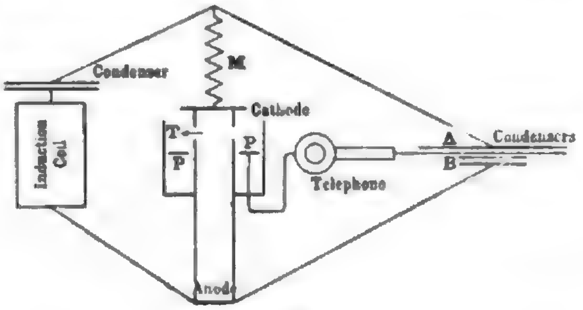

Fig. 3.

The following are details of the apparatus shown in Figs. 1 and 2 that must be specially referred to. The cathode and the glass plate it rests on are both ground perfectly flat. The latter is rectangular in shape, and the edges of the hole d, drilled in it, are perfectly even and free from chips. The plate is put in position in such a manner that the hole d exactly forms the continuation of the tube C; the way in which it is held on the flanged glass cylinder h and the electrode pressed against it by the specially-designed clamp K will be understood from Figs. 1 and 2, as also the manner in which electrical connection is made by means of thin copper foil bent round the rubber washer w (Fig. 2). Practically no leakage took place between the electrode and the glass plate, even when no grease was employed to make a joint. Nevertheless, a small amount of liquid always creeps up, and this seems to give rise to convection currents owing to evaporation, more especially when alcoholic solutions are employed. A very small amount of vaseline thickened with a little paraffin-wax was, therefore, spread round the edge of the electrode before it was placed in position. In order to guard against its being accidentally moved backwards and forwards over the plate, which would have caused the grease to spread over its surface, a cardboard ring, c, was fixed on the glass plate by means of paraffin-wax, and the electrode rotated inside this ring to place it in position. The electrode could easily be levelled both when used as in Fig. 1 and as in Fig. 2, by placing a small spirit level on the glass plate (Fig. 2); the retort stand, to which the apparatus was attached, being fixed on a levelling stand. The tube C, the end of which was bevelled, was fixed centrally in the flanged cylinder H, and was held firmly in position with regard to the latter, not only by the rubber bung L, but also by means of the two clamps M_1 and M_2 (Fig. 2), both of which are fastened to a common short rod n. The clamp M_1 at the same time serves to support the apparatus on its retort stand. The tube C ends about 4mm. below the glass plate, thus allowing sufficient room for a liquid connection between the auxiliary electrodes and the liquid through which the working current is passing. The two auxiliary electrodes have already been referred to. The place where the junction between the electrolyte examined and the decinormal solution of KCl of the standard electrode is made, is indicated in both figures by J. The method of filling the tubes P and O and keeping the liquid in them by means of cotton-wool plugs before placing the tubes in position will need no further explanation. Considerable difficulty was at first experienced in arranging the anode to satisfy condition 2, referred to under the heading "Description of Apparatus and Electrical Arrangements." The method finally adopted consisted in the employment of electrodes of either copper or mercury, the electrolyte under examination being displaced in the vicinity of the electrode by a solution of metal salt which was run in slowly through the capillary tap-funnel U (Figs. 1 and 2). The displaced electrolyte was generally removed through the tube W (Fig. 1). The anode solution employed in conjunction with the copper electrode, when the electrolyte was an acid alcoholic solution, consisted of cuprous chloride dissolved in a mixture of alcohol and hydrochloric acid. When the electrolyte was an alkaline solution containing alcohol, and also in some experiments on alcoholic acid solutions, a mercury electrode was employed in contact with a solution of mercurous nitrate and a little nitric acid. As the latter, however, as a rule, produced a precipitate in contact with the electrolyte under examination, a solution of ammonium nitrate was interposed. The liquids in this case were run under the electrolyte in the following sequence: (1) ammonium nitrate solution; (2) mercurous nitrate solution; (3) mercury.

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* *Zeitschrift Phys. Chem.*, p. 23, 1897.

The requirement that the apparatus should allow several successive determinations to be performed without taking it to pieces, was only met satisfactorily when the cathode was at the top, as in Fig. 1. For this purpose it was necessary to renew the liquid at the cathode by stirring, without at the same time causing anode solution to come into the cathode compartment. As will be seen from Fig. 1, the rubber tube R, with screw clips TT, and the glass side-tube S were, therefore, introduced between the tubes B and C. The method of using them was the following:—When a determination was finished, the side-tube S, which was generally left open during the experiment, was closed, about 5 cubic cm. of air being left in it. The standard electrode was then removed by undoing the connection at J, and a rubber stopper with a tap-funnel introduced in its place. The screw clips YY were then closed. A considerable amount of electrolyte was thus forced out of the rubber tube R, and was allowed to escape through one of the taps. The top part of the apparatus was then taken from the retort stand and moved up and down, the rubber tube R being used as a hinge. Air bubbles from the side-tube S could thus be admitted to stir the liquid and afterwards be returned to the tube S. When it was necessary to leave the apparatus overnight the anode solution was removed through the tube *n* of the tap-funnel U; being replaced by electrolyte run in through the funnel introduced at J. It was thus found possible to keep the cathode compartment perfectly free from anode solution, even when experiments were spread out over several days. The apparatus was also used for single experiments, without the rather troublesome arrangements allowing a repetition. For the purpose of filling the apparatus as illustrated in Fig. 1, both the funnels U and V must be employed, the top being inverted for filling the upper part through the funnel V. A vent-hole with tap (not shown in the figure) allows the air to escape through the bung L. The last air-bubbles are removed from the cathode through the side tube S. When in use the apparatus was placed on a non-vibrating shelf.

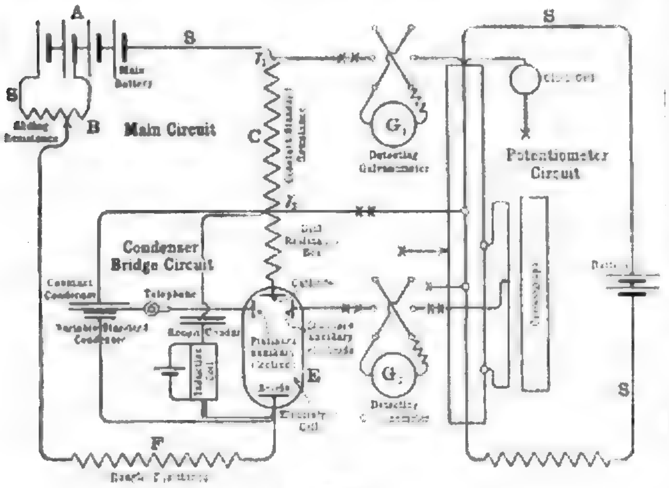

FIG. 4.

The electrical arrangements are shown completely in Fig. 4. They comprise the main circuit, the condenser-bridge circuit already explained and the potentiometer circuit. The current was derived from a battery of small accumulators, A, and was kept perfectly constant by variation within suitable limits of the original E.M.F. employed as shown at B, Fig. 4. It passed through a known constant resistance, C, then through a dial-box, provided for the purpose of introducing when required the resistance *m*. As a rule, this box was, however, kept free from resistance. After this the current passed through the electrolytic cell E and finally through a rough resistance, F, of about the same magnitude as the latter. For the purpose of determining the current strength and the cathode potential, the voltage between the ends g and g_1 of the known resistance C, and between g_2 and the standard auxiliary electrode, were measured on the same potentiometer circuit. The latter was composed primarily of a slide-wire with a variable back resistance. As several points of the potentiometer had to be tapped simultaneously during an experiment, a system of wires along which mercury cups could be moved was arranged in parallel with the slide-wire, and the require potentials tapped off from these mercury cups, the electrical position of the latter relative to points of the slide-wire being arranged by separate determinations before an experiment. The following manipulations and measurements were carried out during an experiment. The current was kept constant at a known value, the potentiometer regulated by occasional comparision with a Clark cell, and the resistance between the cathode and T measured now and again, as explained above. At the same time, the cathode-potential had to be determined by measurement of the E.M.F. between g_2 and the standard auxiliary electrode, and the time had to be read. In order to facilitate the last two determinations a chronograph was designed, which contained a slide-wire that was shunted parallel to part of the potentiometer circuit. The slider on the latter was moved by hand, so as to balance the difference of potential to be measured; its position, however, was automatically recorded on curve-paper moved past it by means of a drum rotated by clockwork. With regard to the already-explained measurement of the resistance from the cathode to T by means of the condenser-bridge circuit, it must be pointed out, firstly, that a false connection is introduced unless the galvanometer G, for measuring the current, is thrown out of circuit during a determination, and, secondly, that the rough resistance F is required in the main circuit on account of this measurement in order to prevent the greater part of the current from the induction coil from finding its way through the battery instead of through the electrolytic cell. The resistance taken from the dial resistance box must be so small that its effect on the current during the fraction of a minute it is in circuit need not be considered. All the points of the various circuits that were ever interchanged were connected by special wires to a central switchboard of mercury cups on which all the connections were conveniently and rapidly made. All such points are indicated in the figure by *xx*, other switches being indicated by S.

(*To be continued.*)

RAWORTH'S SYSTEM OF AUTOMATIC REGENERATIVE CONTROL FOR ELECTRIC TRACTION.*

BY JOHN L. HALL.

Mr. Hall's Paper contained a general description of the Raworth system of regenerative control for tramway motors, in which the current generated by the motors on the down gradients not only assists the braking of the cars, but also returns energy to the line. Many particulars of this system have already appeared in *The Electrician* (see Vol. LI., pp. 527 and 885; Vol. LIII., pp. 41, 46, 106, 249, 330, 537 and 587). In order to avoid repetition, a considerable portion of the Paper has been omitted in the following abstract.

The regenerative motor differs from the series motor principally in the field windings. As far as the general construction is concerned, it is a series motor, and the details of construction in many of the motors in use for series control are exceedingly well adapted for regenerative requirements, and give excellent results in practice. The field windings are composed of shunt and series coils wound and insulated separately from each other. The shunt coils are wound of suitable section of conductor and number of turns to carry the current necessary to secure the maximum field excitation required to give the necessary starting torque and minimum speed at which it is desired to run for regeneration. By means of the shunt field the whole of the speed regulation is effected between minimum and maximum speeds. The minimum speed is generally about 4·5 miles per hour, and the maximum 14 to 16 miles per hour, giving a speed ratio of about 3·5 to 1.

The variation in field excitation is effected by means of rheostatic regulation. This is effected by means of the speed-regulating levers of the controller in about 12 steps, thus giving an average variation of speeds of about 0·8 mile per step. Each of these steps affords the driver of a regenerative car a distinct speed at which he can drive the car, and at every moment he knows at what speed the car is travelling on level track, and the speeds are approximately the same whether ascending or descending gradients.

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* Abstract of a Paper read before the Tramways and Light Railways Association on Thursday, October 20.

When it is necessary to decrease the speed below the minimum of regeneration to line, the armature circuit is automatically disconnected from the line circuit and closed through a suitable resistance, and the speed is reduced to about 1 mile per hour. The actual stopping is effected mechanically, except in cases of great emergency, when another mode of stopping is provided by means of a series field winding.

The series field winding is arranged to give a number of ampere turns sufficient to reduce the speed of the car to about 1 mile per hour, and is designed principally for use when the car is descending a gradient and the current supply fails. Under such circumstances, the series field winding is switched into circuit for controlling the speed of the car. The introduction of the series winding can be effected by the driver or automatically. As a matter of safety, arrangements are provided so that it is switched in automatically and independently of the controller in case of the trolley leaving the overhead wire, or electromagnetically in case of the circuit-breaker blowing at the station. In the regenerative motor, the direction of the current remains constant in the field, but varies in the armature, either automatically or at the will of the driver, without altering the connections of the armature circuit.

There are notable instances in tramway construction where the line pressure varies considerably. I came across one case the other day where in a distance of about 2·5 miles there was a drop of 50 volts.

The regenerative system will rectify those defects in distribution much more effectively than by any other means. Suppose the distribution of line pressure on a level track system is considered under regenerative control. Consider that one car makes eight stops per mile, and, on the average, slows down four times on account of traffic. I will suppose that 10 seconds are, on the average, occupied in these braking operations. Then 12 × 10/60=2 minutes per mile spent in braking. On an average speed of 7 miles per hour, therefore, the time occupied in braking equals 14 minutes per hour. If one car occupies 14 minutes per hour in braking, then 60/14=4·28 is the number of cars that would be required to develop sufficient braking power to maintain a constant return of current to the line and consequently a maintenance of pressure equal to the pressure at the generating station. Current returned to the line during these braking actions would produce on the average a steady current of about 4 amperes. With four cars in operation they would not all be engaged in braking simultaneously, but if there were 100 cars in service there would be sufficient cars on the track to give an average of 23·3 cars constantly engaged in braking and returning current, amounting to about 93·2 amperes. On a level track system operating 100 cars there are, therefore, on the average, 23 of the cars in parallel with the generators, and delivering current to the line; and it is evident the 23 cars distributed over the route would maintain the line at fairly constant pressure throughout. It is evident where the car motors supply part of the current, that a corresponding proportion can be saved in the cable network and in the plant of the generating station.

The cost of energy on the average tramway system is about 1·5d. per car-mile, ranging, however, up to as much as 3·0 and 3·34d. in some instances. These heavy current consumptions are found in hilly districts, where the grades range up to 1 in 9 or 1 in 8, and where grades of 1 in 15 and 1 in 14 are common. It is in districts such as these that the regenerative system is of the greatest benefit, and where energy consumptions of 1·6, 1·7, 1·8, and 1·9 units per car-mile can be very materially reduced. While not claiming to reduce the total amount of energy delivered from the power station by an average of 25 or 30 per cent., yet the consumption as measured on the cars can be reduced by these amounts by adopting a regenerative car.

I give below some particulars of investigations carried out by the Brush Electrical Engineering Co. at Devonport. Records were taken on a recording wattmeter by Elliot Bros. The results of their investigation show an overall saving of 31·3 per cent. in favour of regenerative control:—

Result of Regenerative Motor Trials at Devonport.

Route.	Scale readings.		Per cent. returned.
	Power consumed.	Power returned.	
Mile House to Fore-street	4·570	0·790	17·30
Fore-street to Mile House	4·560	1·955	42·80
Fore-street to Penny-come-Quick	3·095	1·825	58·90
Penny-come-Quick to Fore-street	5·612	0·405	7·20
Penny-come-Quick to Camel's Head ..	11·153	1·780	15·95
Camel's Head to Penny-come-Quick ..	12·085	5·505	45·70
Average	6·846	2·043	31·30

They carried their investigations further and examined the consumption on several grades in detail. The results of their findings is given in the following table:—

Result of Regenerative Motor Trials at Devonport.

	Consumed.	Field.	Returned.	Field.	Per cent. Returned.
Stoke Hill	1·70	3·0 +	0·720	3·8 +	42·30
Stoke Hill	1·76	3·0 +	0·710	3·8 +	40·30
St. Hiliary	1·56	2·8 +	0·815	5·0 + to 2·8 +	52·20
Brick Fields	0·89	7·0 + to 2·2 +	0·480	3·0 +	54·00
Technical School ..	2·31	6·3 + to 2·6 +	1·170	4·0 + to 6·7 +	50·07

In considering these particulars it must not be overlooked that they are obtained from converted series parallel motors, where the electrical losses are greater by probably 5 per cent. than would exist in motors specially designed for the regenerative system.

The table on next page will be of interest as showing the currents in the armature and field circuits in ascending and descending various grades at Devonport.

Report on Regenerative Motor Trials.

Trials with car No. 25 fitted with two 25 H.P. motors. The load for each trial was constant throughout the journey. No. 1 test was made with average number of passengers on board; No. 2 with load equal to half load; No. 3 with load equal to full load.

These observations were noted by myself during the trials last year. I may, perhaps, here remark that in only one instance was there any severe sparking at the commutator, and that was only momentary in mounting Albert-road, when the current rose to 100 amperes by the field being reduced too low. The figures in each case indicate the maximum current observed in either ascending or descending the gradients. The series-parallel motor for operation on level lines is deficient in many ways, and in its application to hilly districts it is more particularly deficient. In such districts it is only in operation about half its time, the other half being spent in idleness when descending gradients. The manufacturers of series-parallel motors claim this as a decided virtue, and say that during the time the motor is remaining idle it can cool down, and by this means of cooling they are able to put in a motor of considerably less power and, therefore, a more economical motor as far as cost is concerned. A pair of series-parallel motors of about 30 H.P. costs approximately £150. These operating 100 miles per day on hilly lines absorb on the average 1·5 units per car-mile, or 150 units per day. For a year of, say, 300 days, the consumption would be 45,000 units, which at an average cost of 1·5d. per unit would cost £281. 5s. At the end of 12 months those motors, with the cost of current added, would, therefore, amount to £431. 5s. Now, I will suppose a pair of regenerative motors for similar work costs £170; for this extra expense the motors can work all day long and do 40 per cent. more work and, at the same time, save, say, 25 per cent. of energy required by the series-parallel system. Now, 25 per cent. of £281. 5s.=£70. 6s. 3d., and £281. 10s. – £70. 6s. 3d. =£211. 3s. 9d., the regenerative motors costing, say, £170, the current costing, say, £211. 3s. 9d., makes a total of £381. 3s. 9d. The saving of the regenerative motors at the end of 12 months, is, therefore, £50. 1s. 3d.

I have, however, taken the regenerative motors as costing £20 more than the series motors, but we see that the makers of this class of motor use the same rated power machine for descending grades when using the electromagnetic brake; therefore there is no need to use a larger machine for regenerative work, so the saving of £50. 7s. 6d. on the first year's work can be increased to £70. 7s. 6d.

The braking being effected principally by the motors, the life of the brake gear is greatly extended. Wheel blocks on level track as a rule last about six weeks; on hilly routes the life is reduced in some cases to as much as two weeks. In track brakes the shoes in some cases are renewed as often as once a day, and in some very hilly districts as often as twice daily. The life of the wheels is also extended in regenerative control. Where the brake gear is constantly being worn out, the labour in the car shed is correspondingly increased. I shall be quite safe in saying that on braking mechanism and car maintenance generally a saving can be effected somewhat as follows:—Brake blocks and mechanism generally, saving *per annum* per car=£10, general car shed labour and attendance=£5, wear and tear of cars, re-wheeling and truing up=£10, making a total of £25.

In support of these claims of economical working, I must refer you to the wheel brake, blocks, &c., which have been sent here for inspection by the managers of the Devonport and District Tramways and the Southport Tramways. The set from the Devonport regenerative car has run 25,000 miles, and is evidently good for running another 10,000. The series parallel blocks run about 1,800 miles, and a pair is lying on the table for inspection.

In connection with the general economy in maintenance, I will now read you what Mr. J. Lloyd, manager of the Southport Tram-

Particulars of Current in Armatures and Fields.

No. of test	(1.)				(2.)				(3.)				Grade.
Name of Hills.	Up.		Down.		Up.		Down.		Up.		Down.		
	A.	F.	A.	F.	A.	F.	A.	F.	A.	F.	A.	F.	
St. Hiliary	38	4·0	80	2·2	60 50	2·4 2·7	25	2·8	75	2·4	35	2·7	1 in 18
Tavistock	..	..	20	2·4	60	4·8	40 30	1·8 2·4	50	2·7	25	2·8	1 in 30
Trafalgar	60	1·8	38	3·0	50	1·8	30	2·8	50	2·7	30	2·8	1 in 15
Technical School	60	2·2	20	2·4	..	..	30	2·8	50	2·7	30	2·8	1 in 15
Brickfield	45 30	2·3 2·5	25	4·0	60 30	2·4 4·6	15 20	2·5 2·8	46	3·0	20	2·8	1 in 80
Stoke	53	3·8	34	3·8	75	3·0	30	3·8	80	3·0	40	3·7	1 in 12
Stuart-road	35	2·3	25 12	1·8 2·4	40	2·3	15	2·4	46	2·3	18	2·4	1 in 35
Technical School	50	3·8	35 22	4·4 4·2	66	3·6	25	5·8	70	3·5	85	5·8	1 in 11
Tamar-terrace	..	..	35	3·8	75	2·2	30	2·8	90	2·6	24	2·6	1 in 15
Albert-road	..	..	30	3·8	100	2·2	15	5·2	80	2·8	30	5·0	1 in 12
Albert-road	56	3·5	21	4·4	80	2·4	20	3·7	50 80	3·4 2·9	30	4·8	1 in 12
Martin-terrace	45	3·6	33	1·7	62	2·6	20	3·0	70	3·0	35	3·4	1 in 20
Gas House	40	2·5	24	3·8	70 50	2·2 3·4	30	3·4	68	2·4	34 30	2·9 3·0	1 in 25
Avondale-terrace	30	3·5	50	1·8	60	2·2	30	2·3	62	2·5	35	2·9	1 in 30
Avondale-terrace	..	..	45	2·4	80	2·6	35	2·2	60 to 70	2·6	15	3·5	1 in 30
Johnson-terrace	40	2·4	20	1·8	50	2·2	10	2·2	50	2·3	18	2·6	1 in 30
Camel's Head	50	2·6	30	2·4	50	2·4	23	2·2	40 50	2·5 2·6	30	2·8	1 in 15
Camel's Head	..	..	..	..	80	1·8	25	2·2	50 to 60	2·4	15	6·0	1 in 15
New Passage	..	..	..	..	90	2·2	24	5·0	60	3·4	28	5·2	1 in 12
New Passage	..	..	..	..	..	..	..	..	70	3·4	22	5·8	1 in 8
Aver. % of main current..	..	6·8	..	19·0	..	4·77	..	13·5	..	4·66	..	14·2	

Average of the mean field currents: Up, 5·4; down, 15·6.

ways, says of the regenerative car in operation. Writing to me on October 12th, he says:—

With reference to yours of 8th for particulars of Demi car, our experience of the regenerative control is that we have less trouble with it than with any of the S.P. cars. The driver himself takes charge of the controller, which takes him about 15 minutes each morning; the shed men examine the under gear each night to screw up any loose bolts; they do not find one a week loose. With the S.P. cars we have one man to clean the controllers each night; we have 13 cars on the road every day and they take him about 20 minutes to each car.

The wheels on the Demi-car have run in service 8,000 miles and 2,000 miles for testing purposes. When the wheels were first put under they were 30in. in diameter, now they are 29¾in. The pinions and gear wheels show no signs of wear at all. The commutators show about $\frac{1}{64}$th, and that was made mostly in the extensive trials originally made.

Now I will give the result of measurements of wheels running on hilly districts, such as Devonport. The wheels measured on the 12th inst. were on the Devonport and District Tramways Company's car No. 4, with the regenerative system of control. The diameter of new wheels when the car was put in service was 30¼in.; the miles run to date were 29,696; the diameter of the wheels at date was 29$\frac{11}{16}$in.; and the estimated life left in wheels at date was 20,000 miles, making a total of nearly 50,000 miles. The reason of the extended life of regenerative car wheels is due to the fact that the drivers do not apply the brake blocks, and, therefore, they are not ground away. In addition to the economy in energy, there are also the other economies to be secured, which have been found in tramway work. The controlling arrangements are much simplified, and no such complications are required as are incidental to multiple-unit control, while all the benefits of that system can be obtained.

The regenerative motors as a rule are generally run in series with the ordinary service speeds in vogue. If it is necessary, where greater speeds than from 14 to 16 miles per hour are required, the change from series to parallel can be adopted, but the change is effected in a way whereby the violent flashing when the circuit is broken is avoided. This method of operation has been tried with very satisfactory results, and without the resort to magnetic blow-outs.

As paralleling is not necessary in ordinary cases, if higher speeds than those indicated are required, the change can be made outside the limits of the towns, at certain pre-arranged points, and the motors can be switched into parallel while the car is stationary.

The following is an abstract of the discussion which took place in connection with the Paper:—

Mr. J. S. RAWORTH, after some general remarks on the principle of the regenerative control, and after referring to the results obtained with a regenerative car in Southport, went on to say that not every tramway series motor could advantageously be converted for regenerative operation. It all depended on the design of that particular motor. He also mentioned that the Raworth converted series motor would not stand a one hour's test at full load, but he expressed the opinion that in actual practice the times of full load were very much shorter and separated by intervals of light load.

Mr. H. M. SAYERS regretted that not more had been said in the Paper on the question of sparking, and was of the opinion that the reduced torque of the regenerative motor as compared with the pure series motor was a drawback, especially on traction systems with many stopping places. Since the one hour's test, referred to by Mr. Raworth, was a conventional one, it would follow that the Raworth motor could not do the same work as the corresponding series motor. He proceeded to say that a saving in current was not the only item to be considered, but that first cost and maintenance had also to be taken into account. The resistance in the controller, of the order of 300 ohms, would be expensive.

Mr. W. M. MORDEY congratulated Mr. Raworth on his work, and mentioned the efforts which had been made in the direction of regenerative control on the old Northfleet tramways. He also alluded to the early suggestions of Sir W. Siemens in this country, and the work of Mr F. Sprague in America. Some time ago he examined the conditions on the Liverpool overhead railway, and found that 50 per cent. of the energy delivered to the trains was lost in braking, 25 per cent. was dissipated in the resistances, while 25 per cent. only was used for the actual driving. Such being the case, a reduction in current consumption might be expected by employing the regenerative system. With alternating current it was much easier to regenerate.

Mr. R. HUMPHRIES (engineer and manager of the Isle of Thanet Tramways) said that he would be sorry to reduce the current output of his station, because by doing so the cost per unit would necessarily increase, and this cost per unit generated was usually taken by company directors as a basis for computing the commercial efficiency of generating stations. The saving in capital cost of the generating station would not be proportional to the energy saved. He doubted whether a car of the regenerative control was safer down hill than a car worked on the series-parallel control. Moreover, the contacts in the controller of Mr. Raworth's car were just as liable to give trouble as the contacts of the ordinary series-parallel controller

The CHAIRMAN (Mr. T. W. How) thought that further experiments on the regenerative system were required before a final verdict as to the merits of the regenerative system could be formulated. The costs of maintaining the regenerative equipment of the car he also thought would be a serious item. He was of the opinion that the regenerative principle was particularly suitable for electric railways; a somewhat reduced starting torque would not matter much in such cases. What was at present badly wanted was a reliable wattmeter for use on moving cars.

Mr. J. S. RAWORTH, in reply to Mr Sayers, emphasised that all regenerative motors up to the present were simply converted series motors, and that there would be no difficulty in designing regenerative motors with very large torques.

Mr. J. J. HALL, in reply to another point raised by Mr. Sayers in the discussion, said that the commutation was satisfactory if the field current was at least 3 per cent. of the armature current.

DINNER TO DR. LEE DE FOREST.

On Tuesday evening, at the invitation of Mr. F. Z. Maguire, Vice-president of the American De Forest Wireless Telegraph Co., a complimentary dinner was given to Dr. Lee de Forest on the occasion of his departure to the United States after a short visit to this country. Sir William H. Preece, K.C.B., F.R.S., was in the chair, and among other guests were Prof. W. E. Ayrton, F.R.S., Lieut. Balmson, Mr. Samuel Barber, Mr. J. H. Carson, Sir Dudley Forwood, Mr. A. L. C. Fell, Viscount Horncastle, Col. H. C. L. Holden, F.R.S., Admiral Sir John David Hay, Capt. Lionel James, Mr. E. H. Johnson, Prof. George M. Minchin, F.R.S., Mr. Gurr MacLean, Mr. Nevil Maskelyne, Mr. G. R. Neilson, Mr. F. C. C. Nielsen, Mr. F. Charles Raphael, Mr. James Swinburne, Mr. A. A. Campbell Swinton, Mr. H. W. Sullivan and Mr. Roger Wallace, K.C.

Sir **WILLIAM PREECE**, in proposing the health of Dr. de Forest, referred to the very small beginnings and very great promises of wireless telegraphy. Speaking of the messages which had been transmitted across the Atlantic, he stated that some persons argued that these messages went through the air, others that they went through the earth, and others that they went through the submarine cable. In connection with the events about and around Port Arthur, however, it had been shown what wireless telegraphy could do. He had always taken great interest in wireless telegraphy, and when Mr. Marconi—he might almost say Master Marconi at that date—came over to England he (Sir William) had placed the whole of his staff and apparatus at the disposal of those experiments, while Mr. Marconi had received at that time no support from his own country. Science was cosmopolitan and knew no country. Referring to enterprise in the United States, he said that when a new scientific fact was placed before an American he immediately considered how he could apply it and how he could make money out of it. One ordeal that wireless telegraphy had yet to undergo was to be beaten in a court of law. In conclusion, Sir William Preece referred to the excellent work done by Capt. Lionel James, who was *The Times* special correspondent in charge of the wireless telegraph installation in the Far East.

In replying to the toast, Dr. **DE FOREST** said that he was certain that Hertzian wave telegraphy had now outgrown those difficulties which were so graphically described by the American national hero, Mr. Dooley:—"Hinnesy, ye wor afther askin' phwat was the wireless tiligraf. I'll teel ye. Yez are on a ship armed with an artinay, a coharar and a jigger, and yez wish to send a farewell missage of love and condolence to yer wife and the childer at horm. Yez contide yer nobil armbishun to the steward for two pound and sixpence, and yer wife gets the news instantly, providin' yez have a confederate on shore, and she'll get it before it's sint if yer not careful." More progress, continued Dr. de Forest, had been made during the last 12 months than during any previous period. It was his good fortune to cross last year with Capt. James, war correspondent of *The Times*, then on his way to the Far East. As a result of their conference followed *The Times* wireless war service, which was the first successful utilisation of wireless telegraphy in journalistic work and had established new records. From a boat equipped with only 96ft. of antenna wire and 1kw. transmitter, messages up to 1,709 words in length had been transmitted over distances up to 210 sea miles, at a speed of 25 to 35 words per minute, and frequently in face of transmission from any number of Japanese, Russian, German and British vessels. Those dispatches, flashed hot from the graphic pen of Lionel James, made up a series of pictures of the naval operations before Port Arthur which stood alone in the history of journalism. In the meantime, they were establishing in America permanent wireless communication over 180 miles of frozen land between Buffalo and Cleveland. At the St. Louis Exposition, some 10 installations had been established. From the steel observation tower a regular Press service with two St. Louis newspapers had been maintained. They had handled from 3,000 to 5,000 words per day in that service, transmitted as fast as an operator could manipulate his Morse key. On September 14th long-distance communication had been established from St. Louis to Chicago, 300 miles overland, and crossing the entire length of the city of Chicago, with its mazes of tall steel structures, miles of elevated railroads, gasometers, and tangles of electric wires. The strength of the received signals at Chicago was surprising, and showed that the limit of distance from the St. Louis station was by no means attained. Since opening, this service had been continuous, and they were daily handling a large number of messages, not only to Chicago but to Kansas City and Springfield, Illinois, the distances being 280 and 105 miles respectively. By the methods of tuning or syntonisation which they employed, there was absolutely no interference between the St. Louis Press messages and the long-distance transmission to Chicago. They were charging the regular Western Union rates from St. Louis because of their contract with the World's Fair management not to cut rates. At the close of the Exposition it was proposed to reduce the rates 25 per cent. less than those now charged, and they are assured of all the business they could handle. They had two stations in Texas, and were building a long-distance station at Fort Worth. One under way at Detroit would be in touch with Chicago on the West and Buffalo on the East, and this would complete a chain, with but one gap remaining between Buffalo and New York, from the Atlantic as far West as Kansas City. Stations were also under way at New Haven and Boston, whereby New York would soon be in aerographic communication with the chief cities of New England. For dispensing news matter from a central transmitting station to a large number of surrounding receiving stations, the wireless telegraph offered special advantages, and this fact had appealed strongly to the Press Associations of America. For the United Fruit Company, in Central America they have been operating two stations, 75 miles apart, for a period of six months without interruption. The messages in that case were almost entirely in code, and of such a nature that mistakes or delays could not be tolerated. The United States Signal Corps had established the system between Cape Nome and St. Michael's, Alaska, across 105 miles of gulf where the ice rendered a cable impossible. For several months now every cable message from here to the United States had traversed the first stage of its journey through the ether. Confident that far greater distances were feasible, the United States navy had granted the American De Forest Company "penalty" contracts for the establishment of five stations in the southern waters. Three of these would be located at Panama, Porto Rico, and Cuba, and represented ranges of 1,000 miles or over. The navy proposed to handle public business from these stations as well as communication with vessels. It was to start this work that he was hastening back to the States on the morrow. The Western Union Co. estimated the cost of construction of a single wire at from $300 to $700 per mile, including franchises, rights of way, &c. According to these figures, a wire from St. Louis to Chicago would, at least, cost £18,000. The cost of the De Forest Company's long distance stations at Chicago and St. Louis would not exceed £3,000 all told; in addition, there was the easier maintenance, resulting in a saving in linemen's salaries and no depreciation of the poles and wire. In fact, recent developments justified his claim that "wireless" would prove of the greatest value as a feeder and adjunct to the cable and the telegraph wire.

Capt. **LIONEL JAMES**, in reply to the toast of "The Press," proposed by Sir William Preece, stated that he had attended the yacht races during which three systems of wireless telegraphy were vieing with one another, and each confusing the messages sent by the other two. He saw, however, that the De Forest system came out of the ordeal best, and he recommended *The Times* to employ that system in connection with reporting events in the Far East during the war. He was, however, only the instrument of that great paper, which always did its best to promote every good result of scientific research. It had taken his advice on this particular subject—the advice not of an expert, but simply that of a man who had always been taught to judge by results. Capt. James then referred to the difficulties he had experienced in the installation of his apparatus and of the work he was ultimately successful in performing with it, an account of which has already appeared in *The Electrician*. The longest distance which he had overcome was between Bundegi, at the entrance to Chemulpo Harbour, and Wei-hai-Wei, 240 sea miles. There was no mistake in the transmission of long messages over this distance at the rate of 20 to 25 words per minute. In another case he had been successful in sending messages when a range of hills 2,000ft. in height intervened between the two stations. The Japanese, he stated, did not expect to transmit more than 100 sea miles with the apparatus on their ships. The excellency of the system had been its own death knell in the Far East. He trusted and believed that in his hands the system was never put to wrong uses, but there was certainly an element of danger for belligerents that could not be overlooked. Therefore, the sooner wireless telegraphy was controlled by international law the better.

Prof. W. E. Ayrton, F.R.S., Mr. F. Z. Maguire and Mr. Samuel Barber also spoke.

BRIGHTON MUNICIPAL TELEPHONES.

The "approximate" accounts for the working of the Brighton municipal telephone exchange from April 1st to September 30, 1904, were presented at the last meeting of the Council. The number of instruments connected to the exchange is 1,448, in addition to 21 junction lines and 27 call offices.

EXPENDITURE.			
Operating	£226	8	0
Line repairs and maintenance	111	1	1
Instrument repairs and maintenance	90	5	11
Exchange repairs and maintenance	72	9	4
Wayleaves	60	0	0
Terminal fees	160	14	7
Post Office commission	2	0	0
Post Office royalty	267	4	0
Rents, rates and insurance	110	0	0
Management and office salaries	352	13	9
General expenses (stationery, &c.)	142	15	7
Commission on call office receipts	4	16	1
Possible bad debts	30	0	0
	£1,630	8	4
Balance to net revenue account	1,263	7	7
	£2,893	15	11
REVENUE.			
Exchange rentals	£2,583	6	2
Private rentals	125	3	10
Local tolls	45	19	6
Public telephones	32	2	3
Terminal fees	40	0	0
Post Office commission	32	4	2
Removals and sales	35	0	0
	£2,893	15	11
Net Revenue Account.			
Interest on debt	£515	0	0
Sinking fund	650	0	0
Balance being net profit for first six months ending September 30, 1904	98	7	7
	£1,263	7	7
Amount brought from revenue account	£1,263	7	7

LEGAL INTELLIGENCE.

Attorney-General (on relation of Willesden Council) and Willesden Council v. Metropolitan Electric Supply Co. (Ltd.)

Late yesterday (Thursday) afternoon the hearing of this case was commenced before Mr. Justice Farwell in the Chancery Division. Plaintiffs' claim was for a declaration that defendants were not entitled to supply to any person, company or corporation electrical energy for consumption or use within the urban district of Willesden otherwise than under the authority of Parliament or under a licence granted by the Board of Trade under the Electric Lighting Acts, 1882 and 1888. Plaintiffs also claimed a declaration that defendant company were not entitled to use any of their cables or wires or any mains or cables connected therewith for the transmission of electric current or electrical energy from their works at Willesden and Acton otherwise than to the several distributing stations of the company in their Paddington, Marylebone and Mid-London areas defined by the several provisional orders in the Metropolitan Electric Supply Co.'s Act, 1898, and the area in St. Martin-in-the-Fields and the neighbourhood defined by the Metropolitan Electric Lighting Order, 1889, or to use the said generating station otherwise than for the purpose of supplying areas or districts over which the company had on Aug. 12, 1898, powers of supply, or over which they might thereafter have such powers under any special act or provisional order. Plaintiffs also claimed an injunction.

Mr. Upjohn, K.C., and Mr. Grieg appeared for the plaintiffs, and Mr. Cripps, K.C., Mr. Jenkins, K.C., and Mr. Sergeant for defendants.

Mr. UPJOHN was opening the case when the Court rose, and the hearing was adjourned.

Pestall v. Potteries Electric Traction Co. (Ltd.).

At Stoke County Court recently, before His Honour Judge Mulholland, K.C., a motorman named John Pestall sought to obtain compensation under the Workmen's Compensation Act for injuries.

Applicant, who was employed as a car driver by the company, had, he alleged, lost the total use of his hands owing to exposure, vibration, the action of electric current and brass poisoning brought about by his handling of brakes, levers, &c., used in driving cars. It was stated that applicant was in a serious condition. He would never be able to work. Both his hands were contracted, and his muscles were in such a condition that he would never again be able to earn his living. It was urged that, in order to ascertain what constituted an accident, one must discriminate between what would occur and what might occur in the ordinary course of employment. Something which would occur could not be called an accident, but if a fortuitous and unexpected element came in there was an accident. Applicant's counsel (Mr Feltham) suggested that this definition might be good guidance in this case. The fortuitous and unexpected had occurred, for Pestall had suffered injury that would not occur in the ordinary course. There were, unfortunately, a lot of men suffering in the same way. The application of the brake caused a great amount of vibration on the right arm, and that was aggravated on cars where the brake skidded owing to the wheels having been worn flat in places. When the brake was applied the vibration must affect a man's hand. It was contended that if something happened which a man could not avoid and could not get out of the way of, then the unexpected and fortuitous did arise.

APPLICANT said he was in the employment of the company from March, 1900, to November last, when he was obliged to consult a docter. He was in the infirmary from Dec. 31 till April 1.

Dr. STORRAR gave evidence that applicant would never be able to work again. He said vibration might certainly have caused the applicant's injury, but he thought the most probable theory was that Pestall's muscular atrophy was caused by holding a cold metal lever in all weathers, and aggravated by vibration.

Applicant's counsel suggested that there might be a small leakage of electricity from the controller of the car, and with a driver holding a metal lever in his other hand a circuit would be formed and the driver affected by electricity. He asked the doctor whether electricity could not escape?

Dr. STORRAR: There was no doubt electric fluid could escape.

Mr. FELTHAM agreed, and said his suggestion might not be an impossible one. Knowledge of electricity was yet only in its infancy!

For the respondents it was urged that there had been no accident within the meaning of the act. Exposure to cold was the normal characteristic of applicant's employment. As to vibration, everyone who got on a car had some vibration to submit to. The driver had more, but that, again, was a normal characteristic without which at present the employment could not be carried on. The vibration was in no sense accidental, fortuitous, or unlooked for.

In giving judgment for respondents, his HONOUR said everyone must sympathise with Pestall, but it was his duty to consider the law. Applicant's injury certainly could not be caused by electric current or brass poisoning. It might be caused by exposure, cold and vibration, but where could an accident be said to come in? Vibration must exist in all locomotive driving. The application of a brake must first cause vibration, and then, by pressure on the wheels, stoppage. Deafness produced by machinery and lead-poisoning were comparative cases. It was impossible to say when the injury first began, and therefore when an accident occurred. Whether or not that which applicant suffered from came about in his employment with the company, he was satisfied that the injury came about slowly and gradually. It would be contrary to common-sense to call an accident that which took five years to happen, and only really happened after five years. He was compelled to find for respondents, but he recommended applicant to their merciful consideration.

Free Wiring Dispute.

In the City of London Court on Friday last, before Judge Rentoul, K.C., an action was brought by Mr. E. H. Hawkins as trustee under a deed of assignment for Cairns & Co., electric lamp manufacturers, against Mr. Reynolds to recover £3. 10s. 9d. for electric lamps supplied. Mr. Cairns said he sold the goods to defendant. Defendant said the lamps were supplied to him on a misrepresentation, and he wrote to Mr Cairns that they did not answer the description. He requested Mr. Cairns to take them away. The lamps which were now in use were supplied by the local electricity supply company, to whom defendant contended plaintiff must look for payment.

Mr. CAIRNS said the supply company would not pay him, and it was ridiculous to suggest that the lamps were not satisfactory as there were hundreds of thousands of them working satisfactorily all over the country.

DEFENDANT said the lamps he was being sued for were lamps supplied by the supply company, who agreed to provide him with current and lamps, the wiring having been done free.

Mr. CAIRNS said if defendant had his current cut off the lamps in dispute would belong to him and not to defendant or the supply company.

Judge RENTOUL said he could not decide which party was in the right, and adjourned the case for further evidence.

Eason v. Syndicate of Electrical Engineers (Ltd.)

Judgment was given in this action (which came before Mr. Justice Farwell on Tuesday) in favour of the defendants, with costs. It was an action for an injuction to restrain alleged interference with ancient lights at the back of the new Faraday House, Southampton-row, London, W.C., and we are pleased to note that the Electrical Standardising and Training Institution has been successful in resisting the plaintiff's claim.

Warren, Beattie & Co. v. Doughty & Son.

At Stockton County Court last week plaintiffs sought to recover £16. 11s. from defendants, balance of account for an electric motor. Plaintiffs contracted to supply a 10 H.P. motor, and defendants made part payment. The defence was that the machine would not do the work required. Plaintiffs said they supplied a 10 H.P. motor according to specification, but at the time they advised defendants to have a more powerful one. The machine was as good as ever, except that it had been overworked.

Judgment was given for plaintiffs for amount claimed, with costs.

The Aston Meter Trouble.

On Friday last a test case against one of the malcontent electricity consumers was opened at Aston Police Court, when Mr. W. Hunter was summoned by the Corporation for non-payment of £2. 10s. 10d. for electrical energy, and 11s. 1d. for rental of fittings.

DEFENDANT contended that the Corporation had not carried out their agreement, and professed willingness to pay on the meter reading and did not dispute rental item.

Mr. LEECH, assistant engineer to the Corporation, gave evidence that the number of units shown on defendant's account was correct.

On the first reading of the meter defendant said he asked the Corporation meter-reader what current he had consumed, and was told "32," but when he received his bill he found that the number of units charged was 128.

Mr. LEECH explained that the number of divisions on the meter had to be multiplied by four, in order to obtain the number of units. That was accounted for by the fact that the meters were delivered without clocks, which had to be made abroad. The delivery of the clocks was delayed, and without those clocks each division shown on the meter was equivalent to 4 units. An expert engaged by the consumers was satisfied that the figures on the meters had to be multiplied by four.

The CHAIRMAN (Mr. C. Wallis) said technically Mr. Hunter had cause for complaint, and the case was adjourned for a fortnight, the bench suggesting that the meter should be then brought into court.

Tramway Assessment.

At Preston Quarter Sessions on Friday last the Blackpool & Fleetwood Tramway Co. appealed against the assessment of the portion of their undertaking in Thornton district, which they claimed should be rated as a railway, at one quarter actual value of undertaking.

Mr. TAYLOR, K.C., for appellants, said tramways were rated because they did not own land. The line in Blackpool and Fleetwood was laid in streets and got the benefit of policing, lighting and drainage, and, therefore, ought to contribute the full rates. But outside Blackpool and Fleetwood the land, except where it crossed the public roads, was freehold and was fenced in.

For the Council, Mr. SUTTON said that the tramway in Council's district crossed numerous carriage-ways and had many stopping places. The Act of Parliament under which it was erected did not describe it as a railway, and the company were prohibited from carrying goods, excepting small parcels.

The Court dismissed the appeal, with costs.

C. Joyner & Co. v. Deakin, Sons & Co.

At Sheffield County Court last week, Messrs. C. Joyner & Co., Birmingham, sought to recover from defendants £33. 12s. 10d., value of pendants, chandeliers and other goods sold. There was a counterclaim for £19. 10s. on the ground that defendants had suffered damage from plaintiffs' negligence in stating that the contents of a certain case of goods for Brazil, invoiced to defendants by plaintiffs, were "rods" instead of "rods and pendants," in consequence of which fines were imposed by the Brazilian Customs officials on defendants' customer, who claimed and had received £19. 10s. in settlement of fines and other expenses incurred.

The case referred to two separate orders for goods, defendants in the first case claiming that the goods were not sent according to order, lengthening rods being included, which were not ordered. In the second case the question raised was that of making a wrong declaration. After hearing a mass of evidence, his Honour found for plaintiffs on both claims, with costs.

In re Ferranti Limited.

In the Chancery Division on Tuesday Mr. Justice Warrington sanctioned, with some modifications, a scheme under the Joint Stock Companies Arrangement Act, 1870.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Midland Electric Corpn. for Power Distribution (Ltd.), 73, Lichfield-street, Wolverhampton, require a number of smart men accustomed to canvass for power and light consumers. Applications to engineer and manager (Mr. J. Hardie McLean). See advertisement.

The Midland Electric Corpn. for Power Distribution (Ltd.), 73, Lichfield-street, Wolverhampton, also want two sub-station attendants. See advertisement.

The Association of Electric Power Companies requires the services of a gentleman to act as secretary. Applications to the secretary pro. tem. (Mr. T. Petersen), Hamilton House, Victoria Embankment, London, E.C., by Nov. 1. See advertisement.

There is a vacancy for an electrical assistant at the Galway Electric Co.'s works. Applications to Mr. J. Perry, M.Inst.C.E., county surveyor, Galway. See advertisement.

Wolverhampton Lighting committee require a canvassing engineer, competent to prepare specifications and estimates for light and motor power installations. Applications to town clerk (Mr. Horatio Brevitt) by noon Oct. 31.

A lecturer in electricity and physics is required in January at the Municipal Technical School, Birmingham. Commencing salary £140. Particulars from the secretary, Mr. Geo. Mellor. Applications by Nov. 19. See advertisement.

A third assistant is required in the mechanical and electrical engineering department of Woolwich Polytechnic. Salary £125. Applications by Nov. 1.

Blackburn General Purposes committee, having decided to separate the electricity and tramways departments, have made the following appointments:—Mr. P. P. Wheelwright, at present chief assistant engineer, to be borough electrical engineer; Mr. F. H. Corson, at present station superintendent, to be chief assistant; and Messrs. Leonard Johnston, assistant tramways engineer, and J. H. Cowell, traffic manager, to be joint managers of the tramways department.

Mr. J. Martin Blair, of Woolwich, has been appointed resident electrical engineer at Acton at £175 per annum.

Mr. J. W. Papworth, West Ham, has been appointed chief assistant engineer at Kilmarnock.

Mr. Bellamy, jun., has been appointed assistant tramways manager at Liverpool.

Mr. Fritz A. E. Nippel, of the Anglo-Argentine Tramways Co., Buenos Ayres, has been promoted to the position of general manager.

Prof. Harry E. Gifford has been appointed acting head of the department of electrical engineering at Massachusetts Institute of Technology, Boston, vice Dr. Louis Duncan.

Mr. J. H. Smith, D.Sc., Wh.Sc., of Sunderland Technical College, has been appointed head of the mechanical engineering department at the Municipal Technical Institute, Belfast.

EDUCATIONAL.

We have received a copy of the report of the Department of Technology of the City and Guilds of London Institute, Exhibition-road, London, S.W., for the session 1903-4, which gives details of the work done during the past year. The number of subjects of examination was 66 (against 65 in 1903), the number of centres 419 (against 396), classes 2,708 (against 2,789), students 41,080 (against 38,648), the candidates' papers 19,041 (against 16,973), and passes 11,293 (against 9,860). The increases in engineering subjects were large. In electric lighting and power transmission the students in attendance increased from 4,740 to 4,911, and the examinees from 1,446 to 1,686; in the practical test for wiremen's work the candidates fell from 330 to 288, but the percentage of passes was distinctly higher; in mechanical engineering the number of candidates increased from 1,008 to 1,129 and the passes from 619 to 743; in telegraphy and telephony the number of students rose from 1,106 to 1,245 and the examinees from 948 to 1,066, while the passes increased from 419 to 687. The increase in students is attributed mainly to the encouragement given by the secretary of the General Post Office to the attendance of employés of the telegraph department at the Institute's registered classes in telegraphy and telephony.

At a meeting on Saturday of teachers in London educational establishments, it was decided to form an association of science, technological and art teachers engaged in the London Polytechnics, Technical Institutes and Schools of Art. The association is to comprise both permanent staff and evening teachers, other than those engaged in purely secondary work. An organising committee was appointed.

In order to make further provision for acquiring scientific and secondary education by their servants, the North-Eastern Railway Co. recently erected a laboratory for practical instruction in physics and engineering subjects at the Railway Institute, York. The laboratory was opened by one of the directors, Sir Edward Grey, Bart., M.P., on 20th inst. The laboratory has been equipped with engineering and electrical apparatus by the locomotive and telegraph departments of the company.

Alleged Nuisance by Tramcars.—At Ealing on Monday a conference was held of local authorities through whose districts the London United Tramways run, in order to discuss, and, if possible, to decide on, a course of combined action to secure an abatement of an alleged nuisance caused by the noise of the tramcars.

The Mayor of Ealing (Ald. D. A. Griffin) presided, and delegates were present from Acton, Chiswick, Brentford, Hammersmith, Hanwell, Hillingdon, Twickenham, Southall, Uxbridge, Hampton and Hampton Wick. A committee was formed to consider and decide upon the next step to be taken.

Arbroath.—All outstanding differences between the Council and the Empire Electric Light & Power Co. were adjusted at the meeting of the Council on Friday, and the Company will at once proceed with the erection and equipment of electricity works.

Argentina.—The "Review of the River Plate" says electricity works, equipped by Buxton, Cassini & Co., have been opened at Gualeguay.

Mr. T. B. Holway is constructing an electric tramway between Plaza de Mayo, Villa Devoto, Urquiza and Ortuzar (Buenos Ayres), on behalf of a British syndicate, who offer to establish municipal electricity works, and to fix the charges for current so as to provide for the payment of 5½ per cent. interest and 1 per cent. redemption per annum on a capital of $18,000,000 gold.

With reference to the decision of the municipal public lighting department that the Compañia Alemana Transatlantica de Electricidad can supply current at 4¼c. gold per kilowatt-hour, and make 5 per cent. net profit on their capital, the "Review" points out that depreciation and other important items have not been taken into account by the department.

Mr. Santiago Keenan has applied for a 70 years' concession from the Rosario municipality for a network of electric tramways, comprising 50 miles of track.

R. von Wenksky & Co. have applied to Buenos Ayres municipality for a concession for tramways from Paseo Colon and 9 de Julio to Barracas, Constitucion, Retiro, Once de Septiembre and Villa Santa Rita.

The official "Bulletin" of Sept. 21 announces that the Institute Superior de Agronomia and Veterinaria has been authorised to purchase abroad, without formality of public tender, scientific instruments for use in the teaching of physics to the value of about £880 (10,000 pesos).

Ashton-under-Lyne.—In future power consumers are to have the option of taking electric current on the maximum demand system at 2d. and 1d., or at a flat rate of 1½d. per unit.

Australasia.—Adelaide City Council have approved the Government bill for the conversion of the suburban tramways to electric traction. Other councils disapprove.

The new three-phase plant at the Launceston (Tasmania) municipal generating station has been started.

The foundation stone of the power house of the Ballarat (Victoria) electric tramway scheme was laid last month.

Auckland (New Zealand) Council recently discussed the establishment of municipal electricity works at an estimated cost of from £50,000 to £55,000, and Mr. Henry, electrical engineer, is to report on the proposal.

Beaumaris.—The Council on Friday rescinded their former resolution to apply for a provisional electric lighting order. Negotiations have been entered into with the North Wales Electric Power & Traction Co. to supply electricity in bulk.

Bermondsey (London).—The Borough Council discussed the question of the extra expense incurred in laying cables under the Surrey and Lavender Docks.

The facts were given in our issue of 7th inst. The Electric Lighting committee thought the consulting engineers and the borough electrical engineer were both to blame for not having reported from time to time since March on the additional expense that was being incurred.

Councillor PEAKE said it seemed a scandal that such a large expenditure should have been incurred without the sanction of the Finance committee.

Councillor LAYMAN, chairman of the latter committee, said his committee had refused to sign the cheque, and until he knew they were responsible for it he should refuse to sign the order. He did not want to be surcharged the amount, and therefore at present he should not sign the cheque.

The discussion was adjourned.

Birmingham.—In the bill which is being promoted by the Corporation for the extension of their tramway system and for the reconstruction of existing tramways, the estimated cost is put at £1,018,815.

Bradford.—In the annual report of the electricity department, it is stated that

The past year was an active one, in consequence of the inauguration of new works, modifications to existing works and serious breaks down which occurred to the plant. The planning of the lighting effects and the installation of power at the Exhibition had also been carried out by the staff of the department. The liability for the breaks down of the engines remained to be determined. Another matter which claimed the attention of the committee was the unsatisfactory nature of the main switchboards at the Valley-road station, which were reported inadequate for their work and dangerous by the city electrical engineer early in 1900. The breaks down of the engines referred to reduced the capacity of the works by two-thirds. Early in Sept. the foundations beneath engine No. 5, having a capacity of 150kw., gave way, with the result that the cast-iron engine bed-plate was cracked, and the plant had to be dismantled and the foundations renewed, when the defects were found to be due to the bad material used for laying the bricks and lack of grouting. The plant was now at work again. On Sept. 21 the crankshaft of a 375kw. generator (No. 7) broke, with the result that all the connecting-rods were bent, considerable portions of the valve gear smashed, and the flywheel and bed-plate cracked, the engine moving over bodily upon its foundations before it could be stopped. The foundations were cracked at the level of the anchor-plates of the foundation bolts, and the foundation had to be reconstructed, and was found faulty in a similar manner to that of No. 5. Parts for the replacement of those broken were coming from the makers of the engine, and the plant would soon be at work again. Other mishaps of a comparatively minor nature had occurred, but ignoring these, plant of 2,585kw. had been disabled at one time out of plant of 7,300kw capacity, and the completion of the fourth 1,000kw. generator had been considerably delayed. It had, in consequence, been necessary upon several occasions to run every available engine overloaded to maintain the supply. The report contains particulars of large works executed during the 12 months to June 30, 1904, the outlay on mains extensions (exclusive of subway) during that period being £33,591. The charge for electricity for lighting was 4d. per unit (2½ per cent. discount for prompt payment), and a free supply of incandescent lamps in proportion to number of units consumed for incandescent lighting. The total number of consumers had increased from 1,740 to 1,923, or 10½ per cent. The total units for the half-year ended June 30, 1899, was 1,019,846, and for the half-year ended June 30, 1904, 6,942,019. The total for 1899 was 2,416,130, and for last year 11,806,529. For traction last year 7,075,300 units were supplied, compared with 618,282 units in 1899. The demand for electricity for motive-power had advanced steadily from 463,630 units in 1899 to 2,540,767 in 1903. For private lighting the advance had not been so substantial, though it had been steady, at about 200,000 units increase per year, the totals for the two ends of the quinquennial period being 1,275,214 and 2,183,545 units respectively. The use of electricity for public lighting had varied considerably, the totals for 1899 being 59,004 units, and 56,917 in 1903. The total number of 8 c.p. incandescent lamps connected is 64,021.

Bury.—The Tramway committee have decided to seek Parliamentary powers to extend the tramways to Ramsbottom and Stubbins, the work to be completed within three years.

Cab-Rank Telephones.—The success of the experiment carried out by the National Telephone Co. in connecting up a number of private residences with the cab rank at Portland-road, London, is likely to be considerably extended, both the National Company and the Post Office having this matter under consideration.

Crompton.—The Board of Trade have extended the period of the Crompton Electric Lighting Order, 1901, to Oct. 14, 1905.

Croydon.—The Corporation have decided to apply for powers for a further extension of the tramway system from the borough boundary to near the High Level entrance to the Crystal Palace, Sydenham, at an estimated cost of £180,000. The extensions would be 9 miles in length.

Extensions of the electric lighting mains, estimated to cost £940 have been authorised.

Dover.—At this week's Council meeting a petition was received for the extension of the electric tramways to the River district and the employment of local workmen upon the necessary road levelling and improvement work. It was agreed to apply for consent of the Board of Trade.

Dublin.—The inquiry before Mr. Cowan into the application of the Corporation for sanction to borrow £21,000 for their electric lighting scheme was concluded on Thursday last.

Mr. HAMMOND, in continuing his evidence, stated that the single-phase system was the most suitable for the old area.

Mr. COWAN: Is it not a fact that single-phase motors have been greatly improved since 1899?—Certainly. They are now as good as three-phase motors, in my opinion.

Mr. COWAN: Will you give me some reasons, Mr. Hammond, for your statement that this is a magnificent property?—Yes. Belfast, which is worked by the Corporation, expended to the end of March, 1904, £330,000. The plant installed was 3,000kw., and the maximum load last Christmas 2,190kw. The average return from private supply is 2·83d. per unit, and after paying interest and sinking fund they had a profit of £6,094. Cork is worked by a company with a capital of £130,715. The installation is of 1,350kw. capacity, and the maximum load 906kw. The price to private consumers on an average is 2·52d. per unit. I do not know what the profit is, because it is a private company and the figures are not available. At Dublin the capital was £330,000 and the capacity 3,300kw. Each kilowatt cost £111 in Dublin, £97 in Cork and £72. 13s. 4d. in Belfast. The mains in Dublin cost £50, against £30 in Belfast. That disparity was caused by having the station at the Pigeon House and by the fact that there was a superior quality of plant and mains in Dublin. In his opinion, Dublin would in about 10 years be producing electricity more cheaply than Belfast. He had said that the operation of the new undertaking had convinced him of the soundness of his estimate in his original report of the possibility of generating and delivering electricity in the city at 1½d. per unit. The figure appeared in the papers as 3d. He meant the bare cost of generation and distribution, without sinking fund or without any profit to the ratepayers. He anticipated that by an expenditure of an extra £40,000 they would get 88,000 more units, and if the selling price was 4½d. per unit there would be a gross profit of £31,803. If the average price were 4d. the profit would be £29,803, and if the price were as low as 3½d. there would still be a profit of £24,803. He had based that calculation on the assumption that there would be a two-thirds greater demand for private lighting than there was at present.

Other witnesses having given evidence, the inquiry ended.

Dunfermline.—Mr. W. B. Sayers, of Glasgow, has been engaged to prepare a report on electric lighting for the Council.

Eccles.—The borough electrical engineer (Mr. H. W. Angus) recommends the Corporation to adopt a scheme for the purchase and letting on hire of electric motors.

Electric Furnace.—During the past fortnight Messrs. Marryat & Place have been demonstrating with an electric furnace at Shoreditch Electrical Exhibition, and the interest taken by the visitors in the experiments was so pronounced that railings had to be erected and the police requisitioned to keep order. The experiments consisted of fusing quartz and refractory metals, such as iridium and chromium, the chief public interest being shown, however, in the pots of boiling steel or molten fire-brick.

Electric Lighting Notices.—Official notice has been given by Ravensthorpe and Bishops Stortford Urban District Councils of intention to apply for provisional electric lighting orders.

Electric Railway Working.—What is probably a record in electric railway operation recently took place on that portion of the N.E. Railway near Newcastle, which has been electrically equipped by the British Thomson-Houston Co. Owing to the festivities occasioned by the visit of the Channel Squadron to Newcastle, the passenger traffic on the electrified line was enormously increased, necessitating on the first day the continuous running of 86 out of the possible 89 available cars, and on the following day the full complement of cars (89) between 5 p.m. and 11 p.m. Although the equipment was subjected to exceedingly heavy and unusual demands, not a single breakdown or interruption to the service was experienced. The successful operation of this line, one of the first and largest surface electric railways in the United Kingdom, and its ability to successfully meet such a sudden and heavy demand augurs well for the future of heavy electric traction.

Electricity in Mining.—Electric winding and pumping plant has been put in at the Raub Mine, Pahang.

At the meeting of the El Oro Mining & Railway Co. on Tuesday, it was stated that the substitution of electric driving for steam power had become necessary, and the directors had had in contemplation the acquisition of water rights within reach of the mines which would enable them to generate their own power. During the past two years, however, an influential Canadian group had undertaken the introduction of electric power into the city of Mexico, and had made a proposal to supply power to the company at El Oro at a price which, although perhaps a little higher than they could have generated it, was on the whole satisfactory, and would relieve them from a large capital expenditure. A contract had been entered into with the company (the Mexican Light & Power Co., Ltd.), and they hoped to be in a position to supply power in April next. The change would involve the purchase of electric motors, and these changes would necessitate an expenditure of from £20,000 to £25,000 during the ensuing 12 months. The expenditure, however, would enable them to make a very substantial reduction in the total cost of their operations

Gillingham.—Sanction has been received to a loan of £19,754 for electricity supply extensions.

Glasgow.—It has been decided to give a supply of electricity to Rutherglen on the same terms as those within the city.

Glasgow and Paisley Tramways Dispute.—Lord Balfour of Burleigh has been appointed by the Board of Trade arbitrator in connection with this dispute. His lordship visited Paisley on Saturday and made an inspection of the tramway route within the burgh boundary.

Harrismith (S. Africa).—About a year ago Messrs. Mordey & Dawbarn, consulting engineers to Harrismith Corporation, issued their specification for the generating plant and station equipment of the new electricity works which it was then intended to erect. Messrs. Mather & Platt secured the contract for the plant, which comprised an overhead travelling crane, two Morrin-Climax water-tube boilers, with fuel heaters and pumps and two steel chimneys, two 80kw. single-phase alternators, with a frequency of 50 cycles per second and a full load pressure of 2,100 volts, with direct coupled exciters and driven directly by two Howden enclosed compound engines, one 25kw. set of similar design, two complete condensing plants with motor-driven centrifugal pumps, switchboard and all cable connections and pipe work. Time was the essence of the contract, and Messrs Mather & Platt undertook to have the whole of the plant erected and at work within three months of the first consignment reaching Harrismith. This undertaking has now been successfully carried out The first goods reached the works at Harrismith on June 14, and on Sept. 12 all three sets of alternators were running on the town supply mains.

Ipswich.—The Corporation have approved a seven years' agreement for the supply of electric motors on the hire-purchase system by the General Electric Co. The agreement precludes the Corporation from giving any other contractor permission to supply motors in the town during the continuance of the agreement, but not from themselves undertaking the supply.

Iron and Steel Institute.—Mr. R. A. Hadfield, chairman and managing director of Hadfield's Steel Foundry Co., Sheffield, has been appointed president of the Iron and Steel Institute for the ensuing year.

Ledbury.—The Council last week decided to apply for a provisional electric lighting order.

Leicester.—The Humberstone-road and East Park-road sections of the tramway system will be opened for traffic on Tuesday.

Leith.—The tramways were taken over by the Council on Saturday last.

Liverpool.—An inquiry was held here last week into the application of the Corporation for permission to borrow £400,000 for extensions of their electricity undertaking.

The assistant town clerk (Mr. R. D. Cripps) said the last sanction was obtained in 1901, and was for £300,000. When the Corporation purchased the undertaking in 1896, the output was only 1,850,000 units; in 1901, the date of the last sanction, it was 20,000,000 units; and to-day it had increased to over 26,000,000 units The additional capital expenditure was needed to increase the generating plant, to extend the mains, &c. The undertaking was in a prosperous condition. For 1903, after paying £43,500 interest, placing £33,200 to reserve and £10,000 to renewal fund, a contribution of over £10,000 was made in relief of rates.

At the Corporation meeting on Wednesday the Tramways committee were authorised to apply for a provisional order to construct additional tramway routes.

Local Authorities and the Supply of Electricity Bill, 1904.—The action taken by the conference of local representatives and companies owning electricity undertakings, in endeavouring to obtain the amendment of the Supply of Electricity Bill, 1904, cost £380 odd, and this is to be met by equal contributions, the share of each authority or company amounting to £7. 12s. 4d.

London County Council.—At Tuesday's meeting it was reported that the Finance committee had considered an application for a loan of £163,879 to repay outstanding balances on loans, borrowed temporarily from its bankers. Of this £102,689 was in respect of electric lighting. The committee recommended that £101,108 be loaned on the annuity method, repayable in 89 years, and £1,581 (for electricity meters) repayable in seven years.—Agreed to.

Government Telephone Wires.—The Local Government committee recommended that the Postmaster-General be approached with a view to contribution in lieu of rates being made in respect of all Post Office telephone wires. The committee pointed out that at present the wires of the National Telephone Co. and of municipalities owning telephone lines are assessed, the undertaking of the National Telephone Co. in London being assessed at £30,000.

Tramways.—It was agreed to issue tokens for use on the L.C.C. tramways by members of the tramways staff, by employers of labour for distribution to their employés, and by the general public.

The Highways Committee recommended that sums on capital account not exceeding £22,500 be expended in respect of the construction for electric traction of the northern tramways along Rosebery-avenue. The Finance Committee, in reporting on the matter, remark that the Council's power for the construction of this tramway will expire in Aug., 1905, and it is, consequently, very desirable that the work should be undertaken without delay. We should have preferred that the construction of this line should not be proceeded with until some definite decision had been come to as to the system of electrical traction to be adopted in the reconstruction of the northern system, but, under the circumstances, we offer no objection to the proposal. We presume, however, that in constructing this comparatively short length of line on the conduit system, the Council will not be considered as committing itself to this system of traction, which is so much more expensive than the overhead system, for the whole of the lines which will be connected with this particular line. The line, although it will be constructed for electrical traction, will, in the first instance, have to be worked by horse traction.

The matter stands over for a week.

Manchester.—The Tramways committee on Tuesday accepted tenders for material for 100 tramcar roof covers. It was also decided to invite tenders for three electric overhead cranes for Hyde-road car shed.

Mansfield.—A report has been prepared by the consulting engineers (Messrs. R. Hammond & Son) recommending the Council to provide water-softening plant at the electricity works. It has been decided to erect 10 further arc lamps, and the charge for arc lighting has been reduced to £20 per lamp per annum.

Marylebone (London).—At last night's meeting of the Council the completion of the loan granted by the London County Council to the Marylebone Borough Council of £1,415,000 was announced. The total applications for London County bills issued by the County Council to cover this loan was £3,624,000, ranging from £96. 17s. 6d. per cent. to £96. 13s. 6d., and the average price obtained for the entire issue was £96. 14s. 10d. The rate of interest which Marylebone will pay upon this loan is rather over 3½ per cent.

Forty-one applications were received by Marylebone (London) Council for the post of mains superintendent. The list has been weeded down to four, who will be interviewed at the next meeting of the Electric Supply committee.

Motor Vehicles on Hungarian Railways.—Messrs. Ganz & Co., of Budapest, have received an order to supply to the Ministry of Trade 120 motor vehicles, at a cost of £164,540, these vehicles to be employed in addition to the regular scheduled train service whenever local traffic requires. The total number of cars ordered by the Hungarian Ministry of Trade for this purpose has been fixed at 300.

Municipal Telephony.—At *Brighton* Council meeting last week the Telephone committee's report on the first year's working of the Corporation telephone service was presented.

The report showed that the number of instruments working was 1,488 and 21 junction lines. The 27 public call offices now open were, it was stated, paying satisfactorily. The service given throughout the area was very satisfactory, and the manager rarely had any complaints from subscribers. Sub-exchanges were working at Burgess Hill (where there were 57 stations), Portslade (which had only been opened six months, 33 stations), and Shoreham (which had just been opened). Exchanges at Steyning and Hurstpierpoint were in course of construction, and would be opened in a few weeks. After charging all working expenses, interest and sinking fund on loan (£42,000) already taken up, the approximate profit for the half-year ended Sept. 30 was £98. 7s. 7d. The annual revenue of the department at present time was £6,411. 7s. 8d., the amount having increased during the past six months at the rate of £411 per month.

Ald. Carden, chairman of the Telephone committee, said customers were still coming forward at a satisfactory rate. The money which had been spent up to end of September was £33,000, and after the first six months' working they had a small balance on the right side. There would be no call on the rates this year in connection with the undertaking, and if they could get another 500 subscribers by next April their accounts would show a profit of £1,000 a year.

Councillor Penfold inquired whether there was any truth in the rumour that the National Telephone Co. had made an offer to purchase the Corporation system.

Ald. Carden said that there was not the slightest truth in the rumour.

On Tuesday *Portsmouth* Corporation agreed, on the recommendation of the Telephone committee, to apply for sanction to borrow £1,200 to complete extensions of the service to Southsea.

The committee also recommended that application be made for sanction to borrow £20,000 to cover future extensions of the telephone system, the estimate being for 1,000 lines at £20 per line.

The Chairman (Councillor W. T. Dittman) explained that they wanted the money to spend as they required it, but the Council would have absolutely full control of the various sums which the committee would want to spend from time to time. Between Aug. 1 and Oct. 20, they had received 130 orders, an average of 11 per week, and that was without undue pushing or advertising. Many users were extending their lines. It was expected that the £20,000 would be exhausted in two years. The present proposal to obtain a large sum instead of a series of small sums was really at the suggestion of the Local Government Board.

The recommendation was passed.

At the *Glasgow* Corporation meeting last week Mr. Russell moved "That in consequence of the divided opinion of members of the Corporation as regards the present and future value of the telephone undertaking, it be remitted to the Telephone committee to call in an expert to report as to the present state and value of the plant, and probable depreciation that will require to be given effect to, in order to avoid loss when the undertaking will be sold to the Government, at a fair value, 10 years hence."

Mr. Russell pointed out that for the year ended May, 1902, the sinking fund was only at the rate of 1 per cent., in the next year the rate was 2½ per cent., and last year it was 2½ per cent. on capital expenditure. The result was that the telephone department had spent £320,782. 12s., and that had been watered to the extent of £17,001. 14s. 11d. for preliminary and general expenses. For the three years the sinking fund amounted to £16,110, and in addition they had created a general reserve of £5,743. 7s. 5d. Taking the amount written off and the general reserve fund together, they got £21,853. 7s. 5d. Deducting from that £17,001. 14s. 11d. of preliminary and general expenses, there remained only £4,851. 12s. 6d. He contended that the £17,000 was originally created in order that it might be written off revenue during the first two or three years' existence of the undertaking, and that was not done, because they could not show up the accounts in a proper way without making a loss. He did not think anybody would say that depreciation should be less than 7½ per cent. The only part of the plant to which a small depreciation of 5 per cent. could be applied was the underground cables, amounting to £168,000. Of the remainder, £47,428 was represented by overhead construction. With regard to the instrument account he had thought that that represented the value of instruments. But on inquiry he found that it included the cost of fitting up, and the greatest portion of the account was made up of wages and stores.

Mr. W. F. Anderson moved the previous question, and urged that the telephone question had been disposed of for the time being.

After discussion the motion was rejected by 30 votes to 4.

Natal.—In the particulars just issued of the import trade of Natal for 1903 electrical fittings stand for a total of £58,300, of which £47,300 came from the United Kingdom, £6,000 from America and £5,000 from Germany. Electrical machinery stands for £134,800, of which £95,800 was from the United Kingdom, £24,000 from America and £15,000 from Germany.

Newcastle-on-Tyne.—The Tramways committee on Wednesday recommended the Corporation to accept the resignation of the general manager (Mr. A. E. Le Rossignol) and that he be permitted to leave immediately, but that his salary be paid to Dec. 9.

In a communication dated 26th inst., Mr. Le Rossignol stated that as he understood the Corporation would consider on Wednesday the question of his resignation of the position of general manager and engineer of the tramways, he felt in justice to himself he must give a short résumé of the work accomplished during the time he had been in the Corporation's service, and the reasons that led him to resign. Five years ago he was appointed resident engineer for the construction of the tramways to plans and specifications of the consulting engineer and of the city engineer, and on the completion of the first portion in 1901 he was appointed general manager and engineer and instructed to organise the necessary staff and service on the different routes. Mr. Rossignol then passed in review the progress of the works during 1902. During 1903 (he continued), he had the heavy work of designing and constructing all the extensions to the power station, pumping station, car works, car sheds and lines authorised by the 1902 Act, thereby saving the Corporation £4,000, which the city would otherwise have had to pay in fees. For that service the Corporation unanimously granted him an increase of £100 a year in salary, and he very naturally regarded that increase as evidence of the confidence the members had in him and also as a tangible proof of the satisfaction which his work had given. During the latter part of 1903, the application of the Tyneside Tramways and Tramroads Co. for running powers put an end to the amicable relations that up to then had prevailed in the Tramways committee, but he would like the Corporation to remember that he was in no way responsible for the unpleasantness that arose therefrom. In 1904 close attention to the Tyneside bill and to the Corporation bill of 1904 had absorbed the major portion of his time, as he was the principal witness for the Corporation and their adviser on all questions arising. Fully weighing the above, he could not think he had received that consideration which for his assiduity to his varied labours he had a right to expect. Since the commencement of 1904, every meeting of the Tramways committee had been rendered unbearable by the action of practically one member, who had hampered all his actions and taken every opportunity of making his position almost unsupportable. He felt that that was not as it should be, but forebore to take any steps, thinking that after the Tyneside difficulty was settled matters would right themselves. That, however, was not the case, and when he received the offer of a good position in the colonies, he telegraphed to the committee asking them if they could not stop that continual unpleasantness. The time available between the receipt of the offer and the meeting of the Tramways committee was too short to enable him to write a letter, but he asked the committee in his telegram to consider his resignation if they could not guarantee him treatment which he thought every public official ought to receive. The committee could not see their way to do that, and accepted his resignation. Since the inauguration of the electric cars in Newcastle, the service given to the city had been admittedly second to none in the kingdom for all-round efficiency, punctuality and cleanliness, whilst the whole of the plant and lines had been maintained in the best possible condition. Now that he was leaving the service of the Council after five years of exceptional difficulty, continual anxiety and ceaseless hard work, he would like the Council and those members from he had received every act of courtesy and consideration to understand his feeling of sincere regret that he was forced to adopt the course of resigning his position, and he could only trust that his successor would have meted out to him a greater measure of fair play than had been dealt to him.

Ald. Newton said he had been a member of the committee since its formation, and he had exercised the right of criticising the management, and had had to take exception to the actions of Mr. Le Rossignol. The Council and the ratepayers were indebted to the individual who had caused Mr. Le Rossignal to sever his connection with the tramways department. The tramway service was not the gold mine which municipalisers alleged it would be, but, with judicious management, the result would have been different from what it was to-day. If the costly service and profligate expenditure had been continued for another six months the management of the tramways would have been in involved in hopeless insolvency, and then the dream of the anti-municipalisers would have been realised. The management of the Newcastle tramways was the most costly in the kingdom. Motor cars had been bought without authority; cars were built, although they had an ample supply of cars, simply in order to give men who were in their employment permanent work. At the Heaton station they found a number of walking gentlemen, whose only business was to draw their salaries. There had been gross mismanagement permeating the tramway service right through. In their tramways they had a magnificent money-making concern; and the economies, he anticipated, would result in the saving of from £16,000 to £20,000 a year.

Mr. Adams thought that they could not altogether blame Mr. Le Rossignol. After all, Mr. Le Rossignol was the servant of the Tramways committee, and it was the business of the committee to make themselves conversant with what was going on. He thought it would be admitted also that the committee were never kept posted as to what was going on. He contended it was the business of Mr. Cail to know what was going on, and if he did not know, he ought to have known. He thought fairness should be shown to Mr. Le Rossignol. He believed he did his best, but he believed if he had been guided and counselled as he ought to have been, much of the present trouble would not have occurred.

Mr. Cail said that if he made a statement at present it would be at a great disadvantage. He did not know what the savings were which the committee said they had made, and he would like to know what they were. If instead of spending money in one year they spread it over five years, that was not saving.

Mr. Cutter suggested that there should be an inquiry by the Board of Trade or some other investigation.

Mr. Heald agreed that the committee was to blame. The committee had not been practical and now sought to put the blame upon Mr. Le Rossignol.

The Council then accepted Mr. Le Rossignol's resignation and agreed to the proposal as to his salary.

Parcels by Tramcar.—The Burton-on-Trent Corporation tramways department will inaugurate a parcels delivery system on Tuesday, and parcels will be received on any car from 8 a.m. to 9 p.m. on weekdays, but no parcels will be carried on Sundays or Bank Holidays. The charge for each parcel will be 1½d., and parcels will be delivered in any district within half a mile of the tramway track. Parcels receiving offices have been established in the town.

Power Transmission in Works and Factories.—The Unbreakable Pulley & Mill Gearing Co., of West Gorton, Manchester, have prepared for publication some notes of various methods of power transmissions in works and factories, written by Mr. W. E. Buck, the company's engineer. These notes are published in pamphlet form, and Mr. Buck, in the course of his remarks, deals with a large variety of methods of transmitting power, and with the factors which enter into power transmission schemes of the class with which he deals. These factors are as set out below:—

(A) Distance of motive power from machines, or of machines from one another.
(B) Arrangement or grouping of machines.
(C) Requirement for sectional or overtime working.
(D) Proportion of machines standing idle or working intermittently.
(E) Requirement for adding machines or extensions.
(F) Amount of power required for individual machines.
(G) Reliability or need for duplicate or standby plant.
(H) Initial and working cost of transmission plant.
(K) Cost of driving transmission plant.
(L) Convenience and cleanliness.

Under these headings Mr. Buck discusses the views expressed in a large number of Papers read before engineering societies and articles contributed to the technical press. In this way much information is compressed into small space, making the pamphlet of particular service to busy engineers interested in this important question.

Presentation.—On Wednesday last week Mr. W. B. Esson, M.Inst.C.E., M.I.E.E., was presented by the staff, foremen and workmen of Johnson & Phillips' electric light and power works with a handsome roll-top writing desk and revolving chair as mementoes of the 10 years Mr. Esson had been associated with them while acting as chief engineer and manager to the firm. The presentation took place at the Charlton Works, Mr. E. A. Brandon, who had been Mr. Esson's chief assistant, acting as spokesman.

Provisional Order Revocation.—The Board of Trade have revoked the Winsford Electric Lighting Order, 1899.

Pudsey.—The Council are applying for a tramway provisional order.

Railway Station Lighting.—The North Staffordshire Railway Co. have put down plant for lighting their Uttoxeter station. Current is supplied by a 20kw. continuous current dynamo coupled direct to a Bumsted and Chandler engine. There are 18 arcs and over 40 incandescents at the passenger station. The goods station and yard are also to be lighted electrically. The installation was carried out under the supervision of the company's electrical engineer, Mr. A. F. Rock.

St. Louis Exhibition Awards.—Messrs. Trollope & Sons and Colls & Sons (Ltd.) have been awarded two grand prizes and three gold medals in connection with their exhibits, including electric light fittings, displayed by them at St. Louis Exhibition. Messrs. John Davis & Son have obtained a gold and a bronze medal for surveying and mining instruments.

Shoreditch Electrical Exhibition.—In connection with the recent very successful electrical exhibition held at the Pitfield-street Baths, Hoxton, under the auspices of Shoreditch (London) Borough Council, a dinner and concert were given at the Great Eastern Hotel on Monday last, under the presidency of the mayor. Both items on the programme proved successful, and during the proceedings it was stated that the exhibition had been satisfactory from the technical, educational and financial aspects. There had been a large attendance, and the interest evinced in the numerous exhibits had proved gratifying to all concerned.

Southampton.—On the recommendation of their consulting electrical engineer (Mr. J. G. W. Aldridge) the Harbour Board have decided to increase the voltage at which electricity is supplied to the pier from 100 to 200 volts.

Southend.—The borough surveyor (Mr. E. J. Elford) has submitted to the Health committee plans of the proposed refuse destructor, which is estimated to cost about £10,000. It is calculated that steam power could be supplied to the electricity department sufficient to generate 400,000 units of electrical energy per annum, which at ½d. per unit would produce £833. 6s., making the total estimated income from the destructor £1,095. 16s. The committee's report on the scheme has been adopted, and it has been decided to advertise for tenders.

Southport.—An unopposed inquiry was held here last week into the application of the Corporation for sanction to borrow £20,000 for electricity extensions. The present borrowing powers (£183,000) have already been expended with the exception of £2,037, reserved for tramway purposes. The borough electrical engineer (Mr. R. S. Downe) estimated that the loan would cover the expenditure for about three years. The electricity undertaking was in a flourishing condition, and for the past seven years had shown a profit of about £2,000 per annum.

Spain.—A Royal Order has been issued authorising the purchase, without formalities of public tender, of certain electric power and lighting plant for use at the Royal Arsenal and Dockyard, Ferrol.

Switzerland.—A concession has been granted to a syndicate (MM. Froté, Westermann et Cie., of Zurich, and three others) for the construction and working of an electric funicular railway from Neuchâtel to Chaumont. The capital to be raised for this venture has been fixed at fr.500,000.

Temporary Electric Lighting Installations.—In a report presented by the Dundee city electrical engineer (Mr. H. Richardson) to the Tramways committee on Monday,

Mr Richardson states that he felt it his duty to report the great danger to large halls during times of bazaars and special shows by having many extra lights added in a flimsy manner to their permanent installations in defiance of all rules of safe and careful workmanship. Should a fire occur, due to a stall catching fire through so much temporary flexible wiring being about, the results would undoubtedly be very serious under such crowded conditions. He had protested time after time with but little result, and the matter would probably go on until some very serious calamity occurred, when, as usual, the danger would probably be put down as having been caused by electricity. In his opinion all halls used for public entertainments, bazaars, &c., should have special arrangements made by which extra lights should be taken from plug circuits with special fireproof leads.

The committee resolved that the proprietors of halls and other buildings coming within the purview of the report should be at once communicated with, further action being, meanwhile, delayed.

Wandsworth (London).—At the Council meeting on Wednesday, the General Purposes committee reported that, having considered the scheme prepared by Mr. W. P. Adams for utilising the Tooting dust destructor for the generation of electricity, they recommended that the County of London Electric Supply Co. be informed that the Council contemplate applying for a provisional order for the supply of electricity in the borough, but before taking that step would be glad to learn

(a) Whether the company would be prepared to hand over to the Council the Streatham area of their undertaking upon terms;

(b) Whether the company would be prepared to purchase in bulk the electricity generated at the Tooting dust destructor.

Ald. Anderson said that, besides the two alternatives mentioned, there was a third. The L.C.C. wanted additional power for their tramways, and might be willing to buy it from the Council. He thought there might be some difficulty in getting a provisional order, and so the committee had considered it best to approach the company first. He did not think the company had the necessary powers to destroy the dust under their memorandum and articles of association.

The report and recommendations were then approved.

Will.—The will of the late Mr. George Benham Stacey, 77, Pulteney-street, Bath, who died on 5th inst., has been proved. The total value of the estate is £14,125. 11s. 4d., the net personalty at £14,075. 1s. 4d. Probate has been granted to Mr. George Lyell Stacey, electrician, Bath, a son of the deceased, power being reserved for making a like grant to his son, Mr. Charles Darwin Stacey, the second executor.

Wolverhampton.—The electric lighting mains are to be extended to the works of Bayliss, Jones & Bayliss at an estimated cost of £645.

The Heath Town-Wednesfield tramway route was opened for traffic last week.

Workhouse Lighting.—Ormskirk Guardians have applied for sanction to a loan of £5,000 for electricity generating plant and other works.

TRADE NOTES AND NOTICES.

◆

TENDERS INVITED.

Hammersmith (London) Guardians invite tenders for a complete wiring installation for electric lighting at their new workhouse and infirmary, Wormwood Scrubbs, and also for supply, delivery and erection of two motor transformers and a battery, with all accessories. Specifications, &c., from the consulting engineers (Messrs. J. & J. S. Enright), 68, Lincoln's Inn Fields, London, W.C. Tenders to the clerk (Mr. J. Lamb), 206, Goldhawk-road, Shepherds Bush, London, W., by noon Nov. 15. See also advertisement.

Johannesburg Municipal Council invite tenders for transformer pillars and switch gear, to the specification of their consulting engineers, Messrs. Mordey & Dawbarn, 82, Victoria-street, London, S.W. Copies of specification may be seen (after Nov. 5) at the Council Offices, Johannesburg, and at the consulting engineers' offices in London. Tenders to Messrs. Mordey & Dawbarn by noon Dec. 27. See also advertisement.

Johannesburg Municipal Council also invite tenders for two 35-ton electric overhead travelling cranes to the specification of Messrs. Mordey & Dawbarn. The specification may be seen (after Nov. 5) at the Council Offices, Johannesburg, and at the consulting engineers' offices, 82, Victoria street, London, S.W. Tenders to Messrs. Mordey & Dawbarn by Dec. 27. See also advertisement.

The Visitors committee of *Cumberland and Westmorland Lunatic Asylum*, Garlands, Carlisle, invite tenders for two Lancashire boilers, feed pumps, steam exhaust and water pipes and valves; two 50kw. and one 30kw. steam dynamos, and a 5-ton travelling crane; economiser; underground bitumenised cables and boxes; wiring of buildings, switchboards, motors, fans, &c. Tenders to Mr. C. W. Allan Hodgson, The Courts, Carlisle, by Nov. 1.

Whitby District Council invite tenders for the supply and erection of one 200kw. direct-current dynamo, coupled to a high-speed engine (reciprocating or turbine type); and one water-tube boiler, fitted with chain grate mechanical stoker. Tenders to the electrical engineer (Mr. L. H. King) by 5 p.m. Nov. 21.

Swansea Corporation invite tenders for the removal, alteration and re-erection at a new station of one 450 I.H.P. modern type triple expansion engine and of a 225kw. continuous-current dynamo; also the supply and erection of an 8-ton travelling crane. Tenders to the town clerk (Mr. John Thomas), by noon Nov. 12.

Manchester Electricity committee require tenders by 10 a.m. Nov. 11 for the wiring of Stuart-street station for arc and incandescent lighting.

Preston Tramways committee invite tenders for motors and tramway boosters. Tenders to engineer and manager by Nov. 9.

Wolstanton and Burslem Guardians invite tenders by noon Nov. 15 for electric lighting plant, &c.

Edinburgh District Lunacy Board want tenders by noon Nov. 12 for the erection of an electric power station and workshops.

Leith Corporation require tenders by noon Nov. 2 for stone, cement, &c., and for cartage in connection with tramway reconstruction.

Musselburgh Corporation require tenders by Nov. 5 for wiring and fitting the town hall and offices for the electric light.

Tenders are wanted by Nov. 14 for wiring a temporary building at the District Asylum, *Ballinasloe*, Ireland.

Tenders for plant will shortly be invited by the New Coronel Suarez Electric Light & Waterworks Co.

It is announced that tenders are invited for a concession to provide the town of Giurgevo, *Roumania*, with electricity supply. Tenders will be opened on Jan. 28 at the Municipal Offices, Giurgevo, where additional information can be obtained.

Tenders are invited for the construction, working and maintenance of three separate routes of electric tramways in *Liege*, Belgium. These tenders will be adjudicated on Nov. 14, and have to be sent in by Nov. 12 to the Gouvernement Provinciale, Liege.

TENDERS RECEIVED AND ACCEPTED.

Isaac Storey & Sons (Ltd.), Empress Foundry, Manchester, have received orders from the Admiralty (through Mather & Platt) for three sets of condensing plant for the power station at Priddy's Hard, Royal Clarence Victualling Yard, Portsmouth, and (through the Lancashire Dynamo & Motor Co.) for three sets of condensing plant for Sheerness Dockyard. The firm have also secured an order for a set of condensing plant for the Spanish Marine Department for Ferrol Arsenal.

Bruce Peebles & Co. have obtained the following contracts :—

Generators, motors, motor-generators and balancers for railway shops of Oude & Rohilkund Railway, India, at £4,990.

500 B.H.P. lighting and traction direct coupled set for Geelong (Victoria) tramways.

40 motors, averaging 10 H.P. each for locomotive shops of Natal and Durban Railways.

Hackney (London) Council have accepted the tender of Fabius Henrion for arc lamp carbons as follows :—50,000 pairs at £3. 4s. 2d. per 1,000 pairs, and 10,000 pairs at £2. 1s. 5½d. per 1,000 pairs. There were 12 tenders, ranging from those accepted to (for class 1) £5. 3s. 6d. and (class 2) £3. 9s.

J. A. Newton & Co., the Melbourne representatives of Thomas Parker (Ltd.), have recently supplied an electric lighting and power plant (comprising a Parker dynamo driven by a water wheel, electric motors, pump, &c.) to the Hunt's Extended Gaffney's Creek (Victoria) Gold Mine.

West Ham Corporation have accepted the tender of P. & W. McLellan for the whole of the tie bars, fish bolts and bonds required for the new electric tramways. An estimate of £20. 15s. of Buck & Hickman to provide guards for machine tools in the car-shed workshops was also accepted.

East Ham Council have accepted the tender of Dick, Kerr & Co. for 50 tons of tramrails at £6. 10s. ; that of William Griffiths & Co for granite setts at 30s. per ton ; and that of Messrs. Weston & Sons for wiring the new library at £99. 8s. 4d.

Davey, Paxman & Co. have received an order from the Admiralty for the supply and erection of four high-speed engines of an aggregate of 1,800 H.P. for the electricity generating station at Sheerness Dockyard.

We are informed by the Burnand Transformer Co. that they have lately completed a contract for the Municipal Council of Shanghai (under instructions from Messrs. Preece & Cardew) for four 30kw. and four 20kw. transformers.

Brighton Corporation have accepted the tender of G. Virgo for wiring for electric lighting, fire alarms and telephones in the diphtheria pavilion of the borough sanatorium at £152.

Devonport Corporation have placed an order with Willans & Robinson for a steam engine at £3,445.

Maidstone Council have accepted the tender of Morris, Jones & Co. for wiring the sanatorium at £54. 17s.

Hackney (London) Council have placed an order with Phillips & Co. for a commutator grinder and accessories at £42. 10s.

Erith Council have accepted the tender of Gunning & Sons for the erection of car sheds, &c., at £7,215.

Watford District Council have accepted the tender of W. T. Glover & Co. for 12 months' supply of cables.

BUSINESS NOTICES, &c.

Mr. Percy N. Hooper, who will resign his present position of chief engineer and manager of the Poplar Borough Council electricity works at the end of the present month, is about to become a director of the firm of Alexander Duckham & Co. (Ltd.), chemical and oil manufacturers, Phœnix Wharf, West Ferry-road, Millwall, London, E., who intend to make a speciality of lubricating and insulating oils, and will make a scientific study of oils used for these purposes.

Veritys Limited have opened a sale depot at Carlton House, 28, High-street, Birmingham (Telephone No. 4,721), which will be under the charge of Mr. N. Edwards. Stocks of all materials, &c., likely to be required by trade customers are to be kept at this depot, to which communications from customers in the Midlands should be addressed, and not to the firm's works at Aston.

Messrs. J. E. Wedekind & T. Miller (trading as Charles Peacock & Co.), electricians, &c., 43, Clerkenwell-road, London, E.C., have dissolved partnership. Debts by Mr. Miller, who continues as T. Miller & Co., at 66, Victoria-street, London, S.W.

The telephone number of Mr. H. W. Ravenshaw, A.M.Inst.C.E., Rutland House, Hanwell, London, W., is 125 Chiswick.

LIQUIDATIONS, &c.

Claims against C. A. Smith (trading as C. J. Smith), electrician, 23, King-street, Regent street, W., and 6, Granard-road, Wandsworth Common, S.W., London, must be in by Nov. 7, to Mr. R. J. Ward, 2, Clement's Inn, London, W.C.

Walker and Hodgetts (Ltd.) is to be wound up voluntarily. Mr. E. A. Radford, 86, King-street, Manchester, is liquidator. Claims by Nov. 30.

A meeting will be held on Nov. 28, at Hamilton House, Victoria Embankment, London, E.C., to receive an account of the winding-up of the Metropolitan District Electric Traction Co. (Ltd.).

The Edison Gower-Bell Telephone Co. of Europe (Ltd.) is to be wound up voluntarily.

Appointment of Receiver.—We are informed that Mr. Alfred Hardy, managing director of the Sir Hiram Maxim Electrical & Engineering Co. (Ltd), has been appointed receiver of the company on behalf of the debenture holders.

Business for Sale.—Tenders are invited for the goodwill of the business of mechanical and electrical engineers carried on by W. & E. Sumner & Clementson (Ltd.), the leases of 140, 142 and 144, Dale-street, Liverpool, fixtures, fittings, furniture and stock-in-trade, comprising electrical fittings, wires, globes, brackets and the machinery and plant. Further particulars are given in an advertisement. Tenders to Mr. J. West, 10, Cook-street, Liverpool, by Nov. 7, on forms obtainable from Mr. West, or from Mr. J. H. Glover, 60, Castle-street, Liverpool.

Plant for Sale.—A six-pole compound-wound dynamo of 150kw. (230 v., 612 amp., 145 revs.) for direct-coupling to engine is advertised for sale, owing to alteration of original scheme of driving. Applications to Messrs. Andrew Handyside & Co., Britannia Iron Works, Derby, or to Messrs. Greenwood & Batley, Leeds. See also advertisement.

A 12½ B.H.P. Hornsby Akroyd oil engine and a 61kw. Crompton dynamo are for sale owing to supply being taken from local company. Applications to "Engineer," Dean Wood, Newbury. See advertisement.

Premises, &c., to Let and for Sale.—A well-lighted factory is advertised in another column to be let. Applications to 499, Hornsey-road, Holloway.

Spacious, modern and well-equipped factory premises, known as the Volenite Works, High-street, Alperton, are to be sold by Messrs. David Burnett & Co., at the Mart, London, E.C., on Nov. 22, in one lot. Particulars of Messrs Linklater, Addison, Brown & Jones, solicitors, 2, Bond-court, London, E.C., or of the auctioneers, 15, Nicholas lane, E.C. An advertisement contains further particulars.

There are three fine shops, with basements, to let in the Strand, London, on a 21 years' lease. Particulars from the secretary's office, Room 41, West Block, Hotel Cecil, Strand, London, W.C. See advertisement.

Three rooms are to be let, separately or as a whole, in a third floor flat in 64, Victoria-street, Westminster, S.W. See advertisement.

Forthcoming Books.—Mr. H. J. Glaisher is about to publish "X-Rays: Their Treatment in Cancer and Other Diseases," by Dr. R. J. Cowen.

Catalogues, &c.—We referred last week to several sheet lists issued by the India Rubber, Gutta Percha & Telegraph Works Co., amongst these to No. 8, dealing with patent connectors for electrical testing. We illustrate in Fig. 1 one of these patent connectors for conductors ¼in. diameter and under. A similar connector is made for conductors of ⅛in. diameter and under. The connector is adjustable within wide limits, and can either connect two large conductors or a large one and a small one, or two or more small wires may be secured in the same slide hole without the risk of one being loose. The slide contacts encircle the wires and give a broad and tight grip, ensuring perfect contact. With a large conductor in each slide contact other small wires to the testing apparatus may be hooked on to one or other of the slide spindles between the nut and its washer. These nuts are practically two single terminals, and may be employed for connecting very small wires, which might be damaged if clamped by the slides. Fig. 2 is a patent terminal connector for electrical testing for electric light and power conductors of 1in. diameter and under, and Fig. 3 is a patent terminal for electrical instruments, made to order only. The slide principle, as above described for Fig. 1 applies also to Figs. 2 and 3.

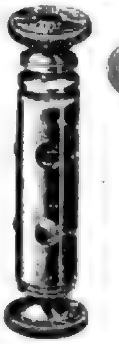


FIG. 1.

Connector for Electrical Testing.

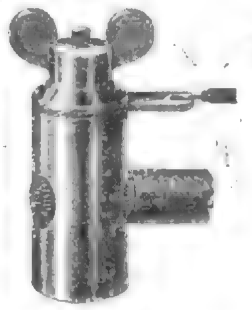


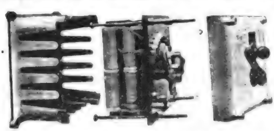
FIG. 2.

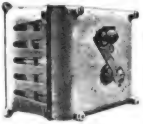
Terminal Connector for Electric Light and Power Conductors.

FIG. 3.

Terminal for Electrical Instruments.

A new list of direct-current motor starters is issued by Messrs. Johnson & Phillips, Old Charlton, Kent, and shows standard sizes from ¼ B.H.P. to 50 B.H.P. All sizes are made in two standard classes, open and protected. We illustrate the "Protected" class. For voltages above 300 the protected class is recommended. The operating lever is removable, and can, if desired, be retained in the possession of an authorised person, thus guarding against improper use. For mine work a "specially protected" class is supplied, with air-tight cover and resistance box. These starters, although fitted with the usual no-voltage and over-load coils, have a special mechanism, whereby the starter cannot be operated against an overload. The starters are adaptable for use not only with shunt and compound-wound motors, but with series motors. Provision is made, with regard to the switch parts, for making the shunt in advance of the armature circuit and breaking the shunt circuit through a non inductive resistance. For the smaller sizes of starter a porcelain type of resistance unit is used, and for the larger sizes an ironclad type clamped together by cast-iron caps is employed. In these there is an entire absence of solder joints, which ensures an absolutely indestructible resistance. This resistance is easily removable for inspection, as shown in the illustration, by the removal of the four nuts. The protected class of starter is composed entirely of non-inflammable material and so is fireproof. The list also contains hints which will be of value to those who have the working of motors under their charge.


"Protected" class of J.P. Motor Starter. Detached for Inspection.


Starter Clo ed.

A new list (No. 7), describing Ferranti Class B current transformers for ammeters, power-factor indicators, relays and indicating wattmeters, is issued by Ferranti Limited, Hollinwood, Lancs. These transformers are made for voltages ranging from 100 to 5,000.

Single-phase alternating-current patent Schuler motors, type DsG, for heavy starting torque, are described in list No. 27, just issued by the Lahmeyer Electrical Co., 109-111, New Oxford-street, London, W.C. It is claimed for these motors that they are specially suitable for lift and crane work on single-phase circuits.

The British Westinghouse Co. have ready circular B 1,071, treating fully Westinghouse type S.B. direct-current motors. A number of these machines and their parts are illustrated, and views are shown where the motors are applied to driving different classes of machinery.

The British Uralite Co., 50, Cannon street, London, E.C., have prepared a catalogue showing the various uses to which "Uralite" can be applied in electrical operations. The illustrations show the application of "Uralite" to a variety of these purposes.

Sections A, B and C (List No. 1), dealing with dynamos and motors for continuous current, have been issued by the Electrical Co., 121-125, Charing Cross-road, London, W.C. These lists contain numerous illustrations and notes on the machines, together with dimensions, outputs, current consumption and other essential particulars.

A new and improved Blake's insulated staple for use in electric wiring work for low voltages (such as telephone, telegraph, annunciator and bell work), has been introduced by Mosses & Mitchell, of Chiswell-street, London, E.C. The staples are made with a standard square shoulder, and the arch of the staple is protected by insulated vulcanised fibre, preventing the cover on the wire coming in contact with the metal of the staple.

We have received from Messrs. David Moseley & Sons, the old-established indiarubber manufacturers, of Ardwick, Manchester, a sample of their special make of electricians' glove, which is now coming into general use. We are informed that these gloves have been tested to over 5,000 volts in the Municipal School of Technology at Manchester. Owing to their special process of manufacture these gloves never harden, and are guaranteed to stand any climate. They are made of absolutely pure Para rubber, and are of extreme softness and flexibility. The glove is thoroughly well made, and the fact that Messrs. Moseley & Sons have been engaged for many years in the manufacture of a large variety of rubber goods used in the electrical industry enables them to offer an article which may be relied upon to be thoroughly satisfactory in use.

"**Light and Power.**"—Under this title Messrs. Drake & Gorham, 66, Victoria-street, Westminster, London, S.W., have prepared a treatise on the application of electric current to every phase of country house and estate requirements. While the compilers of this instructive pamphlet have not entered fully into details, as, in the nature of things, the design and arrangement of each installation has to be studied individually, the main considerations which are likely to apply in most cases where such installations are to be carried out are given. Messrs. Drake & Gorham point out that the qualifications necessary in an engineer competent to lay down a complete country house installation are numerous and are seldom found combined in one man, and, on this account alone, the experience of a firm which has for many years made this class of installations a special study should prove of the utmost service in cases where plant and apparatus is to be laid down for the many classes of work which can now be performed by the aid of the electric current. In the numerous illustrations which accompany the text of this handsome book examples are shown of work carried out by the firm, and these illustrations in themselves convey an excellent idea of the miscellaneous character of the orders executed. A fine selection of interior views is given of some of the principal country houses where artistic electric illumination has been provided to meet many exacting requirements. A summary of the works carried out by Messrs. Drake & Gorham includes electric driving for farm machinery, in the dairy, for pumping, for refrigeration and ice-making, for lifts, radiators and cooking apparatus, fans, bells and telephones, electric baths, &c., &c. Some particulars of cost which are supplied will make the book of additional service. Copies can be obtained, price 1s. 6d.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Oct. 19 to 25, with the ports of destination:—

Africa—Alexandria, £162; Cape Town, £2,049; **Durban, £2,154 (including £730 telegraph material)**; **East London, £172**; **Port Elizabeth, £39.** *Argentina*—Buenos Ayres, £577 (including **£267 telegraph material**); Rosario, £44. ***Australasia***—Adelaide, £568; Fremantle, £70; Otago, £132; Perth, £77; **Sydney**, £1,437; Wellington, £30. *Belgium*—Ghent, £20. *Brazil*—Rio Grande, £210 (telegraph material); Santos, £668. *British Guiana*—Demerara, £29. *Canary Islands*, £6. *Ceylon*—Colombo, £76. *China*—Shanghai, £40. *Denmark*—Copenhagen, £9 (telegraph wire). *France*—Paris, £48. *Germany*—Bremen, £25 (telegraph material). *Gibraltar*, £38. *Holland*—Amsterdam, £47. *Hong Kong*, £15 (telegraph material). ***India***—Bombay, £917; Calcutta, £1,707 (including £130 telegraph material); Karachi, £29. *Japan*—Nagasaki, £265. *Malta*, £102 (including £67 telegraph instruments). *Peru*—Callao, £108 (telegraph material). *Portugal*—Lisbon, £31. *Straits Settlements*—Singapore, £1,088 (including £152 telegraph material). *West Indies*—St. Lucia, £14; Trinidad, £100. **Total, £13,103, against £35,353 in the corresponding week last year (Oct. 22 to 28).**

PATENT RECORD.

The following List of Application for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN ELLIS & PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

September 16, 1904.

20,007 A. Romain and J. d'Ayguesvives. Liverpool. Supports for incandescent lamps.*
20,009 A. Muirhead. Telegraphy.
20,010 C. C. Regnart and The Hunter Electric Candle Lamp Co. Holder for electric lamps.
20,019 W. J. Davy. Arc lamps.

September 17, 1904.

20,029 B. H. Thwaite. Electric propulsion of navigable vessels.
20,070 J. Bohy. Magnetised board for teaching purposes.*
20,039 H. F. Ashe. Incandescent lamps.
20,105 E. H. Pinching and W. H. Walton. Electrical signalling apparatus for fire calls and the like.*

September 19, 1904.

20,129 M. H. Smith. Mechanism for utilising "Hertzian" waves.
20,134 J. Klinkenberg. Glasgow. Controlling apparatus for electric motors.*

September 20, 1904.

20,200 E. Cross. York. Apparatus for controlling and operating points of electric railways and tramways.
20,219 G. Hookham. Birmingham. Electricity meters.
20,224 A. R. Price. Birmingham. Sparking plugs for explosion motors.
20,233 G. H. Ide. Birmingham. Electric bracket of tube only.
20,277 C. D. Abel (Siemens & Halske A.G., Germany). Manufacture of incandescent bodies for glow lamps.*
20,278 C. E. Hunter and W. H. Warren. Switch.*
20,285 F. Martin. Fireproofing electric cables.
20,287 W. J. Davy. Shade holders of electric lamps.

September 21, 1904.

20,314 W. Dixon. Glasgow. Electric capstans.
20,324 F. W. Hayward and R. C. Fox. Norwich. Safety device for electric railways.
20,329 J. Young. Telephones.
20,351 A. P. Jones ("Long Arm" System Co., U.S.). Electrically operating bulkhead doors, hatches or the like.*
20,363 E. Goolding. Insulators.
20,380 E. A. Carolan (G.E. Co. U.S.). Arc lamps.
20,381 E. A. Carolan (G.E. Co., U.S.). Rectifying alternating current.

September 22, 1904.

20,413 J. Heap, J. Bailey, H. Heap, A. Richardson, R. Billington, J. Haydock, T. S. Jones and T. Brierley. Halifax. Hangers and ears for electric conductors.
20,473 E. A. Carolan (G.E. Co., U.S.). Electric transforming devices.
20,478 R. W. James (A. C. Crehore, U.S.). Telegraph systems.*

September 23, 1904.

20,510 A. E. Hacking and J. Pycroft. Birmingham. Electrical-pressure ironing machine.
20,523 W. H. Allen and L. T. Allen. Manchester. Ears for trolley wires.
20,528 W. A. Snape and L. Calvert. Electrolytic meter.
20,531 A. J. Boult (Elektricitäts-Ges. Zschockelt m.b.H., Germany.). Protectors for collectors, collector rings, &c., in electric machines.*
20,535 H. B. White and J. Pitkin. Electrical measuring and indicating instruments.
20,536 W. J. Smyth. Bath for therapeutic treatment by electric and other forms of radiant energy.
20,548 B.T.-H. Co. (G.E. Co., U.S.). Automatic controllers, especially applicable for use in electric metering systems.
20,549 E. A. Carolan (G.E. Co., U.S.). Dynamo-electric machines.
20,550 E. A. Carolan (G.E. Co., U.S.). Control of electric motors.
20,552 B.T.-H. Co. (G.E. Co., U.S.). Dynamo-electric machines.
20,553 E. A. Carolan (G.E. Co., U.S.). Vapour electric apparatus.
20,554 G. C. Fricker. Apparatus for indicating or automatically controlling or varying the flow of current.
20,562 P. C. de Azevedo. Light-regulating switches for incandescent lamps.

September 24, 1904.

20,568 J. D. Macmillan. Ireland. Electro-pneumatic telegraph.
20,573 W. H. Eccles. Starting devices for three-phase motors, &c.
20,585 A. A. Brooks and G. A. Watson. Liverpool. Overhead conductor system for electric traction.
20,609 B.T.-H. Co. (G.E. Co., U.S.). Electricity meters and measuring instruments.
20,627 A. F. Bosquet. Electrolytic manufacture of water-jackets casings and the like. (Date applied for, Feb. 10, 1904, date of application in France.)*
20,630 F. de Mare. Exhauster for the electrification of air or other gases. (Date applied for Sept. 21, 1903, date of application in Belgium.)*

September 26, 1904.

20,655 R. W. Scott. Darlington. Invention for deadening live rail and indicating when said rail is alive.
20,656 P. Auchinachie. Continuous electric furnace for reducing metallic oxides or other compounds.
20,657 J. W. Bennett. Ignition for motor car and other engines.
20,667 J. A. Romer. Inter-communication switchboard.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

13,025 Berman. Machines for coding and decoding messages.
13,487 Evans-Jackson (American Electric Telephone Co.). Selective electrical signalling apparatus.
14,309 Dutertre and Nodet. Electric roasting oven.
17,832 Bullough. Devices for operating tongues of points and frogs for electric tramways and railways.
19,449 Thury. Reducing or preventing sparking at the collectors of dynamos, motors and the like. (Date applied for, Oct. 16, 1902.
19,832 Baly. Electric fuses and the like.
20,072 De Bois. Coin mechanism applicable to electricity meters.
21,240 Smith. Starting switch and automatic cut-out for series-wound electric motors.
21,294 Eric Arthur Fagerlund and A. E. Messer. Dynamo-electric machines and motors.
21,551 Quarry and Kirwan. Switches for electric light and power.
21,909 Lane and Adams. Arc lamps.
23,333 Moss. Magnetic separators for ores or like materials.
24,356 Wade. Contact breakers, commutators, &c., for use on internal combustion engines.
24,630 Shaw. Current-collecting devices for electric railway vehicles.
25,153 Crie. Arc lamps.
25,284 Ruthven-Murray. Support for cables.
26,772 Cardone. Arc lighting.
24,800 B.T.-H. Co. (G.E. Co., U.S.). Electric braking systems.

COMPANIES' MEETINGS AND REPORTS.

Monte Video Telephone Co. (Ltd.)

The annual general meeting was held on Wednesday, Mr. F. Williams Jones in the chair.

The SECRETARY (Mr. E. M. Reiss) having read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: We have double reason for congratulation today. First, that the disastrous civil war which has been waging during the past year in Uruguay has terminated, and second that, despite the revolution, continued improvement in our business in Monte Video has been shown. The accounts require little comment. They show a strengthened position, better, in fact, than at any time before, and an increased net profit of £1,300. The reserve fund shows an increase of £5,000, now to be further increased by a like amount. On the credit side sundry debtors show an increase of £1,182, mainly uncollected camp line revenue, but considered good and collectible. Bills receivable and cash show an improvement of £3,789. The items in the profit and loss accounts differ but little from those of a year ago, except in regard to increased revenue and profit. In the appropriation of profit it will be seen that we are able to put aside the special reserve of £2,000 without encroaching upon the dividends or reducing the amount put to general reserve, which is the same as last year (£5,000), and to carry forward £1,783, a slightly increased amount. I must take this opportunity of saying that there was never more manifest than at present the advisability of continued preparation for a large expense in improvement in plant. I have recently returned from the United States, where the use of the telephone is greater than in any other part of the world. The perfection to which the telephone service has arrived in that country, and the number of subscribers and of communications, are worthy of note. They leave every other country far behind in comparison, and foreshadow what may be expected elsewhere. It is to the absence of legislative and municipal restrictions and interferences, and to the use of the most up-to-date and perfect plant, apparatus, &c., that the unparalleled success which the telephone in the United States met is mainly due, and we must prepare to act upon similar lines in order to ensure our future prosperity. Underground plant, metallic circuits, improved switchboards must come, and the large expenditure connected therewith must be looked forward to and prepared for. I now move the adoption of the report and accounts.

Mr. J. G. Le MARCHANT seconded.

In answer to questions, the CHAIRMAN said he would shortly leave for the River Plate. For some time they had had before the Government at Monte Video a project for laying underground plant. Recently arrangements had been made for electrifying the tramways in Monte Video, and the directors were hopeful of being able to arrive at some arrangement with the municipality for putting their plant underground. In that case the company would require new capital. He presumed the issue would be by way of debentures.

The motion was then carried unanimously, as were resolutions approving the dividends, re-electing the retiring director (Mr. Lock), and re-appointing the auditors. A vote of thanks to the manager in Monte Video and his staff and to the chairman and directors was carried unanimously and the proceedings terminated.

BATH ELECTRIC TRAMWAYS (LTD.)—At the meeting on Tuesday the chairman (Sir V. Caillard) moved the adoption of the directors' report, which stated that a small part of the company's system was opened on Jan. 2 with a few tramcars. Both the mileage and equipment had been increased from time to time during the year, until on Aug. 1 the final section was opened for traffic, and 40 tramcars were in use. The traffic receipts from commencement of operations to Sept. 28 (39 weeks, less two days) amounted to £25,365. Up to 12th inst 5,340,000 passengers had been carried.

BRITISH COLUMBIA ELECTRIC RAILWAY COMPANY.—The report for year ended June 30 states that the business has continued to grow largely in all departments. The gross receipts show an increase over the preceding year of $138,445, and the net earnings an increase of $60,649. The net profit, after making the usual deductions, was £49,015. A dividend on the deferred ordinary stock of 3 per cent. (making 6 per cent. for the year) was declared. The number of 8 c.p. lights in use at June 30 was 112,911, an increase of 19,812 on the year. The number of passengers carried was 8,869,486, an increase of 1,305,197. A number of additional contracts for sale of power were made during the year. Since Dec. 19, 1903, the city of Vancouver street lighting has been carried out by means of power delivered from Trout Lake power station, and a contract entered into to supply the city of New Westminster with current for street lighting for a term of years. The negotiations for the purchase of the Vancouver Gas Co. have been successfully carried through, and the price of electricity has been lowered since the purchase.

DRAKE AND GORHAM (LTD.)—The third annual report of the directors (for the year to June 30 last) states that, after payment of all charges, including bonuses due to staff, there is a net profit of £8,648. 19s. 9d., which, with £2,573 4s. 7d. brought forward, makes £11,222 4s. 4d. A dividend of 6 per cent. will require £7,500, £2,000 is placed to reserve and £1,722. 4s. 4d. carried forward. The reserve now amounted to £9,000. A contract has been obtained for a central generating station at Church Stretton, for the supply of about 3,000 lights, the plant and buildings of which have been designed by the company's staff and will shortly be available for use. A smaller station for the public lighting of Uphall and Broxburn is also being erected by the Scotch branch. A large private installation at Brancepeth Castle, for Viscount Boyne (1,150 lights), has beene ompleted by the Manchester branch during the year with very satisfactory results, and the company have in hand the lighting of Gordon Castle and Goodwood for the Duke of Richmond and Gordon and other important contracts.

ELECTROLYTIC ALKALI CO. (LTD.)—The chairman (Mr. C. C. Connor) presiding at the meeting last week, attributed the smallness of the profit on the past year's working to the general dulness of trade and the very low price of bleach during the year. They had had 12 solid months of the lowest prices for bleaching powder known for a great many years, but, so far from the result being an unsatisfactory one from a working point of view, he thought they had done very well, having allowed for depreciation, and even showed a small profit. The productive power of the plant had been increased, with the beneficial result that they had been able to produce bleaching powder at less cost than a year ago. Mr. W. B. Longsdon moved that the meeting be adjourned, that a committee be formed to inquire into the position of the company, and that new directors and auditors be appointed. The chairman said the board would certainly not object to the amendment, though they had the voting power to do so if they desired; but were willing to have investigation, as they were convinced it would show that there was no foundation for any allegations of mismanagement. He warned the meeting that when the investigation was closed he would exercise all his power as one of the largest shareholders to prevent publication of any details that would injure the company. The amendment was then agreed to as far as the report to a committee was concerned, and the meeting stands adjourned to Nov. 24.

WESTERN TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended June 30 states that the revenue amounted to £241,981. 7s. 1d., and working expenses to £99,547. 12s. 8d. After providing £13,868. 7s. 2d. for interest and sinking fund and £5,893. 6s. for income tax, there remains £122,672. 1s. 8d., added to £4,939. 14s. 5d. brought forward, making £127,611. 15s. 8d. The revenue includes £17,114. 11s. 5d. dividends upon the company's investments in other telegraph companies and £7,322. 1s. 1d. interest on reserve fund investments. A quarterly interim dividend, absorbing £31,189. 10s., has been paid, £22,000 transferred to general reserve and £18,000 to maintenance ships' reserve. Thedirectors now recommend a final dividend of 3s. per share, making 6 per cent. for the year, and the payment of a bonus of 2s. per share, both tax free, which together amount to £51,982. 10s., leaving £4,439. 15s. 8d. to be carried forward.

The register of transfers will be closed from Oct. 25 to Nov. 2 inclusive.

CITY NOTES.

MEMORANDA (Oct. 27).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26 13/16d. per oz. Consols 87⅝–87¾ for money, 87⅞–87⅞ for account; 2½ per cent. annuities 87–87½. Consols Pay Day, Nov. 4; Stocks and Shares Continuation Days, Nov. 9 and 28; Ticket Days, Nov. 10 and 29; Pay Day, Nov. 11; Mining Share Carry-over Days, Nov. 8 and 25.

BURY, ROCHDALE & OLDHAM TRAMWAYS CO.—This company is to be wound up voluntarily in consequence of the acquisition of the undertaking by the local authorities.

BRUNNER, MOND & CO. (LTD.). An interim dividend of 30 per cent. (the same as last year) for the half-year ended Sept. 30 is recommended.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.) There has been issued to this company's stock and shareholders this week £150,000 4½ per cent. second debenture stock at par, the balance of £400,000 of this stock, which ranks immediately after the issued £100,000 debenture stock and is redeemable at 105 per cent. in the event of the voluntary liquidation of the company or at any time after May 1, 1923, by six months' notice.

Letters of allotment and regret in respect of the above issue have been posted.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—Notice is given that the directors have conditionally allotted to the shareholders, in proportion to their holdings, 30,000 £1 shares at the rate of one new share for every seven shares held at Oct. 24, 1904, at £1 per share. Holders of less than seven shares will not be entitled to participate in this pro rata allotment, and shareholders holding upwards of seven shares will only be entitled to one new share for each complete seven shares held. This notice does not apply to shares converted subsequent to Oct. 24, 1904. The shares now offered are payable as follows: 10s. per share on acceptance of allotment not later than Nov. 9, 1904, and the balance of 10s. per share on or before Nov. 30, 1904.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The quantity of electricity sold during the quarter ended Michaelmas is returned at 1,238,880 units, estimated to produce £19,873, against 1,277,469 units, which produced £20,652 for the corresponding period of last year.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have appointed Nov. 10 a special settling day in a further issue of £100,000 4½ per cent. first mortgage debenture stock of *Callender's Cable & Construction Co. (Ltd.)*, and have ordered the same to be quoted in the official list.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Oct. 21	1,109	+ 58	21	32,967	+ 5,684
Airdrie	" 14	103	...	[illegible]	7,249	...
Ayr Corporation	" 22	215	+ 11	28	9,048	+ 477
Barnsley	" 14	188	+ 6	41	7,004	− 488
Barrow	" 14	178	...	86	7,168	...
Bath Electric Trams, Ltd.	" 19	635	...	62	57,810	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	" 23	1,002	+ 78	...	...	...
Birmingham Corporation	" 22	315	...	41	12,908	...
Birmingham Tramways Co.	" 22	5,615	+ 463	16	87,879	+ 8,968
Blackburn Corporation	" 21	860	+ 45	20	29,561	+ 2,911
Blackpool Corporation	" 10	501	+ 91	29	40,262	+ 5,020
Blackpool and Fleetwood	" 12	278	+ 22	16	19,201	+ 225
Blackp'l, St. Anne's & Lytham	" 10	256	− 2	51	20,269	+ 7,134
Bolton Corporation	" 28	1,815	+ 109	20	16,067	+ 475
Bournemouth Corporation	" 19	945	+ 74	‡39	24,783	+ 1,925
Bradford Corporation	" 22	4,414	+ 700	19	180,278	+ 24,476
Brighton Corporation	" 23	961	+ 90	29	32,466	+ 3,265
Brisbane Tramways	Aug. 31	2,788	+ 40	10	34,161	+ 22
	Sept. 7	2,858	− 121			
Bristol Trams & Carriage	Oct. 21	4,887	− 22	11	117,209	+ 652
Buenos Ayres & Belgrano	Sept. 18	3,582	+ 345	23	74,647	+ 3,108
	Oct. 25	3,429	+ 459			
Burnley Corporation	" 22	1,116	+ 104	4	4,813	+ 991
Burton Corporation	" 28	394	− 42	*29	10,846	+ 1,714
Calcutta Tramways Co.	" 19	a61,457	+ a2,318	17	a600,485	+ a77,169
Camborne-Redruth	" 14	111	+ 2	26	2,967	− 112
Cardiff Corporation	" 22	1,161	+ 86	19	62,004	+ 1,764
Carlisle Tramways Co.	" 13	174	− 12	44	8,463	+ 247
Central London Railway	" 22	6,450	− 35	16	97,250	− 248
Chatham & Dist. Lt. Rys.	" 20	546	+ 37	42	25,109	+ 2,146
City & South London Rly.	" 23	2,446	− 140	17	41,552	− 1,477
Colchester Corporation	" 20	278	...	12	3,852	...
Cork Electric Trams Co.	" 20	477	− 28	42	19,983	− 2,208
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	" 14	631	+ 45	41	22,243	+ 3,319
Dover Corporation	" 12	197	+ 13	30	7,285	− 200
Dublin & Lucan Railway	" 21	109	− 7	16	2,254	− 27
Dublin Southern District	" 21	857	+ 65	16	86,651	− 3,310
Dublin United	" 21	5,823	+ 47			
Dudley-Stourbridge	" 14	850	+ 21	41	36,200	+ 1,421
Dundee Corporation	" 19	848	− 25	...	...	...
East Ham Council	" 22	654	− 16	29	22,263	+ 1,493
Gateshead & Dist. Trams	" 14	501	− 14	41	27,450	+ 1,751
Glasgow Corporation	" 22	14,923	+ 1,424	†21	301,897	+ 17,047
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	" 14	591	− 13	41	10,495	+ 578
Gt. Northern & City Rly.	" 22	1,218	...	86	85,848	...
Greenock & Port Glasgow	" 14	168	+ 9	41	24,049	+ 1,275
Halifax Corporation	" 19	2,696	+ 110	19	45,641	+ 3,516
Hartlepool Tramways	" 14	346	+ 13	41	12,358	+ 1,012
Huddersfield	" 22	1,968	+ 58	29	41,457	+ 2,746
Hull Corporation	" 22	2,167	+ 224	29	61,865	+ 6,478
Ilford District Council	" 22	396	+ 21	*29	14,467	+ 630
Ilkeston Corporation	" 19	136	+ 19	8	899	− 58
Ipswich Corporation	" 22	415	...	29	15,242	...
Isle of Thanet Co.	" 22	377	+ 19	3	14,561	− 118
Kidderminster & District	" 14	108	− 2	41	5,478	+ 20
Kirkcaldy Corporation	" 19	208	− 40	42	9,701	...
Lanarkshire Trams Co.	" 20	670	− 72	42	27,830	—
Leeds Corporation	" 22	5,460	+ 120	29	178,496	+ 10,698
Leicester Corporation	...	...	...	...	...	...
Liverpool Corporation	" 15	10,588	+ 291	42	486,780	+ 17,640
Liverpool Overhead Rly.	" 23	1,495	− 137	‡17	17,261	− 1,301
*London County Council	...	...	...	...	...	...
Lowestoft	" 22	165	− 5	...	...	...
Maidstone Corporation	" 20	142	...	14	2,448	...
Manchester Corporation	" 22	12,241	+ 741	19	364,316	+ 15,419
Mersey Railway	" 22	1,454	+ 170	16	23,985	+ 1,959
Merthyr	" 14	213	− 1	41	8,349	+ 101
Metropolitan Elec. Trams	" 21	1,784	+ 596	16	31,003	+ 7,975
Middleton	" 14	297	+ 35	41	13,712	+ 224
Nelson Corporation	" 22	117	+ 26	30	3,663	− 1,155
Newcastle-on-Tyne Corp.	" 22	3,731	+ 73	16	59,019	+ 5,813
Newport (Mon.)	" 22	201	+ 26	8	1,487	+ 124
Oldham, Ashton & Hyde	" 14	512	− 1	41	22,775	− 968
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams	" 21	1,256	+ 50	42	54,582	+ 6,196
Peterborough	" 14	124	− 1	41	6,100	− 148
[illegible] and District	" 14	301	+ 39	41	12,588	− 6
Portsmouth Corporation	...	...	...	...	...	...
Potteries	" 14	1,760	+ 58	41	70,323	+ 6,376
Reading Corporation	" 20	106	+ 32	3	1,578	+ 119
Rochdale Corporation	...	...	...	...	...	...
Rothesay	" 14	54	− 3	41	6,226	− 10
Salford Corporation	" [illegible]	4,149	+ 84	30	133,200	+ 7,711
Sheerness	" 12	61	− 3	41	2,096	− 486
Sheffield Corporation	" 21	6,649	+ 196	§30	149,624	+ 2,865
Southampton Corporation	" 20	917	− 49	19	30,134	− 2,001
Southend Corporation	" 19	274	+ 29	39	17,176	+ 1,292
Southport Tramways	" 14	251	− 9	41	13,866	+ 617
S. Staffordshire Trams	" 14	857	− 127	41	31,744	− 5,645
Stockport Corporation	" 21	573	+ 104	19	17,783	+ 7,168
Sunderland Corporation	" 23	1,248	+ 120	29	39,023	+ 618
Swansea Trams	" 14	694	− 21	41	27,664	+ 907
Taunton Trams	" 14	49	− 10	41	2,345	− 132
Tynemouth and District	" 14	259	+ 2	41	12,768	− 714
Tyneside Trams Co.	" 19	477	+ 150	42	16,054	+ 2,815
Wallasey District Council	" 22	679	+ 53	§29	33,311	+ 1,429
Walsall	" 22	481	...	41	20,448	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	" 20	1,060	...	84	31,682	...
Weston-super-Mare	" 12	62	+ 9	41	5,903	+ 491
Wigan Corporation	...	...	...	...	...	—
Wolverhampton District	" 14	373	− 10	41	16,225	− 20
Worcester	" 14	107	+ 178	36	11,744	+ 5,704
Wrexham	" 14	91	− 16	41	4,623	− 765
Yorkshire Woollen District	" 14	788	− 64	41	24,547	+ 8,849

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 8 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. ‖ Fortnight.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Oct. 26	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Oct. 26.	
				£ s. d.		High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	3/0	Anglo-Argentine Ordinary Shares	6½—7½	4 4 0	April, Oct	7	6¾
5	2 6	Do. 5% Cum. Pref.	5½—5¾	4 8 10	..	5⅞	5¾
St.	6%	Do. Permanent 6% Deb. Stock	130—142	4 4 10	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104—106	4 17 0	—	105	104½
10	6%	Barcelona Tramways Ord.	9—10	3 0 0	—	..	..
10	5/0	Do. 5% Cum. Pref.	9—10	5 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91—95	4 14 0	..	..	..
100	5%	Do. 5 per Cent. Debs.	95—101	4 19 6	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	½—¾	..	..	..	..
1	..	Do. 5% Cum. Pref.	1—1⅛	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 8	—	4⅜	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96—101	4 9 3	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19—20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10—10½	3 15 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106—108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	103—106	5 13 3	..	..	..
St.	5%	Do. Pref. Ord. Stock	102—105	4 15 3	—	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10¼—10¾	4 12 0	..	..	..
50	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102%—104%	4 6 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	97—100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	9½—10½	5 17 3	..	10¼	10
10	6/0	Do. 6 per Cent. Cum. Pref.	11—11½	5 4 4	Feb, Aug	11⅝	11¼
St.	5/0	Do. 5 per Cent. Perpetual Debs	116—119	4 4 3	..	118½	118
St.	14/8	Do. 4½ per Cent. 2nd Deb. Stock	95—98	..	..	97½	97
5	1/6	Buenos Ayres and Belgrano Ord.	3½—4	5 12 6	..	4	3¾
5	2/0	Do. 6 per Cent. "A" Cum. Pref.	5½—6¼	5 4 4	—	5⅞	..
5	3/0	Do. "B"	5½—5¾	5 11 6	—	..	..
St.	5%	Do. 5 per Cent. Debs.	105—108	4 12 8	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	102—105	4 16 3	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. 5% Deb. Stk.	96—99	5 2 6	..	..	..
5	3/0	Calcutta Tramways	7½—7¾	4 2 9	—	7⅝	7½
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105—108	4 4 0	..	107	..
1	1/0	Cape Electric Tram Shares	1½—1¾	5 14 3	..	1⅝	..
St.	4%	Central London Ordinary Stock	91—94	4 5 1	June, Dec	94	92½
St.	4%	Do. 4 per Cent. Pref. Stock	100—102	3 18 2	..	..	..
St.	4%	Do. Deferred Stock	81—83	4 16 5	..	81½	79½
100	4%	Do. 4 per Cent. Debs.	107—110	3 12 4	..	108½	..
5	2/6	City of Birmingham Trams.5% Cm. Prf.	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	96—101	3 19 3	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	47—49	4 10 10	Feb, Aug	48	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122—125	4 0 3	Feb, Aug	..	..
St.	5%	Do. (1896)	117—120	4 3 6	..	..	..
St.	5%	Do. (1901)	113—117	4 6 0	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106—109	3 14 7	May, Nov	108½	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	103—106	4 16 9	..	105	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13—14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15—16	3 15 0	..	..	..
10	3 0½	Gt. Northern & City Rly. Prf. Ord. (4%)	5½—6½	..	—	..	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9—10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19—20	4 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—15	4 0 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109—111	4 1 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4½	5 17 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89—92	4 7 9	..	..	..
10	1½%	Liverpool Overhead Railway Ord	3½—3¾	3 15 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref	10—10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10¾—11	4 10 11	..	10⅞	10¾
St.	4%	Do. 4% 1st Mort. Deb. Stock	103—106	3 16 4	..	..	..
St.	..	Madras Elec. Trams 5% Deb. Stk.	102—106	..	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6—9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10—13	..	..	..	..
1	..	Metropolitan Electric Trams Def	¾—⅞	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	..	..	..
St.	18/7	Do. 4½ Deb. Stock	102—105	..	..	102½	101½
100	5%	Montreal St. Ry. St'g 5% Mrt. Dbs.(1908)	100—103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs.(1922)	103—105	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent.Cum. Pref.	½—1½	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams, 1st Mt. Db. Stk.	102—105	4 16 6	..	..	..
10	10/0	Potteries Electric Traction Ord.	8—9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101—104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	86—89	3 7 5	June, Dec	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	½—1	5 14 2	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	¾—1¼	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	8½—9	6 13 4	July, Feb	8⅞	8¾
5	3 0	Do. 6 per Cent. Pref.	5¾—6	5 0 0	Jan, July	5⅞	5¾
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101—104	4 6 7	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	100—102	4 8 6	..	..	..
5	3/0	British Westinghouse 6% Pref.	3½—4	7 10 0	—	4	3¾
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	87—90	4 10 2	..	89½	88
2	..	Brush Electrical Engineering	½—¾	..	March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1—1½	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	93—96	4 14 6	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	70—75	6 0 9	Jan, July	..	..
5	7/6	Callender's Cable Con. Ord.	9½—10½	6 14 3	Jan, July	9½	9¼
5	2/6	Do. 5 per Cent. Cum. Pref	5—5½	4 10 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	103—106	4 5 8	Nov, May	103½	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1—1¼	4 11 6	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	89—94	4 16 6	..	..	..
1	0/9	Chadburn's (Ship) Telegraph Ord.	¾—1¼	8 17 6	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—2	3 15 0	Jan, July	1⅞	1¾
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	93—95	5 6 5	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	6¾—7½	6 18 0	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	5½—6¼	5 4 4	Sept	5⅞	5½
St.	4½%	Do. 4½% Deb. Stock	103—106	4 5 9	..	..	..
5	..	Edison & Swan United ("A" sh.) (£3 pd.)	½—¾	..	Feb, Aug	½	—
5	..	Do. (£5 paid)	1—2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	78—83	4 17 9	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79—81	6 0 0	..	80	78½
5	4/6	Edmundson's Elec. Corp. Ord.	6½—6¾	5 9 9	H'lf-yearly	6⅝	..
5	3/0	Do. 6 per Cent. Cum. Pref.	6—6½	4 16 0	..	6⅜	6⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	105—108	4 3 10	..	..	..
2	1/7½	Electric Construction Co.	1—1¼	6 8 0	July	1¼	..
2	2/0½	Do. 7 per Cent. Cum. Pref.	2—2¼	6 12 3	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97—100	4 0 6	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90—95	5 5 3	—	..	—
10	6/0	General Electric (1900) 6% Cum. Pref.	9—9½	6 6 3	—	9½	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91—95	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½—11½	4 1 9	Feb, Aug	11½	10¾
5	2/3	Do. 4½ per Cent. Pref.	5—5½	4 1 10	Feb, Aug	5½	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108—111	4 1 5	Feb, Aug	..	..
10	6/0	India Rubber, Gutta Percha, &c., Wrks.	19½—20½	4 17 6	Feb, Aug	20	19
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99—102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11½	4 5 10	Mar, Sept	..	..
10	12/0	Telegraph Construction & Mainten'ce.	36—39	6 3 1	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101—104	3 17 6	Jan, July	..	..
5	..	Willans and Robinson Ord.	1—2	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2—3	..	Apr, Oct	..	..
6		4 per Cent. 1st Mort. Debs.	74—79	6 3 11	May Nov	75	..

Share.	Last Dividend	Name.	Price Wed., Oct. 26	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Oct. 26.	
				£ s. d.		High-est.	Low-est.
		ELECTRICITY SUPPLY.					
..	..	Blackheath & Greenwich Dist. El. Lt. See South Metropolitan Elec. Lt. & Power Co. below	..	..	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	12½	12¼
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11—12	5 0 0	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103—106	4 5 9	..	106½	103
5	..	Bromley (Kent) El. Lt. & Power Shares	5½—6½	..	..	..	..
St.	4½%	Do. Do. 1st Debs	102—106	4 7 9	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..	10¾	..
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7½—8	4 7 6	..	7⅝	7½
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106—109	3 14 6	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8½—9	4 8 9	Feb, Aug	8⅞	8⅝
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4 1 10	Feb, Aug	5½	5½
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4 10 0	—	..	..
5	2/3	Do. Do. (19.3)	4½—5	..	..	4⅞	..
St.	4%	Do. 4% Deb. Stock (red.)	103—106	3 17 8	..	104½	..
5	2/3	Chelsea Electric Supply Ord.	6½—7	4 2 3	March	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108—111	4 1 9	Jn, Dec	110½	110
10	5/0	City of London Electric Lighting Ord.	10½—11	4 10 11	Feb, Aug	10⅞	10½
10	6/0	Do. 6 per Cent. Cum. Pref.	13—14	4 5 9	Jan, July	13⅜	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122—126	4 0 3	Jn, Dec	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	103—106	4 5 9	..	..	..
10	4/0	County of London Elec. Supply Ord.	9—10	4 0 0	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾—12½	4 18 0	Mar, Sept	12½	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106—109	4 3 9	..	..	..
St.	4½	Do. Second Deb. Stock Prov. Certs.	101—104	4 8 7	..	103½	103½
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88—93	5 7 6	..	..	..
5	2 0	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101—104	4 7 6	—	..	—
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	—
5	3 0	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
St.	4½%	I. of W. Elec Lt. & Power 4½% Db. St (red.)	101—103	4 7 6	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	¼—½	..	—	..	—
5	5/0	Kensingtn & Knghtsbdge Ord.	12—13	4 12 4	..	12⅜	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101—104	3 17 8	..	103½	..
3	..	London Electric Supply Ord.	1½—2½	..	..	..	..
5	9/0	Do. 6 per Cent. Pref.	5½—6	5 0 0	..	5⅞	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96—99	4 2 0	Mr, Jn, S, D	97½	..
10	9/0	Metropolitan Electric Sup. Ord.	16½—16¾	5 10 8	April, Oct	16¾	16½
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼—5½	4 1 10	Jan, July	5½	5⁷⁄₁₆
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	112—117	3 18 0	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96—99	3 10 6	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	93—96	4 18 9	..	..	—
10	6/0	Notting Hill Electric Ord.	14½—15½	3 17 6	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	99—102	3 18 6	..	..	..
5	2/6	Oxford Electric Ord.	5½—6½	5 4 0	March	..	..
St.	4%	Do. 4% Deb. Stock	98—101	4 0 0	..	..	..
1	..	Rand Electric	1⅛—1¼	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mt. Deb	98—101	4 9 0	April, Oct	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	14—15	4 16 8	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	8—9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98—101	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2½—3½	6 3 1	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83—87	4 12 6	..	..	..
5	3/0	South London Electric Supply Ord.	4½—4¾	3 3 1	—	4½	4½
1	..	South Metrop'n Elec. Lt. & Power Ord.	¾—1	..	—	..	..
1	0/8½	Do. 7% Cum. Pref.	1⅛—1⅜	4 13 4	—	1⅛	..
St.	4½	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	106—110	4 2 3	—	109	107
5	2/6	Urban Electric Supply Ord.	4¾—5	5 0 0	..	4⅞	..
5	2/6	Do. 5% Cum. Pref.	4¾—5	5 0 0	..	4⅞	..
St.	..	Do. 4½ 1st Mort. Deb.	101—103	—	..	101½	100½
5	6/6	Westminster Electric Supply Ord.	12½—12¾	5 0 0	Mar, Sept	12⅞	12½
5	2/6	Do. 5 per Cent. Cum. Pref.	6½—6¾	3 14 0	—	6⅝	—
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	99—102	3 19 0	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec	..	..
St.	12/6	Anglo-American	49—52	5 6 6	F, My, Ag, N	50½	50
St.	25/0	Do. Preferred	96—98	5 13 5	F, My, Ag, N	97½	96½
St.	2/0	Do. Deferred	8—8½	1 2 6	F, My, Ag, N	8¼	7¾
100	8%	Commercial Cable Capital Stock	170—180	4 4 2	Jn, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93—96	4 3 6	Jn Ap, Jy, O	94½	93½
10	5/0	Cuba Submarine Ord.	7—8	7 10 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15—16	6 5 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7—8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98%—101%	4 9 2	Jan, July	..	..
20	3/0	Direct United States Cable	10½—10¾	5 11 3	Ja, Ap, Jy, O	10⅝	10½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100—102	4 9 6	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	133—137	5 2 1	Ja, Ap, Jy, O	136	133
St.	17/6	Do. 3½ per Cent. Pref. Stock	85—87	3 18 9	Ja Ap, Jy, O	87½	87
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106—109	3 14 3	May, Nov	108	..
10	2/6	Eastern Extension	15½—16	5 7 9	Ja, Ap, Jy, O	15⅞	15⅝
St.	4%	Do. 4 per Cent. Deb. Stock	106—108	3 14 3	Feb, Aug	107½	106½
100	4%	* Eastern & S. African 4% Mrt. Deb. 1906	100—103	3 18 6	Feb, Aug	101	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%—104%	3 18 3	May, Nov	..	..
10	5/0	Gt. Nrthn. (of Copenhagen)	28½—29½	5 1 9	Jan, July	29½	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100—102	4 9 6	June, Dec	..	..
25	37/6	Indo-European	44—47	4 6 4	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97—100	4 0 0	June, Dec	..	..
10	6/0	West African Telegraph Shares	6½—7½	5 6 8	..	..	..
2½	..	West Coast of America	⅛—⅜	..	..	¼	..
100	4%	Do. 4 per Cent. Debs.	97—100	4 0 6	Jan, July	..	..
10	..	West India and Panama	½—¾	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6½—7	5 11 5	May, Nov	6¾	6½
10	..	Do. 6 per Cent. 2nd Pref.	5—6	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101—103	4 17 10	Jan, July	..	..
10	8/0	Western Telegraph	12½—13	5 7 9	Mr, Jn, O, D	12⅞	12½
100	5%	* Do. 5% Debs. (2nd Series, 1903)	101—104	4 16 3	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101—104	3 17 6	—	..	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid)	5½—5¾	6 1 9	August	5½	5⁷⁄₁₆
1	0/7½	Monte Video Telephone Ord.	⅝—¾	..	..	..	..
St.	6%	National Co. Pref. Stock	106—108	5 11 0	..	107½	107¼
St.	6%	Do. Def. Stock	93—94	6 2 0	..	93½	93
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13—14	4 5 8	Feb, Aug	13½	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11—13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5¾	4 14 0	Feb, Aug	5⅝	5½
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97—99	3 10 8	June, Dec	98	97
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104—106	3 15 9	..	105½	105
..	5/0	Do. Do. Prov. Certs. 35% to be pd.	67—69	..	..	67½	..
1	0/8½	Oriental	1½—1⅝	6 6 8	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1½—1¾	4 16 0	..	..	..
5	5/6	United River Plate	6½—6¾	5 13 6	July	6½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 15 3	June, Dec	5⅝	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103—106	4 14 4	June, Dec	..	—
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5½—5¾	5 11 4	—	..	..
10	2/0	Globe Telegraph and Trust	9½—9¾	5 12 8	Ja Ap, Jy O	9⅝	9½
10	3/0	Do. 6 per Cent. Pref.	13½—14½	4 4 3	Ja Ap, Jy, O	14	13½
100	6%	Submarine Cables Trust (Cert.)	117—122	4 18 4	April, Oct	—	..
..	86/7	Underground Elec. Rys. Co. of London 5% Profit Sharing Secured Notes	89—90	—	..	90½	89¾

ulating the yield, allowance has been made for accrued interest but not for redemption. ‡ The London Stock Exchange Committee have refused to quote these.

THE ELECTRICIAN:

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NOTES.

IF proof were wanting of the superiority of electricity over gas for street lighting, then no better could be found than in the report which has been compiled by Mr. S. L. PEARCE, chief electrical engineer to the City of Manchester. It is shown that, for a degree of illumination equivalent to 1,000 c.p. lasting 4,000 hours, the cost of "intensified" gas lighting, calculated on a basis of 1·08d. per 1,000 c.p.-hours, which includes 10 per cent. for depreciation, is £18. Under the same conditions, and including carbons, re-trimming and 10 per cent. depreciation, with electrical energy at 0·95d. per unit, the cost of electric lighting works out at only £12. 12s. 6d. From actual measurements taken Mr. PEARCE finds that the cost per mean candle-foot per hour for the arc lamps is 0·28d., whereas that for intensified gas lamps is 0·395d. Now, these tests can in no sense be regarded as mere laboratory experiments, since they were carried out under ordinary working conditions, by practical engineers, and with an instrument the accuracy of which is beyond doubt. They are not the result of the cogitations of untrained persons who juggle with imaginary statistics and finally evolve a comparison which is striking only by reason of its grotesqueness. Many such comparisons have, of late, emanated from those interested in the gas industry, but they have lacked the hall-mark of authenticity and have, therefore, been very properly ignored.

◆

IT is not to be denied that Mr. PEARCE's figures are due, in large measure, to the low cost of electrical energy (0·95d. per unit) and to the employment of arc lamps which do not require re-trimming or any other attention for many hours. At the same time it must be remembered that the price of gas in Manchester is also very low, and that the improved systems of gas lighting are claimed to be very economical as regards maintenance and labour. We would suggest that the report, which is reprinted in another column, should be supplemented by another comparing the costs of Nernst and incandescent electric lighting with incandescent gas and ordinary flat flame lighting respectively for interiors.

◆

Mr. G. W. O. HOWE, on another page of this week's paper, shows, by a concrete example, how great may be the difference between the theoretical short-circuit current, upon which the Heyland diagram is based, and the short-circuit current as actually determined by a test. The author suggests that the theoretical short-circuit current corresponding to the working voltage of the motor be obtained by extrapolation, preferably graphically. To this end he determines experimentally the two short-circuit currents for two low pressures and connects the two corresponding points by a straight line, which then represents the short-circuit curve, assuming no saturation in the motor iron to take place. But the points themselves cannot be determined to a high degree of accuracy, on account of observation errors and so on, and the connecting line, therefore, may deviate to some extent from the correct locus. It would seem advisable for this reason to determine a third point, which would not only act as a check on the two other points, but would also indicate at once if one or the other of the points determined should happen to lie in the curve.

◆

SOME Papers of interest on the subject of wireless telegraphy were read at the International Electrical Congress at the St. Louis Exhibition. One, which appeared in our last issue, was a *résumé* by Prof. NICHOLS of past achievements in the way of linking into a continuous spectrum ultra-violet, visible, ultra-red and Hertzian waves, and contained a forecast of the direction of future progress and suggestions for workers in this interesting field. We publish two other Papers this week. That by Dr. K. E. GUTHE, constitntes an excellent summary of present-day knowledge of the properties of the coherer, and offers to explain these properties by a comprehensive scheme built up of minor hypotheses. Briefly, the scheme submitted describes how electrostatic attractions between neighbouring particles in a filings coherer will draw them together till the dielectric film between them is squeezed sufficiently thin to be ionised by the feeble voltages concerned, and will finally bring the opposed metallic surfaces within the range of their mutual molecular forces. The supposition of electrostatic attractions which finally make cohesion between the particles possible is in essence due to Sir OLIVER LODGE; the intermediate stage in which ions may cross the thinned dielectric is due to Dr. GUTHE. Together these hypotheses give a very plausible account of many of the complex phenomena of the coherer. But the old riddle, that decoherence can be produced by warming but not by cooling, is still not satisfactorily explained.

◆

Dr. LEE DE FOREST'S Paper is on the subject of electrolytic detectors. He draws a vivid picture of the minute actions occurring during the operation of these receivers and analyses them admirably. The experiments he describes go far to clear away the obscurity which has shrouded the internal actions of the instrument. For example, the difficulty that the same disposition of very close electrodes in an electrolyte sometimes functions as a "decoherer" sometimes as a "coherer" seems now removed. In the former case, filamental bridges formed between the electrodes by electrolytic deposition are broken by the oscillations received; in the latter case, bridges not quite completed become gas covered, but are cleared of their gas by the waves, with consequent reduction of the resistance between the electrodes. Exactly why and how the gas is removed from the filaments by minute oscillatory currents remains, however, a mystery.

◆

Mr. H. ENGLAND, President of the Association of Tramway and Light Railway Officials, is quite right in calling attention once more to the mistake of having three distinct associations of tramway officials. There can be no doubt that a powerful association representative of tramway and light railway interests should be an essential to the proper development of electric tramway enterprise in this country; and it is equally evident to those in tramway circles that no one of the three existing tramway associations provides what is required. The proceedings of the Association which are now being concluded at Wakefield resemble to some extent the nervous and self-conscious efforts of a private debating society. For instance, the Press is invited to attend the meetings, but is not encouraged to report them fully; difficulties have been placed in the way of our representative obtaining copies of the Papers, and he has been requested to omit the names of the subsequent speakers should he report the discussions. This peculiar attitude towards the Press generally, and the technical Press in particular, may, however, be due only to the Association's diffidence as to the quality of the fare to be placed before the meeeting, for certainly the proceedings yesterday disclosed nothing of great value. The Municipal Tramways Association, on the other hand, has occasionally been the means of collecting some useful statistical data with regard to the working of tramways, but the Association is rather a society of tramway managers than of engineers, and the engineering element is, therefore, much neglected. The third association is the Tramways and Light Railways Association, and this is the association which should form the nucleus of the much-needed organisation to which we have referred. Its members, however, take little interest in its doings, good Papers are few and far between, and the attendance at the meetings is miserably poor. Possibly an amalgamation of the three Associations would benefit all of them. The difficulty is, as Mr. FELL put it in a recent speech, to induce the municipal lamb to lie down with the company lion—or was it the municipal lion and the company lamb?

◆

Crystal Palace Old Students' Society.—A smoking concert will take place at the Caxton Hall, Caxton-street, Westminster, on Tuesday next, November 8th.

Wakefield and District Light Railways.—The formal inauguration of Wakefield and District Light Railways took place yesterday. A few general notes upon the scheme appeared in our issue for August 19th, and we hope to publish an illustrated description in our next issue.

Personal.—Mr. E. G. Coker, M.A., D.Sc., of McGill University, Montreal, has been appointed professor of mechanical engineering and applied mathematics at the City and Guilds of London Technical College, Leonard-street, Finsbury, in succession to Prof. W. E. Dalby, who, as already announced, has been appointed professor of mechanical engineering at the Central Technical College, Exhibition-road, South Kensington.

It is announced that Mme. Curie has been officially appointed assistant-professor to her husband at the Paris Faculty of Science.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne—Pinheiros	Aug. 13, 1902	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902	—
Tarifa—Tangier	Jan. 18, 1904	—
Cayenne—Paramaribo	July 13, 1904	—
Cap Haitien—Mole St. Nicholas	Aug. 20, 1904	—
Cap Haitien—Puerto Plata	Sept. 26, 1904	Oct. 30, 1904
Trinidad—Demerara	Oct. 11, 1904	—
Bolama—Bissao	Oct. 13, 1904	—
Jupiter Julets (Florida)—Nassau (Bahamas)	Oct. 20, 1904	—
Rhodes—Sitia	Nov. 1, 1904	—

Students' Section of the Institution of Electrical Engineers.—The opening meeting of the Students' Section of the Institution of Electrical Engineers will be held on Wednesday, November 16th, at 92, Victoria-street, S.W., when Mr. James Swinburne will deliver an address. The following Papers have been arranged for:—November 30th, "Motor Controlling Switch Gear," by L. J. Pumphrey; December 7th, "The Gordon Electric Light Installation at Paddington, 1884–1904," by M. G. Tweedie; January 18th (1905), "Notes on the Construction and Maintenance of Large Telephone Exchange Equipment," by A. L. Stanton.

Eastern European Submarine Telegraph Cables.—Rumours and reports have been in circulation for some time past concerning the negotiations between a German telegraph company and the Turkish Government. The East European Telegraph Co. of Berlin—the company in question—is desirous of laying a cable between Constanza and Constantinople. The position taken up by the Eastern Telegraph Co. is, we understand, that the Turkish Government has granted a concession to the East European Company without regard to the treaty rights of the Eastern Telegraph Co. The latter company has taken the matter up with the Turkish Government.

Opening of the Stoke Electricity Works.—The electricity works which have been erected by the Stoke-upon-Trent Corporation were opened on Monday. The scheme, for a combined electric lighting and refuse destructor, was sanctioned in 1898, the responsible officials for the designs being Mr. P. J. S. Tiddemann (borough electrical engineer) and Mr. A. Burton (borough surveyor) respectively. The system of electrical supply is the three-wire continuous-current at 240 and 480 volts. The power station contains two Lancashire boilers, having a total evaporative capacity of 10,000lb. per hour. These supply steam to two Willans three-crank engines direct-coupled to Dick, Kerr multipolar dynamos, with an aggregate capacity of 300kw. About 6 miles of cable have been laid, solid in wood troughing, the distribution being Callender three single cables, and the feeders Callender concentric vulcanised bitumen cables. There is a battery of 240 Tudor cells in the generating station, the capacity being 350 ampere-hours. There is also a Mavor & Coulson balancer and the two boosters. The refuse destructor is of the Meldrum type. The total capital expenditure up to date amounts to £30,640.

University of Birmingham Engineering Society.—In the course of his presidential address, delivered before this Society on Thursday last week, Prof. Thomas Turner said that the price of aluminium in 1856 was about £20 per pound Troy, and now it was only £120 per ton. Its manufacture by means of electricity was abandoned in the early days owing to the high cost of electrical energy and resort was made to the sodium process. Now, however, in the days of cheap electrical energy, the manufacture of aluminium was carried on almost exclusively by electrical reduction. The amount of aluminium produced annually by the whole world, was about 10,000 tons, for more than half of which America was responsible. In 1890 only 40 tons were produced, and the price was £1,000 per ton. Bulk for bulk, aluminium was now as cheap as copper and cheaper than tin, and it would, therefore, seem that there was every prospect of considerable extension in the industry which produced it. The president then described its manufacture, and expressed the opinion that it could never be as cheap as iron and other metals requiring less heat for their production. A reference to the various aluminium alloys brought the address to a close.

The Junior Institution of Electrical Engineers.—The annual general meeting of this institution was held recently at the Westminster Palace Hotel, when the council's report, balance-sheet, &c., were presented. Good progress was recorded, the membership having risen to nearly 800 and the assets to close on £1,000. Mr. Samuel Cutler, jun., M.I.M.E., was re-elected chairman. During the evening two of the past chairmen, Mr. W. J. Tennant and Mr. Percival Marshall, gave an extremely interesting account, illustrated by lantern slides, of their visit to the United States and the St. Louis Exhibition. On Saturday, October 22nd, the members paid a visit to Messrs. Stuart's Granolithic Stone Works at Millwall Dock. Electric power is used for the crushers and grinders, current being obtained from the public supply. There is also an electric elevated transporter running on a rail for conveying finished blocks between different parts of the works. Another visit took place on the following Saturday afternoon, when an inspection was made of the National Physical Laboratory at Bushey House, Teddington. The opening meeting of the new session is to take place on November 18th, when Mr. W. H. Lindley, M.Inst.C.E., F.G.S., of Frankfort-on-Maine, is to deliver the Presidential Address, his subject being "Municipal Engineering on the Continent."

Opening of the New York Subway.—The first section of the New York subway system, of which a technical description was begun in *The Electrician* of October 21st, p. 10, was opened at two o'clock on Thursday afternoon, the 27th ult., when the Mayor, Mr. McClellan, started the first public train. Bells began ringing at the same time, guns boomed and the steamboats on the rivers blew their sirens. Travelling on the system was free to everyone on this day, and this privilege is reported to have been made use of by some 350,000 people. Although the cars were crowded to their utmost limits, the service was quite inadequate to deal with all the would-be passengers. A number of lady passengers had to be removed in a fainting condition. The fare for any distance is 5 cents (2½d.), and the service includes some express trains running at about 40 miles an hour. It is stated that within the four years of construction 1,700,300 cubic yds. of earth have been excavated, 921,182 cubic yds. of hard rock have been blasted and removed, 368,606 cubic yds. of rock have been tunnelled and nearly 150,000 tons of steel and iron have been employed in the tunnel construction. Fifteen miles of sewers have been taken up and relaid at the side of the subway, besides miles upon miles of gas and water mains and electric cables. According to the New York correspondent of the *Daily Telegraph*, about 50 workers were killed during construction and some 200 were more or less disabled. The first accident since the opening happened last Monday to an electrician, who was killed by a train while installing signals.

Wireless Telegraph Notes.—It is stated that an attempt made by the Indian Government to establish wireless telegraphic communication in Burmah between Diamond Island and Amherst, a distance of 212 miles, across the Irrawaddy Delta and the Gulf of Martaban, was not altogether successful owing to atmospheric disturbances. We understand that the experiments were carried out with the view of establishing communication subsequently with the Andaman Islands.

We are informed that the De Forest Company is introducing a "ship localiser," designed to indicate to a captain the distance of his ship from a danger point and point out to him the direction of the rock or shoal. Part of the wireless equipment on board ship will be used both for the localiser and the wireless telegraph apparatus. It is announced that 52 automatic wireless stations will be erected on the principal danger points from the source of the St. Lawrence river through all of the five Great Lakes. The sending distance of these automatic stations will be limited to about 6 miles. They will not work constantly, but will be set in operation by watchers on duty for the purpose upon the approach of storms or fogs. Each station will have an individuality in a letter call—for example, the White Fish Point station will send out, repeating over and over again, "W F P." The ship receives a weak signal on the extreme edge of the 6-mile radius, and the signal grows stronger as the ship approaches the source of the wireless waves. The instrument by which the captain may determine his direction from the danger point consists of a long flat screen turning on a pivot. The signals are heard most distinctly when the hands of the screen are pointed exactly towards the source of the automatic wireless signal, and its direction can thus be estimated.

Patent Law.—Before the Civil and Mechanical Engineers' Society last evening Mr. C. T. A. Hanssen delivered his Presidential address, the subject chosen being "The Effect of Patent Law on Modern Civilisation." The address throughout was a strong plea for the better protection and remuneration of the inventor. Vast benefits had been derived by this country from the work of inventors, but the inventors themselves had shared to but a small degree in this prosperity. For instance, James Watt would have received practically no return at all unless his patent had been extended over 31 years, yet landowners along the routes of many railways have had the value of their property increased enormously. The whole tendency of the law seemed to be to consider the patentee as an undesirable person who was plundering the community by means of his patent. It would be to the advantage of all classes, said Mr. Hanssen, if such views could be changed, and the law so amended as to encourage invention by making patents sufficiently safe as investments and of sufficiently long duration to repay the heavy expenditure generally incurred in developing a new invention and in bringing it before the public. A patent, he thought, should be given approximately the same validity as an act of Parliament, but at a very much lower cost, and it should be possible to prolong its life under proper conditions dependent on the capital spent in developing it. Further, if patents, instead of being issued at a uniform rate of taxation, were taxed according to the income derived from the monopoly, a very considerable revenue might be obtained from successful patents, whilst the charges for undeveloped inventions might be correspondingly lowered. Mr. Hanssen's suggestions are novel and interesting.

Power Used by Brakes.—In a recent issue of the *Street Railway Journal* of New York there appeared an article setting forth the results of tests carried out for the purpose of determining the power required for operating brakes on electric cars in commercial service. These tests were made by Mr. H. M. Wheeler, instructor in the Lewis Institute, Chicago, and formerly in charge of tests in the engineering deparment of the Chicago Union Traction Co. The car upon which the air-brake tests were made was a double-truck city car, equipped with four G.E.-70 motors, and weighing, approximately, 25 tons. The air brakes were supplied with the latest type of Christensen motor-driven compressor, To measure the amount of electrical energy supplied to the compressor motor an ammeter and voltmeter were connected in the motor circuit. The time the motor operated in seconds was measured by a stop watch, and the two tests may be summed up as follows:—

	Test No 1.	Test No. 2.
Round trip, miles	11·88	11·88
Running time, minutes	92	85
Number of stops	130	107
Stops per mile	11	9
Total time pumping	18' 22"	26' 30"
Per cent. of time pumping	20	31
Total kilowatt-hours at car	0·5293	0·7584
Total kilowatt-hours at power house	0·6229	0·9034
Number of times pump operated	27	33
Average voltage at car	467	461
Average voltage at power station	550	550
Kilowatts at car during pumping	1·73	1·72
Kilowatts at power house during pumping	2·03	2·05
Aver. kw.-hours at car for each pumping	0·0196	0·023
Aver. kw.-hours for each pumping at power house	0·0231	0·0274
Average amperes during pumping	3·70	3·70
Average time for each pumping, seconds	41	48
Kilowatt-hours per car-mile for braking	0·0525	0·076
Kilowatt-hours per car-hour for braking	0·406	0·637

The automatic governors started to pump at 45lb. gauge pressure and cut out at 60lb. A glance over the test sheet shows that the pump operated from a maximum of 57 seconds to a minimum of 30 seconds each time, the average being 41, as given in the summary. The number of stops to each time of pumping was from 10 to three; in the majority of cases it ran four, five and six stops. The car was comparatively new in service, having been in operation 24 days. From the number of stops per mile it will be seen the test was made in city service on crowded streets. Calculating on a basis of kilowatt-hours per stop, test No. 1 required 0·00478kw.-hour, and test No. 2, 0·0084kw.-hour per stop. A test of a double-truck 22½-ton car in suburban service, with two-motor equipment and a new type of electric brake, was made about the same time. The brake was of a type taking electrical energy from the storage battery of the car, which was charged from the trolley.

Oscillographic Observations on the Melting of Fuses.—In a recent issue of the *Elektrotechnische Zeitschrift*, Mr. E. Oelschlager records a series of interesting experiments relating to the melting of fuses, carried out with the aid of an oscillograph. The tests described related to a standard 20-ampere fuse of the Siemens-Schuckertwerke type, capable of carrying continuously 25 amperes, but fusing within two minutes when loaded with 40 amperes. When cold, the resistance of the silver wire was 0·0054 ohm, and this resistance increased to 0·017 ohm just before fusion took place at 1,000° C. Current for carrying out the experiments was furnished at 110 volts from a 1,000kw. generating plant. The leads from this plant to the place where the fuse was tested consisted of two single-core cables, each of a length of about 330ft., and a copper section of 1,000 sq. mm. (1·55 sq. in.). Although the combined resistance of these two cables (0·003 ohm) was small compared with the resistance of the fuse, it was found that their self-induction affected the results materially, only allowing the current through the fuse to increase gradually on being switched on, augmenting the disruption voltage at the fuse and cutting down the maximum current which ought to have flowed according to Ohm's law. With a resistance of 0·6 ohm and a self-induction of 2·5 henrys in the circuit, in addition to the resistance and self-induction of the cables themselves, the current rose from nothing to 180 amperes within 0·11 second. Shortly before 0·12 second the fuse began to melt and the current quickly diminished, being totally interrupted 0·135 second after closing the switch. Other experiments were then carried out in which both resistance and self-induction were gradually diminished and numerous observations made in the corresponding conditions. The general character of the phenomenon of fusion remained the same, although, of course, the rush of current increased successively and the time taken by the fuse to melt diminished accordingly. With neither resistance nor self-induction connected in the fuse circuit, the current rose from nothing to 850 amperes in 0·005 second, remained at this value until 0·0052 second, and reached zero again after a lapse of time of 0·00535 second, reckoned from the time of switching on. It is interesting to note that at the time of fusing, the voltage across the terminals of the fuse rose for an instant to 800 volts, but dropped again as suddenly as it had risen. The heat required to blow the fuse was calculated to be equivalent to 30 to 40 watt-seconds, being nearly independent of the current. Of this heat, about 5·8 gramme-calories were required to raise the temperature of the wire to 1,000° C., while about 1·75 gramme-calories were further required to melt the wire. In order to carry out tests, undisturbed by the resistance and self-induction of the supply leads, short-circuit tests were conducted in close proximity to a 110-volt accumulator battery. In this case the current rose in 0·0002 second to 5,000 amperes, then fell rapidly to a negative value of 3,000 amperes, and finally reached zero. At the same time, the maximum voltage across the fuse at the time of melting was 420 volts. Even at the terminals of the battery, the voltage increased temporarily to 350 volts.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, November 4th.

MANCHESTER STUDENTS' SECTION: INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Meeting at the Manchester School of Technology, Sackville-street. Paper to be read: "Electric Railways," by F. O. Mills.

MONDAY, November 7th.

SOCIETY OF CHEMICAL INDUSTRY: LONDON SECTION.

8 p.m. Meeting in the Chemical Society's Rooms, Burlington House, Piccadilly, W. Paper to be read and discussed: "The Trend of Invention in Chemical Industry," by J. Fletcher Moulton, K.C., F.R.S.

TUESDAY, November 8th.

INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW LOCAL SECTION.

8 p.m. Meeting at 207, Bath-street, when Mr. Robert Robertson, the Chairman, will deliver his Inaugural Address.

THURSDAY, November 10th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Mr. Alexander Siemens, the President, will deliver his Inaugural Address, after which the premiums for the session 1903-4 will be presented.

INSTITUTION OF ELECTRICAL ENGINEERS: DUBLIN LOCAL SECTION.

8 p.m. Meeting at the Royal College of Science. Mr. Mark Ruddell, the Chairman, will deliver his Inaugural Address.

FRIDAY, November 11th.

TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

2 p.m. Visit to the London County Council Tramways. Meet at Greenwich Power Station 2:10 p.m. Book from Charing Cross or Cannon-street to Maze Hill, Greenwich.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Concert (Ladies' Night) at Holborn Restaurant (King's Hall). Mr. J. S. Raworth in the chair.

PHYSICAL SOCIETY.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "Investigation of the Variations of Magnetic Hysteresis with Frequency," by Prof. T. R. Lyle; (2) "The Determination of the Mean Spherical Candle-power of Incandescent and Arc Lamps," by G. B. Dyke; (3) Exhibition of Physical Apparatus by Robert Paul.

SATURDAY, November 12th.

MANCHESTER STUDENTS' SECTION: INSTITUTION OF ELECTRICAL ENGINEERS.

2.15 p.m. Visit to Messrs. Mather & Platt's works, Salford.

GLASGOW TECHNICAL COLLEGE SCIENTIFIC SOCIETY.

7:30 p.m. Meeting at 38, Bath-street, Glasgow. Paper to be read: "The Diesel Internal Combustion Engine as applied to Electrical Generation," by A. J. Lawson.

THE SHORT-CIRCUIT CURRENT OF AN INDUCTION MOTOR.

BY G. W. HOWE, M.SC., WH.SC.

If it is desired to draw the Heyland diagram for an induction motor which is already constructed, and on which actual tests can be made, it is generally considered necessary to make two tests—viz., a no-load and a short-circuit test. The current taken and the power-factor are observed for each case, and the two currents, being set out to an appropriate scale from the origin at the observed angle of lag with the vertical, give us two points on the semicircle, which can then be drawn. For motors in which the magnetic saturation is low this semicircle will be the correct locus for the current vectors drawn from the origin for any load between no-load and full load. If the magnetic saturation of the leakage paths be high the semicircle as above determined may differ widely from the actual locus, as the following experiment shows. The motor was a 10 H.P. three-phase motor by a leading Continental firm, and the tests with which we are here concerned consisted of a short-circuit test at normal frequency and variable pressure, the rotor being fixed by means of the brake, and a normal variable load test. The results of the short-circuit test are given in Table I. and plotted in Fig. 1.

Table I.

Voltage.	Amperes.	Watts.	Cos φ.
48·3	21·2	508	0·287
65·0	28·4	940	0·294
82·1	36·7	1,560	0·30
103·3	47·7	2,710	0·32
125·0	61·4	4,370	0·33
147·5	78·0	6,760	0·34
158·5	88·6	8,260	0·35
186·8	112·0	12,430	0·34

The normal voltage of the motor was 235, and it can be seen from Fig. 1 that the leakage paths of the motor become highly saturated as the pressure approaches this value, increasing the reluctance, and requiring, therefore, a larger current to produce flux corresponding to the pressure. By producing the curve we see that the actual short-circuit current is about 170 amperes, which is 6·3 times the normal full-load current of 27 amperes.

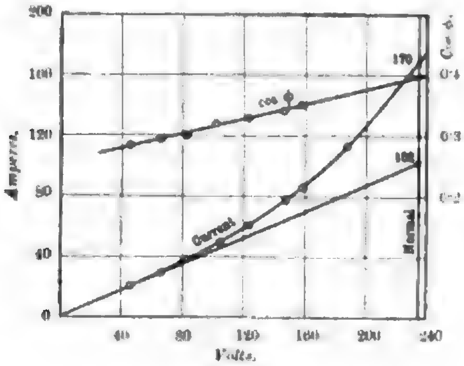


FIG. 1.

For currents up to the normal the curve is practically a straight line, which, if produced to the normal pressure of 235 volts, gives a short-circuit current of about 102 amperes, which is only 3·8 times the normal current or 0·6 of the actual short-circuit current. It is this value, however, which must be used to construct the Heyland diagram, and not the actual short-circuit current, if the diagram is to give accurate results within the working range—*i.e.*, from no-load up to, say, 100 per cent. overload. This follows from the fact that the Heyland diagram is based on the assumption of a constant ratio between current and leakage field, which is true within the working range, and must, for the construction of the diagram, be assumed true throughout. Hence we must assume a straight line for Fig. 1, in order to obtain the circular locus. This conclusion is borne out by the brake test, which gave results as in Table II. and Fig. 2.

In Fig. 3 these results are plotted, and two semicircles are drawn, the larger for the actual short-circuit current of 170 amperes and the smaller for the imaginary current of 102 amperes. The figure conclusively proves the correctness of the above argument. We see, then, that it is not necessary or desirable to make a short-circuit test at the normal voltage, an experiment which is objectionable at all times, on account of the excessive rotor and stator heating. Two points taken at low pressures are all that is required to determine the short-circuit current for the diagram.

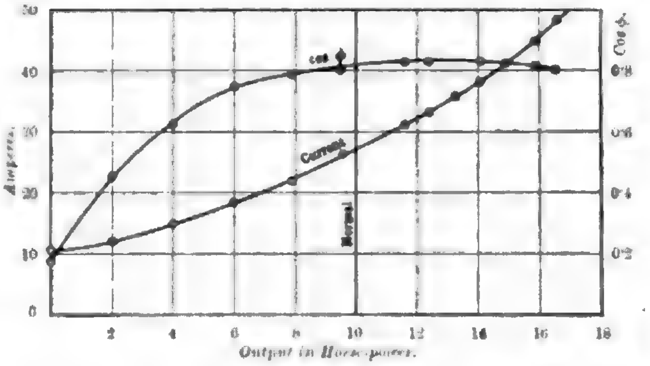


FIG. 2.

Table II.

Output. H.P.	Current.	Cos φ.	Output. H.P.	Current.	Cos φ.
0	10·8	0·18	11·6	31·1	0·820
2·01	12·0	0·454	12·5	33·6	0·821
4·0	14·6	0·624	13·35	36·0	0·824
5·94	17·9	0·74	14·12	38·2	0·825
7·92	21·8	0·78	15·08	40·2	0·821
9·72	26·3	0·80	16·47	47·1	0·802

It may be remarked that the directions of the motor E.M.F. and the terminal voltage have been assumed as coincident in plotting the circle diagram points—*i.e.*, the currents have been set out at the observed angle φ from the vertical. Had the correction of phase angle for stator copper drop been applied, the points would have been thrown further within the smaller circle.

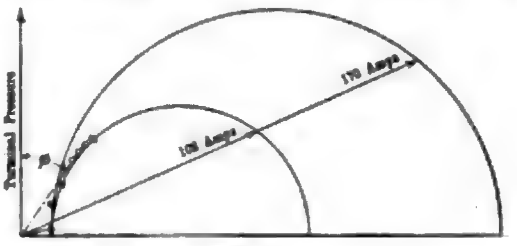


FIG. 3.

The tests having been carried out for a Continental firm, the horse-power is taken as equal to 736 watts or 75 kilogramme-metres per second. All the measurements were made with recently-calibrated precision instruments.

Sunday Closing Law applied to Electric Lighting Stations.—It is reported by the *Western Electrician* of Chicago that, as a result of violating a stringent Sunday-closing statute recently passed in Lexington, Ky. (U.S.A.), the operators of the power plant of the electric light company were arrested, and the city might have been in total darkness, but the officials ordered the men to remain at their posts under all conditions. Needless to say, some modifications of the statute are advocated by even the most straitlaced of Sunday observers.

THE LIGHTING OF STREETS IN MANCHESTER.

The following report on street lighting with new arc lamps has been presented to the chairman and members of the Special Street Mains sub-committee of the Manchester Corporation by Mr. S. L. Pearce, the chief electrical engineer.

I now have the pleasure to report that the whole of the alterations to the existing system of street lighting, together with certain extensions thereto as sanctioned by you in March last, have been carried out, and that important data and figures have been obtained therefrom as to costs and illuminating effect, these results being embodied in the present report. It may be of interest to state briefly what has been done during the past few months.

The six old open-type 10-ampere Crompton lamps in front of the Infirmary on Piccadilly have been replaced by nine 9-ampere enclosed Gilbert lamps. In addition, 12 6-ampere lamps of the same make have been placed on the centre poles of the tramways running from Portland-street to Mosley-street. The old 16 Brockie-Pell 10-ampere open-type lamps in Albert-square have been replaced by 6-ampere Gilbert lamps to the same number. In St. Ann's-square, the old six Brockie-Pell lamps have been replaced by new Gilbert lamps, and two more have been added, one on either side of the centre of the square. These latter took the place of the gas lamps that were taken down. We have, therefore, in all now 45 lamps, and so far the new Gilbert type of lamp has given great satisfaction, burning with a clear and very steady light for at least 120 hours without re-carboning, trimming or any attention. The current consumption is, as stated by the makers, 600 watts, or six amperes at 100 volts, equivalent to seven-tenths of a unit per 1,000-c.p.-hours.

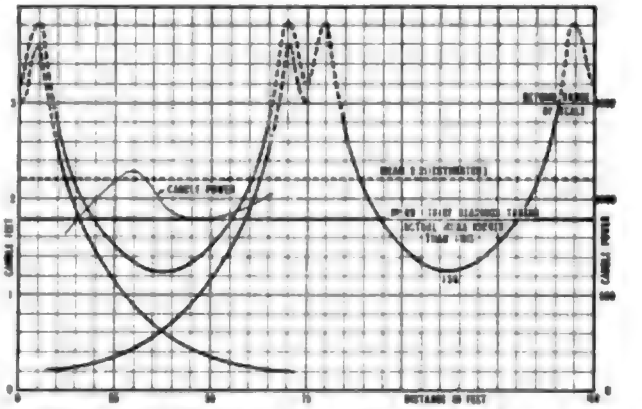
Under the superintendence of Mr. Ratcliff, the head of the testing department at the Polygon, an extensive system of comparative tests have been made between (1) the new arc lighting, (2) the intensified gas system, and (3) the ordinary incandescent gas lamps, on a portable street photometer, kindly lent me for the purpose by the Technical School authorities. The results of these tests are shown in the form of curves appended to this report. The readings were all taken at a height of about 4ft. 6in. from the ground, this being the most regular height for measurements of this class. The results are expressed in the usual illumination units—viz., "Candle-feet," or, in other words, the particular illuminating effect at any point is expressed in terms of the equivalent number of candles at a distance of 1ft. away from that point. Ordinary street lighting illumination varies from 0·08 to 1·5 candle-ft. Anything over 1 candle-ft. is very good, and over 1·5 candle-ft. exceptionally good. Lines are shown giving the mean illuminating effect, and also approximate curves for the candle-power given from the different lights. The curves show clearly the effect from lamp-pole to lamp-pole. The maximum candle-powers observed were as follows:—Piccadilly, 9-ampere arcs, 1,152 c.p.; Albert-square, 6-ampere arcs, 850 c.p.; Piccadilly, 6-ampere arcs, 753 c.p.; Sackville-street, intensified gas (three burners), 525 c.p.; All Saints', incandescent gas, 312 c.p.; Parker-street, "Scott Snell" gas (one burner), 291 c.p.; Cheetham Hill-road, incandescent gas, 147 c.p.

Fig. 1 shows the curves of illumination for the 9-ampere arcs on Piccadilly and the intensified gas lamps round the Technical School, which are to a great extent self-explanatory. With the arc lamps the light was so intense within a distance of 10ft. of the poles that the readings were off the scale of the instrument, and the curves had therefore to be calculated beyond a certain point with the help of the results from the 6-ampere lamps.

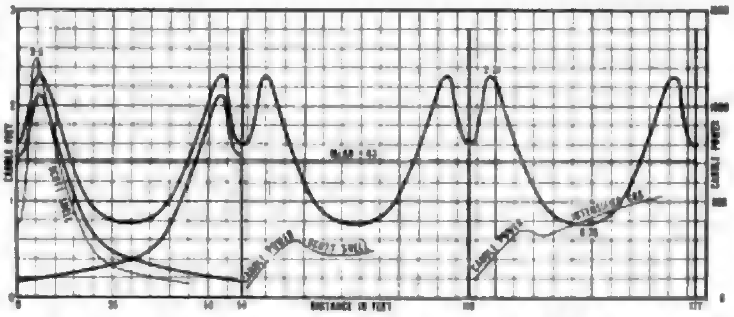
Fig. 2 shows the curves of illumination for the 6-ampere arcs in Albert-square and the incandescent gas lamps at All Saints'. It is interesting to compare the former with the "intensified" lighting round the Technical School, the lamp-posts being approximately the same distance apart, the mean illuminating effect in the case of the arc lamps being 2·03 candle-ft., as against 1·43 for the intensified gas. It will further be observed that the lowest mean illuminating effect is for the arcs 1·08 candle-ft. and for gas 0·76. Allowing even for the difference in the candle-powers of the respective lamps, this is an interesting result, as it disposes of the statement that the electric arcs in Manchester do not diffuse their light so well as the gas.

Fig. 3 shows the curves for the centre-pole arcs in Piccadilly and incandescent gas in Cheetham Hill-road. The lamp-poles in the latter locality are 200ft. apart, and the curves show that at a greater distance than about 50ft. from the posts there is no illumination at all. This would be a good route for the adoption of arc lighting.

The question of comparative costs, I have already submitted an estimate to you in my report of March 10th, and the results obtained have practically borne out those figures, and little modification is necessary. The price hitherto charged for current for street lighting has been 2d. per unit, but considering that the load factor is a very high one, approximately 40 per cent., the price could be fairly reduced to 1½d., and still allow a margin of profit. The latest available costs show that for a demand of this nature the running and standing charges together only amount to 0·95d. per unit, so that there would be a profit of 0·3d. per unit based on the 1½d. rate, irrespective of the fact that the fixed charges are going on now the whole time, whether the demand is made or not. We have at the present time 24 all-night lamps and 21 lamps that are switched out at 11 p.m. Averaging these together, I find that under the new working



Position: Piccadilly. Description of Lamp: Gilbert Arc Lamp, 9 amps. Height: 19ft. 8in. Distance between Lamps: 78ft. Illuminating Effect: Maximum 3·85 (estimated), Minimum 1·24, Mean 1·78 (of Readings taken); (Candle-feet) 2·21 (estimated).

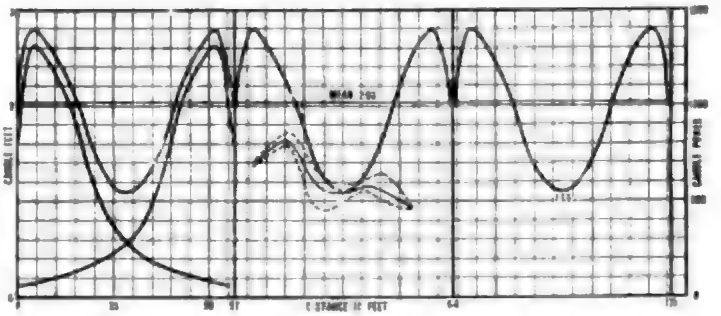


Thin Line Curve.—Scott Snell Intensified Gas Lamp at the corner of Parker-street and George-street. Height of Lamp: 11ft. Maximum Illuminating Effect in Candle Feet 2·5.

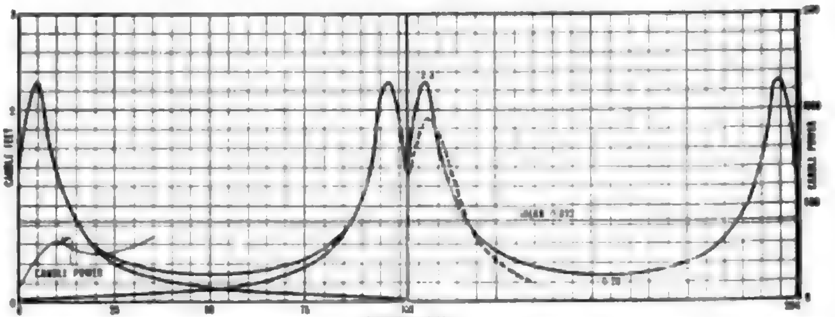
Thick Line Curves.—Position: Sackville-street, alongside Technical School. Description of Lamp: Intensified Gas, 3 burners. Height: 13ft. 4in. Distance between Lamps: 58ft. 8in. Illuminating Effect: Maximum 2·31, Minimum 0·76. Candle Feet: Mean 1·43.

All readings taken 4ft. 6in. above the ground.

FIG. 1.—COMPARATIVE CURVES OF ILLUMINATION. ARC LIGHTING VERSUS GAS LIGHTING.



Position: Albert Square. Description of Lamp: Gilbert Arc Lamp, 6 amps. 100 volts. Height: 17ft. Distance between Lamps: 57ft. Illuminating Effect (Candle-feet): Maximum 2·5, Minimum 1·08; Mean 2·03.



Position: All Saints'. Description of Lamp: Incandescent Gas, 2 Lamps on each Standard, 3 Burners in each Lamp. Height: 14ft. 6in. Distance between Lamps: 162ft. Illuminating Effect. Maximum 2·3, Minimum 0·28. Candle Feet. Mean 0·822.

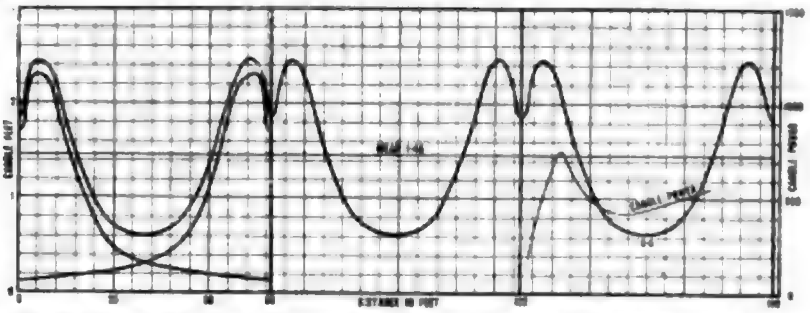
FIG. 2.—COMPARATIVE CURVES OF ILLUMINATION. ARC LIGHTING VERSUS GAS LIGHTING.

conditions, and with current at 1¼d. per unit, the equivalent price per lamp per annum works out at £11. 17s. 6d. The price charged on the basis of the old working was approximately last year £19 per lamp per annum. It is evident that a substantial reduction could be made in the event of the department obtaining consent to extend the present street lighting system.

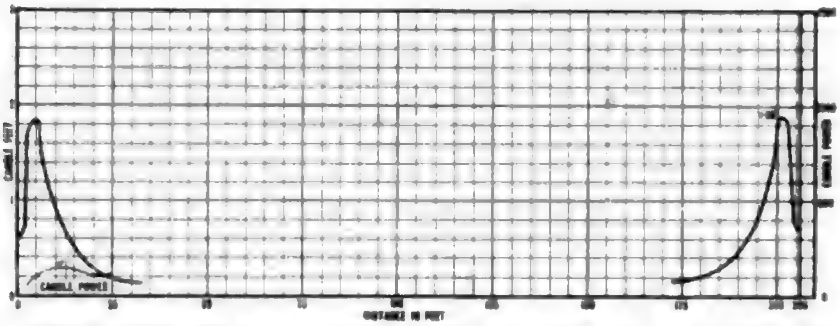
Comparing the costs of production for street lighting as between "arcs" and the "intensified gas," I take the last figure furnished me by the gas department for the latter method, which is at the rate of 1·08d. per 1,000 c.p.-hours. I believe this figure also includes 10 per cent. for depreciation.

Gas—At 4,000 hours of burning. Degree of illumination equivalent to 1,000 c.p. Cost = 4,000 × 1·08d. = £18.

Electricity—Under the same conditions as above:—Number of units used = 4,000 × 7/10 = 2,800. 2,800 × 0·95d., £11. 1s. 6d.; Carbon and trimming, 8s.; Depreciation 10 per cent., £1. 3s. Cost = £12. 12s. 6d. Equivalent to 0·75d. per 1,000 c.p.-hours. I have taken the same figure for depreciation for comparison.



Position: Piccadilly on Centre Tramway Poles. Description of Lamp: Gilbert Arc Lamps, 6 amps. 200 volts. Height: 18ft. 8in. Distance between Lamps: 66ft. Illuminating Effect (candle-feet): maximum 2·45, minimum 0·60, mean 1·45.



Position: Cheetham Hill Road. Description of Lamp: Incandescent Gas, 4 Burners. Height: 11ft. Distance between Lamps: 206ft. Illuminating Effect (candle-feet): maximum 1·56.

FIG. 3.—COMPARATIVE CURVES OF ILLUMINATION. ARC LIGHTING VERSUS GAS LIGHTING.

From calculations made I find that the costs of illumination in Albert-square and Sackville-street work out as follows:—

Albert-square arcs—

Consumption, 600 watts per hour.
Mean candle-feet (M.C.F.), taken from curves = 2·03.
Board of Trade units per M.C.F. per hour = 600/2·03 × 1,000 = 0·295.
Which at 0·95d per Board of Trade unit = 0·28d.
∴ Cost per M.C.F. per hour for arcs = 0·28d.

Sackville-street Intensified Gas—

Cost of production ......1·08d. per 1,000 c.p.-hours.
Equivalent to ....0·565d. „ 525 „
Mean candle-foot, taken from curves = 1·43.
∴ Cost per M.C.F. per hour for gas = 0·565d./1·43d. = 0·395d.

The above calculations, as far as they affect the "arcs," are based on actual measurements taken on the site. These results are based on the results of working of the past few months, and are, therefore, reliable, and there is only one conclusion to be drawn—viz., that the electricity department can carry out a system of street lighting that compares more than favourably with the "intensified gas system," both from the point of view of annual cost and illuminating effect.

As the committee are probably aware, we have at the present time a large amount of arc lighting cable laid in various parts of the city. I find this amounts to no less than 22 miles, and the approximate cost of same is £13,000, not one penny of which is bringing in any return—in fact, the cables never have been put into use yet.

The following is a list of the principal streets in which these cables are laid:—Cheetham Hill-road, Great Ducie-street and Bury New-road, Rochdale-road, part of Oldham-road, part of Ashton Old-road, Stockport-road (Longsight to Heaton Chapel), Oxford-street, Oxford-road and Wilmslow-road to Fallowfield, Corporation-street, New Islington, Bradford-street and Beswick-street, Deansgate, Brook-street and Upper Brook-street, Whitworth-street West and Whitworth-street.

Short lengths in addition to above in various parts of the city.

I trust that as the outcome of this effort on the part of the committee some tangible extensions will result.

NOTES ON PERMANENT WAY FOR TRAMWAYS.*

BY A. N. CONNETT.

The cost of new track varies in general from £4,000 to £6,000 per mile of single line. There is naturally a wide variation in the proportion of cost of the various items entering into completed track, due to local or special requirements. The following analysis of proportionate costs will be found to be a fair general average for new lines:—Rails and fastenings, 22; special work, 10; paving material, 30; cement, sand and broken stone, 14; labour, 15; bonds, 2; and cartage and miscellaneous, 7 per cent.

Rails.—The necessity of standardisation has been amply demonstrated by the unanimity with which the recommendations of the Engineering Standards Committee were adopted. I have no desire to say anything about the standard sections, further than that I think them admirable, having regard to the conditions imposed upon tramways in this country. I am not, however, an advocate of too rigid an adherence to the specifications suggested by the Committee; not but that they may be quite correct when properly interpreted—as a layman I would not suggest otherwise. The experts on the Continent differ from their brethren in Great Britain and the United States in that they consider that the physical tests show sufficiently whether the product is fit for its intended use, and they therefore limit themselves to such tests, leaving to the manufacturer a free hand in other respects. There is a risk that the engineer, who cannot always be expected to be an expert in metallurgy, may specify chemical requirements inconsistent with the physical tests. Again, the product may pass satisfactorily the required physical tests, but depart from specified limits in one or more comparatively unimportant elements in the chemical analysis.

Joints.—When the permanent-way construction consists of rails laid on sleepers with ballast foundation, the tramway engineer may feel justified in adopting a splice-bar joint, either of the ordinary type, or combined with some such feature as the continuous joint gives. Such a permanent way is at least fairly comparable with that of steam railways. If the sett-paving is laid with sand joints it is not a very expensive matter to have access to the joints when they need repairs. Such conditions largely exist in the United States. In this country the requirement of a concrete base for paving, with the setts laid almost directly on the base, makes the construction as above outlined hardly admissible. Having given a foundation of artificial stone, what more natural than to lay the rails directly thereon. Most of the tramway construction has been so made, and there seems to be no marked tendency to depart therefrom. The conditions existing in permanent way so constructed must of necessity differ widely from those found with the elastic road-bed of a steam railway. For example, the wave motion which is so well known in railway practice must be, if not practically absent, at least much modified with the continuous rigid foundation of a tram line. There is thus no necessity for a tramway engineer to give much consideration to the possible bad effect of unduly stiffening the joint on account of prejudicially affecting the continuity of the "wave." On the other hand, the tramway engineer has a serious condition to meet that the railway engineer has not, in that the tram-joint is inaccessible for inspection and repairs. This in reality is the vital difference. If tramway joints could have the same attention that they have on steam roads, the joint problem would have about the same relative importance in the one case as in the other.

Disregarding any other than mechanical joints, it will be found that splice-bars of special form, or ordinary bars used in conjunction with some other device, form the great majority of joints, patented or otherwise. A well-designed bar should have the following features:—(1) Large area of bearing surface at top and bottom. The load from one rail to the other being transmitted by the joint, it is evident that this load should be distributed over a large bearing surface. (2) The maximum thickness of bar that circumstances will permit. Having given a determined depth of rail, the stiffness of the bar to resist flexure can only be increased by added thickness. It is, of course, evident that the stiffness is immensely increased by adding to the depth of the bar. This would explain why the ordinary form of fish plate has been so successful with the deep rails used in America. The thickness of metal also prevents deformation of the bar by the bolts. (3) The vertical member of the bar slightly convex in relation to the web of the rail. The advantage of this is two-fold. It prevents the bar from being drawn inwards from the vertical position by the effect of tightening the bolts, and it also permits the use of concealed bonds. (4) A clear theoretical distance of from ⅛in. to ⅜in. on the fishing surface of the rail, top and bottom, to be left after the bars are finally fixed in place. This allows for slight inequalities in the rollings without destroying the fishing effect, and also permits taking up the wear which occurs in service on the flat fishing surfaces of rails and bars. (5) Long splice bars, say between the limits of 26in. to 32in. The great wear of the fishing surfaces of rail and splice bar appears in that portion near the joint. It is, therefore, of little practical utility to make the bars of an abnormal length. Personally, I believe that 26in. is, all things considered, about the right length. This permits a good distribution for six bolts.

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* Paper read last night before the Tramways and Light Railways Association. Slightly abridged.

The engineer should make rigid requirements in his specifications for accurate fit between the bars and the rails, and see that such are carried out by the manufacturers. To accomplish this the bearing surface of the rails should be thoroughly cleaned of rust and scale by using a hand hammer and file. If the splice bars have been dipped, the compound should be removed from the bearing surfaces in some suitable way. The splice bars should be put on "square," and at first only drawn up sufficiently to hold the rail snugly together. After the rails are surfaced, the bolts should be drawn up tightly, using not less than a 2ft. spanner, and at the same time tapping the head with a light hammer. As a final precaution, the bolts should be gone over in the same way, just ahead of the paving work. From experience, I feel safe in saying that such joints will give excellent service, provided they are opened up and refixed once a year. The cost of repairs to such joints, including taking out paving, refixing plates and reinstatement, should vary from 3s. to 4s. per joint. If 60ft. rails are used, the number of joints will average, say, 190 per mile of single line. The cost then will vary between £30 and £40 per annum.

What is called the "anchor" joint is very largely used in this country. This type of joint might with advantage be called "girder sole plate" joint, the anchoring feature being merely incidental. Usually a piece of the rail is used, though any ordinary girder section answers quite as well. Such a construction has been used on steam roads, where it was called a "crop end" joint. It was found to give a stiff joint, so stiff, in fact, that it was a question whether the rails did not wear more from this cause than they would have with the ordinary flexible angle-bar joint. This objection can have little weight for tram rails laid continuously on an unyielding concrete foundation. Such a joint should be of considerable assistance to prevent the initial loosening and consequent refixing, but wear will occur between the bottom of the rail and the top surface of the girder sole plate. The experience gained by putting joints on extended yoke seats in cable railway construction, demonstrated conclusively that such wear does occur. When once looseness at the joint commences, the subsequent maintenance of a good joint will depend upon the splice bars. Whether the presence of a stiff girder sole plate will affect the refixing of the splice bars to get a good joint, I am unable to state, having had no personal experience to guide me. In fixing the joint above described, it is necessary to take the precaution of careful examination of the rail heads. The slightest difference in level in the two abutting rails will cause "pounding"; the rail ends consequently should be filed or ground off, wherever necessary, before the tracts are used for car service.

Scarfed or bevelled joints have been quite extensively tried on the Continent. If there is any advantage in these, it must be on the principle that the wheel drops into the space between the rails when the joint is square. How slight the drop is may be seen from the example of a 30in. wheel and a ¼in. joint, the drop in this case being less than $\frac{1}{1000}$in. If joints were damaged from this cause, the rail ends should be "battered." An examination of the rail heads at worn joints will quite invariably show a bright or battered spot, an inch or more from the gap between the rails. On double lines the direction of travel of the cars can be determined by the relative position of this worn or bright spot, it being found on the entering and not the leaving side of the joint. This would indicate that the wheel jumps before arriving at the gap between the rails, and that this is due to flexure at the joint. It would appear, then, that the scarfing or bevelling of rail ends can have no beneficial effect.

Special Work.—There has been a notable advance in the past three years in the ideas of engineers as to the type of special work best suited to tramway requirements. Short castings with "baby" tongues and primitive arrangements for fishing the joints are being replaced on most work by much more suitable types. Long points, from 11ft. to 13ft. over all, are now being generally used, the tongue having a length of about 7ft. The tongues should be invariably curved on the curved side. The body of the casting is either of ordinary cast steel or manganese steel. The difficulty with both is to get a good joint with the abutting rail section. It is almost hopeless to expect to get as good a joint here as elsewhere on the track. The consequence is that these joints fail before the others. It is questionable, then, why such material as manganese steel should be used for the body of the casting. Outside of the joints the real wear takes place on the tongue. These are made of annealed cast steel, manganese steel or forgings. Either of the former will wear longer than the last mentioned, but the cast tongues have the disadvantage of breaking more frequently from flaws or blow-holes. At all facing points, where the cars will take either one or another direction, it is preferable to use one tongue and one blind point. In this manner all mechanism is avoided to connect the two tongues and pointsmen can be dispensed with. All that is necessary is to have a hooked end rod hung over the front dasher. The motor-man stops over the points and unhooks the rod which has a flat rectangular piece welded on its lower end. He can throw the tongue in an instant and resume his journey. The blind point is designed with an inset piece to give it a long life. Even if it does not give as great a life as a double-tongue arrangement, certainly the difference will not by any means compensate for the outlay in providing pointsmen.

Crossings should by all means be of the well-known "iron-bound" type, with hardened inset placed at the junction of the grooves. This construction permits of as good a joint being made at each end of the crossing as elsewhere on the track. It is possible that in practice it will not be found feasible to renew the hardened wearing piece; nevertheless, it will give in itself a much longer life to the crossing, and should invariably be a part of the same. If, when it wears out, it can be successfully replaced by another one, so much the better. There is too great a tendency for these inset pieces to shake slightly loose after being in service but a comparatively short time. Manufacturers should pay great attention to overcome this defect. The raised floor of the hardened piece should be bevelled at the ends, but nevertheless, so designed that its height from the rail head is the same as that of a new wheel flange. In this way, the jolt to the car which is so often felt at the crossings will be avoided

On any tramway system there is no necessity to have more than, one radius for the points, even for lay-outs. Immediately beyond the point the curve can be compounded into a greater or less radius, if necessary. This will mean that there will be only four patterns in use on any system, assuming that no double-curved tongues are used. For cross-over roads and turn-outs, standard angle crossings need only be used. If there could be some uniformity in the types of points and crossings used generally in the country, it would be of very material advantage. These could then be made up and kept in stock by the manufacturers, and construction work could be proceeded with in a much more satisfactory manner than at present. It is a well-known fact that in almost every case the date of completion of permanent-way work is dependent upon the delivery of special track work.

Of course there can be no uniformity in the crossings of special lay-outs at junctions. On most tramway jobs, however, the greater portion of the special work occurs in turn-outs and cross-over roads, and if these can be had promptly the junction work can be manufactured during the construction period, so that they can be put in towards the last, and in this way the time of completion of the whole job materially hastened. If the type of iron-bound crossings is generally adopted, manufacturers can at any rate keep in stock the standard British sections, so that these can be put in hand without waiting for the rolling of rails for any particular piece of work.

Curves.—The wear of rail at curves is quite a serious matter in lines where the car traffic is heavy and the curvature considerable. A due consideration of how the wear is produced may not be inappropriate. Wellington, in his well-known work on railroad location, made an analysis of the problem, from which most of what follows is taken:

If the rear wheels of the truck have no flanges, the rear axle would assume a radial position, and, consequently, the wheels would leave the rails, taking a place inside of the curve, the amount of which would vary inversely with the radius, and directly with the wheel base. On railways with bogie trucks and large radius curves, the rear axle does take this radial position, but with tramways where the radius of the curves is so small, comparatively speaking, the distance that the rail wheels tend to stand away from the rails is much greater than the play of the gauge; therefore the near axle is prevented from taking its natural position, and in consequence the axle takes a position parallel to a radius drawn to the centre of the truck. In the case of the tramway truck, there is therefore a certain wear on the rear wheel flanges, and, consequently, on the rails also, due to the effort to keep the rear wheels on the rails. This wear is inversely proportionate to the radius of the curve, but is not considerable, because the displacement from the natural position of the wheels is not great, and the centrifugal force of the car on the curve acts in the contrary sense, thereby tending to diminish this wear. The real work in pushing the wheels laterally from the straight line direction, where they naturally roll, is performed by the front inner wheel. If the axles could assume the radial position the wear would be slight, but the angular position of wheel and rail, which increases with the wheel base and with the sharpness of the curve, produces rubbing friction between rail and flange. If the wheel base is short, practically the whole work will be performed by the inner front wheel. With long wheel base, the rear outer wheel will do a portion of this work—*i.e.*, the total amount of the work will be greater, but the distribution of the wear will be better. Of course, there is a limit in length of wheel base which, if exceeded, will not permit the flanges to enter the groove in the angular position of the wheel with respect to the groove. A section should be made of the proposed flange in the minimum curve, in the angular position determined by the wheel base, to see that the flange will roll in the groove. If is does not, the wheel base must be shortened, or the flange made narrower. This is not a plea for long wheel bases, but only an effort to show that, within certain well-defined limits, they are not so prejudicial as is generally supposed.

In a Paper recently read it was shown that bogie cars of the maximum traction type have a largely increased current consumption for about the same carrying capacity car body. The statement was made that the test conditions were favourable to the bogie cars in that the route had an excessive amount of curvature. I believe, on the contrary, that the difference would not have been so marked on a straight route. With the bogie truck the flange and rail has to overcome the friction of the centre plate for pivotal trucks, and, for maximum traction trucks, the very serious side-plate friction. The experiment above referred to was made with side-bearing maximum traction trucks against single trucks. If centre pivotal trucks had been used, in all probability the difference in current consumption would not have been so great. I know of an instance where single and maximum traction trucks are used, and where the wear of flanges and curve rails is excessive. This is attributed to the single trucks because the wheel base is 7ft. I believe, on the contrary, that the maximum traction trucks are the worst offenders. Theoretically, the flange pressure to overcome centre or side-plate friction on bogie trucks only takes place on entering and leaving the curve, assuming that this is not compounded. The trucks not being absolutely rigid, there is some "give" in them, and consequently flange pressure from this cause will exist all through the curve, though, of course, to a much greater degree at the two ends. To sum up, one cannot assume a minimum rail and flange wear with bogie trucks, especially of the side-bearing maximum traction type. Previous to the introduction of the standard types, most of the curve rails had vertical sides to the lip or guard. Consequently, the wear of the lip and flange was very rapid until the angle of wear (12 to 16 deg.) was reached. Unfortunately, there was then very little lip left, and renewals were consequently unnecessarily rapid. With the standard type of curve rails much better results will be obtained. Perhaps, in the near future, curve rails will be rolled of a more suitable material, say nickel steel.

Construction.—It has already been said that the concrete type of construction will, in all probability, remain standard in this country. There is nothing to show but that, all things considered, it is the most suitable. Notwithstanding that the best cement is that which is slow setting, progressing slowly and uniformly to its maximum strength, tramway conditions are such that quick-setting cement is essential. If the work could be protected from traffic for a long period, slow-setting cement might be used with advantage, but this is generally an impossible condition. The proportions to make a good concrete are often specified in a misleading way. For instance, six to one concrete is mentioned in a schedule, and described in the specifications as four parts broken stone, two parts of sand and one cement. Such a mixture is, in reality, nearer a four to one than a six to one. Ballast or pit gravel, if suitable, is often allowed to be substituted for the mixture of sand and broken stone. In this case a mixture of six of gravel to one of cement is considered, for all practical purposes, the equivalent of the mixture of four of stone to two of sand. A little consideration will show that this cannot be the case. A suggested variation in the specification is that the sand and stone shall be mixed in specified proportions, and that the concrete shall consist of a mixture of so much of the aggregate to one of the cement. If, for example, six to one concrete is intended, this could be specified six of the aggregate to one of cement, the aggregate to be composed of four parts of stone to two of sand.

There are two ways of setting the rails on the concrete. In one case the concrete is laid to within, say, an inch of the proper surface for the base of the rail, and the rails are then laid on the concrete and surfaced by blocks or wedges. The space between the base of the rail and the top of the concrete is packed in with fine concrete. The principal disadvantage of this method is that the surfacing of the rails to the required levels may diminish the packing space to such an extent that only a very thin skin of fine concrete can be placed between the base of the rail and the foundation, properly speaking. The vibratory action of the rails due to the car traffic may crack, pulverise or otherwise injure this thin layer of concrete or mortar. The other way is to block up the rails to the required levels first, and then place the concrete in one operation. To do this the concrete needs to be made rather wet, so that it will have the characteristics of a quaking mass. The concrete should also be carried up beyond the base of the rails on each side, and worked well under the rails, and then all smoothed off with the shovel before it is set. If the work is properly done this method should give the better result.

A very interesting variation from the usual method of construction is that adopted by Mr. A. E. White, M.Inst.C.E., at Hull. The construction is essentially a concrete one, but there is interposed between the rail and the concrete a creosoted Baltic redwood sleeper 4in. deep and 7in. wide. A similar construction was used in the Third Avenue conduit construction in New York, a continuous wooden stringer being placed between the rails and the yoke seats. The purpose of this wood liner is to provide some elasticity to the running rail, and, consequently, a more noiseless and perhaps easier riding track. Such a track must in no way be confounded with what is known generally as the sleeper construction, so widely used in America. The longitudinal sleeper in Hull is merely a cushion between the rail and the concrete foundation. The rail used in Hull has novel features. The groove is in the centre, with two narrow treads on each side. The wheel, of course, has two treads and a central flange. The advantage of such a rail is that there is uniform wear each side of the groove. The joints are bevelled to an angle of 45deg. This type of rail can in the very nature of things have little general use for the reason pointed out by Mr. White—viz., that it cannot be connected up for intercommunication with systems on which the ordinary rail is used. If what has previously been stated on the subject of rail joints is true, the good results shown in Hull with these joints should be due to other causes. Mr. White writes "that comparatively little trouble has been experienced with the rail joints, and the rhythmic hammering of the car wheel as it passes over the joint is not heard on the Hull system in the same way as in most other systems which have been in operation for any length of time with ordinary joints. The two routes first constructed have now been running for over five years, and, until during the last few months, the rail joints have had practically no attention. We are now, however, having them all tried over with a straight edge, and all joints which are in any way loose, or show a depression of more than $\frac{1}{4}$in. on a 5ft. stretch with the straight edge are being opened out, packed where required and tightened up." Mr. White further points out that, making due allowance for extraordinary expenses connected with the maintenance of the permanent way, there is left a sum of £700 for ordinary maintenance. This for a car-mileage of 2,500,000 makes an expense of 0·067d. per car-mile, which is only about one-quarter of that usually found on tram lines that have been running for this period, which is certainly very satisfactory. Personally, I believe that this result is in a great measure due to the care which must have been exercised originally in the construction of the lines, and that the special features of the construction, if contributory to the good results, are only so in a minor degree.

There is a very marked tendency in permanent-way construction now to anchor firmly the rails to the concrete bed. The object of this is to prevent the working of the rails under the rolling action of the cars. The principal disadvantage in the vertical motion of the rails is to produce a joint between the abutting paving and the rails. Whether anchoring will prevent this, and, if so, what form of anchors should be used and the requisite spacing, will have to be determined by experience. There is one thing that is quite evident—viz., that the amount of movement is slight, and that any anchor which allows the slightest play between it and the rails or between it and the concrete will not be efficient.

Paving.—From the point of view of maintenance, there can be no question but that granite sett paving is the proper one for tramway tracks, but considerations of another nature have often more force than the permanent way up-keep of tram lines. Consequently, wood paving has been largely used, especially in streets where paving from the kerb to the rails is wood. Outside the question of wear and early renewal of such paving, there is always the danger that the blocks will expand to such an extent that the gauge of the track is endangered. With a 7in. rail and 4in. depth of block, there is little, if any, danger of this occurring; the concrete and floating coming up 3in. from the base of the rail surrounds it, so that it is held tightly against any lateral movement. The effect of expansion in this case is that the wood arches from rail to rail. It is quite common to hear a dull hollow sound when a vehicle passes over such a pavement. With deeper blocks, or shallower rails, or the combination of both, there is danger of the rails moving or tilting. In this case, dependence can be placed on the anchors, if such form part of the construction, to prevent the movement of the rails. The tie-rods should be especially strong, placed as high as possible and spaced closely together. My own experience has been that with soft wood thoroughly creosoted, there is little or no danger of disturbance to the track from expansion of the wood blocks. With hard wood blocks, which naturally are untreated, this danger exists, and very great precautions must consequently be taken.

Tarred macadam has been used to some extent for lines in sparsely settled districts where the roads are but little used. Such pavement must be put down when the weather conditions are suitable. There is but little use in specifying tarred macadam for winter work and expecting good results therefrom.

COHERER ACTION.*

BY DR. K. E. GUTHE.

The type of instrument best known by the name of coherer—*i.e.*, a glass tube filled with metal filings—was studied as early as 1885 by Munk af Rosenschoeld, who clearly describes the permanent increase of the electrical conductivity of filings of tin, pieces of carbon and other conductors, by the discharge of a Leyden jar, and who showed that a shaking of the tube would restore the original high resistance. The formation of a good electrical contact in a finely-divided mass of black lead or charcoal, by a sufficiently high voltage, was observed by Varley in 1870. Fifteen years later Calzecchi-Onesti designed a filing tube and clearly recognised its peculiar action. After having noticed the lowering of resistance due to the opening of a battery in the circuit or to discharges from a Holtz machine he went as far as to connect the tube in series with the secondary of an induction coil producing the coherer effect by interruptions of the primary. In 1890 Branly published his first investigation in which he demonstrated that the filing tube, re-invented by him, would respond to sparks produced at a distance from it—an investigation which formed the beginning of a systematic study of coherer action. Similar results have also been observed with conductors forming a so-called single contact. Hughes clearly grasped, as early as 1879, the importance of the coherer action upon a microphonic contact as a means of signalling through space, but was prevented by circumstances from following up his important discovery. Schuster and Bidwell had probably to do with similar phenomena without, however, recognising their value. In 1889 Lodge was led from a study of Boltzmann's form of wave detector to the construction of the double knob coherer, and employed it in his syntonic jar experiment. After becoming acquainted with Branly's tube he immediately recognised the similarity between the two and gave the name "coherers" to all instruments which showed the striking decrease of resistance due to electrical action, a name more appropriate according to our present knowledge of the subject than "radio-conductor" or the German "fritter."

A great many different explanations have been proposed for "coherer action." The one which seems to have found the largest number of adherents is that of Lodge, who believes that the metallic surfaces are originally separated by some badly-conducting film which may be compressed and partly be pushed aside by electrostatic attraction. The film finally bursts "with what we must be allowed to call a spark, though an infinitely small one," and the metal particles are welded together. Though Lodge is very careful in his statement, a large number of investigators have tried to prove the existence of sparks by direct observation under the microscope, but in all these cases the excitation was far beyond that which is necessary to produce a distinct coherer effect; while Harden, Muraoka and Tamaru have shown that frequently in spite of strong sparking no cohesion takes place, unless the gap between the particles is made smaller than 0·001cm. Further, it is not surprising that in cases of strong excitation a motion of the small particles has been observed, as by van Gulick, Appleyard, Hanchett and Semenov; consequently it has been suggested that this motion plays an important role. Eccles considers orientation of the particles as the first and most important step in coherer action. Tissot's magnetic coherer shows that orientation due to a magnetic force improves the sensitiveness, though he has never observed an orientation of the particles while coherence took place.

Auerbach, who observed the influence of sound waves upon the resistance of a coherer, believes that pulsations may be set up in the particles by the electric oscillations and thus the resistance be reduced by "mechanical" action, a view also shared by Drago; but many observers show beyond doubt that a lowering of resistance takes place even if the particles are imbedded in solid dielectrics (Branly, Arons, Fromme). Looseness of the particles, in fact, often facilitates an increase of resistance under strong electrical influence as Blanc has shown. Branly's experiments with large metal discs as well as those with single contact coherers are also strongly against such an interpretation. Branly even advises to press the filings together in order to obtain the best results.

Finally, as far as the welding is concerned, it must be admitted that, after cohesion has set in, the particles may form chains (Tommasina, Sundorph, Malagoli), and the resistance is a metallic one, as can easily be proved by an alternating current measurement. A force is necessary to separate the particles, but Fromme, Guthe, Shaw and Tissot have been unable to detect under ordinary conditions the slightest trace of an actual welding under the microscope. Here, again, we must be careful not to base our interpretation of the coherer action upon the effects produced by lightning (Stroh), discharges from a Leyden jar or an electrostatic machine (Tommasina) or by a strong electric current (Sundorph). As van Gulick points out, we can hardly speak of a fusion in the case of carbon, which is known to form good coherers. Mizuno states that the lower the melting point the lower will be the resistance of the coherer, but his observation has not been confirmed by other investigators. It would also be difficult to explain, as found by Branly and Aschkinass, that a slight increase of temperature—not necessarily higher than the one at which the coherer action was produced—will restore the high resistance while a cooling has no such effect. From a slightly different point of view Eccles, Ferrié and Shaw are led to believe that by the electrical influence short metallic bridges—possibly of metallic dust—are formed which break down again on tapping. Sundorph's experiments on the formation of such bridges with large currents seem to support this view. The greatest objection to this theory is, however, that it will not embrace the phenomena of self-decohesion, of which we shall speak presently.

Branly believes that the nature of the dielectric between the conducting particles is changed by electrical impulses, and that it becomes in some way conducting. A direct influence of this kind upon dielectrics has, however, never been observed, and coherer action is entirely suppressed, as Hurmuzescu and Childs have shown, if the insulating film is not extremely thin. The nature of the dielectric has also no influence upon the phenomena unless its viscosity is considerable (Fisch) or an electrolytic action is possible; filings in vacuo seem to act just as well as in air or other gases (Dorn, Jervis-Smith and Aurén). Huillier has shown that a change of the dielectric, after cohesion has taken place, will not affect the resistance. While we must, therefore, deny the possibility that the dielectric as such becomes the conducting agent, the theory may be modified, as will be shown later, so as to conform more closely to the observed facts.

Bose's interesting speculations lead to an exactly opposite conception of coherer action. Some filing tubes show an increase of resistance instead of a decrease, and others, especially those containing dry carbon, will decohere again as soon as the electrical influence ceases. This suggested to Bose that the metals exist in two allotropic forms, one being a poor conductor and the other a good one. According to the modification present, we would observe a high or a low resistance. The change from one modification to another is produced by electrical oscillations. Strains due to the formation of the new molecular arrangement may, however, become so large that a sudden return to the more stable form—*i.e.*, spontaneous decohesion—may set in.

Eccles has shown that a steady difference of potential has the same effect as electric oscillations, and even Bose has admitted that the variation of the E.M.F. may be exceedingly slow and still produce this transformation in the metals. The results with decohering instruments are, moreover, often so variable with different degrees of excitation that the assumption of different modifications in the metals seems rather to complicate the problem instead of bringing it nearer to a solution.

Shaw also assumes some kind of rearrangement or orientation of the molecules at the surface, though not necessarily resulting in a new modification. He found that, after cohesion has set in, the contact been broken, and the electrodes brought together again at the same point, the resistance will be quite low—proving that the condition of good conductivity will remain for a short time at the surface of the metals.

An adequate theory of coherer action must take into account "decohesion," but frequently this phenomenon has as little to do with the real coherer action as have the visible sparks or the phenomena produced by excessive electrical influences. Schäfer's anti-coherer is based upon the principle that fine metallic connections are broken and thus the resistance increased, a fact observed before by Lodge, Arons and Mizuno. Guthe shows the same effect for a single contact coherer, with a loose particle between the electrodes, and also a part of Blanc's results may be explained in the same way. In the electrolytic decoherers designed by Neugschwender, Tommasina and de Forest a very similar action takes place, and Tommasina proved that the decohering action which Bose observed is in many cases due to the breaking of a fine metallic film in the oil, while the metals behaved normally in air. In this connection it may also be stated that moisture has to be guarded against carefully in the construction of the coherer. It would, however, be wrong to explain all coherer action as an electrolytic phenomenon, as Busch does. The decohesion of coherers containing lead peroxide and copper sulphide was explained by Sundorph, Aschkinass and others as due to chemical action, and by Drogo as due to mechanical disturbance. Instruments showing the sudden increase of resistance under the influence of electrical waves with following spontaneous decrease should not be called coherers; De Forest calls them "responders." The self-restoring coherers—*i.e.*, instruments the resistance of which decreases under the action of electric waves and then increases again—are, however, real coherers, and will be treated in detail below.

Recent investigations have brought to light the existence of a "critical" voltage—*i.e.*, a minimum difference of potential—which must be applied to the terminals of the coherer before a decided decrease of resistance takes place. Branly pointed out as early as

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* Abstract of a Paper read before Section A of the St. Louis International Electrical Congress.

1891 that the voltage plays an important rôle. Aschkinass found in 1898 that if the P.D. is above a certain value the coherer cannot be restored to its original state by tapping. This he called the critical voltage, a definition adopted also by Blondel and Dobkewitch two years later. Trowbridge defined in 1899 the critical voltage as the difference of potential which must be applied in order to produce coherer action and found it to be 8 volts for 20 steel contracts in series. Guthe and Trowbridge were able to show that for a given E.M.F. in the circuit the curves of the terminal P.D.s of a coherer, plotted as functions of the current, exhibited for small currents only a slight increase of conductivity, but with increasing current the curves bend rather sharply and finally approach asymptotically a definite value, which was called the "critical voltage," though it may be objected that some coherer action takes place before this value is reached. The final value was found to be proportional to the number of contacts in series, while contacts in parallel will each respond when the voltage has reached its critical value, results which have been corroborated by the investigations of Fényi, Turpain and Robinson. Guthe extended the investigations to a large number of different metals and determined their critical voltages, which for single contacts lie between 0·05 and 0·25 volt. He also emphasised the fact that the critical voltage seems to stand in a definite relation to the atomic weight and the valency of the metal. Though usually the difference of potential is plotted as a function of the current, the curves show very plainly that the former depends also on the total resistance of the circuit, or, if you wish, upon the applied E.M.F. Taylor undertook a research in order to test these results. Though he obtained a number of curves agreeing closely with the types described, others varied considerably from it, showing a number of sudden steps in the value of the difference of potential. Robinson took up the problem again, and found that with a single contact coherer the difference of potential has to be raised beyond that found by Guthe and Trowbridge before coherer action sets in, but that with larger currents it will always drop to a value agreeing closely with theirs, and which seems to be identical with the one defined by Aschkinass. He proposes, therefore, to call the latter the "impulse" value, while he wishes to reserve the name "critical voltage" for the indefinite value at which coherer action sets in.

On the other hand, Eccles obtained curves of exactly the same form as Guthe and Trowbridge by varying the difference of potential of a constantly-agitated coherer and measuring the current. Also Bose, in an interesting research, obtained curves which show all the characteristics of Guthe and Trowbridge's curves, though the final values reached are somewhat higher. It may be pointed out here that Guthe and Trowbridge always used freshly-cleaned contacts, while Robinson's coherers were oxidised. The latter observes, besides, that the less the oxidation, the smaller the critical voltage. We have thus apparently, in addition to the coherer effect proper, one due to the presence of an oxide film. Many observers are inclined to believe that such a film is necessary to produce the original high resistance. Dorn, Aschkinass, Tissot and others have shown, however, that this is not the case, but that the absence of oxide simply makes the original adjustment a little more difficult. Fisch, in a recent investigation, has come to the conclusion that the phenomena leading to Robinson's "critical voltage" do not form an essential part of coherer action.

We return now to the theories proposed for an explanation of coherer action. Guthe and Trowbridge assume that there is an electrostatic attraction due to the P.D. between the metallic particles—produced either by direct connection with a battery or by the E.M.F. induced by electric waves in the receiving system. This force brings the metallic surfaces within molecular range of each other, allowing ions to pass across the gap. Later, an increase of current will increase only the number of ions but not the P.D. This theory, accepted also by Wolcott, was later given in a somewhat modified form by Ferrié, but only as an explanation for decohesion, which the former did not attempt to account for. Ferrié follows Lodge in his conception of the regular coherer action; but assumes that in some cases the dielectric may be pushed aside by closely touching metallic particles, and that hereby a vacuum is formed. Under an electric influence a discharge takes place which increases the width of the vacuum space, but is restored to its original dimensions as soon as the excitation ceases.

In the following I shall formulate a theory along similar lines of reasoning and attempt to show its agreement with the perplexing multiplicity of phenomena observed in coherer action. The first step is in general an electrostatic attraction between the metallic particles. Lodge has shown that two conductors separated by a film of air 0·00001cm. thick and having a difference of potential of 1 volt are attracted by a force of 44 atmospheres per unit area. Shaw found that the maximum distance at which traces of cohesion occurred was a little less than 0·00001cm. The effect of electrostatic attraction may be shown indirectly. To illustrate I shall make use of a set of results obtained by Guthe and Trowbridge (*Phys. Rev.*, Vol. XI., pp. 26 and 27, 1899) with a single contact steel coherer, which was put in series with a variable resistance and an E.M.F. which in the different experiments was 6·5, 14, 60 and 220 volts respectively. While curves of the P.D.s as functions of the current are entirely distinct from each other, we obtain a single curve for all four series, if we plot the terminal P.D. and the reciprocal of the total resistance of the circuit.

We see from the figure that in all four cases the difference of potential is at first inversely proportional to the total resistance, or, in other words, that the resistance of the coherer is inversely proportional to the applied E.M.F., and that as long as the latter is constant, it will not change until the terminal difference of potential rises to nearly the critical voltage. On the other hand, if the external resistance is kept constant and the E.M.F. increases we must expect even in the early part of the curve a slight lowering of the coherer resistance, and this is what Eccles, Bose and Robinson have found. If we release the electrical stress at this stage there will be at least a partial elastic return to the original condition, as observed by Bose, Robinson and Blanc.

That in the coherer we have to do with very small distances follows also from a consideration of the critical voltages. From Earhart's investigations on sparking distances* we may calculate that one volt would be required to bridge a gap 0·00000056cm. wide. Guthe found as critical voltages 0·062 volt for silver and 0·22 volt for iron, which would allow for the distances at which the real coherer action sets in, only $3\cdot5 \times 10^{-8}$cm. and $13\cdot8 \times 10^{-8}$cm. respectively. I will not discuss the question whether the relation between the critical voltages and the atomic weights, alluded to above, has anything to do with these molecular distances. According to modern theory free electrons are moving about in the metals in every direction. J. J. Thomson says:† "One of the reasons the corpuscles do not escape from the metal is that as soon as they leave the metal there is an electrostatic attraction between the corpuscles and the metal equal to $\epsilon^2/4r^2$ where ϵ is the charge on one corpuscle and r the distance of the corpuscle from the surface of the metal." But in our case we have a strong external electrostatic field which will assist the electron in leaving the metal by increasing its kinetic energy. Thus electrons will be carried over from the metal charged negatively to the other side and we have an electric current, carried on entirely by the electrons. On this account we are unable to observe a transference of metal in the coherer even after it has been used for some time. A close parallel to this is found in an electric arc between cooled electrodes.‡ As soon as the metals have been brought within molecular range, an increase of the electrical energy will produce only an increase of the number of electrons—*i.e.*, the current will increase while the difference of potential remains constant. We cannot call this transference of electricity a spark in the ordinary sense, even disregarding the small distance, because the heat effect of the spark is absent. The passage of electricity is accompanied by a pressure at right angles to the flow,§ and this will push aside molecules of the dielectric which were possibly lodged between the metallic particles, and there remains what we may consider a continuous metallic conductor.

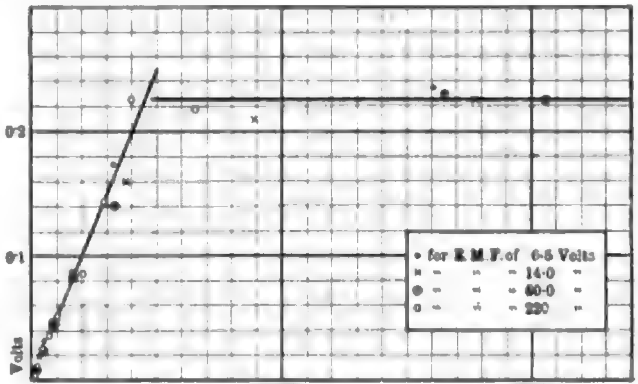

DIAGRAM SHOWING RELATIONS BETWEEN VOLTAGE AND CONDUCTANCE.

After the electrical impulse ceases we can hardly expect a return to the original state unless some force is applied to separate the particles; in other words, the resistance has been permanently lowered. Now, suppose that we separate the electrodes. In a short time the dielectric will condense again upon the metallic surfaces and the original high resistance is restored. But if immediately after separation the metals are brought together again at the same point, the dielectric has not found time to condense and the resistance is still small, as Shaw's observations show. In this case a reversal of the current seems even to be favourable to a return of electrons. Possibly an electrolytic or chemical action may be the cause of this. A tapping or shaking of the coherer displaces the particles with respect to each other and brings into contact new points at which the dielectric is not removed.

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* Earhart, *Phil. Mag.*, Vol. I., p. 147, 1901.

† Thomson, "Conduction of Electricity through Gases," p. 386.

‡ Weedon, *Trans.* Am. Electroch. Soc., Vol. V., p. 171, 1904.

§ Semenov, *Journ. de Phys.*, Vol. III., p. 125, 1904.

Another point which is in favour of this theory is the influence of temperature upon coherer action. It is well known that heated powders are good conductors. Guthe showed that on heating a single contact its resistance became very small and the critical voltage dropped practically to zero, and that both returned to the original values on cooling. The similarity between this and the effect of heating the cathode in a vacuum tube is apparent.

So far we have considered only the case where the metallic areas in immediate contact are large enough to supply practically all the electrons necessary to carry the current. But let us suppose that this is made impossible by the shape of the particles, for instance, where the surfaces are rough or where sharp points form the contact. The coherer would, in this case, offer a larger resistance than under ordinary circumstances—and this is characteristic of the self-restoring instruments. Doubtless in some cases, especially when the restoring power was observed under very weak influences, we have to assume that only the first of the two steps described above is produced, while a stronger excitation results in a permanent lowering of the resistance. In other cases this cannot be the reason for spontaneous decohesion. An ionisation of the surrounding gas must in part assist in the transference of the electrons, but will disappear again with a corresponding increase of the resistance—as soon as the electrical excitation ceases. The ionisation depends on the energy supplied: the resistance will, therefore, become smaller as the applied E.M.F. increases, but return to a higher value when the E.M.F. is lowered. With a constant E.M.F. and a small external resistance in the circuit, the decrease in the potential difference of the coherer when the current is established may allow a recombination of the gas molecules, accompanied by an increase in the P.D., which in its turn will again make the current larger, thus repeating the phenomenon. The combination of the E.M.F. and the resistances in the circuit are in this case such that the system is just on the verge of coherer action, and periodic alternations of this kind may give rise to musical sounds, as have been noticed by Ferrié and Hornemann. In vacuum tubes also such sounds can be produced.

As Warburg has first pointed out, there is always a retardation of a spark discharge, unless the surrounding medium is ionized by some independent outside action. A retardation of coherer action has first been observed by Aschkinass, who suggested a relation between the two phenomena, and later by Bose, Robinson and Hurmuzescu. Especially when the applied E.M.F. is near the critical voltage the "creeping of the resistance" is very striking, considerable time being needed for the sufficient ionisation of the medium.

Finally, it has been frequently observed that coherers show a tendency to fatigue—*i.e.*, after some use they become less sensitive. In many cases this is due to an increase in thickness of the oxide film. But as Huth has shown, this cannot be the only explanation. In his experiments, in which paraffin oil or air formed the dielectric, a fatigue is very apparent. In the case of the coherer containing the oil a recovery was noticeable after the instrument was left undisturbed for 12 hours. In the one containing the air admission of fresh air produced an almost complete return to the original state. We have here the same effect which is observed in discharge tubes. In the filings coherer the effect may be even more noticeable on account of the large number of solid particles which do not take part in the coherer action, but remove some of the ions from the path which the current is forced to follow by the given arrangement of the particles.

While we have distinguished so far the two ideal cases—one in which the current is due to the electrons from the metals alone and the other in which the ions of the surrounding medium are the principal carriers of electricity—we have doubtless a mixture of the two cases in most types of coherers, especially in the filings tube. The "partial" return to higher resistance on lowering the applied E.M.F. noticed by Bose, Ketterer and Blanc point to this conclusion. However, the results obtained with filings coherers are not easily interpreted. The shaking of the tube in order to decohere the instrument may produce a new arrangement of the particles and new conditions. While at first spontaneous decohesion may be predominant, in course of time the particles, especially if they are loose (Rochefort), may settle down with surfaces in contact large enough to produce permanent cohesion. It takes a freshly-filled filings tube a considerable time to reach a somewhat steady condition, as is brought out forcibly by Bose and Hurmuzescu. In the formulation of a theory we have to rely principally upon results obtained under well defined conditions, and these we find only in the case of coherers consisting of a single or of only a few contacts.

ELECTROLYTIC RECEIVERS IN WIRELESS TELEGRAPHY.*

BY DR. LEE DE FOREST.

The form and nature of the ordinary filings-tube coherer, as applied to-day in wireless telegraphy, is fairly familiar. Branly discovered, in 1891, that the effect of electrical oscillations upon a body of metallic filings was to produce a marked increase in the conductivity of the mass, a conductivity which persisted until the particles were broken apart again by mechanical jar. Although Varley, Hughes, Onesti and others had previously noted this phenomenon, none of these investigators had fully appreciated the causes involved, or given to the world of science the benefit of their researches in thorough published reports. The discovery of the "coherer," therefore, is rightfully attributed to M. Branly, but to Prof. Popoff, and to Sir Oliver Lodge must be given the credit of applying the relay and mechanical tapper to the filings tube, the addition of antennal wings, of upright wire and earth connections, and the first steps toward refinement and an appreciation of the possibilities of the new detector as applied to an unborn branch of human enterprise and progress. The notable work of Marconi in still further adapting the Popoff-Lodge arrangement to commercial requirements resulted in the gradual increase of distance on which aerographic communication was established. Ingenious improvements in coherers by such men abroad as Tissot, Ducretet, Castelli, then by Lodge and Branly themselves, and in this country by Shoemaker, comprise the history of that form of detector.

Theories of the action involved have been numerous, but divided chiefly into two schools: First, that of Lodge, who demonstrated an actual welding together of metallic filings, after the same had been drawn into contact by the electrostatic attraction of the opposite charges induced upon the faces of the filings; and, second, that of Branly, who ascribed the action to a breaking down or puncturing by minute sparks of the dielectric film (either gaseous or a metallic oxide), which he held must exist between opposing surfaces of the filings. The result of the years of investigation, which have followed the early work of these two pioneers, proves that in a measure both were right. The Branly effect undoubtedly exists and affords a satisfactory explanation of the self-decohering phenomena observed in the microphone type of auto-coherers. These insulating oxide or gaseous films inevitably form and cling to the surface of any metallic particles not enclosed in absolute vacuum, and where strictest care is not taken to prevent. They are, moreover, elastic, self-healing; and unless the electric impulses are of excessive violence, so that adjacent particles are actually welded firmly together, the original high resistance is automatically restored upon cessation of the electric impulse. This is notably the case when the elements of the radio-conductor are of carbon, hardened steel, carbon-mercury, aluminum, &c., where the formation of this resisting film is easily accomplished, or where, amid the minute roughnesses of the carbon surface, the adhesion of a gaseous film is made more easy. If, however, the coherer consist of filings of some soft metal of relative low-fusing point—silver, gold, lead—the Lodge cohering effect through actual welding follows upon the Branly action, making the final fall of resistance far more marked, and necessitating a vigorous mechanical jar to break up the cohered filings and restore sensitiveness.

The filings tube frequently shows a change from hundreds of thousands of ohms down to a few ohms under the influence of exceedingly weak electrical impulses. It is on account of this enormous change in conductivity of the filings tube coherer that this form has been the standard used almost exclusively in the coherer systems of wireless telegraphy. The result of all this has been necessarily a system employing delicate relays, tapping-back adjuncts, complications of apparatus requiring frequent and careful adjustments, a skill and delicacy on part of the receiving operator seldom found outside of the physics laboratory—least of all upon a man-of-war.

Again, despite numerous claims for speeds of word transmission by coherer systems, I have yet to see proof of anything exceeding 12 to 15 words per minute, while the actual everyday speed attained seldom exceeds half that amount. For commercial applications of wireless telegraphy this pathetic speed limitation of itself renders the filings-tube systems to-day an impossibility, regardless of any other considerations, such as uncertainty of their action, ill adaptability to electrical tuning, liability to interference (notably from atmospheric electricity), harmful effects from mechanical vibrations, &c. Better commercial results are obtained with the auto-coherer, or so-called microphonic contact. Since no tapping-back is required, a relay is superfluous, although the changes of resistance in the auto-coherer are generally so slight, and the normal resistance such a shifting quantity, that no relay capable of operating reliably with the auto-coherer has yet been perfected. A telephone is invariably used to-day in place of the relay and inker, and, inasmuch as the auto-coherer is usually a quantitative instrument possessed of no critical voltage, its combination with the telephone affords an extremely sensitive wave-detector. With this arrangement one obtains a word reception limited only by the ability of the operators to send dots and dashes with the transmitter spark and to translate them into words. Consequently, in this country, we find the alternating current of relatively high frequency and excellent regularity of action employed; with an ordinary Morse key, obtaining a speed of 25 to 35 words per minute, instead of the antiquated induction coil with its spluttering, sticking hammer interrupter, or its messy, explosive mercury-break; and the pump handle "Zeichengeber," which is considered abroad as a fitting accompaniment to the coherer receiver, and is so well designed to hold down the impatient sender to a sloth sufficient for that form of receiver. As we occasionally have seen in the daily press, the spark-coil, coherer systems are excellently adapted to the trying requirements of a "chess game by wireless telegraphy."

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* Abstract of a Paper read before Section G of the St. Louis International Electrical Congress.

The auto or microphonic coherer is, however, not well suited to the requirements of close syntony or electrical tuning. This is on account of its variable normal resistance and normal capacity. The device is liable to close up under the effects of severe static discharge, requiring readjustment by tapping, rendering difficult its employment during time of severe atmospheric disturbances and lightning storms. Moreover, its inability to operate reliably by a relay a bell for calling purposes often necessitates the addition of a filings tube for that purpose. Following this brief review of the field of cohering indicators of electric waves, I will call attention to an entirely distinct line of research leading up to forms of receivers which I believe may well be set in a class by themselves as regards sensitiveness, simplicity and general adaptability to most of the demands which can be made to-day in the field of wireless telegraphy.

In 1898 the German Neugschwender performed the following experiment; The silver-plating of a strip of mirror-glass was divided into two parts by a sharp razor cut, leaving a narrow gap between two silver edges, completely insulating the two sections. Each of the sections was now connected to the terminals of a dry battery, and a telephone and galvanometer inserted in series in the circuit. No current was observed to pass until a film of moisture was deposited upon the slit, either by blowing the breath thereon, or by placing a saturated sponge near by, or by placing a drop of water directly upon the slit. After a brief period the galvanometer began to show violent and irregular deflections; in the telephone a scratching, bubbling sound was heard, followed shortly by comparative quietness and a stable position of the galvanometer needle, indicating that the resistance of the gap in the silver mirror had been broken down until it measured but a few ohms. If now electric waves were generated in the neighbourhood, as from the spark of an induction coil, the galvanometer showed an increase of resistance in the circuit, while the listener in the telephone heard a humming sound, reproducing that of the induction-coil spark. Upon cessation of the electrical impulses the conductivity of the gap in the mirror instantly reasserted itself, and the sound in the telephone ceased.

Aschkinass, a year after Neugswender discovered this strange action of the Hertzian waves, noted the same phenomena, the publication of which led the former further to pursue his researches, and to examine the action at the moist edges of the silver electrode under a powerful microscope. His observations thereon, and my own investigations in 1899, coincide in all essentials, and demonstrate that the phenomenon is one of electrolysis due to the combined action of the Hertzian and local currents. They demonstrate, however, several features new to the generally accepted ideas of electrolytic action, and open up lines of speculation and research of unusual interest to the physicist. The phenomena noted above exist to a more prominent degree with tinfoil electrode in place of silver, and these I shall now attempt to describe. With the telephone to the ear and the eye at the microscope, the action, thus doubly observed, affords in fact one of the most fascinating, most beautiful pastimes (as I may well term it) ever granted to the investigator in these fields. When the local E.M.F. is first applied to the gap, minutest metallic particles, all but invisible, even with a thousand-power lens, are seen to be torn off from the anode, under the stress of the electric forces, apparently mechanical in action; and these dust-like particles, floating in the fluid, move across to the cathode, some rapidly, some slowly, by strange and grotesque pathways, or directly to their goal. Tiny ferry-boats, each laden with its little electric charge, and unloading its invisible cargo at the opposite electrode, retrace their journeyings, or caught by a cohesive force, build up little bridges, or trees with branches of quaint and crystalline patterns. During this formative period (lasting perhaps for half a minute) the ear hears an irregular boiling sound, and the average deflection of the galvanometer indicates a gradual decrease of resistance, until one or more of these tin trees or tentacles has been built completely across the gap. Then silence ensues until the current across the bridge is suddenly increased, as by the Hertzian oscillation from an electric spark made in the neighbourhood, or even from a source of so low frequency as the ordinary 60-cycle alternating current. Instantly all is commotion and change among the tentacles, and especially where these join the cathode. Tiny bubbles of hydrogen gas appear, and, enlarging suddenly, break or burst apart the bridges, while the click in the telephone indicates the rupture of the current's path. Yet they are persevering—these little pontoon ferrymen—and instantly reform, locking hands and hastening from their sudden rout back to build new paths and chains. So the process continues, the local current re-establishing, the electric oscilations breaking up, its highways of passage, with furious bubblings and agitations—a veritable tempest in a microscopic teapot. The hydrogen gas, having, of course, twice the volume of the oxygen, is most in evidence, and, therefore, the rupture of the tentacle occurs chiefly at its cathodic terminal, and where segregated branches of the tin trees are broken off the bubbles of gas are generally noticed at the cathode. The oxygen, to a large extent, enters into chemical combination with the tin, and after the slit has been used for some time a greyish deposit of stannous oxide may be scraped from the anode. One fact must be borne in mind, that the fine tentacles (whose diameter, by the way, is of the order of some hundred-thousandths of an inch) do not come into actual metallic contact with the anode terminal. A film of electrolyte of almost molecular thickness must exist between the two, conducting normally by electrolytic ionization and conduction, yet easily decomposed and transformed by a sudden increase of current into an insulating gaseous film, the expansion of which still further increases the resistance of the gap.

The nature of this electrolytic action when soft metals, such as tin, silver, lead, are used as anode, and when the distance to the cathode is decreased to the order of $\frac{1}{1000}$in. or less, is rather surprising. The E.M.F.s needed for electro-deposition from anode to cathode are extremely small, nowhere approaching the critical E.M.F. of polarisation of the electrolyte. Moreover, distilled water, so called chemically pure glycerine, oils, &c., contain enough of impurities, such as acid traces, to enable them to act here like an electrolytic solution. I have in 10 minutes plated a firm deposit of tin on a gold cathode, using distilled water only and a P.D. not exceeding $\frac{1}{10}$ volt. For the same reasons it is possible to decompose the water films interposed between branches of these tin trees by a very minute difference of potential between; meaning that this electrolytic responder does not necessarily possess a "critical potential," as is common to a coherer. It does not, therefore, cease to respond to electric impulses, the potential of which is less than the E.M.F. of polarisation of the electrolyte, as commonly understood.

If now the electrodes be slowly separated from one another, with one or more of the minute tentacles clinging thereto, a counter E.M.F. of polarisation may be observed when the distance between the nearest electrodes exceeds a certain small limit. This counter E.M.F. exists whether the electrodes be of like or unlike material or shape. Upon the first application of the local battery to the terminals of this cell, a temporary flow of current is observed, the resistance of the cell being at first slight, especially if a dilute alkali or acid form the electrolyte. Immediately thereafter, however, the current flow falls almost to nothing, and the counter E.M.F. of the cell asserts itself. This counter E.M.F. is due to the formation of a layer of gas insulating the faces of the electrodes. It means that unless some depolarizing means be added, the local applied E.M.F. must be raised above the opposing E.M.F. of the cell, or above the critical voltage required for the decomposition of the electrolyte. Now when the cell is placed in the path of the high-frequency electrical oscillations, the effect is found to be a temporary, more or less complete, annulment of the counter E.M.F. of polarization. This effect is scarcely noticeable when the tentacles are made the cathode, but when made the anode so that oxygen is the gas surrounding and insulating the fine tentacles, the effect of the Hertzian oscillation is to decrease to a marked degree the apparent resistance of the cell. The sensitiveness of the electrolytic cell to this action of the Hertzian oscillations is in a measure proportional to the exposed area of the anode. With such coarse anodes as are furnished by the point of a 1mil. platinum wire, the action is extremely sensitive. I am using such in working from a St. Louis Exposition station to Springfield, Ill., 105 miles overland; yet the diameter of these electrodes is 100 times that of the fine tentacles or trees previously described.

Last year a German experimenter, Schlemilch, reported the discovery of this same effect in what he called "polarisation cells." Anodes having diameters sufficiently small to give great sensitiveness to the responder may be obtained by mechanical means, using the Wollaston wire, having a gold or platinum core and a silver sheath wherewith, after drawing the whole to a fineness of 2 or 3 mils, the silver sheath is dissolved in concentrated acid, in a manner long known the arts. The order of diameter thus obtained is comparable to that of the metallic trees built up by electrolytic deposit; and the wire anodes are more stable and better suited to the work in this second type of the electrolytic responder. Prof.

Fessenden maintains that the phenomenon observed in this form of the electrolytic respondor is a heat effect, and on that supposition chooses to style this form of receiver a "liquid barreter." His theory is that the Hertzian currents passing from the fine electrode into the electrolytic heat this latter, and since the thermal coefficient of most electrolytes is negative, such heating would result in a decrease of resistance of the electrolyte. I have been unable, however, to find a single fact warranting such a view. First of all, the fact that the device has a valve-effect, not indifferent to the direction of applied local potential, but practically inoperative if the tin anode be made negative, shows that the effects obtained are not chiefly I^2R effects, as would be required were the action a heat phenomenon due to the amount of current flowing. Second, that it is a potential-operated and not a current-operated device, possessing a capacity and normally insulating the fine anode. Third, that its action is sensibly unaffected by extremes of temperature, high or low. Numerous experiments have been pursued with scrupulous care, all of which show that this heat theory is untenable. A few of these I will outline. In these experiments a form of the electrolytic cell was employed having the dimensions and constructions shown in Fig. 1.

It was first necessary to determine quantitatively the effect of the received oscillations upon the local circuit of the detector. Preliminary experiments had shown that the magnitude of this effect depended upon the voltage of the local battery as well as the strength of the received oscillations. It was, therefore, important to determine the resistance changes for a constant intensity of received oscillation with varying battery potentials. For this purpose the circuits shown in Fig. 2 were set up.

Galvanometer readings were taken every 0·2 volt between the limits 0 to 4·5 volts of the normal currents flowing through the cell when no oscillations were being received, and the apparent resistance of the cell calculated from this by dividing the voltage of the local battery by the current value. The results showed that the magnitude of the response, that is to say, the ratio of normal resistance to responding resistance, is greatest with low potentials. But the loudness of the sound in the telephone receivers is greater with the higher voltages. The reason for this is apparent when we consider that the intensity of sound in a telephone receiver is proportional to the square of the current variation, or in other words, a great variation of a feeble current does not give the sound that a slight variation of a relatively strong current produces. It so happens, however, that the human ear does not respond to sound in a linear ratio to its absolute intensity, so that the observed increase is more nearly linear than quadratic. Assuming that the recovery of the high resistance is due to polarization of the small electrode, it is evident that if the electrode becomes in any way depolarized, and is then left to itself, repolarization would be very rapid. As the immersed area of the anode is of the order of a millionth of a square inch, the amount of separated gas required to completely polarize it would be infinitesimally small, and could readily be supplied by the decomposition resulting from a current flow of a few micro-amperes for a thousandth of a second. On this assumption the current flow through the cell before, during and after the passage of a group of oscillations would be something as shown in the curve of Fig. 3. The actual observation of this current would require an exceedingly sensitive oscillograph. It is doubtful if our present knowledge of oscillograph construction would enable us to make such an instrument. But our knowledge of the polarisation taking place in electrolytic cells with larger electrodes warrants the assumption of very rapid polarisation.

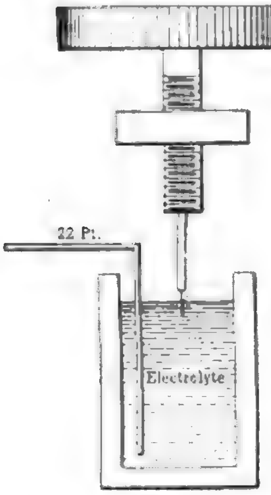

Fig. 1.

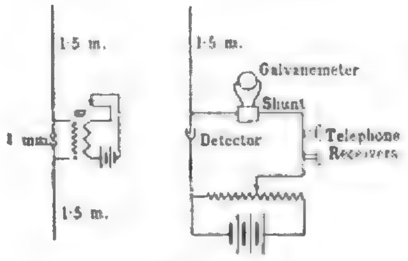

Fig. 2.

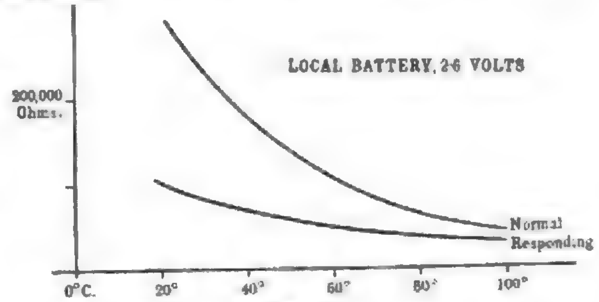

Fig. 3.

Now to determine beyond doubt that the action of the electrolytic detector is due to a breaking down of polarisation, followed by a rapid restoration, several experiments were made under conditions that did not permit of anodic polarisation. In one experiment a platinum wire 3 mils in diameter was substituted for the Wollaston wire. This anode gave a fair response when adjusted so that it just touched the surface of the alkaline electrolyte. Substituting for this solution dilute sulphuric acid, a fair response was still observed. The platinum anode was then replaced by an iron wire also 3 mils in diameter. With this electrode no response could be obtained, even with very strong received oscillations. According to theory, the first action that took place with this electrode was the separation of oxygen at its surface and the oxidation of the iron. As the oxide thus formed was soluble in the electrolyte it was removed as fast as formed, going into the solution as ferrous sulphate, the anode being rapidly eaten away. The electrode itself acted as the depolariser in this experiment, preventing the formation of a polarisation layer.

In a second experiment another method of preventing polarisation was employed. It is well known in electrochemical operations that bright platinum electrodes are readily polarised, an almost infinitesimal amount of separated gas being sufficient. It is stated that the products of the decomposition of $\frac{1}{10}$th milligram of water on two platinum plates, each having an area of 1 sq. metre, will give an E.M.F. of about 1 volt. In measurements of the conductivity of electrolytes this effect can be practically eliminated by coating the electrodes with platinum black. This is usually accomplished electrolytically, by passing a current backward and forward between the electrodes, the cell being filled with a solution of platinic chloride, containing a trace of lead acetate. In this experiment a platinum wire 1 mil in diameter was used in place of the Wollaston wire. Using an alkaline solution, a very good response could be obtained. The cell was then filled with a dilute platinic chloride solution, and the electrode platinised in the method before mentioned. A very feeble current was used, so that an extremely thin coating was obtained—so thin that when examined under the microscope the diameter of the wire was seen to have been increased by less than 2 per cent. The alkaline solution was then replaced in the cell, and the electrode immersed as before, but no response could be obtained, even when the oscillations were made very strong.

A third experiment was performed, similar to the second, save that a Wollaston wire, thirty-eight millionths of an inch in diameter was used in place of the 1-mil platinum wire. With this wire performing the platinising under the microscope resulted in a coating so thin that the diameter of the wire was increased by only about 10 per cent., or a thickness of two-millionths of an inch. Despite the thinness of the coating the result of this experiment was that of the second, no response being obtained. This experiment has been repeated a large number of times, always with the same result; the thin coating of platinum black either stops the response to the Hertzian oscillations altogether or makes it extremely faint. A strong vigorous response in the telephone may be entirely stopped by a coating of platinum black too thin to alter visibly the diameter of the electrode as seen under a powerful microscope. Now, according to the thermal theory of the electrolytic detector advanced by Fessenden, the platinising of the anode should have but little effect, the increase of diameter being so slight that the dimensions of the minute circumscribed sphere or cylinder of liquid would not be greatly altered. Yet the experiments show an absolute cessation of response.

A fourth experiment was performed in direct consideration of the thermal theory. If this theory were correct, it is evident that an electrolytic detector would operate very feebly or not at all when the temperature of the electrolyte was raised to its boiling point. In fact, as any temperature elevation would generate steam a reversal of effect might be expected, the resistance increasing in the responding condition. The cell of the detector was placed in a paraffin bath, and the temperature raised from that of the room to the boiling point of the electrolytic solution. The temperature was raised very slowly, and the operation of the detector observed with galvanometer and telephone. It was found that the action of the detector was the same at all temperatures, the only effect of the heating being to diminish the counter E.M.F. of polarisation, so that a very much lessened potential of the local battery was needed. The normal and responding resistances of the detector are given in Fig. 4, plotted for constant potential of local battery. If the curve is compared with the curves of Fig. 8, a rather striking similarity will be noticed. The effect of heating the electrolyte is similar to that produced by raising the voltage of the local battery. And although the loudness of the response in the telephone receiver is not increased the detector seems to be more sensitive when heated. In a fifth experiment, dilute nitric acid was used in place of the alkaline solution. The result was in no way different, save that there seemed to be considerable attack upon the anode with the acid near the boiling point.

It is well known that, in general, the temperature coefficients of electrolytes is positive. The conductivity of an electrolyte is dependent upon two factors: (1) The dissociation and (2) and the frictional resistance offered by the solution to the passage of the ions through it. Certain bodies, the weak acids, phosphoric, acetic and hydrofluoric, have negative heats of formation; that is, the heat of dissociation is positive, and, therefore, the dissociation becomes less with increasing temperature. If the temperature coefficient of fluidity either decreases with rise of temperature, keeps constant or increases more slowly than the negative coefficient of dissociation, it is clear that maximum conductivity must be reached at a certain temperature, beyond which any further heating will decrease the dissociation more than it increases the fluidity; and thus on the whole diminish the conductivity. Thus in the next experiment an electrolyte with a negative temperature coefficient was used in the detector. This solution was dilute hypophosphorus acid, having a maximum conductivity at about 60°C. Substituting this solution for the alkaline solution a very good response was obtained, the galvanometer showing an increased current when responding, the temperature being maintained at 60°C. to 65°C. According to the thermal theory there should have been no response at 65deg., and above that temperature the current should have decreased.

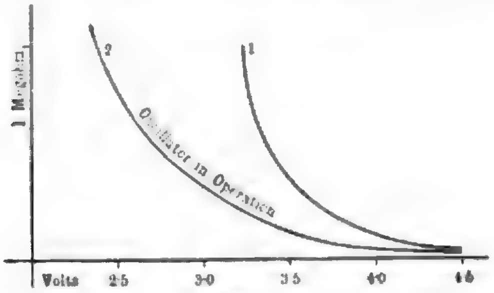

FIG. 4.

Again, when the usual alkaline solution was gradually heated to boiling point, no change in the sensitiveness of the wave response could be observed until the violent agitation of the surface due to the boiling destroyed the contact. A 1-mil platinum wire sealed into a glass tube and immersed operates perfectly when the liquid is boiling violently. From these and many other proofs it is, therefore, evident that the wireless telegraph receiver employing a small electrode or electrodes immersed in an electrolyte depends for its action entirely upon electrolytic phenomena, and can in no sense be classed as bolometer, or barreter, or heat operated detector.

It is interesting to note the phenomena as the distance between the fine electrode and the other is altered. Consider one electrode a silver sheet covered by a thin layer of electrolyte (water, alcohol, dilute acids or alkali). If the fine point be immersed without touching the silver sheet, we have the action just described, of the normal polarisation layer momentarily absorbed or dissipated during the passage of the Hertzian wave train, and the normal apparent resistance of the cell greatly reduced. In this case, of course, the small electrode must be the anode; for if the gas layer surrounding it be hydrogen instead of oxygen, the sensitiveness is very slight. In this case we would expect the thickness of the gas dielectric film to be twice that which oxygen would allow, and that the capacity of the little condenser thus formed would be much less. Again, the hydrogen will be occluded, whereas oxygen will not be, and the polarisation phenomena, on which the entire action depends, will be less marked. Now let the fine platinum tentacle actually touch the metal sheet and become welded to it by the application of a sufficient local E.M.F. We have here the true hot-wire effect, and the resistance of the device, nominally slight, is increased by the passage of the high-frequency current. Next make the plate the anode and separate from it the fine platinum point by a few thousandths of an inch. A bridge of fine silver particles will form, and by raising the cathode may soon be drawn up out of the liquid. The normal resistance of the responder is slight, and the action of the wave train is to decompose the thin layers of electrolyte between particles of the bridge, as at first described. But it can be shown that both the *increase* and the *decrease* of resistance under the wave influence exist in this latter form, popularly called the anti-coherer. When one listens in a telephone receiver in the local circuit of the electrolytic anti-coherer to a transmitter giving oscillation groups with sufficient frequency to form a musical note, two distinct sounds are heard. The first, and usually the loudest, is an irregular rumbling sound overlaying the second, which is a pure musical note of the same frequency as that of the transmitter. In the seventh experiment a condenser of small capacity (two or three-thousandths of a microfarad) was shunted around the detector, which was placed in an untuned circuit. The condenser shunt had the effect of suppressing almost entirely the musical note in the receiver, but had very little effect upon the irregular rumble. In an untuned circuit, a condenser shunt has the effect of reducing the potential rise due to the received oscillation; as the rumbling note was but little affected by the shunt, we may assume that this is the anti-coherer action, the breaking down and re-forming of the conducting bridge. This is a current-actuated effect and would be but little affected by the shunt. A galvanometer in the local circuit showed a greater decrease of current in the responding state with the shunt on than with it off. This would indicate that there were three states of resistance in the anti-coherer: (1) A very low resistance, due to the conducting bridge; (2) a comparatively high resistant state, due to the rupture of the bridge; and (3) a very high resistant state, due to the rupture of the bridge, *and the polarisation of the broken ends of the bridge.*

Represented graphically, as current flow in the local circuit, the response of this detector to a signal consisting of six impulses would be as shown in Fig. 5. For simplicity the six impulses are considered as single unidirectional impulses. The line *ab* represents the normal current flowing through the anti-coherer when no impulses are being received and the detector is of low resistance. The first impulse breaks down the bridge, and the line *bc* represents the fall of current due to the rise in resistance, the detector passing rapidly through the second to the third state, or very high resistance polarised condition. The impulses in this signal may be considered to be one-hundredth of a second apart. From *c* to *d* the detector remains highly resistant, and at *d* the second impulse arrives. This second impulse breaks down the polarisation, and

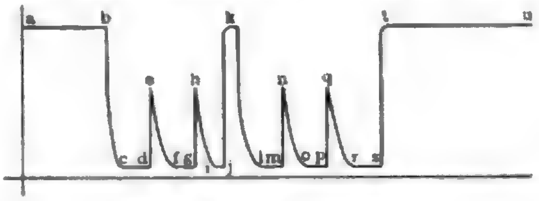

FIG. 5.

the detector falls momentarily to the second state of comparatively high resistance. It is then acting as an electrolytic coherer, the rise in current *de* being due to the breaking down of a polarisation layer, which is almost instantly re-formed, the current falling again as shown by *ef*. This is repeated by the third impulse. Between the third and fourth impulse the bridge succeeds in re-forming, but is broken down again by the fourth impulse, as shown by the current fall *kl*. The fifth and sixth impulses operate the device to decrease the resistance, and after the last impulse the bridge has time to re-form, shown by the current rise *st*, the low resistant state *tu* continuing until the next signal. The rumbling note heard in the telephone is due to the occasional re-forming of the bridge, as shown at *k*. It will be seen that while the breaking down of the bridge is accomplished by current, the opposite action is due to potential, so that the condenser shunt eliminates the current peaks *ehmq*, leaving the detector of very high resistance from *c* to *j*, and from *e* to *s*. This not only eliminates the musical note heard in the telephone receiver, but decreases the galvanometer deflection during the responding state. This curve is intended to be an ideal one, and no attempt is made to show real ratios of current.

Returning to the form of the electrolytic detector first considered, it is apparent that although it is capable of rectifying high-frequency currents, this rectification is not an important action. Like the metal filings coherer, the energy in the local circuit is derived from the local battery, the chief effect of the received oscillations being to release this energy. In its construction certain electrolytes are found to give better results than others. In all probability this is partly due to their relative capacity for absorption of oxygen. For example, hypophosphorus acid gives much better results than phosphoric acid, and nitric acid with a certain amount of nitrous is better than nitric alone. As the *ous* acids contain less oxygen than the *ic* acids, this is the probable reason for the difference.

The electrolytic responders which I have described seem to possess in the highest degree the qualities necessary to place the art of aerography on a basis to compete with existing telegraphic service by land as well as sea. They are extraordinarily sensitive; regular in response; strictly quantitative and automatic in action; have approximately constant normal factors as regards resistance and capacity, allowing thus a speed of word transmission limited only by the ability of operators to send and receive. By such means the problem of electrical tuning, or syntony, are enormously simplified; for heretofore the erratic nature of the coherer has rendered it impossible to regulate closely the constants of the tuned electrical circuits in which it is placed, thus making syntonisation by its employ at best crude and uncertain.

In regularity of action the responder is strictly comparable with the Rutherford magnetic detector as developed by Wilson, Shoemaker, Marconi and Ewing; while as regards relative sensitiveness there is to-day no comparison between that of the magnetic detector and the electrolytic receiver. Moreover, the device is practically indestructible, while its syntonising qualities enable us to so cut out foreign signals and electric disturbances as to render wireless communication by this means immune from interruption where the coherer or less sensitive magnetic detector is an impossibility.

THE BAY COUNTIES POWER CO.'S TRANSMISSION SYSTEM.*

BY L. M. HANCOCK.

The Bay Counties Power Co.'s system is remarkable for the fact that alternating current at different voltages and frequencies is distributed from one main generating station (Colgate) over a wide area in California. Formerly, the system was operated by the company named, but now the system forms part of the plant of the California and Electric Corpn. The main central station is driven by water-power, and its equipment is as follows :—

Generators.

3 2,000kw., 240 revs. per min., 3-phase 60-cycle 2,400-volt inductor.
3 900kw., 360 revs. per min., 3-phase 60-cycle 2,400-volt inductor.
1 720kw., 286 revs. per min., 2-phase 133-cycle 2,400-volt inductor.
2 50kw., 800 revs. per min. exciters.

Suitable tangential water-wheels with deflecting nozzles are directly connected to each generator and exciter. The low-potential switching is made as simple as possible, and only such instruments are centralised as are needed to control the plant. The rest are scattered about the building near the apparatus to which they belong. Oil switches are used exclusively for the 2,400-volt circuits, at which voltage all the machines operate. The transformers are all oil-insulated and water-cooled, the majority of them having a capacity of 750kw., but there are a number of smaller sizes.

All low-potential wires and cables are run in a subway, while all the high-potential wires and connections are overhead in the gallery. Originally an immense amount of wood was used in mounting the high-potential switches, lightning arresters, &c. This construction was destroyed by fire in March, 1903, and has been replaced by a brick and tile and steel construction built up on the cellular system.

The unique feature of Colgate, as mentioned above, is the number and variety of very high-potential circuits radiating from the plant. The following table gives a list of them :—

Name of circuit.	No. of circuits.	L'ngth in miles.	No. of pole lines.	Material.	Phase.	Wires in each circuit	Cycles	Kilo-volts.
Bay	2	140	2	Copper .. Alumin'm	3	3	60	40-50-60
Sacramento	2	61	1	60 M : Alu. 1 m. Cpr.	3	3	60	40
Oroville .	1	28	1	Aluminum	3	3	60	40-50-60
Marysville ..	1	28	1	Part Al. Cpr.	2	4	60	15
Nevada ..	1	19	1	Copper ..	3	3	60	24 On same
Nevada ..	1	16	1	Copper ..	2	4	133	24 pole line

This variety of service can only be handled successfully at the power house end by either using individual transformers for each line, by using a great many high-potential switches, or by a combination of the two methods. The third method was eventually adopted. The odd phase and voltage lines had to have separate transformers which were operated from the low-potential switches, and were, to all intents and purposes, a part of their respective lines. The growth of the plant was such that the odd voltage three-phase lines could not be avoided; however, it was planned ultimately to have these all operated at the same tension.

There were four designs of switches employed, as follows :—First, an emergency switch, which, when open or closed was perfectly safe but would not stand being opened under full voltage and heavy current. This was simply a blade about 30in. long with jaws mounted on large insulators which were carried and held in place by suitable frame work, the blades being pivoted to one of the jaws. These switches were suitable for cutting out a dead line or would open the full voltage of a 30-mile line if there were no load on it. They were also adapted for cutting in and out banks of unloaded transformers but with full voltage on. They were used in series with main switches, lightning arresters and other devices that must be taken out of service occasionally without having to shut down, and were also employed for temporary work and testing. Second, the Stanley switch, which was arranged to break the arc in a tube filled with plaster of Paris. This served the purpose in the absence of anything better, but was clumsy, slow of operation and often out of repair. Third, the oil switch with horizontal break. This switch was not installed where it had to handle heavy loads, but there were some very severe tests put on it which it stood remarkably well. These tests consisted of opening a dead short at a distance of 100 miles from Colgate with full generator capacity behind the line. Fourth, the oil and water switch. This switch in its original form was put under extremely severe tests which it stood wonderfully well, opening 25 dead shorts on a 40-kilovolt line in quick succession, some of which were 240 miles from the generator via the pole line. However, the design of this switch was not suitable to the duties required of it. During a severe lightning storm it broke down and was not replaced. The concensus of results pointed to the horizontal break oil switch as the one that stood the test of actual service the best of any.

The sub-stations and the wiring for them were as various as could be imagined. The transformers, as a general thing, were wound so that they could be used anywhere on the system, and taps were brought out so that either three-phase or two-phase circuits could be fed from them. Three transformers were generally used, and taps were brought out from the winding so that the voltage could be varied as needed. When two-phase service was given from three transformers it was found unsatisfactory for motor work on account of the regulating coils varying the phase angle. In several cases a single transformer was installed for single-phase service in small towns, the high-potential side having one wire attached to one of the line wires and the other to a ground plate, very satisfactory service being given in this way in small towns. The sub-station buildings varied from steel frames covered with corrugated iron in important locations to an ordinary wooden building in some of the small towns.

The switchboards in a few of the larger stations were quite complete, but in the majority were very simple, there being generally apparatus to meet only the most urgent needs. High-potential switches were usually provided in each station; in the larger ones they were either Stanley or horizontal oil break; in the smaller stations the cheapest kind of a long knife switch. Devices were usually provided outside to cut the line clear from the building. Ten sub-stations were put into service when the line went into commission. In three years this number had increased to 26. The majority of these stations needed little attention.

The lines demanded, and got, especial care and attention. It might be said, on general principles, that there never is enough money put into the lines. We will deal alone with the 140-mile line, because this is typical of how all the others were handled, especially those carrying the higher potentials. Elaborate precautions were taken to discover any weakness and repair it before a breakdown could result. However, we could not always tell just how fast things were going to happen. In the course of operation the following observations were made :—

Wood pins were destroyed by the hundreds near salt water, cross-arms a few and poles only two or three in the course of three years' service. Glass is not suitable for high-potential insulators under the conditions as they exist on this system. An all-porcelain insulator has been and is being substituted for the composite insulator as fast as conditions will permit, especially near salt water. The insulator first installed has so little margin of safety that if it were broken at all it was ordered to be removed from the line. If only a small piece were chipped out of the edge the risk was taken for a time. The only place where we had trouble with the accumulation of dirt on insulators was near salt water and cement works. There may be a good deal of noise at an insulator on a wood pin for many weeks and not much damage result, but it should be watched closely. With a steel pin and a wood cross-arm this noise will not be anything serious except in some unlooked-for place, due to local conditions. These should be watched closely on general principles. Ocean fogs cause the burning of very many wood pins, while cross-arms and poles suffer but little. Fogs a few miles back from salt water do not affect either pins, cross-arms or poles. Rain is Heaven's own blessing on a high-potential transmission line. It cleans the insulators and stops a good deal of the damage to wooden supports. This is true of salt water districts especially. The first few drops that fall after a prolonged dry spell causes a good deal of a display, which soon passes, however, and all is quieter and better than it was before. This display does not affect the power-house load to an appreciable extent nor does it affect lights or motors.

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* Abstract of a Paper read before Section E of the St. Louis International Electrical Congress.

The starting of this line in a rain storm never caused the slightest trouble, in fact, in changing from one line to the other, full voltage has many times been thrown instantly on the dead line during heavy rain storms without the slightest disturbance. The experience has been that long spans are preferable in almost every case. On a mountain line built about two years ago some very long spans were used. One was 1,800ft. with the regular line conductor, a 350,000 cm. stranded aluminum cable, and it has given the best of satisfaction. Every indication is that steel should be used for high-potential line supports from the ground up to the insulator throughout the system.

The low-potential distributing systems gave very little trouble, and it was very seldom that the current available could not be used.

AMERICAN PRACTICE IN HIGH-TENSION LINE CONSTRUCTION AND OPERATION.*

BY DR. F. A. C. PERRINE.

Above 2,300 volts, where transmission proper really begins, the first voltage now commonly employed is 6,600, which figure has been established as standard by the needs of the lighting plants in the great cities. For this voltage direct generation at high pressure is almost invariably used. The next higher voltage now commonly employed, and practically the first one for which step-up transformers are used, is 15,000. The next step is to 25,000 volts, which is the highest figure reached without special study of insulators, switches and lightning arresters. A voltage of 35,000 is employed in a number of plants built about five years ago, and at this figure the special difficulties due to line capacity, insulator size, erratic lightning-arrester effects and switching begin to make themselves seriously felt. Above 35,000 volts the standard voltage is called 60,000, although in all plants that have heretofore been established to operate at this pressure, there have been installed transformers arranged for connection to various voltages of from 40,000 up to 60,000 volts, and the majority of these plants are to-day operating at about 50,000 volts, some of them being unable to operate at the highest pressure on account of the character of line insulators originally installed.

For switching, the present type of 2,300-volt oil switch has been so well developed, by reason of the great number of plants operating at this pressure, that for handling a particular amount of energy it is both cheaper and better than any 500-volt switch on the market. Use has been made of a long arc-breaker between carbon terminals and long enclosed fuse—a fuse drawn through a tube filled with a fine, non-conducting powder—and of oil switches. The first two types, while interrupting the circuit well, draw an arc of excessive length and produce a surging which may result in an increased potential of at least as much as 50 per cent. In consequence, these types are rapidly disappearing except in plants operating at 15,000 volts and below, where the carbon break is preferred to the enclosed fuse, though it is common to instal the two in series, allowing the fuse to operate as a safety device, but not for the purpose of switching. The type of fuse where wire is drawn through a tube filled with powder was found to operate successfully up to 40,000 volts and without serious surging on the circuit, but the powder being blown out with great force, scattered over the entire station. The vertical-break oil-switch has the advantage that the amount of oil contained in the oil tank is relatively small, and will add to possible conflagration only a slight amount of fuel. This switch is often found on severe short circuits blowing all the oil out of the tank unless the tank is built very strongly, when it becomes necessary to insulate the plunger from the tank as it enters the switch. The horizontal break switch, while containing a large amount of oil, will for the same length of break handle about 25 per cent. more energy at any definite potential. This switch can successfully be used at 60,000 volts, and up to the present time has not been found to blow the oil from the tank. No distinct preference is given to the horizontal switch, though the writer believes that in the future this type will be used as a standard for the highest potentials.

Three-phase transmission with two-phase distribution, described by Mr. Scott at the International Congress of 1893, is very extensively employed. In general it may be stated that up to 25,000 volts the delta connection is generally preferred, principally because with this connection a ground upon one line does not necessarily result in a short circuit, and, furthermore, the service is not necessarily interrupted in the case of the failure of a single transformer. At voltages higher than 25,000 volts the transformers for delta connection become more difficult to build and insulate. Furthermore, a single ground anywhere produces disturbances of a serious character, and in consequence the star connection with the grounded neutral is employed, advantage being taken of the fact that a grounded neutral aids in the distribution of unbalanced loads, and furthermore the rise of pressure which may occur from line discharge at the time of an open circuit or a short circuit are not so likely to produce serious results.

For the distribution of current through the low-tension mains, it is generally the custom to transform to 2,300 volts two-phase unless either the load is mainly one of motors, or unless there are important motors of considerable size to be supplied at a distance of ½ mile or more from the sub-station. In such cases three-phase star-connected four-wire distribution is employed, allowing the connection of distributing devices either to a 2,300-volt circuit between lines and the neutral wire or a connection to a 4,000-volt delta circuit for balanced loads. This combination of circuits is found to be extremely useful where a mixed load is to be supplied at varying distances.

In the most recent types of construction the height of pole is limited as much as possible. Many series of tests with glass and porcelain insulators have shown conclusively that the porcelain insulator has a greater mechanical strength, is less liable to surface leakage, has a safe dielectric strength, and, in addition, that it is exceedingly difficult to so break the head of a porcelain insulator as to allow the wire to fall away from it. On the other hand, the glass insulator is cheaper and easier to inspect. One disadvantage of porcelain is that there is an uncertainty as to its solidity, and that it is only possible to ascertain its solidity by most careful high-voltage tests. The question of the form of high-voltage insulator as yet is in dispute, operating engineers being inclined to a design where the petticoats are very long and comparatively close together, so that great creeping distance be given over the surface of the insulator between line and line and between line and pin, comparatively little regard being placed on the flashing distance. Engineers of the manufacturing companies, however, incline toward one of a much more open type, of large diameter and with few petticoats. This latter form undoubtedly gives the greatest sparking distance, has the least dark spaces within it, and is more readily cleaned by rain storms. It is also important that such an insulator be constructed to operate at high voltage without noise, and, as there is a definite loss of energy whenever the insulators on a line are noisy, it may be safely predicted that the open type of insulator is to be the one that will be in the future considered as the standard. While insulator size may be largely determined by form, at the same time we may in general note that up to 10,000 volts insulators, whether of glass or porcelain, have a minimum diameter of about 5in. A 7in. insulator can successfully be used on voltages as high as 25,000, a 13in. insulator is sufficient up to 40,000 volts, while at 60,000 volts it does not seem safe to instal insulators having less diameter at the top than 14in. A greater size would invariably be used for these high voltages if the problems of the manufacture of porcelain and support of the insulator were altogether solved.

At 25,000 volts and below a wooden insulator-pin can be successfully used, and, indeed, forms a certain protection to the line by reason of the fact that the pin itself is a safe insulator, and is only in danger of being burned where the insulator is punctured. Above this voltage, however, only metal pins can be employed, not only on account of the large size of the insulator, but also on account of the fact that there is much burning of wooden pins. There is no doubt that this burning effect is due to leakage over the surface of the insulator, but it is extremely interesting to note that in some cases the pin is actually charred, whereas in other cases there is an apparent disassociation of something in the wood, and peculiar salts are left behind either reduced from the atmosphere or from the material of the wood itself.

For transmission work, where the wires are smaller than $\frac{5}{16}$in. in diameter, use is not made of soft-drawn copper wire, and it may be stated that the standard in American practice is to use soft-drawn wire only for large, low-potential circuits where the small change in conductivity due to the hard drawing is an important factor. Up to $\frac{5}{16}$in. hard-drawn copper may be considered standard. Between $\frac{5}{16}$in. and $\frac{7}{16}$in. diameter the practice is evenly divided between solid hard-drawn wire and strand. Larger than $\frac{7}{16}$in. strand is almost invariably employed. Some use has been made of solid aluminum, but, as the material must be handled with great care, it has been found generally to be the better practice to employ aluminum strand, which is more readily installed and more reliable after installed. For short lines, delivering a small amount of power at voltages of 40,000 or above, aluminum is decidedly to be preferred, since it is found that at these voltages a wire less than ½in. in diameter will discharge through the air, and this discharge may result in a considerable loss of energy. Accordingly, it is not possible at these voltages to successfully use wires less than $\frac{7}{16}$in. in diameter no matter what the amount of energy or the distance. Accordingly where the amount of energy and the distance may result in the loss not being the determining factor, aluminum is much preferable for the reason that at a definite size it is materially cheaper than copper. Where salt sea fog is to be encountered, both aluminum and copper are acted upon. The action on aluminum is greater than the action on copper, and, in consequence, copper must necessarily be used. Where such conditions are not encountered, aluminum is an entirely safe material, provided it is not exposed to the elements in contact with any other metal. The joints, therefore, must either be made of aluminum of the same quality as the wire, or the joints must be carefully insulated so that no moisture will penetrate. Aluminum must be strung with careful reference to the temperature at the time of erection, since its coefficient of expansion is very large, about three times the coefficient for copper, and experience in the erection of copper lines will result in an unsafe aluminum line. The horn form of lightning arrester developed in Germany has been found to operate with invariable success so far as the lightning arrester itself is concerned, but, as it is interrupting the ground circuit, it draws a large arc, and oscillations are produced on the line, which in many cases have been found to have more serious results than the discharge they were installed to remove. Condensers in parallel with the lightning arresters and ingenious arrangements of arresters and resistances have been used with some success, but none of these plans may be considered to be entirely satisfactory for the highest potentials operated from the largest generated plants.

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* Abstract of a Paper read before Section D of the St. Louis International Electrical Congress.

A NEW ARC LAMP.

It is claimed for a new continuous-current arc lamp, which is being introduced from America into this country by Messrs. J. Defries & Sons, that it is exceptionally economical, owing to the absence of an external steadying resistance. There are, however, two small internal resistances, one of which permits the final adjustment of the voltage, while the other allows some variation of the current. In the adjoining illustrations these resistances are denoted by A and K. For a pressure across the mains of 110, 115 and 120 volts, the pressure across the arc is stated to be about 97, 102 and 107 volts respectively, so that about 13 volts only are lost in the lamps. This result has been obtained by the use of a choking coil. When the carbons come into contact with each other there is a rush of current, and in the usual type of arc lamp this rush is limited in strength by an external ohmic resistance, but in the arc lamp in question it is retarded by the action of the choking coil, connected in series with the arc. During the time the main current is thus choked back, the current in the shunt coils F, which is not throttled, causes the carbons to be separated by a suitable interval.

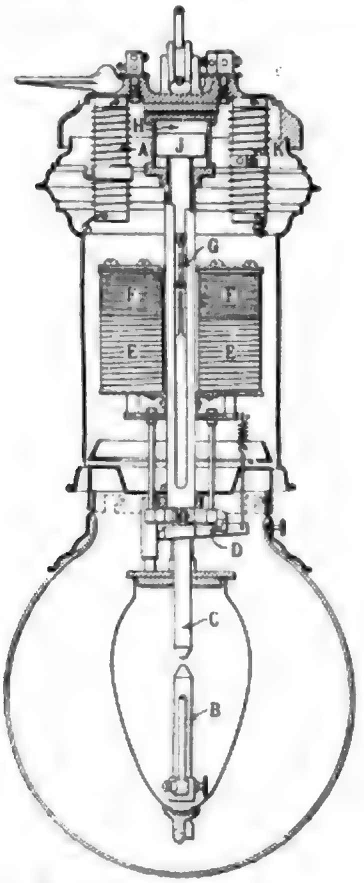


FIG. 1.—SECTION THROUGH STEWART CONTINUOUS-CURRENT ARC LAMP.

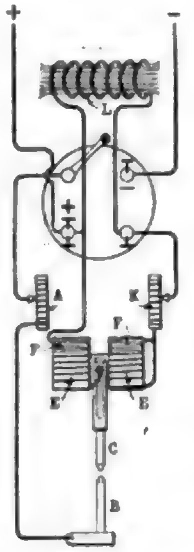


FIG. 2.
DIAGRAM OF CONNECTIONS OF STEWART ARC LAMP.

Fig 2 represents the diagram of connections. From Figs. 1 and 2 it will be seen that the main current flows from the positive terminal to the choking coil L, the small internal regulating resistance K, the series regulating coils E, the carbons C and B, the second small resistance A and back to the negative terminal. The current path to the shunt-regulating coils is as follows:—From the positive terminal to the shunt coils F, through the series coils E, past the carbons C and B and the resistance E and back to the negative terminal. As the shunt coils have very little self-induction, the current through them is practically always in phase with the impressed voltage, and the regulation, therefore, takes place promptly whenever the pressure across the arc, or, in fact, anywhere in the circuit, changes.

Such mechanism as there is in the lamp is of a simple character. The feed is by gravity and is effected in the following manner:—As the carbons burn down and the arc lengthens, the current both in the series and the shunt coils decreases, and the armatures of these solenoids gradually sink down. These armatures carry a clutch, which in its turn embraces and supports the upper carbon C. When the main current has diminished to a predetermined degree, the arrangement of clutch and armatures is lowered to such an extent that the part D (Fig. 1) touches the table, shaded in the illustration. The clutch sinks a little more, until its prongs are forced away from the carbon by the wedging action of D. At this moment the upper carbon drops, the shunt current increases with a rush, and the armature, clutch and carbon are drawn, *en bloc*, upwards. Simultaneously, or an instant after, the main current wave arrives. The cycle of regulation then begins afresh. The arc lamp is of the enclosed type, said to burn for about 125 hours with one set of carbons. Unfortunately it is not possible to operate the lamps in series at present, but they burn satisfactorily when placed singly on 110 volt mains, and, we understand, even with voltages of anything up to 160 volts, although at the higher pressures the arcs are long and bluish.

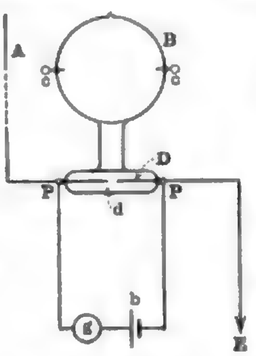
The lamps are designed for 3¾ and 4½ amperes. In one pattern, the lamp is entirely self-contained, the choking coil being fitted inside the lamp, whose total height is 29in. In another design the coil is external.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Action of the Coherer.—J. Hardén describes a form of coherer in which the "cohesion" is of a purely gaseous kind. The arrangement is shown in the diagram, where D is a vacuum tube connected with a larger vessel, B, both of which are exhausted down to a point at which the conductivity, determined by means of the electrodes *cc*, is greatest. The sparkgap *d* consists of two platinum wires 0·2mm. apart. The antenna A is connected to one of the electrodes, P, while the other is earthed. A battery circuit is shunted across PP, and contains a battery, *b*, and a galvanometer, *g*. No spark passes at *d* until electric waves impinge upon A. Then the gap is bridged by a spark, the battery circuit is completed, and the galvanometer shows a deflection, which continues while the waves impinge upon A, and then ceases, there being an automatic decoherence independent of shock. If a mercury lamp is substituted for *d*, and a 200 volt continuous current for *b*, a strong wave impinging upon A lights the lamp.

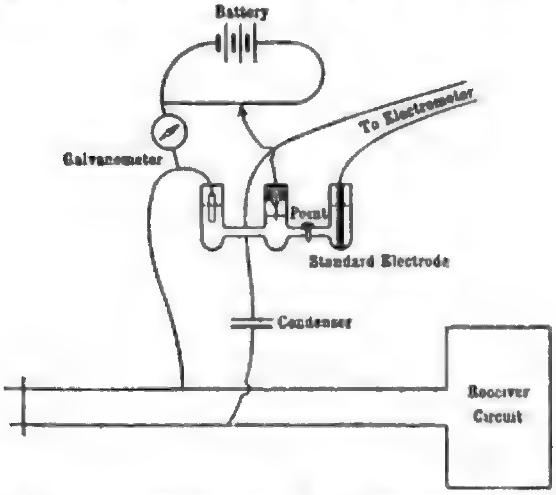
[J. HARDÉN, *Physikalische Zeitschrift*, October 15, 1904.]



Colour Photography.—E. Rothé has succeeded in obtaining Lippmann photographs without the aid of a mercury mirror. He noticed that the gelatine side of an under-exposed Lippmann negative presented by reflection colours varying with the thickness of the gelatine. He found that these colours were due to reflection, not from the mercury mirror adjoining the gelatine, but from a thin film of unexpelled air. He therefore took photographs without the mercury mirror, simply exposing the plate with its film away from the lens. The exposure was long, and amounted to half an hour in sunlight and two hours in a well-lighted room. A spectrum of an arc lamp took 15 minutes. The exposure may be reduced to a few minutes by treating the plates before use with an alcoholic solution of silver nitrate. Pyrogallic acid is the best developer, and the negatives may be intensified with mercuric chloride and amidol. The colours are less vivid than those obtained with the mercury mirror. All the colours, except the extreme red, are faithfully reproduced. The method is within the reach of any amateur.

[E. Rothé, *Comptes Rendus*, October 10, 1904.]

The Electrolytic Detector.—V. Rothmund and A. Lessing publish the results of an investigation of Schlömilch's electrolytic detector which go to show that the effect of the detector is not due, as Fessenden thought, to the evolution of heat, but to a process of depolarisation. They used a point made of platinum wire 0·01mm. thick in dilute sulphuric acid. The receiver is shown in the diagram, which also shows the standard cell used for determining the polarisation of the detector cell. The reaction of the detector sets in at very low differences of potential, the impact of electric waves producing an increase in the current strength and a lowering of the E.M.F. The point may be either an anode or a cathode, and the chemical process is without any influence. With the same electrolyte, the sensitiveness varies as the conductivity. Ordinary voltaic cells show an increase of both E.M.F. and current under the influence of electric waves when one electrode consists of a fine point.



[Rothmund and Lessing, *Annalen der Physik*, No. 11, 1904.]

Standards of Light.—E. L. Nichols reviews the present state of the question of luminous standards, and points out that the flame standards so far hold the field. Hefner's amyl-acetate lamp is the most widely accepted. The physical constants of this flame, and its dependence upon the carbonic acid and moisture in the air are well determined. But its feeble intensity and colour are against it. Were it possible to burn the proper mixture of acetylene and air in a burner, the dimensions of which like those of the Hefner lamp were sufficiently great to admit of accurate workmanship, there is every reason to suppose that this source of light would show the uniformity desired in a standard. The mixture is, however, violently explosive and in order to keep the flame from striking back the gas orifice must be very small. Not only is it impracticable to make burners with such small openings which will give strictly the same size and intensity of flame but in a given burner the orifice is subject to partial clogging. The result is a variation in the proportion of acetylene to air and a change in size and intensity of the flame. While it is probable that the future will see the development of a satisfactory primary standard based upon the electrical heating to incandescence of carbon or of some metallic oxide, the immediate basis for standardisation of artificial light sources lies in the use of a primary standard consisting of a flame standard and the preparation of calibrated incandescent lamps as secondary standards of light. Such lamps may in the present state of the art be made to agree with each other with all necessary exactness. While the absolute definable value of such standards can for the present be considered as exact only within the limits of reproducibility of a flame standard such as the Hefner lamp, the actual agreement of the standards existing in those laboratories in which photometric work is based upon the Hefner unit appears to be much closer than the performance of the amyl-acetate lamp would lead us to anticipate.

[E. L. Nichols, *St. Louis Congress Papers*, Section A, 1904.]

Gaseous Conduction at High Temperatures.—J. Trowbridge has endeavoured to obtain a new series of hydrogen lines by exposing the gas to temperatures higher than any yet attained in spectrum analysis. His object was to identify some of the new lines with lines found in stellar spectra, to imitate, in fact, more closely the conditions under which the stars shine. He failed to find the new series, though he went so far that the silica of the capillary tubes was vaporised. The experiments were made with a storage battery of 20,000 cells, which were used to charge large condensers. The temperature attained was probably about 1,800deg. All the specimens of glass gave broad bands due to silica. The narrow capillaries with metallic terminals experimented with, may be called electric furnaces in which there is no permanent product or permanent decomposition; moreover, the spectra which we observe do not reveal all that the capillaries contain. Hydrogen may be present, but it is concealed. Oxygen shows its presence only by probable oxides; the constituents of rarified air are undoubtedly always there. The conditions which prevail in the case of discharges in such narrow capillaries seem to be analogous to those in the case of discharges under liquids. Some metallic lines are reversed and others suppressed. The author puts the question whether helium is really obtained by transmutation from radium, or whether it is a result of an electrical stimulus which brings to light the helium which refused to manifest itself by chemical analysis. The author concludes: "In this study of the upper limit of temperature which one can reach by electric discharges through rarified gases, we perceive that spectrum analysis is one of the most difficult analyses which modern science has revealed. There are a few broad facts such as Doppler's principle and the reversal of spectral lines according to Kirchhoff's law; on the other hand, there is ionisation, dissociation, adsorption and absorption, all modified by the glass or quartz vessels which must be employed."

[J. Trowbridge, *St. Louis Congress Papers*, Section A, 1904.]

Electrostriction.—Electrostriction is the strain in dielectrics, and their consequent mechanical deformation, produced by the passage of electricity through them. The action is supposed to take place in solid, liquid and gaseous non-conductors when they are electrified. Faraday and Maxwell made it the cornerstone of their electromagnetic theory. L. T. More, in describing his recent experiments on the subject, says: "There seems to be a considerable degree of confusion prevalent in regard to the significance of electrostriction. It does not involve the pressure produced by the attraction of two charged bodies but is a property of electric flux in a non conductor. For example, two charged bodies attract each other and if they touch a solid dielectric, glass for instance, placed between them, the glass must be deformed mechanically whatever theory is adopted. But those who believe in electrostriction maintain that if the charged plates be separated from the glass and if the intervening spaces be filled with a fluid dielectric of the same dielectric constant as the glass and filled in such a way that the mechanical force of attraction of the electrified armatures cannot be communicated by the fluid to the glass, still the latter will contract in the direction of the lines of force and expand perpendicularly to them. This mechanical deformation, called electrostriction, is due, then, entirely to the electrical stresses in the ether communicated to the glass immersed in it." The author's own experiments with glass tubes subjected to strong electrostatic fields gave no results which could with certainty be ascribed to electrostriction.

[L. T. More, *St. Louis Congress Papers*, Section A, 1904.]

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THE LIMITATIONS OF PROVISIONAL ORDERS.

On more than one occasion we have pointed to the difficulty which our law-makers are bound to find in legislating for such a progressive industry as electrical engineering. After a law has been passed for a few years, fresh discoveries are brought to light, or new developments are made, which produce radical alterations in prevailing ideas and their adaptation in practice, with the result that lawyers and judges are continually being called upon to decide upon the interpretation of an act in its application under conditions very different to those for which it was originally intended. An instance of this is afforded by the judgment delivered by Mr. Justice FARWELL in the case of the Attorney-General and Others *v.* the Metropolitan Electric Supply Co., and reported in another column. The Metropolitan Electric Supply Co. were allotted certain supply areas in London under their Act of 1889 and subsequent Provisional Orders. The Act and the Provisional Orders all contained the clause, subsequently embodied in the Electric Lighting (Clauses) Act, to the effect that the undertakers should not, after the commencement of the Order, "supply energy or (except for the purposes of the Order) lay down electric lines or works beyond the area of supply," except with the sanction of Parliament or under a Board of Trade Licence under the Electric Lighting Acts. Finding it necessary to erect a larger power station, the company obtained Parliamentary sanction in 1898 to supply the areas in question from a generating station external to the areas of supply—a contingency not contemplated in the original Electric Lighting Acts. When these original Acts were passed, it was not realised as well as it is now what large economies could ensue from the adoption of large generating units and the concentration of all the generating machinery into one large works—an economy which might far out-balance the loss due to fixing the site of these works at some distance from the area to be supplied. The works were duly completed at Willesden, and all went smoothly until the end of last year, when the company commenced supplying energy to the London and North-Western Railway

Co., whose sidings adjoin the Willesden works. Now, the Urban District Council of Willesden had in the meantime commenced an electric supply in their own district, and considered therefore that the North-Western Railway Company should buy its electrical energy from them, as they were the only authority in the district possessing statutory powers to supply there. Of course, the Urban District Council does not possess a monopoly, and there would have been nothing to prevent a company from erecting electricity works adjacent to the railway siding and supplying the railway company with current. The Metropolitan Electric Supply Co. contended that they had a right to do this under their articles of association, but the District Council contended that under the terms of the Provisional Orders and Acts already referred to, this particular company's area of supply was limited to the metropolitan areas already specified. Mr. Justice FARWELL has upheld this point of view, and has granted an injunction against the company.

As there will, of course, be an appeal against Mr. Justice FARWELL's decision, we have no intention of criticising his interpretation of the Electric Lighting Acts, but it will not be out of place to point out that, if the interpretation be a correct one, the effect will be far reaching. There are not likely to be many cases on all fours with the present one, but nevertheless there are several in which the judge's reading of the Act will apply in a manner hitherto unsuspected. According to the interpretation of the clause quoted in the commencement of this article—a clause which is identical with clause 4 of the Electric Lighting (Clauses) Act—no company possessing a Provisional Electric Lighting Order may erect "electric lines or works" except in the area to which that order refers, without express Parliamentary sanction in the form of a supplementary Provisional Order or a Special Act. A company owning a Provisional Order or Provisional Orders is, in fact, debarred from carrying out any electrical contracting business except in the area covered by the Order or Orders. Assume, for instance, that a company, whose business has hitherto been the erection of private installations all over the country, desires to extend the scope of its business, and obtains a Provisional Order for the supply of electricity in a small town. From that time forward it would be in the power of anyone interested, to prevent the company from going on with its former business except in the particular area covered by the Provisional Order. More serious still would be the position of the manufacturer of electrical machinery who is in the habit of taking contracts for the entire erection of electricity works or electric railways; if he obtained a Provisional Order for any district, the Electric Lighting (Clauses) Act would forbid him "to erect or lay down any electric lines or works beyond the area of supply otherwise than under the authority of Parliament . . ." It is well known that these things have been done in both the instances we have taken. The conclusion may appear absurd, but it is the logical sequence of Mr. Justice FARWELL's judgment. We may quote his words:—

> Further, it was clear from certain clauses that Parliament took into consideration the financial condition of the companies which asked for statutory powers. The Legislature would naturally take pains to see that every company had sufficient funds not only to carry out the necessary works, but to carry on the undertaking when once they had started active operations, and certain clauses were inserted with that view. Now he was asked to say that the prohibition contained in Clause 5 of the Act of 1889, and repeated in the subsequent Provisional Orders (Clause 4 of the Electric Lighting (Clauses) Act of 1899), was not a general prohibition, but only applied to the company as undertakers under the particular Act. He agreed that some qualification was necessary, and that was that the undertakers, so long as they were undertakers working that particular undertaking, must not supply electricity outside the statutory area—the prohibition was not meant to extend to the company for all time. But he could not interpret the prohibition so as to limit it in the way the defendants wished. Further, the proviso to the clause excluded the idea of limitation, for if this was not a general prohibition the proviso would be unnecessary. The result was that he could not insert limiting words in Clause 5.

We can only hope, therefore, that Mr. Justice FARWELL's reading of the clause is wrong, and that it will be reversed on appeal. If he is correct, a modification must be made in the new Electric Lighting Bill when it is introduced next year, in order that the law on this point may be put upon a more reasonable basis.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

◆

The Diseases of Electrical Machines: their Symptoms, Causes and Remedies. By C. KINZBRUNNER. (London and New York: Harper and Brothers). 1904. 1s. 6d. nett.

This is a little book of about 80 pages on a novel plan. The principal troubles that are likely to be met with in the care of dynamos, alternators and motors, such as sparking, heating, failing to generate, &c., form the sub-divisions of the book; and under each in one column are given specific additional symptoms, in the next column is given the corresponding cause, and in the third column the remedy is dealt with. Everything is stated with as much brevity as possible, but in treating of the remedy the author expands his remarks and adds a diagram, if necessary, to make his meaning intelligible. At the end there is a useful appendix of about a dozen pages on the installation, care and maintenance of electrical machinery. The book does not pretend to be an elaborate treatise for the experienced man, whose natural insight or acquired knowledge will tell him all that he will find here. The reader is, of course, supposed to have some knowledge of electrical machinery, but need not have any acquaintance with theory. It is just such a book as might be placed with great advantage in the hands of an intelligent mechanic, or a student just entering the testing shop.

Electrical Motor Installations. By F. J. A. MATTHEWS. (Manchester: The Scientific Publishing Co.) 2s. 6d. net.

The second edition of this book is very much on the same lines as the first, its object being to place before non technical users of electrical energy some practical information regarding the construction and working of plant. This is achieved by the use of simple non-technical language which may be easily understood by a person of average intelligence. Much of the matter has been re-written, and the second edition is undoubtedly an improvement on the first. The descriptions of the various applications of motor driving to industrial purposes are very interesting, but more might well have been written on mining work. Naturally, a great many of the facts regarding motors and appliances in ordinary work apply equally to those employed in mines, yet the latter application is one of such growing importance that all possible attention should be paid to it.

Elementary Manual on Applied Mechanics. By ANDREW JAMIESON. 6th edition. (London: Charles Griffin & Co.) 3s. 6d.

The words "sixth edition" on the title page are as eloquent as the most eulogistic review. An important feature of the new edition is the inclusion of a large number of elementary questions set at the May examinations of the Board of Education, South Kensington, and the now defunct Science and Art Department, for the last 12 years. At the end of the book there is also an appendix containing the 1902 and 1904 elementary applied mechanics and ordinary grade mechanical engineering papers of the City and Guilds of London Institute, together with the general instructions for these examinations. As an example of the way in which Prof. Jamieson keeps his books up to date, it may be mentioned that he describes in considerable detail a modern electrically-driven hexagon turret lathe. The matter which appeared in earlier editions has been revised and enlarged, and the volume still maintains its standard of excellence.

The Story of Wireless Telegraphy. By ALFRED T. STORY. (London: George Newnes, Ltd.) 1s.

Attempts to give explanations of scientific phenomena in popular language are mostly failures and frequently ludicrous. These charges cannot be laid to Mr. Story's work since he only attempts to explain matters which can be understood without the aid of special training and knowledge. Commencing with the early experiments in communication by means of conduction and induction, the author proceeds by easy stages to set forth the history of Hertzian-wave telegraphy. Necessarily, the book is simply a compilation of records of wireless telegraphy achievements, but it is, nevertheless, anything but tedious reading.

A SCIENTIFIC INVESTIGATION INTO THE POSSIBILITIES OF GAS TURBINES.*

BY R. M. NEILSON.

(Continued from page 64.)

Cycle I., Case 3a.—Instead of employing cooling arrangements for the metal, some or all of the available heat energy of the gas can be converted into kinetic energy before causing it to act on the turbine, so that the latter is not exposed to an unduly high temperature. This can be done by allowing the gas when at the maximum temperature to expand in a divergent nozzle till its temperature falls to a degree that the turbine can stand. More than one nozzle can be employed, but to reduce the radiation losses the nozzles should be large and few in number.

Suppose that the gas is compressed adiabatically to 300lb. abs., and then is heated at constant pressure to a temperature of 2,273° abs. C., as in case 3. If now the gas be allowed to expand in a suitable nozzle, adiabatic expansion can be obtained; and if this be continued till the pressure falls to 15lb. abs. the temperature will be 966 abs. C. This is just below the temperature which was fixed on as a maximum for a turbine without artificial cooling. The entropy-temperature diagram will be the same as in case 3, Fig. 8, and E will, therefore, be the same—namely, 0·58. The ratio of negative work to gross work will also be the same as in case 3—namely, 0·3. Referring to the pressure volume diagram for cycle I., case 3, Fig. 7, the area $zZHK$ represents the kinetic energy of the gas leaving the nozzle, which kinetic energy equals 33,840 foot pounds. This is for a quantity of gas that measures 1 cubic ft. at A. The velocity is 5,290ft. per second.

To get the best results from a fluid velocity such as 5,290ft. per second, would require with a single turbine wheel a vane speed which cannot be obtained at present for want of a sufficiently strong and light material. The obvious way out of the difficulty is to employ several wheels in series, the gas passing through the several wheels with diminishing velocity, but with nearly constant pressure.

The frictional losses in the nozzles of a gas turbine will probably be less than those in a steam turbine for the same velocity of exit from the nozzle.

Cycle I., Case 4a.—Let us now try working as in case 4, but employing a divergent nozzle, as in case 3A, to reduce the maximum temperature to 700 C., so that the gas can be used in a turbine without cooling arrangements.

T_1 in this case will be 725° abs. C. (452°C.). It is not necessary, therefore, to perform all the adiabatic expansion in a divergent nozzle, but a portion of it can be performed in the turbine. If the fluid is expanded in the nozzle only till its temperature falls to 700°C., the pressure will then be 42lb. abs.; so that 27lb. can be dropped in the turbine.

The kinetic energy of the gas leaving the nozzle amounts to 33,660 foot-pounds (for 1 cubic ft. of gas measured at A), and the velocity works out at 5,280ft. per second. E will be the same as in case 4, and so will the ratio of negative work to gross work.

It seems to the author that an engine working on this cycle, according to case 3a or case 4a or between these, has good prospects. The ideal efficiency is high, from 0·58 to 0·68.

The losses in the motor proper may be taken to include the losses in the combustion chamber if such is employed and in the nozzles. The motor losses will then consist of:—1. Loss of heat by radiation and conduction. 2 Fluid friction. 3. Friction in turbine bearings. 4. Loss due to incomplete expansion.

The first loss will be large, but should be less than in reciprocating engines, owing to the higher velocities employed and to the higher temperatures allowable in the metal. The second loss will be considerable, but much less than in turbines using saturated steam. It has been found by experiment that hot dry air causes much less friction than wet steam. The third loss will be trifling and the fourth loss should be moderate. The discharge of heat with the exhaust gases is here only considered as a loss in so far as it exceeds that of an ideal engine.

It is difficult to estimate the pump losses. Rotary compressors on the turbine principle seem to have been employed only up to about 80lb. pressure. Whether or not they are suitable for high pressures is a point which we want very badly to know about. One would be inclined to believe that the fluid frictional losses with such machines would be very great if attempts were made to obtain high pressures. A reciprocating compressor always has the disadvantage that the air when drawn in becomes heated by contact with the hot metal surfaces before compression commences. This evil is reduced by compounding. It is an evil that occurs to a serious extent with reciprocating gas engines working on the Otto cycle. With a reciprocating compressor it will be difficult to avoid the necessity of jacketing the cylinder if high compressions are employed. This will bring the compression curve below the adiabatic and reduce the efficiency as before explained.

In any case, whatever be the nature of the pump there is bound to be a certain amount of heat passed through the walls of the pump cylinders or casing. If this loss is made up by friction or impact within the pump, the compression may be along an adiabatic curve, but the loss will still have to be paid for.

The ratio of negative work to gross work is somewhat high, 0·3 to 0·4. In the case of a turbine one need not fear the increase in the bulk of the engine due to this high ratio; for the bulk of the turbine will probably be very small for the power. Frictional and other losses become, however, of much greater importance when the ratio is high. To show this forcibly, consider an extreme case. Suppose that the ratio of negative work to gross work in an ideal engine is 0·5, or, in simpler language, suppose that the pump requires half the gross power of the machine, there being no friction. If now the machine is not ideal, and if the mechanical efficiency of the pump is only two-thirds and that of the motor proper only three-fourths, no useful work whatever will be got out of the machine—all the work will be absorbed by friction. When there is a high ratio of negative work to gross work, success will therefore be dependent largely on the efficiency of the pump. In the Diesel engine the bulk of the air is compressed to about 500lb. per square inch, and the air which carries the oil into the cylinder is compressed from 100lb. to 200lb. higher.*

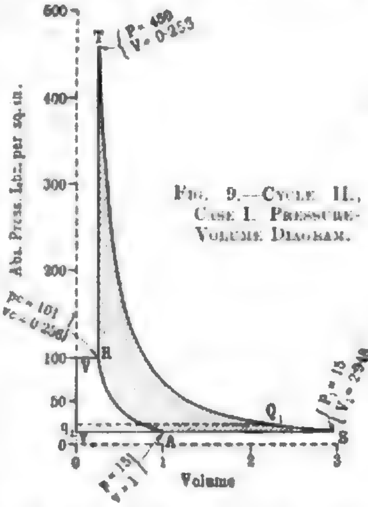
FIG. 9.—CYCLE II., CASE I. PRESSURE-VOLUME DIAGRAM.

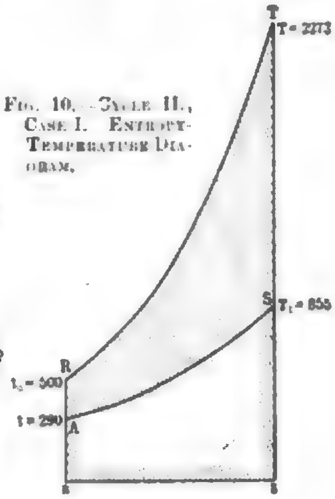
FIG. 10.—CYCLE II., CASE I. ENTROPY-TEMPERATURE DIAGRAM.

Otto cycle reciprocating engines having ideal efficiencies of 0·4 to 0·45 have given practical efficiencies of half that amount. By practical efficiency is meant ratio of B.H.P. to thermal units in gas consumed, calculated on the higher calorific value. When the ideal efficiency is increased above 0·45, the ratio of practical efficiency to ideal efficiency usually falls below 0·5—the greater the ideal efficiency the greater are the losses. With a turbine the losses ought also to increase when the ideal efficiency is increased, but whether to the same extent as with an Otto engine it is difficult to say. When considering high compressions it is well to note that the Diesel engine with a high compression and an incomplete expansion has given some of the highest practical efficiencies yet attained. The compression should not cause the same trouble in starting a turbine as in starting a reciprocating engine, as with a turbine we should be able to arrange that at every instant the gross work is greater than the negative work.

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* Abstract of a Paper read before the Institution of Mechanical Engineers last Friday.

* "The Diesel Engine," by H. Ade Clark. Paper read before the Institution of Mechanical Engineers at Leeds in July, 1903, p. 395.

Cycle II., Case 1.—With regard to explosion turbine engines, suppose that the fluid is compressed adiabatically to, say, 101lb. per square inch abs., that is, to a temperature of 500 abs. C. Let it now be heated at constant volume by explosion, and let there be a mixture of such a strength that the temperature will rise to 2,000°C. (2,273° abs. C.). The pressure will then be 459lb. abs. If the gas is now allowed to expand adiabatically till its pressure is atmospheric (when its temperature will be 855° abs. C.), and then cooled at that pressure till it resumes its original state, the pressure-volume and entropy-temperature diagrams will be as shown in Figs. 9 and 10.

In Fig. 10 the heat supplied to the fluid is represented by the area *a*RT*s*, the heat rejected by the area *a*AS*s* and the heat converted into work by the area ARTS.

$$E = \frac{\text{area ARTS}}{\text{area } a\text{RT}s} = 0{\cdot}55.$$

The negative work can be compared with the gross work in Fig. 9. The ratio of negative work to gross work

$$= \frac{\text{area } r\text{VRA}}{\text{area } e\text{VRTS}} = 0{\cdot}23.$$

Cycle II., case 1, very nearly resembles common practice to-day with reciprocating explosion engines. The expansion is, however, continued to atmospheric pressure. This, as a rule, is not desirable in a reciprocating engine on account of the extra length required to be given to the engine cylinder. This not only increases the loss by friction but increases the loss of heat by the expanding gas, and, if the same length of stroke is employed for drawing in the fresh charge, increases the heating of the charge before compression. The case, however, is very different with turbines; and there seems no good reason why with these the adiabatic expansion should not be carried practically to atmospheric pressure. In practice the maximum pressure and the average minimum temperature throughout the gas would be less than the values here indicated owing to radiation losses.

Cycle II., Case 1a.—The gas could not be allowed into an uncooled turbine at the maximum temperature in cycle II., case 1; but, if the expansion were performed wholly or nearly wholly in a divergent nozzle, the temperature of exit from the nozzle would be sufficiently low to allow of the gas entering an uncooled turbine.

For example, if the gas at the maximum temperature of 2,273° abs C. and the maximum pressure of 459lb. abs. were expanded in a perfect divergent nozzle till the temperature fell to 700 C. (973° abs. C.), which was fixed on as the maximum allowable temperature in an uncooled turbine, the mean pressure on leaving the nozzle would be 23·5lb. abs. The kinetic energy of the gas (1 cubic ft. at A) on leaving the nozzle would be represented by the area VRTQ_1q_1 in Fig. 9, and would amount to 20,500 foot-pounds. The mean velocity (the square root of the mean square) would be 4,120ft. per second.

On comparing cases 1 and 1A of cycle II., by reference to the table given below, with cases 2, 3, 3A, 4 and 4A of cycle I., which have the same maximum temperature, it is found that the efficiency is very much greater than cycle I., case 2, is nearly as great as cycle I., cases 3 and 3A, and is considerably below cycle I., cases 4 and 4A. The ratio of negative work to gross work is, however, greater than in cycle I., case 2, and less than in cases 3, 3A, 4 and 4A of cycle I.

One of the objections to cycle II. is that explosions at constant volume have to take place intermittently, while a turbine desires a continuous supply of fluid. If the supply is not continuous the power of the turbine is less than it would otherwise be for a given size of machine; and the initial cost, the bulk and—most important—the loss by friction are greater in proportion to the power developed than they would otherwise be. The other objection is that the fluid must leave the explosion chamber at varying pressure. This necessitates, unless special means are provided to prevent it, the fluid entering the turbine casing either at varying pressure or at varying velocity. This, of course, is objectionable, as the speed of rotation of the turbine cannot during the period of a cycle be made to vary correspondingly.

The second objection might be met by employing in a parallel-flow turbine of the De Laval type long radial blades, and causing the nozzles to be altered in position according to the pressure, so as to direct the gas on to the outer ends of the blades at high pressures and on to the inner ends of the blades at low pressures. The difficulty could also be met by an arrangement of reciprocating engine combined with a turbine, the gas being first expanded in the reciprocating engine to a certain pressure and then passed on to the turbine to complete its expansion. If several reciprocating cylinders were employed, the first objection also would be got over. It is true that with such a combination some of the most important advantages of the turbine would be lost. The idea is, however, in the author's opinion, worthy of consideration. Reciprocating steam engines have been successfully combined with steam turbines in this manner.

Table Comparing the Several Cycles and Cases.

Cycle.	Case.	Compression. Temp. abs. C.	Compression. Press. lbs. per sq. in. abs.	Max. temp. abs. C.	Max. press. lbs. per sq. in. abs.	Ideal efficiency. (E.)	Ratio of neg. work to gross work.
I.	1	389·0	42	973	42	0·25	0·40
I.	2	389·0	42	2,273	42	0·25	0·17
I.	3 & 3A	682·5	300	2,273	300	0·58	0·30
I.	4 & 4A	909·0	818	2,273	818	0·68	0·40
II.	1 & 1A	500·0	101	2,273	459	0·55	0·23
II.	2 & 2A	750·0	417	2,273	1,265	0·68	0·38
III.	2	682·5	300	2,273	300	0·33	0·41
IV.	..	353·0	30	2,273	30	0·84	0·16

Cycle II., Case 2.—An explosion engine in which a very high compression pressure is employed will now be considered. If a compression of 417lb. abs. is adopted, this will give a temperature of compression of 750° abs. C. Working on the same cycle as in the last case and arranging the explosive mixture to give a maximum temperature of 2,000 C. (2,273° abs. C.), a maximum pressure of 1,265lb. abs. is obtained.

It is found that in this case $E = \frac{\text{area AUWW}_1}{\text{area } a\text{UW}w} = 0{\cdot}68$. It is also found that $\frac{\text{Neg. work}}{\text{gross work}} = \frac{\text{area } u_1\text{U}_1\text{UA}}{\text{area } u_1\text{U}_1\text{UWW}_1} = 0{\cdot}38$. E is the same as in cycle I., case 4, and the ratio of negative work to gross work is also the same. The compression is lower than in cycle I., case 4, but the maximum pressure is very much higher, and is an objection to this case.

Cycle II., Case 2a.—If the expansion took place in an ideal divergent nozzle, as before, till the temperature fell to 700 C. (973° abs. C.), the gas would still have a pressure of 70lb. abs., while the mean velocity of exit from the nozzle would be 4,300ft. per second. If the gas were expanded in the nozzle down to 25lb. abs., the temperature would then be 741° abs. C., and the mean velocity of the gas leaving the nozzle would be 4,830ft. per second.

Cycle III., Case 1.—It has been proposed, when a water jacket is employed, to utilise the heat passed into the jacket water by causing this heat to generate steam from the water. This steam could then receive further heat from the products of combustion, which would, therefore, be reduced in temperature, while the steam would be superheated. The steam and products of combustion could then expand adiabatically, doing work in the same or in separate turbines. The carrying out of this idea would affect the efficiency in the several cases considered of cycle I. Cooling arrangements are not required in cycle I., case 1. In cycle I., case 2, let it be supposed that the combustion chamber is jacketed, and that the jacket water is heated and converted into steam by heat taken from the products of combustion, which have their temperature thus lowered from 2,000°C. to 700°C., that is, to the temperature at which they can safely be allowed into an uncooled turbine, the steam being superheated up to 700°C. Let this be called cycle III., case 1.

Referring to Fig. 6, the heat in the products of combustion which is converted into work is now represented by the area ABCD instead of by the area ABEF. The heat represented by the area *d*CE*f* has, however, been employed in heating water and generating and superheating steam. The fraction of this heat which is converted into work will not now be as great as in the original scheme of working. That is to say, the net work got out of the heat put into the water and steam will be less than the area DCEF. By transferring heat to the water and steam from the gas, E is therefore reduced. There must, however, in any case, as already mentioned, be lost in practice a large amount of heat from the products of combustion when these products of combustion enter the turbine casing at a temperature such as 2,000°C., and, by adopting this combined steam and gas scheme, a much higher practical efficiency may possibly be obtained than would otherwise be possible. As the net work ideally is less than in cycle I., case 2, and as the negative work is not less (and may be greater by the amount of work required to pump the water into the jacket if under pressure), the ratio of negative work to gross work is increased. In case 2 of cycle I., the ratio of negative work to gross work is low, and it will be, therefore, allowable to increase this ratio.

Cycle III., Case 2.—Case 3 of cycle I. could be modified in the same way by reducing the temperature of the products of combustion from 2,000 C. to 700 C., and by employing the heat so given up in heating water and generating and superheating steam. The steam could be generated at 300lb. pressure abs. (the same pressure as the products of combustion) and superheated to 700°C. at this pressure. The steam and gas could then be expanded adiabatically in the same or in separate turbines. As in the previous case, E would be reduced and the ratio of negative work to gross work increased. As in the previous case also, the practical efficiency might be largely increased. The pressure volume and entropy temperature diagrams for the gas in this case (called cycle III., case 2) are shown in Figs. 11 and 12 respectively. The gas is compressed along the line AG, as in cycle I., case 3, till its pressure is 300lb. abs. and its temperature is 409·5° C. (682·5° abs. C.). It is then heated by combustion at constant pressure along the line GH, as in cycle I., case 3, till its temperature is 2,000° C. (2,273° abs. C.). Heat is now withdrawn from the gas at constant pressure and transferred to the water and steam, the temperature of the gas falling along the line HH_1 to 700° C. (973° abs. C.) at H_1. The heat transferred from the gas to the water is represented, Fig. 12, by the area K_1H_1HK. The gas now expands adiabatically along the line H_1K_1 till the pressure is 15lb. abs., when the temperature will be 140° C. (413° abs. C.). The contraction of the gas at constant pressure along the line K_1A completes the cycle. Dotted lines have been placed on Figs. 11 and 12 to illustrate cycle I, case 3, where this differs from the present cycle. The two cycles can thus be compared.

Pressure-volume and entropy-temperature diagrams for the water are shown in Figs. 13 and 14. Referring to Fig 14, the water is heated at a constant pressure of 300lb. per square inch abs. along the line *fc* from 100·6 C (373·6° abs. C.) to 214° C. (487° abs. C.), which is the boiling point at this pressure. The water is now converted into steam, this process being represented by the line *cg*, and the steam is superheated at constant pressure as represented by the line *gd*, till its temperature is 700° C. (973° abs. C.). The steam is then expanded adiabatically along the line *de* till it falls to 15lb. pressure abs., its temperature then being 184° C. (457° abs. C.). The steam is now exhausted and cools along the line *eh*. At *h* it is saturated, its temperature being 100·6° C. (373·6° abs. C.), and thereafter it condenses along the line *hf* and is compressed to its initial state.

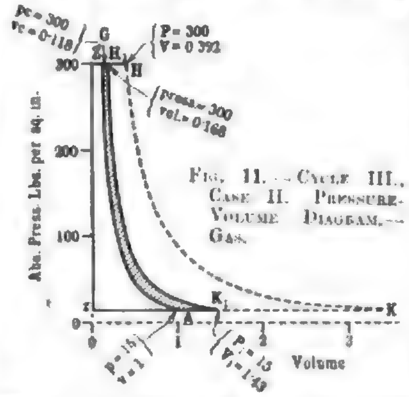


FIG. 11.—CYCLE III., CASE II. PRESSURE-VOLUME DIAGRAM.—GAS.

Fig. 13 shows the work done by the steam in its generation, superheating and adiabatic expansion. The work done in forcing the water into the chamber at 300lb. pressure is not shown in Fig. 13, and is negligible in an investigation of the nature of the present. The heat required to raise the water from 373·6° abs. C. to 487° abs. C. is represented in Fig. 14 by the area f_1fcc_1. The area c_1cgg_1 represents the latent heat of steam at a pressure of 300lb. abs. (the temperature being 487° abs. C.), and the area g_1gde_1 represents the heat required to superheat the steam from 487° abs. C. to 973° abs. C. The area f_1fhh_1 represents the latent heat of steam at a pressure of 15lb. abs., and the area h_1hee_1 represents the heat required to superheat this steam from 373·6° abs. C. to 457° abs. C.

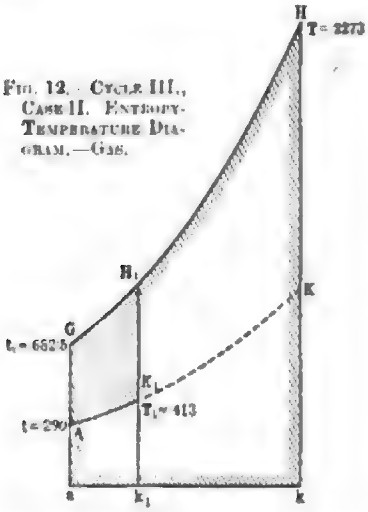


FIG. 12.—CYCLE III., CASE II. ENTROPY-TEMPERATURE DIAGRAM.—GAS.

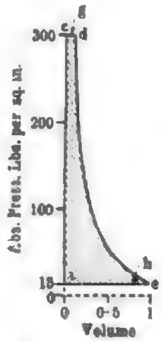
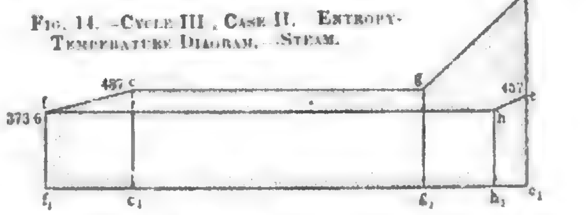


FIG. 13.—CYCLE III., CASE II. PRESSURE-VOLUME DIAGRAM.—STEAM.

Comparing this case with case 3 of cycle I., it is found that the total heat absorbed is the same in both cases, being represented by the area *aGHk* in Fig. 12. The portion of this heat which is converted into work in case 3, cycle I., is represented by the area AGHK, while the corresponding portion in the present case is represented by the sum of the areas AGH_1K_1 (Fig. 12) and *fegdeh* (Fig. 14). This sum is less than the area AGHK, and E in this case is only 0·33 as compared with 0·58 for case 3 of cycle I. The fall in the value of E is due to the relatively low efficiency of the steam portion which has an ideal efficiency of only 0·28. (This is really not low for a steam engine.)

The feed-water has been taken at a temperature corresponding to atmospheric boiling point. It has been assumed that the steam is exhausted into the atmosphere, and is not condensed for use over again. It would, therefore, be necessary, in order to follow the cycle, to heat the feed-water to 100° C. It should not be difficult to approximately accomplish this by utilising the heat of the exhausting gases. By heating the feed-water still more, the efficiency could be improved; but the improvement would be slight (less than in an ordinary steam engine), and the feed-water would have to be under pressure. As, moreover, any increase of exhaust or back-pressure is a serious matter with a turbine, and as feed-water heaters must, to a certain extent, affect this back pressure, any prospect of gain by heating the feed-water beyond 100° C. need not be considered. The gross work in the present case is represented (Figs. 11 and 13) by the area zZH_1K_1 + the area *acde*. This is less than the gross work in cycle I., case 3, which is represented by the area zZHK. The negative work in cycle I., case 3, was represented by the area zZGA. In the present case it is also represented by this area, neglecting the work of pumping the water into the jacket. The ratio of negative work to gross work in the present case is 0·41, as compared with 0·3 in cycle I., case 3. This ratio (0·41) is rather high. It will, however, probably not be so objectionable in the present case as the ratio 0·40 in case 4 of cycle III., as the real efficiency in practice will come nearer to the ideal in this case than in case 4 of cycle III. We could, in the present case, reduce the ratio by lowering the compression. This would reduce E. As the mass of the water employed is not the same as the mass of the air and fuel, the scale for entropy in Fig. 14 has been made different from that in the other entropy-temperature diagrams, so that in all these diagrams areas represent quantities of heat to the same scale. In all the pressure-volume diagrams the scales are the same except in Fig. 15, which will be referred to hereafter. It might be mentioned here that all the numerical results given in this Paper have been obtained by calculation and not by scaling the diagrams.

FIG. 14.—CYCLE III., CASE II. ENTROPY-TEMPERATURE DIAGRAM.—STEAM.



It will be seen that it has been assumed that the gas and steam expand adiabatically separate from each other. The adiabatic curve of the one is different from that of the other as the specific heats are different; and while the gas falls to a temperature of 140° C. (413° abs. C.) the steam falls only to 184° C. (457° abs. C.). This will be correct if the steam and gas are not mixed. It is much simpler to consider this case than to consider the case where the gases are intimately mixed. In this latter case the diagram (Fig. 12) would be altered, and it could not so easilly be seen where the loss of efficiency came in. In practice, however, it will probably be found convenient to mix the gases. This will alter the diagrams and the efficiency somewhat; but what has been considered gives a good idea of the general effect of the employment of steam in conjunction with gas. If the steam and gas are not mixed, a condenser could be employed for the former. The steam could then be expanded to a much lower temperature and pressure, and the efficiency would be considerably raised.

(To be concluded.)

THE MEASUREMENT OF THE POTENTIAL OF THE ELECTRODES IN STATIONARY LIQUIDS.*

BY HENRY J. S. SANDS, PH.D., M.SC.

(Continued from page 68.)

Results Obtained with Aqueous Solutions of Copper Sulphate, Silver Nitrate and Zinc Sulphate.—The first series of experiments we have to refer to is one carried out with aqueous solutions of metal salts, the substances employed being solutions of copper sulphate, silver nitrate and zinc sulphate. As long as metal salt is left in the layer of liquid touching the cathode, the metal is deposited from such solutions at a cathode potential, probably either identical with or differing only slightly from the potential at which it is in equilibrium with the solution of its salt. But when the salt has been removed from the electrode by the current, a sudden drop of the potential of the electrode takes place. A marked difference is, however, observed in this connection between solutions of copper sulphate and silver nitrate. In the case of the former the cathode-potential drops about 1 volt, and then becomes fairly constant again. At the same time the resistance of the layer of liquid around the cathode increases by about 175 ohms per square centimetre, the combined effect being that the difference of potential between the standard electrode and the cathode, as measured in the experiments, increases by 1·2 to 1·3 volts above its original value. The increase of resistance is found to be due to the formation of a deposit of copper hydroxide arising from hydrolysis of the copper sulphate at great dilutions. In the case of the silver nitrate, however, when depletion of the silver occurs a drop of the potential of the cathode amounting to only about 0·2 volt takes place, after which the potential approaches its former value again more or less rapidly. The cathode is then found to have become covered with a mass of silver crystals which grow into the solution. The curves in Fig. 5 show results obtained with a silver nitrate, and with a copper sulphate solution. As has been shown in the previous communication referred to, the diffusion coefficient of the salts experimented on may be calculated when the time is known which elapses until the concentration of the salt in the layer of liquid at the electrode becomes zero, and this time may be taken as that at which the break in the curve takes place. The actual points chosen on this break were 5 centivolts in the case of the silver nitrate, and 50 centivolts in the case of the copper sulphate solutions. The formula employed is—

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* Paper on "The Measurement of the Potential of the Electrodes in Stationary Liquids; the Determination of Changes of Concentration at the Cathode during Electrolysis" read before the Faraday Society, Oct. 25th.

$$k = \frac{1 \cdot 1284^2}{96540^2} \frac{i^2 t n_a^2}{c^2},$$

k being the diffusion coefficient of the salt in cm.^{2} sec., when c is the concentration of the solution in mg.-equiv. cm.^{3}, i the current strength in milamps. cm.^{2}, t time in seconds and n_a the transport value of the anion. Details of the experiments and results are arranged in the following table :—

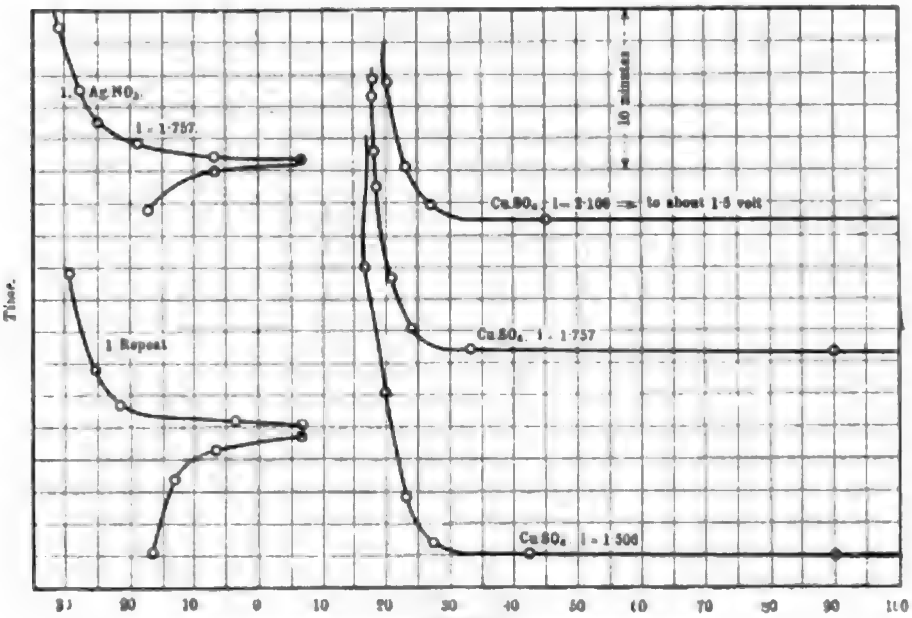

FIG. 5.—AQUEOUS SOLUTIONS OF SILVER NITRATE AND COPPER SULPHATE.

Table I.

A. Copper sulphate solution concentration 0·204 mg.-equiv/cc Electrode : Platinum-iridium of available surface 0·7589cm.^{2} $n_a = 0·63$.

Current-density in milamps. /cm^2.	Time in seconds.	Temperature T in °C.	Diffusion coefficient at T° in cm.^{2}/sec.	Diffusion coefficient at 18° by formula $k_{18} = \frac{k_T}{1 + 0·026(T - 18)}$.
2·109	790	15½	$4·58 \times 10^{-6}$	$4·86 \times 10^{-6}$
1·757	1,053	16	$4·24 \times 10^{-6}$	$4·45 \times 10^{-6}$
1·506	1,566	16	$4·63 \times 10^{-6}$	$4·86 \times 10^{-6}$
1·042	3,297	16½	$4·66 \times 10^{-6}$	$4·81 \times 10^{-6}$

B. Silver nitrate solution concentration 0·1 mg.-equiv./cc. Electrode as above, $n_a = 0·528$.

1·757	580	18½	$6·82 \times 10^{-6}$	$6·73 \times 10^{-6}$

Table II.

No. of experiment.	Ratio of condensers.	Resistance in dial box.	Resistance calculated.
1a	500 : 20	65	From 1a and 1b 77 ohms
b	: 40	207	
c	: 50	278	From 1a and 1c 77 ohms
d	: 70	425	From 1a and 1d 79 ohms
2a	500 : 50	122	From 2a and 2b 218 ohms
b	: 100	462	

According to Wiedeburg[*] the diffusion coefficient of $CuSO_4$ at 18deg. is $4·479 \times 10^{-6}$ for the concentration 0, and $4·226 \times 10^{-6}$ for the original concentration of the preceding table. The values in the table thus appear somewhat high. The value found for the diffusion coefficient of silver nitrate is very much too low if we take as correct the number $k_{18} = 12·5 \times 10^{-6}$ cm.^{2}/sec., which has been calculated by Nernst from the migration velocities of the Ag· and the NO_3' ion,[†] and which agrees with values extrapolated from Scheffer's determinations of diffusion coefficients.[‡] This fact seems to point to the break in the curve occurring before complete depletion of the silver at the electrode has taken place. The matter is, however, undergoing further investigation. See also remarks below regarding deposition-potential of copper.

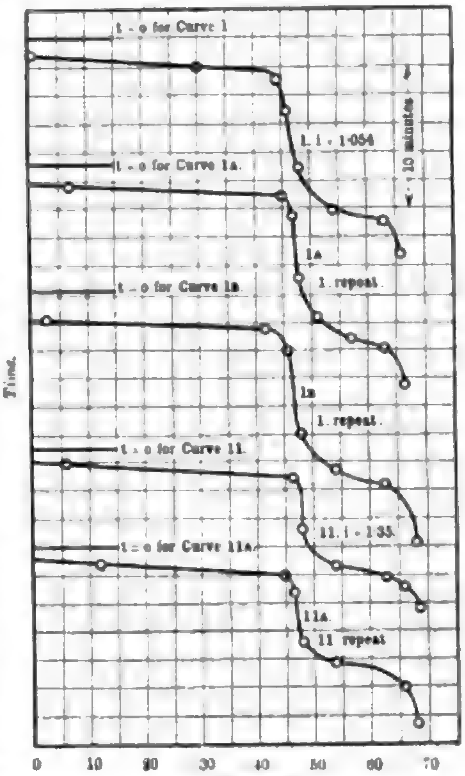

FIG. 6.—ALCOHOLIC SOLUTION OF CUPROUS CHLORIDE.

The numbers given in Table II. may be taken as typical results for the determination of the resistance of the copper sulphate solution between the cathode and the junction T. The experiments 1, a, b, c, d, were carried out before the current passed through the solution ; experiments 2, a and b, after the break in the potential of the cathode had taken place.

The potential of the cathode, after allowance had been made for the drop according to Ohm's law between the cathode and the junction T, was, in the majority of experiments on copper sulphate solutions, found to lie about 10 to 20 millivolts below the potential of equilibrium. This matter, as well as the slight retrogression of potential at the beginning of the experiments which is visible in the copper sulphate curves (Fig. 5), similarly the conditions on which the crystallisation of the silver depends, is undergoing further investigation. Some of the results referred to, if corroborated, would lead to the conclusion that the deposition of metals from solutions like copper sulphate is not an absolutely reversible process, and this, again, would prove of importance in its bearing on the different nature of metal deposits obtained from different solutions. In a series of experiments on a decinormal zinc sulphate solution with an amalgamated copper electrode similar curves resulted to those obtained with the copper sulphate. Owing, no doubt, to the fact that hydrogen is evolved sometimes after all the zinc has been removed from the solution and sometimes before, according to slight differences in the nature of the electrode, the results were somewhat irregular, and have, therefore, not been reproduced as curves. The values obtained for the diffusion coefficient of zinc sulphate varied between $3{\cdot}5\times10^{-6}$ and $4{\cdot}5\times10^{-6}$ cm.²/sec. They point to an increase of the diffusion coefficient of zinc sulphate at great dilutions, the value obtained by Weber* for solutions of 2·114 per cent.—*i.e.*, 0·26 mg.-equiv./cc., being $2{\cdot}78\times10^{-6}$ cm.²/sec. In agreement with this we should expect the diffusion coefficient of zinc sulphate not to differ greatly from that of copper sulphate at great dilution, owing to the fact that the mobilities of the zinc and the copper ion are nearly equal at great dilution.

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[*] *Wied. Ann.*, 41, 675, 1890.

[†] *Zeitschrift Phys. Chem.* Vol. II., 400 (1888).

[‡] *Zeitschrift Phys. Chem.* Vol. II., 628 (1888).

Alchoholic Solutions of Cuprous Cholride.—The next series of determinations was carried out with the object of testing whether the method was suitable for alcoholic solutions. The solution chosen was one of cuprous chloride in a mixture of hydrochloric acid, alcohol and water, its composition being 1 gramme Cu_2Cl_2, 25 cubic cm. strong hydrochloric acid, 45 cubic cm. 95 per cent alcohol, 30 cubic cm. water. Owing to contact with the air, part of the cuprous chloride became oxidised to cupric chloride. The curves on Fig. 6 show the degree of coincidence obtained in successive experiments, three determinations having been carried out with the current-density 1·054 milliamperes/centimetres², and two with the current-density 1·318 milliamperes/centimetres². The curves obtained are of interest inasmuch as they show plainly that two successive processes take place: firstly, the reduction of the cupric chloride to cuprous chloride, which begins at potentials lower than those registered in the figure, and goes on to about 45 centivolts; and, secondly, the deposition of copper from the cuprous chloride beginning at about 45 centivolts and going on until the break in the curve is completed, when the potential becomes fairly constant at about 65 to 70 centivolts, and hydrogen comes off.

(To be concluded.)

GRAPHIC TRACINGS OF THE FARADIC AND OTHER INTERRUPTED CURRENTS.†

BY H. LEWIS JONES, M.D., F.R.C.P.
(Medical Officer in Charge of the Electrical Department, St. Bartholomew's Hospital.)

The object of this Paper is to bring to the notice of the medical profession the results of an examination of the characteristic curves of certain medical induction coils. These have been taken by means of an instrument known as Duddell's oscillograph. The interest of these curves lies in the indications which they seem to afford as to the proper construction of medical coils. To supplement them I have also to show some tracings taken in the same way of other forms of interrupted currents, and hope to make a few remarks upon these as well. I do not propose to enter at any length into the electrical technicalities of the subject, because I do not consider that the section of medicine is the proper place for such details, however interesting they may be to those who have specially studied the applications of electricity to medical practice; and I feel very great regret at the action of the British Medical Association in not affording its members the facilities of a sub-section in electro-therapeutics, a deficiency which I sincerely hope to see rectified in time.

Although the honour of bringing these results to the notice of this meeting is mine, I wish to state at the outset that this Paper is the outcome of work done in conjunction with Dr. Head and Dr. Reginald Morton. The interest which I have long felt in the measurement of induction-coil currents for purposes of exact diagnosis received a fresh stimulus last winter from the problems brought to me by Dr. Head in regard to medical coils and their effect upon sensory nerves. In pursuing the questions raised by him, the idea of trying to obtain tracings by means of the oscillograph occurred to us, and later on Dr. Head brought me some actual tracings of medical coil currents obtained with that instrument. We were so impressed with the clearness of these tracings that we decided to investigate further, with the results which I now am about to show to this meeting. A difficulty which arose at the outset was due to the irregular action of the interrupting hammer devices used with coils, and we then called in the mechanical skill of Dr. Reginald Morton, the medical officer in charge of the electrical department at the London Hospital, and he has himself constructed for us some of the apparatus upon the table, without which it would have been almost impossible to proceed with our investigations.

The discharges of a medical coil, if we consider those of the secondary winding, which are most commonly employed, consist, as is well known, of a series of electrical impulses or waves of current, alternating in direction and unsymmetrical. From theoretical considerations this must be so, but the actual shapes of the waves and their actual duration have not hitherto been demonstrated in the clear way in which they can be done to-day. In an examination into this point made by myself in 1892, towards the expenses of which I received a grant from the funds of this Association, I was able to show that the discharges of a coil might be of comparatively long duration, much longer than was believed at that time to be the case, and also that the two waves—namely, those at make and at break—might interfere with each other under certain conditions of the vibrating hammer. It is necessary to mention that Dr. Kellogg had taken tracings of induction-coil currents some years earlier, and that the same points can be discerned in his tracings, if due allowance be made for the inertia of his recording apparatus, which had the effect of degrading the finer variations of his curves to a certain degree.

By way of definition, let me say that, in considering the medical coil, we have to think of three separate currents or circuits: (1) The secondary current, which is an alternating current; (2) the exciting current or inducing current or magnetising current—that is to say, the flow from the battery through the primary coil and interrupter; (3) the extra current of the primary, which is a current induced in the exciting circuit at the moment of rupture of the exciting current, and one which can be led off by suitable connections for purposes of medical testing and treatment. This requires special arrangements, if it is to be traced by the oscillograph, and is not shown in the tracings to-day. In many of the tracings the curve of the exciting current is shown above the induced currrent, an arrangement which adds to their value by making their interpretation more easy. In Fig. 6 it is below.

In order to illustrate the appearance of oscillograph tracings, and to explain what is to follow, I will first show two slides which are not tracings of induction coils, but which I have made to show the effect of iron in altering the time element of a circuit carrying a varying current. The first is a circuit of very low inductance, and consequently the current rises almost instantaneously to a maximum, at which it remains steady until broken, when the return to zero is also almost instantaneons. The second is the same circuit, when modified by the introduction of a coil of a few hundred turns of wire wound round an iron core. In the first the current reaches its full value in a time which is not more than [illegible]th of a second; in the latter it has not reached a steady state after [illegible]th of a second, but is still rising when the break comes (Figs. 1 and 2).

The tracings taken by the oscillograph employed in this investigation are taken on a moving photographic plate. The speed of the plate is 4 metres per second in all cases, and this permits of measurements of the duration of the different current waves, and also of their direct comparison, so far as times are concerned. The length of each slide represents about [illegible]th of a second. The actual height of the rise and fall of the waves is adjusted to suit the capabilities of the measuring instrument, just as the magnitudes of current might be adjusted before application to the human subject.

Proceeding now to an examination of the current waves of medical coils, we find that several points are illustrated by the tracings of the oscillograph. First, it shows that the vibrating hammer, used commonly as an interrupter, is in need of attention, for it is apt to be a defective device, and does not always produce clean, sharp makes and breaks. In the next figure a tracing is given of the exciting current, as influenced by a form of interrupter in common use, and in it six inadequate attempts at contact can be counted before the proper establishment of the steady flow at make, while at the break of circuit there are also two irregularities (Fig. 3).

As each of these partial contacts is reflected in the curve of the secondary circuit, it is thus seen that the secondary current of a coil so fitted is one of great complexity, and one finds in practice that it is highly disagreeable. We also learn from the tracing that the rate of this type of interrupter is slow. In the slide shown each interval lasts [illegible]th of a second, and each impulse about [illegible]th or more; the whole cycle, therefore, occupies [illegible]th of a second, a frequency which is not very suitable for medical application.

Induction coils with auxiliary electromagnets for operating the hammer, especially when the hammer itself is heavy and vibrates up and down, give these irregular currents of low frequency. The shocks of such coils are disagreeable, and they are bad forms of instrument for electrical testing, and for most forms of electrical treatment.

The next figure shows the character of the current waves of a coil with a long secondary and auxiliary electromagnet as it occurs when the iron core is removed. The effect of the iron of the auxiliary magnet is still present. The upper curves show the growth, the period of steady flow, and the abrupt rupture of the exciting circuit, while the lower show the currents induced in the secondary coil. It is easy to see which one of the wave corresponds in time to the make and which to the break of the exciting circuit; the former rises less abruptly from the zero line, and is a lower and a longer wave than the latter, and their respective durations as measured are [illegible]th and [illegible]th of a second, and the frequency of the interruptions in this paticular instance is one of 80 per second (Fig. 4).

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* Wied. Ann. 7, 536, 1879.

† Paper read in the Section of Medicine at the Annual Meeting of the British Medical Association, Oxford, July, 1904.

In the next figure everything is as before except that the iron core has been inserted. The change in the contours of the tracings is profound, for the wave of current at break now lasts more than twice as long (or about [illegible]th of a second), while the current at make is prolonged to more than [illegible]th of a second—that is to say, it has a duration five times as long as was the case when no iron core was present (Fig. 5).

It is also instructive to compare the upper curve which represents the exciting current. Its rise is slow, so slow that it has not reached its steady state at the moment of rupture, although the rate of interruption is a slow one.

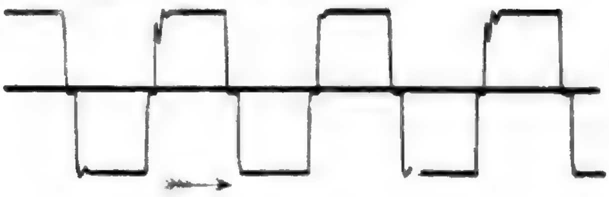


Fig. 1.

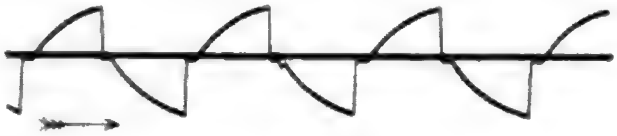


Fig. 2.

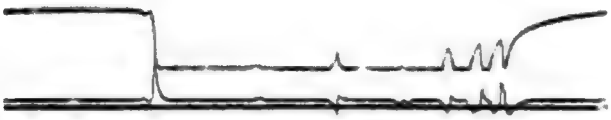


Fig. 3.

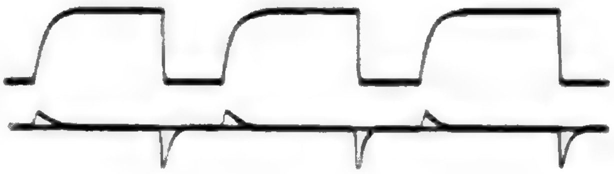


Fig. 4

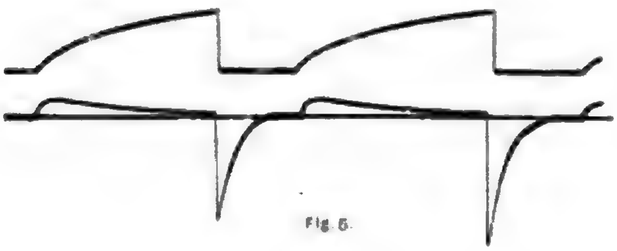


Fig. 5.

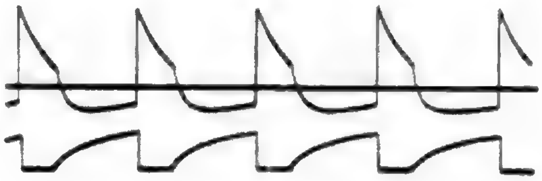


Fig. 6

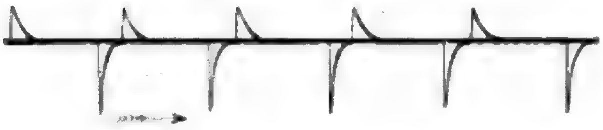


Fig. 7.

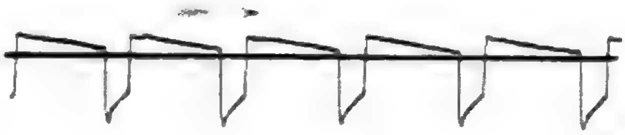


Fig. 8.

Another interesting point is the effect of alterations in the speed of the interrupter. As would naturally be expected from the duration of the waves, a speed can be reached at which the waves at make and at break begin to tread upon each other's heels, so to speak, so that before the make wave is over it is suddenly reversed by the wave at break, and vice versa. The next figure shows this point clearly (Fig. 6).

Fig. 7 is a tracing which, in my opinion, represents an almost perfect type of induction current. Note the quick rise and fall and the distinct interval between the pairs of impulses. If the make current (the upper wave) could be made equal to the wave at break, without increasing its duration, it would represent a very good current for muscular stimulation. The introduction of an iron core ruins it, as the next slide shows (Fig. 8).

The point which comes out most strongly in these tracings is the influence exerted by the iron core upon the duration of the currents of a coil. The effect of long lengths of wire is similar, but is less in degree, and in both cases the effect is an effect of the inductance of the circuit. Briefly, it may be said that the inductance of a long coil is greater than that of a short coil, while the presence of an iron core increases both proportionately and very largely.

Duchenne long ago maintained that the physiological effects from long secondary windings were not identical with those from short windings. At that time electrical science could offer no explanation of this. It was suggested that the difference was a matter of E.M.F., which is greater with a long secondary. This did not satisfy Duchenne, because the differences observed by him were independent of the mere strength of the E.M.F. or current. Differences in these points may be adjusted, and were adjusted by him, but the innate differences in quality remained, in spite of adjustments. The essence of Duchenne's contention was this, that the ratio of motor to sensory effect was not identical in the two types of secondary coil. With long coils the sensory effects were strong at weak degrees of motor effect, with short coils sensory effects were weak at strong degrees of motor effect.

These tracings afford an explanation. They show that duration of wave is an important factor, and further tells us that the presence or absence of an iron core determines the duration of the impulses even more than the length of the windings. Dr. Head has been able to satisfy himself that sensory effect and pain predominate in discharges of long duration, and are at a minimum in those of shortest duration. In my own work I have found that for testing muscles with comfort to the patient the shortest impulses are the best. Waller, working with condenser discharges, has found the same thing.

The work which has been done by Dr. Head, Dr. Reginald Morton and by myself with the various coil currents whose tracings you have just seen, indicates that for painless, or nearly painless, testing of muscles the shortest impulses are best, and coils with short windings and without iron cores afford the most agreeable form of current.

As induction coils must have an iron core if they are to be operated by the ordinary vibrating spring contact breaker, we are at once confronted by a constructional difficulty, and must inquire afresh as to whether it is possible to employ an iron core without sacrificing any essential point, and the answer to this is in the affirmative, provided we are prepared to be content with something a little less than the best, and will take pains with the manufacture of our contact-breaker by making it very light and springy. Moreover, we may greatly reduce the slowing effect of the iron if we use as a regulator to the coil the device of a metallic tube or sleeve to slide over the core or over the primary windings, as is commonly done.

When all has been said and done with regard to medical induction coils, we have to confess that the instrument labours under very serious objections if accurate work is wanted. The inequality of the impulses at make and break, the unknown duration of the intervals between successive impulses and the capriciousness of the hammer vibrator render measurements of current not only untrustworthy but actually misleading as a guide to physiological effect. The instruments used in measurement measure the mean or average current, but the physiological effect depends, not on the average current, but on the magnitude, the suddenness and the duration of the individual waves which compose it. Thus an instrument suitable for use with coils in general cannot be constructed, although instruments have been made which can give useful indications of measurement when working with an individual coil.

When the question of the use of coil currents in diagnosis is examined we find that there is no apparent reason why interrupted currents from other sources should not be used in their stead. Dr. S. Leduc (Nantes) has recently called attention afresh to this matter, and by using a continuous-current source and a mechanical interrupter he has been able to produce all the effects upon muscle which are generally considered to be peculiar to the induction current or "faradism," as it is commonly called by medical men.

The interrupter of Leduc is a very ingenious device, which permits of alterations in the durations of the impulses without altering their frequency, and he has drawn some very valuable information from his experiments with this apparatus, an account of which and of his investigations will be found in the *Archives d'Electricité Médicale* for September, 1903.

Recently I have been working with a mechanical interrupter which differs from that of Leduc in giving alternating impulses instead of simple interruptions. To my mind this has an advantage, because the chemical effects of electrolysis are eliminated. I have found this instrument of great value for purposes of diagnosis, and have employed it, to the complete exclusion of the induction coil, for nearly six months in the electrical department at St. Bartholomew's Hospital.

Its advantages are as follows:—The current used in testing can be measured directly in milliamperes; the volts applied can be measured equally well if desired, the frequency of the interruptions can be regulated and measured in a moment, and, finally, the painful effect upon the sensory nerves of the patient is reduced. I believe that, with certain minor modifications, such as the addition of a speed counter, and of a means of shortening the duration of individual impulses by extending the intervals of no current, this instrument is bound to supersede the induction coil altogether when exact work and measurement of results are wanted, although, no doubt, the coil in a modified form, perhaps, will continue to hold its ground for a long time to come as a means of producing simple excitation of nerves and muscles.

The curve of this machine I now show once more on the screen in order to draw attention to its abrupt rise and fall, to the symmetry in its alternate impulses, to its duration and the duration of the periods of no current (Fig. 1).

The photograph was taken when the duration of each impulse was $\frac{1}{200}$th of a second and the frequency was about 100 per second. Leduc has specified the best duration of an impulse for muscle stimulation to be $\frac{1}{1000}$th of a second, and he also attaches importance to the duration period of the intervals of no current; and I hope on some future occasion to be able to show a modified apparatus on these lines in which these points may be realised, and a scientific instrument placed in the hands of those who wish to make use of interrupted currents for purposes of diagnosis.

ASSOCIATION OF TRAMWAY AND LIGHT RAILWAY OFFICIALS.

A general meeting of the Association of Tramway and Light Railway Officials took place at Wakefield on Wednesday, Wakefield having been chosen as the place of meeting in view of the formal opening of the Wakefield and District Light Railways, which took place yesterday. At 2:30 p.m. the Association was welcomed by the Mayor of Wakefield and the chairman of the Wakefield and District Light Railways Co. Mr. A. R. Fearnley, general manager of the Sheffield Corporation tramways, replied on behalf of the Association.

Mr. H. England, general manager of the Wakefield and District Light Railways, then delivered his presidential address. He endorsed the opinion already expressed by many members at the recent meeting of the Municipal Tramways Association that there were too many tramway associations, and suggested that there should be an amalgamation of the three existing associations—viz., the Association of Tramway and Light Railway Officials, the Municipal Tramways Association, and the Tramways and Light Railways Association. Speaking on the question of goods traffic on tramways, he pointed out that the real difficulty was with regard to sidings, as without them enormous delays would be occasioned to the passenger traffic. Another difficulty which had to be met was that, since goods traffic would have to be carried at night, the line would never be left free for repairs. Referring briefly to the question of running powers, the president stated that the Wakefield and District Light Railways Co. and the Leeds Corporation had come to an arrangement by which both systems would have ample running powers.

Mr. A. R. Fearnley (Sheffield) then read his Paper on "**Average Speeds and Speed Allowances.**"

As the result of a Conference held between the Board of Trade and tramway representatives in the early part of 1901, a number of statistics were obtained from continental tramways on the question of average speed. Up to that time the maximum speed allowed on British tramways appeared to have been in most cases only eight miles per hour, and in a few cases ten miles an hour. During the conference it was ascertained that continental tramways often ran at considerably higher speeds, especially on "purely suburban" roads, and as a result, the Board of Trade assented to consider the question of higher speeds when requested, and to send officials to re-inspect any routes on which it was thought that a higher speed should be allowed. The author had sent enquiries to all the British tramways to ascertain what advantage had been taken of this offer of the Board of Trade, and replies to his enquiries had been sent to 81 tramway undertakings. The replies are summarised as follows:—

Maximum Speeds.—The highest speed now allowed on any British tramways is 15 miles an hour—on the Leeds Corporation Tramways, the Dublin and Lucan line (which is really a light railway) and the Hartlepool Tramways. Ten tramways have replied that 14 miles an hour was their maximum allowance: Barrow-in-Furness, Birkenhead, Cardiff, Glasgow, Hull, Lanarkshire, Liverpool, Manchester, Walsall and Newcastle-on-Tyne. Twelve miles an hour appears to be the average maximum speed allowed. Thirty-seven tramways have obtained this allowance, amongst these being Sheffield, Salford, Blackburn and the London County Council. There are 25 tramways which are still only allowed 10 miles an hour as a maximum, among them Chester, Blackpool, Doncaster, Farnworth, Southport (both company and municipal) and South Staffordshire; on all of these, in the author's opinion, a much higher maximum might be allowed with safety on certain portions of the route. The maximum allowed at Burton-on-Trent is 9 miles an hour, and this is the only tramway making a return where this allowance is fixed as a maximum. Eight miles an hour is still the maximum on six tramways—viz., Chatham, Dover, Oldham (Ashton and Hyde), Wigan, Wrexham and Middleton.

Average Speeds.—Leaving out of the question light railway undertakings, 14 tramways have an average speed of from 8 to 8¼ miles an hour. These are—Blackpool, Chester, Darwen, Doncaster, Gateshead, Gravesend, Grimsby, Lowestoft, Newport, Oldham (Ashton and Hyde), Poole, Warrington, Worcester and another very large tramway undertaking, the official of which requests that the information should be treated as strictly confidential. It is interesting to note that in this list of 14 just read, there is not included a single tramway which has been granted the maximum allowance of 14 to 15 miles an hour mentioned in the previous paragraph, and further, that only half of those named—*i.e.*, seven—have even 12 miles an hour allowed as a maximum, so that on many of these roads, where 8 to 8¼ miles is being obtained as an average speed, the maximum allowance is 10 miles an hour. Four towns returned 7¾ to 8 miles an hour as their average; 10 towns 7½ to 7¾ miles, among which are such busy tramways as Liverpool and Birmingham; 10 returned 7 to 7¼ miles, among which we find Manchester and Glasgow; three returned 6¾ to 7 miles as their average, included in the three being Newcastle and Hull; 12 returned 6½ to 6¾ miles an hour, included in which are Huddersfield and Halifax (both towns with very steep gradients), and also Wolverhampton, with a system of traction peculiar to itself; 10 returned 6¼ to 6½ miles, and included in this list is Leeds, with its maximum speed of 15 miles; 10 returned 6⅛ to 6¼ miles; three returned 5¾ to 6 miles, amongst which is Sheffield; two returned 5½ to 5¾ miles—viz., Norwich and Chatham—and two returned 5¼ to 5½ miles—Ipswich and Wigan. An average of the average speeds of the 81 tramways who have sent returns comes out at 7·24 miles an hour.

These averages, Mr. Fearnley pointed out, were considerably lowered in many towns by the great amount of time that cars were allowed to stand idle at the termini. A short time ago, on visiting a certain large city, he had noticed at one termini three cars standing idle, the last car having probably at least 10 minutes standing time. This standing-over time at the termini had certain advantages, the car acting as a waiting room and the men being allowed time for meals, but he thought it would be better always to keep the car moving, only allowing sufficient time at the terminus for the motorman and conductor to change ends and reverse the trolley.

Considerable advance has been made in the question of speeds during the past three years. Eight miles an hour appeared to have been the standard maximum speed with the Board of Trade since the late seventies or early eighties. A speed of 16 miles an hour, however, had recently been promised to one large tramway undertaking for certain routes on condition that they fitted their cars with a certain kind of brake. Leaving out lines which are described as "purely suburban" the English towns were now equal in speed to the Continental lines, the respective averages being 7·24 and 7·2 miles per hour. An American return published in 1903 stated that the average speed on urban routes passing through the centre of cities from one extremity to the opposite extremity was 8·13 miles per hour. There was no doubt that the public approved of higher speeds.

Mr. Fearnley concluded his Paper by a suggestion that the same maximum speed which has been granted to motor cars might also be granted to tramways for those portions of their routes where it might be run with safety. The conditions which might be required were: An urban route; track to be kept in first-class condition; to be either double track or long lengths of single track without crossings, &c.; cars to be fitted with power brakes which are to be used as service brakes; gradients not to exceed 1 in 20. These conditions, he believed, were to be met in many cases, especially on routes owned or worked by such companies as the British Electric Traction Co. and others. In America tramcars were now making through journeys of over 90 miles and attaining a speed of 30 miles an hour. Unless higher speeds were to be allowed and maintained in this country it was difficult to see how many existing and suggested suburban tramways and light railways were to be worked successfully. Tramways running between towns 12 and 14 miles apart would not attract much through traffic if it took 80 minutes to complete such a journey, except in very fine weather or by reducing the fares considerably below those charged by the competing railway companies. Higher speeds, however, would necessitate a decided change in our methods of constructing tramway tracks. To attempt to run at such high speeds as the American tramways on tracks laid on what might be termed the "solid" system would lead, he was convinced, to serious trouble, and he wondered whether the advocates of goods traffic on tramways had considered the matter from this point of view.

In the discussion it was pointed out that the local authority was more to be feared than the Board of Trade as an opponent of higher speeds. It was maintained that the average speed should be half the maximum, and that increased speeds would mean increase of maintenance of track, and possibly different construction.

Mr. A. N. Banister then read a Paper on "**Cost and Maintenance of Tramway Car Wheels and Rails.**"

The author pointed out that the flanges of iron wheels were usually considerably chipped, especially on rails with narrow grooves and where there were many points. Steel-tyred wheels he had found in practice to be cheaper by 6·6d. per 1,000 miles than iron wheels, the latter costing about 21d. per 1,000 miles. Every wheel was calipered once per fortnight, and ground when the difference between two wheels on a car was more than $\frac{1}{16}$ in. The average mileage of chilled wheels was 19,000 miles. The radius of curves leading to and from points should be as large as possible, even if this entailed a sharp curve later on, as it was cheaper to replace rail on the curve than to replace points. He did not think there was any rule regarding corrugation. It occurred on the Norwich system, on up and down grades and on curves and straights. They ground the corrugations down by fastening carborundum blocks in the slipper-brake blocks on a spare car, and simply ran the car backwards and forwards all night.

Most of the speakers in the discussion favoured steel-tyred wheels.

(To be concluded.)

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Report of Engineering Standards Committee on British Standard Specification and Sections of Bull-headed Railway Rails." (London: Crosby Lockwood & Son.) 10s. 6d.

"The Conductometer and Electrical Conductivity." By Rollo Appleyard. (London: Alabaster, Gatehouse & Co.) 1s. 6d.

"Le Turbine a Vapore ed a Gas." By Guiseppe Belluzzo. (Milan: Ulrico Hoepli.) L.12.

"Die Radioaktivitat." By F. Soddy. Translated by Dr. L. F. Guttmann and Prof. G. Siebert. (Leipzig: J. A. Barth.) 5.60m.

"Life and Energy." By W. Hibbert. (London: Longmans, Green & Co.) 2s. 6d.

"Science Abstracts." October. Vol. VII. Part 10. Section A: Physics. Section B: Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

"A Handy Book of Logarithms." (London: Blackie & Son.) 2s.

"Transactions of the American Institute of Electrical Engineers." Vol. XXI. No. 8. October. (New York: The Institute.) 50c.

"Dampfturbinen, Entwickelung, Systeme Bau und Verwendung." By Wilhelm Gentsch. (London: Williams & Norgate.) 10s. net.

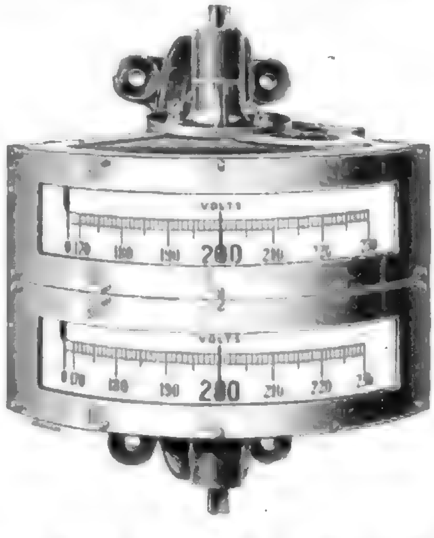
"Proceedings of the Royal Society," Vol. LXXIV., No. 500, November. (London: Harrison & Sons.) 1s. 6d.

"Tecnological and Scientific Dictionary," Part VI. Edited by G. F. Goodchild and C. F. Tweeney. (London: Geo. Newnes.) 1s.

"Die Berechnung Elektrischer Leitungsnetze in Theorie und Praxis." 2nd edition. Vol. II.: Dimensionierung der Leitungen. (Berlin: Julius Springer.) 12m.

NEW PARALLELING VOLTMETER.

The difficulty that is frequently met with in central station practice, when it is desired to parallel machines on to the 'bus bars, is that no really suitable voltmeter has been made for the purpose, other than a small instrument known as the paralleling voltmeter which is used in connection with the incoming machine. When the voltage of this machine is the same as that of the 'bus bars, this instrument gives a zero deflection, and the switches are then closed. This practice is open to the objection that if there is anything wrong with the voltmeter windings it will point to zero under any conditions, consequently a machine may be introduced when the voltage is far from correct. If this method is not used it is usual to use two voltmeters, one across the 'bus bars and one a machine instrument. These instruments have to be observed simultaneously, which is always more or less a difficult matter.



Messrs. Nalder Bros. & Thompson have recently placed upon the market a paralleling voltmeter which gets over these difficulties. It consists of two moving coil instruments of the edgewise type, the two being hinged together and fitted on a bracket, as shown in the illustration. The bracket is mounted on the wall of the engine room or on the switchboard, and these two voltmeters may be turned so as to face in any desired direction. This instrument could also be used for the indication of the voltage on both sides of a three-wire system.

CORRESPONDENCE.

BOILER HOUSE ECONOMIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest and approval the letter upon the above subject by Mr. C. E. C. Shawfield, of Wolverhampton, which appeared in your issue of October 7th. With Mr. Shawfield's views upon the subject of fuel analysis I am, of course, in agreement. I much regret, however, that neither Mr. Downe nor any other electrical engineer holding similar views regarding the waste of time and money involved in the laboratory examination of fuel in electric light and power stations, should have replied to Mr. Shawfield's letter, since a discussion upon this subject confined to electrical engineers would have been timely and useful. Mr. Shawfield's statements respecting the advantages to be gained by systematic and regular sampling and testing of the fuel supplies at Wolverhampton are conclusive, and are simply confirmatory of what is known and practised in all the best-managed manufactories and works in the country where fuel is an important item in the costs of production. That electrical engineers have been so slow to recognise the value of such laboratory examinations of fuel is not to their credit, and seems to indicate some defect in their professional training.

The only criticism I have to make upon Mr. Shawfield's letter and statements is that he does not appear to recognise the need for specially-trained men for the sampling and testing work carried on in his works. Fuel analysis and the calorimetric examination of fuel is not simple work, and the ordinary shift engineer with only an electrical training, is certainly not qualified to carry out these tests, or even water and gas tests, in a reliable manner. A properly-trained chemist with special training in these branches of technical analysis only can be relied upon to obtain trustworthy results. Mr. Shawfield's assertion that 15 guineas expended upon apparatus will place any electrical engineer in a position to do all his own sampling and testing work is, therefore, somewhat misleading, and requires qualification by the complementary statement that the apparatus must be placed in charge of a properly-qualified chemist.

Some of the distrust with which laboratory and analytical results are now regarded by electrical engineers is, I believe, due to the somewhat foolish policy they have followed in the past—of putting their shift engineers to this work. Only when they have recognised that analytical and calorimetric work in connection with water, oil and fuel demands as much special training and knowledge as their own profession, will they be in a position to act rightly in this matter. An electrical engineer is no doubt a man with a wide training, but the attempt to turn him into a fully-qualified chemist at a moment's notice, is almost as foolish as it would be for an analytical chemist to attempt to design or run an electric power station.

Electrical engineers of large stations if wise should, therefore, add a fully-trained and qualified chemist to their staff, and give him charge of all the sampling and testing work; while the engineers of the smaller stations should (if equally wise) employ outside assistance and save their 15 guineas.—Yours, &c. JOHN B. C. KERSHAW.

The West Lancashire Laboratory,
Waterloo, Liverpool, Oct. 31.

LEGAL INTELLIGENCE.

Attorney-General (on relation of Willesden Council) and Willesden Council v. Metropolitan Electric Supply Co. (Ltd.)

The hearing of this case was resumed on Friday last. The grounds of the present claim for an injunction were set out in our last issue. The defendant company under its Memorandum of Association has unrestricted powers of acquiring land, erecting electricity works and producing and supplying electric energy. Sec. 3 of the Metropolitan Electric Lighting Act, 1889, enacts that the undertakers, for the purposes of the act, were the Metropolitan Electric Supply Co. (Ltd.), and sec. 4 provided that, subject to the provisions of the act, the area of supply should be the whole of the area included in the first schedule. Sec. 5 provides as follows:—"The undertakers shall not at any time after the passing of this act supply energy or (except for the purposes of this act) erect or lay down any electric lines or works beyond the area of supply otherwise than under the authority of Parliament, or under a licence granted by the Board of Trade under the principal act, provided that where the undertakers were on May 25, 1889, supplying or under any binding agreement to supply energy to any premises beyond the area of supply, they may continue to supply or supply energy to such premises until Sept. 29, 1890. All electric lines or works used by the undertakers under the provisions of this section for the purpose of supply and energy beyond the area of supply, and situate in or on or across any street or public place may and shall, unless sold or transferred to some body or person authorised to supply energy in the place where such electric lines and works are situate, be removed by the undertakers within six months after the expiration of the period during which they are by this section authorised to supply energy by means of such electric lines or works. If the undertakers fail to remove any such electric lines or works within the period of six months they shall be liable to a penalty not exceeding £20 for each offence, and any Court of Summary Jurisdiction on complaint made, may make an order authorising the removal of any such electric line or work by such persons, and on such terms as they may think fit." The areas of supply described in the first schedule to the 1889 Act, plaintiff submitted, did not in fact comprise the Willesden Urban District Council. By three subsequent provisional orders, as confirmed by Parliament, the company obtained similar powers in three other districts, all situate in the County of London, and each order contained a prohibition similar that contained in sec. 5 of the Act of 1889. In 1898 the company secured the passing of another private act, the preamble of which, after reciting the act of 1889 and the subsequent orders, contained the following further recitals:—"And whereas the demand for the supply of electric current within the areas supplied and authorised to be supplied by the company has increased and is increasing very rapidly, and in order to enable the company to meet this demand, the company had found it practically impossible to provide adequate station accommodation within their said areas; and whereas the company, in order to provide for the demand upon them, has acquired a piece of land in the parishes of Willesden and Acton, and are engaged in constructing a large electrical generating station and works thereon, on which they have expended and are in course of expending large sums of money; and whereas it will conduce to the convenience of those who use the electric current in the said several areas of supply of the company that the company should be empowered to supply from the said electrical generating station and works electric current to their distributing stations within the several areas of supply hereinbefore mentioned, and for that purpose to lay down electric cables or wires from the said lands to connections with their several distributing stations and mains and cables within their several authorised areas of supply." The act provided as follows:—"It shall be lawful for the company to hold and use as a station for generating electric current or electrical energy certain lands recently acquired by them in the parishes of Willesden and Acton—namely, lands bounded on the south or south-west by the Grand Junction Canal, on the north-west by Acton-lane, on the north by the London & North-Western Railway, on the east by the Midland & South-Western Junction Railway—and to establish and work on those lands plant for generating electrical energy and for other purposes incidental to and connected with their undertaking or business" (sec. 2); "It shall be lawful for the company to use any of their cables or wires and any mains or cables connected therewith for the transmission of electric current or electrical energy from their works on the said lands at Willesden and Acton to the several distributing stations of the company in their Paddington, Marylebone, and mid-London areas defined by the several provisional orders hereinbefore mentioned, and the area in St. Martin-in-the-Fields and the neighbourhood defined by the Metropolitan Electric Lighting Act, 1889, and to use the generating station on the said lands for the purpose of supplying electric current or electrical energy within the several areas or districts over which they may hereafter have such powers under any special act or provisional order" (sec. 16). The land at Willesden upon which the defendant company erected their generating station was not situate within the limits of any of the statutory districts which they were empowered to supply with electricity. In December, 1903, the defendant company commenced to supply the London & North-Western Railway Co., which has sidings adjoining their generating station at Willesden, with electrical energy from the said station, and the plaintiffs contending that such a supply was a violation of the statutory prohibition in the Act of 1889 and the subsequent orders, the before-mentioned relief was claimed.

In their defence the defendant company stated that under their memorandum of association they have full and unrestricted powers of acquiring land, erecting electric works, and producing and supplying electric energy. Such powers are aided in particular districts by ancillary statutory facilities conferred by various acts and provisional orders, but are not dependent thereon. Defendants further submitted that the Metropolitan Electric Lighting Act, 1889, and the other acts of Parliament and provisional orders referred to by plaintiffs formed part of a large number of acts of Parliament and provisional orders which were passed in or about 1889, in pursuance of the recommendations contained in a report made on May 9, 1889, by Major Marindin to the Board of Trade. The true intention and effect of the acts and provisional orders were and are to give in specified districts within the metropolis statutory facilities for supplying electric energy to various undertakers within such districts, and to prevent such undertakers from using the special statutory facilities in their own districts to enable them to compete with the similar undertakings created in adjoining districts under similar statutory facilities but were not and are not to limit the general powers of the defendants in the carrying on of their general business. If (which defendants did not admit) they were but for the acts prohibited from supplying electric energy from their land at Willesden otherwise than in connection with the undertaking for which the defendants had special statutory facilities, the acts operated to remove or qualify such prohibition. The arrangements between the defendants and the London and North-Western Railway Co. for the supply of electric energy had throughout provided that such supply should be given on the works of the defendants at Willesden and not beyond. It appeared however, to have been arranged between the engineers of the parties in view of the existing conditions of the defendants' building operations and without specific authority, that the defendants' cable should be carried a few yards beyond their works and the meter placed in the signal box of the railway company nearest to the Willesden works. The defendants intended, on the completion of their building operations, to remove the meter to and to give the supply on the boundary of their works and not beyond. In any case the supply had not involved, and would not involve, the crossing of any public or private roads or any trespass on the lands, or any interference with the rights of any person or corporation. Accordingly defendants submitted that the plaintiffs had no right of action.

Mr. UPJOHN, K.C., said plaintiffs claimed an injunction to prevent defendant company doing certain acts in direct and flagrant violation of prohibitions contained in a special Act of Parliament and in three provisional orders confirmed by Acts of Parliament. He contended that the prohibition in defendants' private act and in the orders was general, and meant that they could supply electricity only within the limits of the statutory districts. The Act of 1898 did not confer any power upon the company to supply electrical energy in Willesden; it merely allowed their generating station to be used for the purpose of supplying the statutory districts and no others.

Mr. CRIPPS, K.C., replied for defendants, and contended that the prohibition referred to was not a general one preventing them from exercising their general powers; it meant that the company, as undertakers under the special act or order, should not raid neighbouring districts and compete with other companies. In the alternative, sec. 2 of the Act of 1898 was quite general, and conferred upon the company the power of supplying electricity in Willesden.

At the conclusion of the arguments his LORDSHIP delivered judgment. He said that in this action the Attorney-General maintained that the defendants were contravening the prohibition contained in an act of Parliament, and he sought an injunction to restrain them. The question which had to be decided turned upon the construction of two acts of Parliament. The defendants had at the present time three statutory areas of supply in the county of London, their powers having been conferred by a private act and provisional orders, the wording of all of which was practically identical. In 1898 the defendants found that they could not generate sufficient electrical power within their areas of supply, and obtained another act, which authorised them to use a generating station at Willesden for the purpose of supplying these areas. The defendants were not a company created by statute, but a limited company under the Companies Acts, and it was agreed that no question of ultra vires arose in the case. The Act of 1889 defined the "undertakers" as the Metropolitan Electric Supply Co. He thought it was germane to inquire what the legislature had in view in passing that piece of legislation. He was entitled to put himself in the position of the legislature with the knowledge which it had acquired at that time. It appeared that the object of that and similar legislation was to allot certain metropolitan districts to certain companies—sometimes one in a district and sometimes two, but never more than two. It was clear, also, from certain clauses, that Parliament took into consideration the financial condition of the companies which asked for statutory powers. The legislature would naturally take pains to see that every company had sufficient funds not only to carry out the necessary works, but to carry on the undertaking once they had started active operations, and certain clauses were inserted with that view. He was asked to say that the prohibition contained in clause 5 of the act of 1889, and repeated in the subsequent provisional orders, was not a general prohibition, but only applied to the company as undertakers under the particular act. He agreed that some qualification was necessary, and that was that the undertakers, so long as they were undertakers working that particular undertaking, must not supply electricity outside the statutory area, the prohibition was not meant to extend to the company for all time. But he could not interpret the prohibition so as to limit it in the way the defendants wished. Further, the proviso to the clause excluded the idea of limitation, for if this was not a general prohibition the proviso was unnecessary. The result was that he could not insert limiting words in clause 5. The object of the Act of 1898 was clear from the preamble. Parliament had thought proper to have a number of electric districts complete in themselves. But in this preamble Parliament was told that the system had broken down, and could not work in this particular instance, owing to the increase in the consumption of electricity. The company appealed to Parliament to relax its policy so far as to allow them to erect a generating station for supplying their statutory areas outside those areas. The plain meaning of the Act was that it was intended to benefit customers of the company within their areas. Section 2 was in general terms, and what it would mean if the company at any time relinquished its areas he would leave to someone else to decide when the case arose. The section did not authorise the company to supply electrical energy from the station indiscriminately, while section 16 enabled them to supply their districts and was consistent with the recitals in the preamble. He could not find anything in the Act giving the defendants power to supply electricity in Willesden. On all these grounds it seemed to him that the company were acting in contravention of legislation and must be restrained by injunction. He would, however, suspend the injunction for a month to allow the railway to make other arrangements for a supply of electricity, and if the defendants appealed within a fortnight, then it would be suspended until the hearing of the appeal. There must also be a proviso to the effect that the declaration and injunction should not apply in the event of the company parting with its statutory undertakings, as to which event the court expressed no opinion.

Electric Tramways Construction & Maintenance Co. (Ltd.)

Mr. Justice Warrington on Tuesday ordered a petition and two summonses relating to this company to stand over till the second petition day in next sittings.

American Single-phase Railway.—Steps are being taken to equip electrically a part of the Colorado & Southern Railroad, beginning with the existing line between Denver and Boulder, a distance of 30 miles, for passenger service only. It is also proposed to build a line within the limits of the city of Denver on some of the principal business streets, and later on to apply for a general franchise in the city. The proposed location of the power house is at one of the coal mines half-way between Denver and Louisville, and the fuel used will be lignite slack, costing about 50 or 60 cents a ton. A single-phase alternating-current system will be employed with 20,000 volts on the feeder line and 3,000 volts on the trolley line. The cars will be 55ft. long, carrying 60 passengers, and will weigh from 35 to 38 tons. The run of 30 miles from Denver to Boulder, it is expected, will be made in 50 minutes, including 11 stops, the motors and equipment being designed for a speed of 60 miles an hour.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Croydon Council want an assistant engineer in the distribution department, with experience of h.-t. alternating and three-wire direct-current systems. Salary £2 per week. Applications by 12th inst. to the borough electrical engineer (Mr. A. C. Cramb), electricity works, Factory-lane, Croydon. See advertisement.

Oldham Electricity committee require a junior assistant electrical engineer with previous experience in central station work. Salary £75. Applications to the borough electrical engineer (Mr. S. Wilmott Newington) by 14th inst. See advertisement.

A designing engineer capable of taking entire responsibility for the design of direct current motors, boosters, &c., is required by Messrs. Dick, Kerr & Co. See advertisement.

Notice is given in connection with the forthcoming examination for assistant examiners in the Patent Office that Dec. 15 is the latest date on which applications can be received on the official forms. See advertisement.

Battersea (London) Council require an electrical engineer Salary £400. Applications by noon Nov. 15.

Battersea Council also require an assistant superintendent for town hall buildings. £2 per week and uniform. Applications by noon Nov. 16.

Chester Corporation want a station superintendent. Salary £130, rising to £180. Applications by 14th inst.

Acton District Council require a senior charge engineer, with both h.t. and l.t. experience, salary £180; an office clerk, and two arc lamp trimmers.

A lecturer in electricity and physics is required in January at the Municipal Technical School, Birmingham. Commencing salary £140. Particulars from the secretary, Mr. Geo. Mellor. Applications by Nov. 19. See advertisement.

There is a vacancy for an electrical assistant at the Galway Electric Co.'s works. Applications to Mr. J. Perry, M.Inst.C.E., county surveyor, Galway. See advertisement.

Mr. F. Purser-Fletcher, senior engineer at the Fulham electricity works, has been appointed station engineer at Woolwich (London) municipal electricity works.

Mr. H. H. Jeffcott has been appointed assistant in the metrological department of the National Physical Laboratory. Mr. Jeffcott, after a distinguished career at Trinity College, Dublin, in physics and engineering, during part of which he was a pupil of the late Prof. Fitgerald, has been with Messrs. Siemens Brothers at Woolwich and Stafford for the past two years.

Mr. Schnauber, draughtsman at Fulham, has been appointed engineering clerk of works in connection with the carrying out of the Borough Council's electrical extension scheme.

Belfast Corporation have confirmed the appointment of Mr. J. H. Smith, D.Sc., Wh.Sc., as head of the mechanical engineering department at the municipal technical institute at £500 per annum.

Acton.—Middlesex County Council have sanctioned the application of the St. Helens Cable Co. (on behalf of Acton Council) for sanction to laying of electric cables and the erection of arc pillars on each side of the Uxbridge main road in connection with the Acton electricity undertaking.

Argentina.—The Municipality of Chivilcoy, Buenos Ayres, is stated to be open to receive proposals for the erection and equipment of electricity supply works for the district.

Armagh.—The Council have decided to promote a bill providing for the establishment of electricity supply.

Aston.—The electric tramways were officially inspected by Col. Yorke, C.B., R.E., on Wednesday, and approved, subject to compulsory stops at certain crossings on all routes and to the use of single-deck cars only under the railway bridge in Lichfield-road pending the completion of an agreement for the reconstruction of the bridge so as to give a headway of 16ft. 6in.

The Lichfield-road tramway will be opened this week.

Barking.—It has been decided to apply for sanction to a loan of £8,100 to meet £4,614. 5s. 8d. spent in excess of amount already authorised for light railways and £3,500 due to contractors.

The consulting engineers (Messrs. Hawtayne & Zeden) recommend the extension of the London-road line along North-street, Broadway and Axe-street. Consideration of the proposal has been deferred till March.

245,000 units of electrical energy were sold during the half-year ended September, an increase of 76 per cent. over corresponding half of last year.

Belfast.—An unopposed inquiry was held here last week into the Corporation's application for permission to borrow, amongst other sums, £15,000 for extending the municipal technical institute.

It has been decided to transfer the control of the electricity undertaking from the Gas and Electricity committee to the Tramways committee.

Bermondsey (London).—On Tuesday the Borough Council sealed an agreement to supply current for three years to the Surrey Commercial Dock Co. upon the following terms:—*Power:* 2d. per unit up to 10,000 units per annum, 1¾d. up to 20,000, and 1½d. up to 30,000 per annum. *Lighting:* 3½d. per unit up to 30,000 units per annum. If power consumption is not less than 30,000 and lighting consumption is not less than 30,000 units per annum, then the price for the whole will be 1¼d. per unit up to 80,000 units per annum, 1⅛d. per unit in excess of 80,000 and up to 130,000, and 1d. per unit in excess of 130,000 units per annum.

Bewdley.—The Board of Trade have granted the local tramway company an extension of six months for complying with their tramway order.

Bohemia.—Reichenberg municipality are about to erect electricity works for the supply of current to Reichenberg and several adjacent townships.

Bury.—The Council have received sanction to borrow £45,000 for buildings, plant, mains, house services, &c., for the electric lighting department and £5,000 for motors for the tramway department, the periods of repayment being 21 and 10 years respectively.

Bury Guardians have declined the Corporation's offer to supply current to the workhouse, and will put down independent plant.

There are now 408 private consumers connected to the Corporation mains with the equivalent of 42,373 8 c.p. lamps, compared with 366 and 37,877 respectively last year.

The Council have decided to carry out extensions of the electric tramways, including a line from Holcombe Brook to Walmersley, under powers taken over from Ramsbottom District Council.

Cardiff.—In a report presented to the Lighting committee on Monday by the borough electrical engineer and manager (Mr. Arthur Ellis), it was stated that it would be necessary to borrow £87,000 for extensions of the electric lighting plant and mains.

Mr. Ellis explained that they had been obliged to issue a notice that they could not connect fresh customers, although they had new orders for next year equivalent to 46,000 8 c.p. lamps. The loan would cover all capital required for extensions of plant for at least two, and perhaps three, years, while the committee would not be called upon to expend any of the money for 12 months, as the plant could not be installed before then.

The committee decided to make a recommendation to the Council in accordance with Mr. Ellis's suggestions.

Church Lighting.—Gas lighting at Chesterfield parish church is to be discarded for electric lighting. The borough electrical engineer (Mr. R. L. Acland) estimates the initial cost of the change at £300.

Dover.—The electrical engineer (Mr. L. W. Woodman) is to report upon a proposal to light the Corporation buildings electrically, also as to terms for supply of motors and as to cost of providing prepayment meters.

The Council have decided to apply for powers to supply electrical energy in Hougham, Poulton, River, Alkham, Ewell, Whitfield, West Langdon, East Langdon, St. Margarets-at-Cliffe, West Cliffe, and Guston. The Council have decided not to undertake consumers' repairs.

An inquiry will be held on Monday into the Corporation's application for sanction to a loan for extensions.

Edinburgh.—The Council have asked the Electric Lighting committee to consider whether a simpler and more economical system of cleaning public arc lamps and renewing carbons can be devised.

Egypt.—The imports of electrical, telegraphic, telephonic, &c., apparatus into Egypt during 1901, 1902 and 1903 were valued at about £42,100, £55,350 and £67,800 respectively. Of these Great Britain supplied the largest portion each year, as is shown by the following table:—

	1901.	1902.	1903.
Great Britain	£24,200	£30,150	£31,000
France	6,950	6,375	8,500
Germany	4,350	6,600	14,500
Austria-Hungary	2,650	2,710	3,500
Sweden	2,240	2,925	1,920
Italy	1,930	3,100	1,120
Belgium	700	1,550	1,050
Switzerland	78	945	6,250
United States	70	1,226	535

Electric Lighting Notices.—*Hessle* District Council give official notice of intention to apply for an order authorising them to erect a generating station (or take supply in bulk) and to supply electrical energy in Hessle and Anlaby. *Spalding* Urban Council have given a similar notice.

Electricity in Steel Works.—Thos. W. Ward, Ltd. (local agents for the Electric Construction Co.) have recently equipped an electric generating station at the steel works of Cocker Bros., Sheffield, for both motive power and lighting. The power plant includes a Marshall steam engine and an E.C.C. belt-driven continuous-current generator, which supplies energy at 200 volts to two 25 H.P., one 20 H.P. and one 10 H.P. E.C.C. motors; there is also a smaller plant for lighting. Messrs. Ward have also recently installed at the works of Taylor Bros., saw manufacturers, Sheffield, a lighting plant consisting of a Tangye engine and E.C.C. dynamo (90 amp. at 200 volts). A main switchboard controls six circuits feeding about 300 lights.

Exhibitions.—Bradford Industrial Exhibition, which closed on Saturday, had been open nearly five months, was visited by nearly 2½ million people, and has resulted in a profit of about £17,000.

Our readers are not directly interested in gas exhibitions, but it is well to be acquainted with the advances made by competitors. There is to be a gas exhibition at Earl's Court, London, on Nov. 19, on which it is said a very full display of the latest type of gas apparatus for lighting and other purposes will be shown.

Fulham (London).—The borough electrical engineer (Mr. A. J. Fuller) recommends the Council to open a workshop at the electricity works to do the smaller repairs.

Regarding the first section of the electric lighting extension scheme authorised by the Council, Mr. Fuller has submitted a report as to the date on which the various portions should be ordered:

Generator switchboard (already ordered, and estimated to be completed by Dec.), 1,000kw. Belliss set and chimney (to be ordered in Dec. and completed by July), boiler house, buildings and alterations, including new rectifier room (part ordered and balance in Dec., to be completed by August), coal bunkers, elevators, &c. (ordered Dec. and completed Sept.), four boilers and accessories (portion already ordered, the balance and boiler pumps to be ordered in Dec., to be completed by Sept.), condendenser, sump and river work (to be ordered in Jan. and completed by Sept.), wiring motors (to be ordered in March and completed in Sept.), exciter set (to be ordered in Jan. and completed in July), pipes (portion already ordered, balance in Feb., to be completed by Sept.), economisers (to be ordered in March and completed by Sept.), turbo-alternator (ordered). Extra buildings and connections as required.

Provision having been made in the extension scheme approved by the Council for new mains and connections to the extent of £6,000, the Council are recommended to adopt the borough electrical engineer's proposals for side-street lighting, particularly having regard to the fact that in many of the streets referred to paving has not yet been laid.

The Council are also recommended that electric mains be laid in several additional streets at an estimated cost of £875.

Godmanchester (Hunts.)—After a discussion on the present defective lighting arrangements, the Council are prepared to receive proposals for the use of the old water mills for supplying motive power for electric lighting or other purposes.

Goole.—Application is to be made for extending the period of the electric lighting order obtained in 1901.

Hammersmith (London).—The electricity works are to be extended at an estimated cost of £2,000.

The electrical engineer (Mr. G. Gilbert Bell) has reported that the maximum demand required for the workhouse, when supply is given, will be 220kw. The Council have authorised the laying of a new high-tension cable for this supply. The cost will be about £1,462. The laying of another high-tension main, at a cost of £203. 12s., for consumers in King-street has also been authorised. Tenders are to be invited for the cable for both these extensions and also for supply to Olympia.

Hanwell.—Ealing Corporation have intimated to Hanwell Council that they propose to apply for powers to supply electric energy outside their own area, and, if they obtain these powers, they offer to give a supply of electric current to Hanwell on reasonable terms.

Lambeth (London).—The London Southern Tramways Co. have served notice on the Borough Council of intention to apply for Parliamentary powers to adopt electric traction on their tramways.

Lanarkshire.—The Middle Ward District committee have applied to the County Council and to the Standing Joint committee for consent to their proposed electricity works (exclusive of refuse destructor), and to the borrowing of £12,839 therefor.

Leicester.—The East Park-road section of the Corporation's electric tramways was opened on Tuesday.

Light Railways.—Herts. District Council have decided to acquire land for widening the main road in connection with the Barnet light railway scheme, and also a small piece of land as a site for a generating station, "which it might be desirable to erect in case any hitch occurred in obtaining current from the North Metropolitan Electric Power Supply Co."

Llandudno.—The report of the borough accountant (Mr. Walter Wood) records a net profit of £53 on the electricity department for the year ended March last, compared with a deficiency of £368 the previous year. The receipts from sale of current show an increase of £350, and the generation and distribution expenses a diminution of £43.

London County Council.—At Tuesday meeting a loan to Battersea of £11,855 for electric lighting purposes was granted.

Consideration of a recommendation of the Improvements committee that vacant land in the Strand, recently partly occupied by the Salvation Army, should be let for 11 months at a rental of £7,500 for the purposes of a Japanese Exhibition was postponed, pending receipt of further particulars as to the nature of the Exhibition.

Northern Tramways.—The Highways committee recommended an expenditure of £22,500 for the construction for electrical traction of such tramways.—Agreed.

Streatham Car Shed.—It was agreed to expend £19,250 in connection with the Streatham car shed, the laying of rails, the construction of conduits, &c., the work to be carried out by the works department.

Precaution against Fire on Underground Electric Railways.—The Fire Brigade committee submitted a report, in which reference is made to an intimation received from the Board of Trade (Railway Department) intimating to promoters of underground electric railways the requirements in certain matters which will be made by the officers of the Board when such lines are hereafter constructed. The Board proposes, if there is no objection from the Council, to call upon promoters of underground railway lines, on inspection, to produce, for the information of the Board, an expression of opinion on the part of the chief officer of the Council's fire brigade, as to the sufficiency of the provision made in respect to hydrants, hose and fire prevention apparatus. In reply, the committee forwarded certain minimum requirements and recommendations on the subject. These have been embodied in a circular letter and are issued by the Board to promoters of tube railways. The committee have suggested to the Board that it should make a requirement that motors should be contained in separate compartments made of non-combustible material and not be underneath the carriages, but the Board has replied that its advisers are of opinion that the requirement suggested is hardly practicable. The report was approved.

London Electrical Contractors' Association.—The annual general meeting was held on Monday, when Mr. E. L. Berry, who presided, speaking of the forthcoming London County Council Omnibus Bill, urged the members to oppose the measure. An honorarium of £50 was made to the retiring secretary. The new council, executive committee, &c., were appointed.

Mansfield Woodhouse.—Application has been made for sanction to borrow money to cover cost of obtaining a provisional order.

Mexico.—An opinion has been expressed by Col. Penna, president of the Society of Geographical Research in Mexico, that the water power existing in the eastern districts of Mexico may be estimated at 1,500 H.P.

The railway from Mexico to Vera Cruz is, it is stated, to be operated electrically, the generating station being in course of erection at Necaxa.

Middlesex Light Railways.—Middlesex County Council have granted remuneration at the rate of £200 per annum to their engineer and surveyor, Mr. H. T. Wakelam (in addition to his salary of £1,200) during the period of construction of the Council's light railways. The salary of Mr. A. J. Lander, chief assistant in the light railways department of the engineer's office, has also been increased from £320 to £400.

Mirfield.—An inquiry has been held here into the application of the District Council for borrowing £4,948 for electricity supply. Current would be taken in bulk from the Yorkshire Electric Power Co. and supplied at 5d. per unit for lighting and 2d. for power.

New Brunswick.—There are three telephone companies operating in this province. The oldest of these is the New Brunswick Telephone Co., next in order of age being the Union Co., of Florenceville, and the Central Co., with headquarters at Bellisle, King's County. Rumours of a possible amalgamation of the Union and Central Companies are afloat. It is also announced that the municipal authorities of St. John are about to instal a municipal service to compete with the first-named company. Estimates for the work have been prepared and the project is now under consideration.

The St. John City Council are disposed to purchase the undertaking of the local company which supplies electric lighting to the west side of the city. The Municipality already carry out the lighting of the northern end, and the east end is lighted by the company owning the local tramways.

Newport (Mon.)—Successful trial trips have been run over the new portion of the Council's electric tramways.

Obituary.—Mr. Harry Woodhead Aspinall, late local manager at Huddersfield for the National Telephone Co., died on Oct. 26, at the early age of 35 years.

We regret to record the death of Mr. Duncan Stewart, founder of the firm of D. Stewart & Co. (1902), Ltd., engineers, of Glasgow, which took place on Sunday last.

Ormskirk.—The Council have decided to enter into an agreement for the erection, equipment and maintenance of electricity works by the National Electric Construction Co., at an initial cost of £15,000, which the Council will shortly apply for permission to borrow.

Paisley.—The accounts of the electricity department to May 15 show capital expenditure £138,897. 3s. 9d., an increase of £11,598. 14s. 9d. for the year. The year's receipts were £10,853. 8d. 6d., working expenses were £6,207. 18s. 8d., leaving gross profit £4,645. 9s. 10d. After deducting interest (£3,795. 14s. 5d.) and sinking fund (£1,956. 14s. 2d.), the deficit was £1,085. 3s. 9d. 1,215,055 units of electric energy were generated, 176,499 being supplied to public lamps, and 671,372 to private consumers. The total maximum supply demanded was 703kw.

Personal.—Mr. H. E. Brown, mains superintendent at Poplar, has resigned.

Perth.—On the recommendation of the burgh electrical engineer (Mr. John Lambert) the Electric Lighting committee propose to put down additional plant, at an estimated cost of £5,000, to provide current for the tramways which the Council have acquired and are about to convert to electric traction.

Pontardawe.—An offer from Daniel Jenkins & Sons, Gwauncaegurwen, to supply current for electric lighting in this district has been referred to the Streets Lighting committee of the Council.

Presentation.—Mr. R. H. Wilkinson, tramways manager at Oldham, has been presented by the employés and staff with a gold watch and marble timepiece on his departure to take up a similar position at Bradford.

Provisional Order Revocation.—The Board of Trade have revoked the Staines, Egham and Chertsey Electric Lighting Order, 1900.

Poland.—According to a report from the French Consul-General at Warsaw there is a good opening in Poland for all kinds of electrical goods (including motors, primary batteries, generating machinery, accumulators, ornamental fittings, incandescent and arc lamps, materials, electric bells, telephone material, &c.) All these goods now imported come from Berlin and Vienna. The consul further states that there is a very large extension of electric lighting going on in this part of Russia.

Roumania.—Electricity works are to be erected at Carncol.

Rowley Regis.—The new electric tramways were inspected on Wednesday by Col. Yorke, C.B., R.E., and passed, subject to the speed being restricted to 6 miles an hour on the down grade from Blackheath through the Tump estate. Regular service will shortly be commenced, and single-deck cars will be used.

Russia.—A local company has been formed to construct and equip works for supplying the town of Kokand (Ferghana) with electric current for lighting and power. The capital of the company is 1,000 shares of 60 roubles each (£6. 6s. 8d.) and the capital has been wholly subscribed. The Kokand municipality has stipulated that 5 per cent. of the lights installed shall be supplied free of charge to the Government and municipal buildings of the town.

St. Andrews.—The Electric Supply Corpn. are to establish electricity supply here, and a contract for the erection of station buildings has been let.

St. Helens.—The borough electrical engineer (Mr. E. M. Hollingsworth) recommends additions to the generating plant at an estimated cost of £8,000.

Shildon.—The Northern Counties Electricity Supply Co. have entered into an agreement with the Council to supply current by the beginning of next year.

Sligo.—A syndicate composed of Messrs. P. A. MacHugh, J. P. Higgins and Edward Foley have asked the Corporation's consent to a scheme for the erection of works to supply electrical energy in this district.

Southampton.—Sanction has been received for borrowing £2,020 for prospective expenditure on electric light mains and services.

Stockton-on-Tees.—The Council have authorised the extension of electric lighting cables to Hartburn.

Sunderland District Tramways.—The local company's electric tramways from Sunderland to the Herringtons and Shiney-row, via Ryhope and Silksworth, are expected to be opened for traffic early next year.

Swindon.—In future the charge for electric current for power will vary from 1½d to 1d. per unit.

Telephones in Rural Districts.—The Postmaster-General will receive a deputation during the Smithfield Show week in December on the subject of improved telephonic communication in rural districts.

Tottenham (London).—The Metropolitan Electric Tramways (Ltd.) have offered to provide and fix arc lamps or clusters of incandescents on the centre poles of the tramways (including the supply of current to the lamps) until April next. By that time it is contemplated that the Council will have decided as to their electric lighting scheme.

The General Purposes committee recommended the acceptance of this offer, but the matter has been referred to a Joint committee for further consideration.

Village Lighting.—Sunnybrow (Co. Durham) is now lighted electrically.

Walthamstow.—The Council have considered a report from the electrical engineer (Mr. F. A. Wilkinson) recommending that as the electricity works have been in operation for three years, a reserve and depreciation fund should be created. It was, however, resolved that the question stand over.

The number of 8 c.p. lamps now applied for is equal to 48,303, against 38,458 12 months ago.

Wellington (N.Z.).—The city electric tramways are to be extended to Island Bay, Ohiro and Kilbirnie.

West Hartlepool.—The Works committee have been authorised to summon the local electric tramway company for alleged failure to keep the rails and permanent way in good condition and repair, and also for failure to avoid noise alleged to arise from certain of the cars.

Westminster (London).—In a report just issued, the Works committee of the Council notify the receipt of a communication from the Charing Cross & Strand Electricity Supply Corpn. with regard to the Council's disapproval of the construction of certain new surface boxes.

The corporation state they will be compelled to build these boxes, but before doing so propose to appeal to the Board of Trade. It is further pointed out that a large number of the boxes are those actually ordered by the Board of Trade to contain the Peard fuses for fusing the network of mains of the company in accordance with the Board's regulations. The corporation, therefore, ask if the Council still insists that the boxes shall not be built, and further asked permission for building only those boxes necessary for the carrying out of the Board of Trade regulations, leaving the general question to be decided on appeal to the Board.

The committee express the opinion that the previous decisions of the Council should be adhered to.

In another report to the Council, the Works committee notify that they have decided in favour of giving the St. James' & Pall Mall Electric Light Co. 12 months' notice of intention to terminate the existing agreement for the lighting of the parish of St. James. The city engineer is to obtain competitive tenders from gas and electricity companies for the lighting of the area.

Wimbledon.—An unopposed inquiry has been held here relative to the Council's applications for a loan of £6,600 for extensions of mains, and for transformers and meters.

Windsor.—The Rural Council are in treaty with Messrs. Foote & Milne as to the erection of electricity works for the districts of Sunninghill and Sunningdale.

Wolverhampton.—The new Heath Town-Wednesford line was opened for traffic on Monday.

Electro-Harmonic Society.—The next concert (Ladies' Night) will be given at the Holborn Restaurant, London, W.C., on Friday evening next, Nov. 11, at 8 o'clock, Mr. John S. Raworth in the chair.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Johannesburg Municipal Council invite tenders for transformers, pillars and switch gear, to the specification of their consulting engineers, Messrs. Mordey & Dawbarn, 82, Victoria-street, London, S.W. Copies of specification may be seen (after Nov. 5) at the Council Offices, Johannesburg, and at the consulting engineers' offices in London. Tenders to Messrs. Mordey & Dawbarn by noon Dec. 27. See also advertisement.

Johannesburg Municipal Council also invite tenders for two 35-ton electric overhead travelling cranes to the specification of Messrs. Mordey & Dawbarn. The specification may be seen (after Nov. 5) at the Council Offices, Johannesburg, and at the consulting engineers' offices, 82, Victoria street, London, S.W. Tenders to Messrs. Mordey & Dawbarn by Dec. 27. See also advertisement.

Belfast Corporation invite tenders for the following plant, works, &c.:—Tramway permanent way, road bed, paving and bonding, overhead equipment, underground feeders, telephone and test wires, spare conduits, &c., steam dynamos, switchboard, three-phase plant, condensing plant, overhead travellers, station lighting, &c., boilers, superheaters, mechanical stokers, economisers, conveying plant, steam exhaust and feed pipes, pumps, &c., and double-deck electric cars. Specifications, &c., from the town clerk (Sir Samuel Black), to whom tenders by noon 18th inst. See also an advertisement.

Hammersmith (London) Council invite tenders for the supply of extra high-tension feeder mains, draw boxes, frames, covers, &c. Forms of tender, &c., from the borough electrical engineer (Mr. G. Gilbert Bell), electricity works, 57, Fulham Palace-road, W., and tenders to the town clerk (Mr. H. Thompson), Town Hall, Hammersmith, W., by 4 p.m. 16th inst. See also advertisement.

Hammersmith (London) Guardians invite tenders for a complete wiring installation for electric lighting at their new workhouse and infirmary, Wormwood Scrubbs, and also for supply, delivery and erection of two motor transformers and a battery. Tenders to the clerk (Mr. J. Lamb), 206, Goldhawk-road, Shepherds Bush, London, W., by noon Nov. 15.

Whitby District Council invite tenders for the supply and erection of one 200kw. direct-current dynamo, coupled to a high-speed engine (reciprocating or turbine type); and one water-tube boiler, fitted with chain grate mechanical stoker. Tenders to the electrical engineer (Mr. L. H. King) by 5 p.m. Nov. 21.

Swansea Corporation invite tenders for the removal, alteration and re-erection at a new station of one 450 I.H.P. modern type triple expansion engine and of a 225kw. continuous-current dynamo; also the supply and erection of an 8-ton travelling crane. Tenders to the town clerk (Mr. John Thomas), by noon Nov. 12.

Applications are wanted before 7th inst. by the Hearts of Oak Benefit Society, Charlotte-street, Fitzroy-square, London, W.C., from firms willing to tender for electric bell work in the Society's new offices, Euston-road, *London*.

Manchester Electricity committee require tenders by 10 a.m. Nov. 11 for the wiring of Stuart-street station for arc and incandescent lighting.

Dundee Electricity department invite tenders for laying insulated cables instead of the present copper-strip feeder mains. Tenders by Nov. 12.

Tenders are required by 26th inst. for wiring and supply of switchboards for new buildings at Glasgow and West of Scotland Technical College, *Glasgow*.

Camberwell (London) Council require tenders by 5:30 p.m. Dec. 5 for 12 months' maintenance of electric bells and private telephones.

Yarmouth Corporation want tenders by noon 22nd inst. for about 800 tons of steel girder tramway rails, fish plates, &c.

Blackpool Corporation require tenders by 10 a.m. 14th inst. for steel tramway rails, fish plates, &c.

The acting Deputy Postmaster-General for the Australian Commonwealth will receive tenders at *Sydney*, New South Wales, up to 2:30 p.m., Dec. 28, for supply and delivery of telegraph, telephone and electric light materials. Specifications and condition, &c., can be obtained from the General Post Offices of Sydney, Melbourne, Brisbane, Adelaide, Hobart and Perth. Samples can be seen at the four first-mentioned offices.

TENDERS RECEIVED AND ACCEPTED.

Correction.—We stated erroneously in our last issue (p. 78) that the tender for 12 months' supply of cables to Watford District Council had been secured by W. T. Glover & Co. The contract should have been credited to W. T. Henley's Telegraph Works Co., who have secured the order.

Middlesex County Council has received the following tenders:—

Railway No. 3.—Station-road, Wood Green.

Clift Ford (*accepted*)	**£17,266**	**0**	**0**	Wilkinson Bros.	£18,351	0	0
Railway & Tramway Construction Co.	21,196	9	5	J. A. Ewart	18,339	12	7
Sir Weetman Pearson	21,865	17	5	Muirhead, Greig & Matthews	18,217	[illegible]	9
Nowell & Co.	19,721	14	4	T. Adams	17,675	18	0
G. Law	19,275	0	0	W. Griffiths & Co.	17,368	0	0
W. Manders	18,572	0	0	Dick, Kerr & Co.	17,266	15	4

Railway No. 6.—High-street, Harlesden.

Dick, Kerr & Co. (*accepted*)	**£36,337**	**16**	**9**	Pethie Bros.	£41,145	0	0
Railway & Tramway Construction Co.	60,634	4	10	Mowlem & Co.	40,678	0	0
Sir Weetman Pearson	47,631	8	0	J. A. Ewart	39,300	10	5
Nowell & Co.	45,478	16	3	W. Griffiths & Co.	38,976	0	0
G. Law	43,537	19	11	D. R. Paterson	38,489	0	0
Muirhead, Greig & Matthews	42,575	0	0	Winipeg & Co.	37,053	0	0
				Clift Ford	36,337	0	0
				T. Adams	35,036	14	5

Middlesex County Council have also accepted the tender of Dick, Kerr & Co., for a light railway in Turnpike-lane, Hornsey, at £40,905. 14s. 6d. The tender of J. G. White & Co. (at £39,245) for this line had been provisionally accepted, but the contractors declined to sign the contract.

For installing telephones, electric bells, fire alarms and tell-tale clocks at Napsbury Asylum, the tender of Cox-Walkers has been accepted at £2,477 by Middlesex County Council.

Barking District Council have accepted the tender of D. T. Jackson for road widening and trackwork in connection with light railway extensions at £11,200, and that of Dick, Kerr & Co. for electrical equipment, &c., at £994. 15s. 8d.

Falkirk & District Tramways Co. have placed an order with Bruce Peebles & Co. for permanent way construction of tramways (8¾ miles), complete electrical equipment, cables and overhead construction, rolling stock, car shed, &c., at £81,000.

Fulham (London) Council have accepted the tender of the British Thomson-Houston Co. for a main switchboard at £492 if the company agrees to the Council's conditions in the contract, failing which the tender of the British Westinghouse Co. at £498 is to be accepted.

Raworth's Traction Patents have received instructions to equip 40 new cars for the Birmingham & Midland tramways with regenerative control.

Walthamstow Council have accepted the tender of F. Suter & Co. for globes for incandescent electric street lamps at 1s. 3d. each. Messrs. Johnson & Phillips tendered at 1s. 6d. each.

Thos. Topping, Edinburgh, has secured the contract for the erection of the electricity works which are to be run by the Electric Supply Corpn. under agreement with St. Andrew's Town Council.

The tender of Skipworth & Jones has been provisionally accepted for the steel work of a bridge at Sculcoates-lane (Hull) electricity works at £213. 17s. 5d.

The A.B.P. Accumulator Co. have obtained an order from Handsworth District Council for a battery of 256 19-plate cells of the Company's standard S. type.

Twelve tenders (from 10 firms), varying from £120 to £184 were received for installing telephones at the union workhouse, Richmond, Surrey, and the lowest (Hemingway & Pritt) was accepted.

Dover Corporation have accepted the tender of E. J. Philpott for wiring the post office at £75.

Ipswich Corporation have accepted the tender of Venner & Co. for supply of continuous-current meters for the ensuing 12 months.

Leyton Council have accepted the tender of A. H. Marshall & Co. for wiring Newport-road school.

The tender of T. Abell has been accepted for the erection of Exmouth generating station building at £2,160.

Parfitt, Webber & Co. have secured the contract for wiring the Shire Hall, Gloucester.

Warrington Council have accepted the tender of G. F. Milnes, Voss & Co. for four top-covers for tramcars at £80 each.

Swindon Council have placed an order with Dick, Kerr & Co. for two tramcars at £1,120.

Poplar (London) Borough Council have accepted the tender of the Whitwell Coal Co. for supply of coal at 11s. 5d. per ton for the electricity works.

BUSINESS NOTICES, &c.

Nottingham Guild of Mechanical and Electrical Engineers have moved to larger headquarters at the Welbeck Hotel, Milton-street, Nottingham. The first meeting was held on Nov. 1 under the chairmanship of Mr. E. L. Thorpe, M.I.E.E., and a lecture was delivered by Dr. J. H. Jacob on "Röntgen Rays," the lecturer being assisted by Mr. J. Mears, electrician to Nottingham Joint Hospital.

Owing to the expiration of lease, the business of E. & F. N. Spon (Ltd.), technical publishers, has been removed to 57, Haymarket, London, S.W.

BANKRUPTCIES, LIQUIDATIONS, &c.

On Friday last Mr. Registrar Brougham resumed at the London Bankruptcy Court the hearing of the application for the discharge of Max Margowski, managing director of the Automatic Telephone Co. (Ltd.) (in liquidation), and a director of public companies. The commencement of the hearing was reported in our issue of Aug. 19 last.

It was now stated that debtor came to this country in 1892 to dispose of or develop mining concessions in Honduras, which he transferred to a company. Mr. Leyton, for trustee, asked for a further adjournment, as his client desired to allege fraud against debtor in connection with transfer to Mrs. Margowski of 50,000 Automatic Telephone Co. shares for a nominal consideration, and they had, so far, been unable to obtain the attendance of the lady for examination. The Registrar ordered the application to stand over to Dec. 16.

At the meeting, at Birmingham last week, of the creditors of Jas. Marsden, electrical fittings maker, Woodcock-street, Sparkhill, it was stated that debtor traded in partnership until Sept. last, and owed his partner £424. 3s. 10d. The liabilities are £872. 6s. 2d., assets £500. 4s. 8d. Failure attributed to heavy interest, losses on business and ill-health.

In the failure of G. W. G. Booker, electrical fittings maker, &c., formerly of Regent-parade and Vyse-street, Birmingham, the first meeting of creditors is on Nov. 10 at 174, Corporation-street, and the public examination on Nov. 30 at the County Court, Birmingham.

A receiving order has been made against A. E. Brooks, electrical engineer, 110, Cheapside, London, E.C. First meeting of creditors Nov. 7, at Bankruptcy-buildings, London, W.C., and the public examination at the same place on Nov. 30.

The examination of J. Gray, electrical engineer, 19, Waterloo-street, Glasgow, takes place at County Buildings, Glasgow, on Nov. 9.

Claims against the Electrical Bleaching Co. (Ltd.) are to be sent by Nov. 14 to Mr. W. B. Winnicott, Prudential-buildings, Queen-street, Nottingham.

South Lancashire Electric Traction & Power Co. (Ltd.) is to be wound up voluntarily. Mr. H. D. Eshelby, 24, North John-street, Liverpool, is liquidator.

A meeting will be held on Dec. 2 at Clun House, Surrey-street, London, W.C., to receive an account of the winding-up of the British Schuckert Electric Co. (Ltd.)

Business for Sale.—Tenders are invited for the goodwill of the business of mechanical and electrical engineers carried on by W. & E. Sumner & Clementson (Ltd.), the leases of 140, 142 and 144, Dale-street, Liverpool, fixtures, fittings, furniture and stock-in-trade, comprising electrical fittings, wires, globes, brackets and the machinery and plant. Tenders to Mr. J. West, 10, Cook-street, Liverpool, by Nov. 7, on forms obtainable from Mr. West, or from Mr. J. H. Glover, 60, Castle-street, Liverpool.

Plant for Sale.—A 12½ B.H.P. Hornsby-Akroyd oil engine and a 61kw. Crompton dynamo are for sale owing to supply being taken from local company. Applications to "Engineer," Dean Wood, Newbury. See advertisement.

Premises, &c., to Let and for Sale.—A well-lighted factory is advertised in another column to be let. Applications to 469, Hornsey-road, Holloway, London, N.

Spacious, modern and well-equipped factory premises, known as the Volenite Works, High-street, Alperton, are to be sold by Messrs. David Burnett & Co., at the Mart, London, E.C., on Nov. 22, in one lot. Particulars of Messrs Linklater, Addison, Brown & Jones, solicitors, 2, Bond-court, London, E.C., or of the auctioneers, 15, Nicholas lane, E.C.

There are three fine shops, with basements, to let in the Strand, London, on a 21 years' lease. Particulars from the secretary's office, Room 41, West Block, Hotel Cecil, Strand, London, W.C. See advertisement.

Three rooms are to be let, separately or as a whole, in a third floor flat in 64, Victoria-street, Westminster, S.W. See advertisement.

Stores for Sale.—Messrs. Horne & Co., 8, Delahay-street, Storey's-gate, Westminster, S.W., will sell by auction at the Royal Arsenal, Woolwich, on Thursday, 24th inst., at 11 a.m., some obsolete and unserviceable stores, including a quantity of copper and other metals, machinery, electrical stores, telephone and telegraph appliances, 50 tons of underground cable, hydraulic lifts, &c. Further particulars are given in an advertisement. The lots may be viewed at the Royal Arsenal, Woolwich, on Monday, Tuesday and Wednesday previous to and on morning of sale. Catalogues at the War Office, Pall Mall, S.W.; the Ordnance Office, Tower, E.C.; and the Ordnance Office, Royal Arsenal, Woolwich, S.E., London.

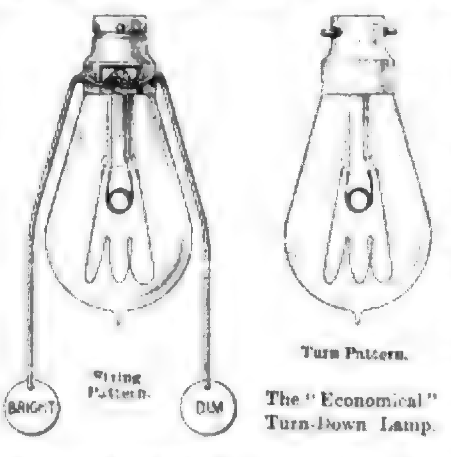
Awards.—Messrs. Nalder Bros. & Thompson have been awarded a gold medal for electrical measuring instruments at St. Louis Exhibition.

Messrs. Everett, Edgcumbe & Co. have also received a gold medal for their exhibit at the same exhibition.

Messrs. Sherard Cowper-Coles & Co. have obtained two gold medals (one for electro-chemistry and the second for metallurgy) for their exhibit at the St. Louis Exhibition.

Forthcoming Book.—Messrs. W. Hodge & Co. are about to publish "Electricity: Its Place and Power in the Universe."

Economical Turn-down Lamp.—We have received from Messrs. Geipel & Lange, Vulcan Works, St. Thomas-street, S.E., a circular descriptive of the new lamp which they are introducing into this country from America, where, it appears, the lamp already enjoys considerable popularity. This lamp, as will be seen from the accompanying illustration, has two filaments. One of these is the ordinary filament, while the other is a high-resistance filament, emitting, when switched into circuit, 1 c.p. only. The switch for connecting the one or the other filament to the supply is small and is contained in the lamp cap. It is operated by pulling one of two strings, as indicated in the illustration, or (in the "turn" type of lamp) by giving the lamp a turn to the right or left. An exceptionally long life and considerable saving in current is claimed for the "Economical" lamp, which is made in two sizes (8 c.p. and 16 c.p.) for all usual pressures from 50 to 250 volts. The lamp is especially designed for places where a light has to be kept continually burning, but where a reduction in brightness at times is either desired or not objected to, such as hospitals, passages, bedrooms, &c.



The "Economical" Turn-Down Lamp.

Catalogues, &c.—The British Thomson-Houston Co., in pamphlet No. 176, treat of continuous-current series-multiple lamps. These lamps are manufactured in three forms; (1) With entirely self-contained line and substitutional resistances inside the lamp; (2) with self-contained substitutional and external line resistances; (3) with self-contained line resistance only. The first and last-mentioned are illustrated in the pamphlet.

Messrs Kelvin & James White (Ltd.), Cambridge-street, Glasgow, have issued to their trade clients a new list of discounts and a note of guarantee on instruments listed in sec. II. of their electrical catalogue.

Mr. K. Schall, 75, New Cavendish street, London, W., has prepared an illustrated catalogue of X-ray apparatus, in which is included an account of their construction and management.

Automatic motor starters and electric lift controllers are listed in two circulars issued by Messrs. Geipel & Lange, St. Thomas-street, Southwark, London, S.E.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Oct. 26 to Nov. 1, with the ports of destination:—

Africa—Alexandria, £457 (telegraph material); Cape Town, £673 (telegraph material); Delagoa Bay, £664; **Durban, £1,409**; **East London, £1,869**; **Port Elizabeth, £348**; **Suez, £53.** *Argentina*—Buenos Ayres, £928; ***Australasia***—Adelaide, £85; Auckland, £168; Brisbane, £160; Fremantle, £48; Hobart, £18; Melbourne, £184 (and 53 cwt. telegraph wire); Perth, £277; **Sydney, £1,489**; Wellington, £339. *British Guiana*—Demerara, £46. *Canada*—Toronto, £25. *China*—Shanghai, £77; Tientsin, £798. *Ceylon*—Colombo, £8. *Denmark*—Copenhagen, £3,559 (including £19 telegraph material); *France*—Boulogne, £19; Paris, £15. *Germany*—Bremen, £143; Hamburg, £10. *Gibraltar*, £20. *Holland*—Amsterdam, £431 (including £154 telegraph wire); Rotterdam £50. *Hong Kong*, £110. ***India***—Bombay, £2,452; Calcutta, £1,088 (including £13 telegraph material); Madras, £178. *Italy*—Genoa, £22. *Japan*—Tokio, £1,436. *Maderia*, £27 (telegraph instruments). *Malta*, £522. *North Atlantic*, **£2,000** (telegraph cable, &c.) *Norway*—Christiania, £49 (including £14 telegraph material). *Portugal*—Lisbon, £39 (telegraph instruments). *Russia*—St. Petersburg, £2,939 (including £2,540 telegraph apparatus). *Siam*—Bangkok, £8. *Straits Settlements*—Penang £244 (including £110 telegraph material). Singapore, £33. *U.S.A.*—New York, £386. *Uruguay*—Monte Video, £82. Total £25,985 against £11,850 in the corresponding week last year (Oct. 28 to Nov. 3).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

September 26, 1904.

20,670 H. F. Joel. Forest Gate. A commutating switch and circuits for controlling electric carriages and like purposes.

20,689 C. P. E. Schneider. Regulation of dynamos and motors.*

20,713 B.T.-H. Co. (G.E. Co., U.S.). Transformers.

20,714 B.T.-H. Co. (G.E. Co., U.S.). Bearings for the shafts of delicate instruments.

20,715 B.T.-H. Co. (G.E. Co., U.S.). Insulations for edgewise-wound tools.

September 27, 1904.

20,725 W. Coates and O. Wright. Gateshead-on-Tyne. Safety contact trippit for electric trains.

20,749 S. Hindley. Sheffield. Trolley boom controlling apparatus.

20,759 A. J. Clarke. Electrically-operated pianos and other musical instruments.

20,782 A. G. Bloxam (Société Anonyme d'Etudes Electro-Chimiques, Switzerland). Electrolytic extraction of zinc and its ores and apparatus therefor.

20,783 A. V. Vyvyan and L. Newitt. Telegraphs and controlling apparatus.

20,788 Elektrizitats A.-G. vorm. W. Lahmeyer & Co. Winding for monophase or polyphase alternating-current machines. (Date applied for, Nov. 12, 1903, date of application in Germany.)*

20,790 F. Bettmann and J. Zapp. Supporting electrical conductors.*

20,801 W. P. Thompson (Gesellschaft für Drahtlose Telegraphie, m.b.H., Germany). Liverpool. Wireless telegraphy.*

20,809 and 20,810 B.T.-H. Co. (G.E. Co., U.S.). Electric furnaces.

September 28, 1904.

20,833 A. C. Virgin. Bristol. Operating rail and wire points overhead systems of electrical traction.

20,846 J. Liddle (E. R. Hartmann, U.S.). Glasgow. Circuit-breakers.*

20,849 W. G. Allen. Manchester. Electric blowouts and fuses.

20,872 W. J. Ford and S. Sudworth. Wire connector.

20,877 A. Goodwin and W. J. Hollidge. Magnetic separators.

20,896 A. F. Bosquet. Manufacture of water jackets, &c., by electrolytic means.*

20,898 E. J. Chambers. Additions to pipes or tubes for underground cables.

September 29, 1904.

20,927 J. Mackenzie. Dundee. Suspending incandescent lampholders.

20,931 F. C. Ruddle. Blackburn. Switchboards for electrical purposes.

20,965 E. A. Carolan (G.E. Co., U.S.). Leading-in conductors for incandescent lamps and the like.

20,968 J. S. Highfield. Central station electric installations.

20,970 A. Hultqvist. Braking device for electric motors.

20,975 A. J. Boult (Ad. Wegner, S. Brechtel & Co., Germany). Electric lamps.*

20,976 R. S. Clouston. Electric traction.

September 30, 1904.

20,997 J. Graham and R. Kendal. Darlington. Controlling flow of electricity into third-rail, said means being also available for signalling purposes.

21,027 A. Schneider. Controlling supply of electricity.

21,028 G. K. B. Elphinstone and H. F. Fast. Electrical measuring instruments.

21,038 J. H. Hilliar. Electric bell push.

21,040 F. W. E. Schuler. Arc lamps.

21,042 E. R. Grote and M. V. Ely. Arc lamps.

21,043 E. A. Carolan (G.E. Co., U.S.). Alternating-current motors.

21,045 E. A. Carolan (G.E. Co., U.S.). Single-phase dynamo-electric machines.

October 1, 1905.

21,081 J. T. Dawes. Liverpool. Magnetic separators for ores or the like.

21,131 P. B. H. Seabrook and H. H. P. Seabrook. Automatic electric switching devices for advertising purposes.

21,132 W. P. Thompson (L. Dill, Germany). Liverpool. Switch gear for electric driving.

21,135 A. R. Pritchard and R. Whipp. Liverpool. Fuses for electric circuits.

21,138 E. Bachelet. Electromagnetic therapeutic apparatus. (Date applied for, Oct 2, 1903, date of application in U.S.)*

21,142 E. A. Carolan (G.E. Co., U.S.). Variable speed mechanisms.

21,144 H. Leitner and R. N. Lucas. Byfleet. Electric lighting of trains.

21,145 H. Leitner. Byfleet. Automatically controlling electric circuits.

21,146 H. Leitner. Byfleet. Accumulator plates.

October 3, 1904.

22,440 A/03. W. C. Fairweather (Kellogg Switchboard & Supply Co., U.S.). Telephone switchboards. (Date applied for, Oct. 17, 1903.)*

21,157 H. W. Cox. Nottingham. Switches.

21,170 W. C. M. Pettingill. Leeds. Automatic trolley pole adjuster.

21,211 R. Kieseritzky. Regenerating negative accumulator plates of diminished capacity or avoiding diminution in capacity of new plates.

21,217 A. Damaskinos. Automatic telegraphic apparatus.*

21,222 B.T.-H. Co. (G.E. Co., U.S.). Sockets or holders for incandescent electric lamps.

October 4, 1904.

21,242 O. Gross. Manchester. Arc lamps.

21,243 H. F. Rogers and S. Edmonds. Birmingham. Automatic contact make-and-break for electric ignition for gas and other engines.

21,247 D. P. Corbet and W. M. Hughes. Kidderminster. Electric automatic alarm letter box opening.

21,259 H. W. Cox. Nottingham. Switches.

21,264 A. Eckstein and A. E. Angold. Manchester. Arc lamps.

21,276 P. T. J. Estler. Supplying and collecting current for driving vehicles.

21,307 E. J. Javaux. Electricity meter.

21,310 W. Moseley. Smelting furnaces and electric stoves.

21,314 K. Edgcumbe and E. J. Everett. Electric phase indicators.

21,315 B.T.-H. Co. (G.E. Co., U.S.). Ground detectors and electric cutouts.

21,322 O. C. Strecker and H. Strecker. Etching metal plates by electrolysis.*

October 5, 1904.

21,329 T. Cowburn. Gloucester. Trolleys.

21,332 D. Thornicroft. Bradford. Attachment of telephone receivers.

21,340 C. F. Adams and L. R. Whitfield. Liverpool. Producing electric light.

21,382 A. T. M. Thomson and The Thomson-Davis Telephone System. Operating telephone exchange systems and apparatus therefor.

21,388 B.T.-H. Co. (G.E. Co. U.S.). Electric measuring instruments.

21,400 A. C. Eborall. Electric traction systems.

21,401 A. T. M. Thomson. Effecting communication between telephone exchanges.

21,402 E. W. Jungner. Electrodes for accumulators with invariable electrolyte. (Date applied for, Oct. 7, 1903, date of application in Sweden.)*

21,403 E. W. Jungner. Increasing activity in electrode masses of badly-conductive metallic oxides or hydrates in accumulators with invariable electrolyte. (Date applied for, Oct. 31, 1903, date of application in Sweden.)*

21,405 A. Ruchinka. Suspending overhead wires or cables.

October 6, 1904.

21,409 G. C. Shanks. Hull. Appliance for indicating presence of electricity.

21,415 S. G. Bennett. Wolverhampton. Construction of electric tramways.

21,422 H. Nunns. Halifax. Switches.

21,423 J. C. Barker and F. C. Rylands. Glasgow. Electric lamp bulbs.

21,435 O. S. Gill. Liverpool. Covering and protecting the "live" rail of electric railways, and a current collector arm to be used with same.

21,447 W. P. Nesbitt. Electric railways.

21,454 S. S. Bromhead. Burglar alarm. (American Bank Protection Co., U.S.)*

21,455 S. S. Bromhead. Electric time alarms. (American Bank Protection Co., U.S.)*

21,464 J. A. Cohet. Electrotyping.

October 7, 1904.

21,513 J. M. de la Croix and H. F. Joel, Sen. Construction of accumulators.

21,519 C. Turnbull, Jun. Liverpool. Starting apparatus for electromotors.

21,523 O. O. Donovan. Birmingham. Arc lamp mechanism.

21,532 F. B Fellows. Electric signs and illuminated devices.

21,548 W. W. Strode. Electric light fittings.

21,353 W. Strickland. Galvanic dry cells or batteries.

21,563 E. B. Koopman (C. P. Townsend, U.S.). Electrolytic method and apparatus for the production of white lead.

21,564 E. N Bray, F. R. Markham, F. E. Reiss and Markham & Reiss. Pillar brackets for the control gear of electrical or other mechanism.

21,566 S. O. Cowper-Coles and The Metals Corporation. Electro-deposition.

21,567 S. O. Cowper-Coles and The Metals Corporation. Removing metallic cylinders from mandrels on which they are electro-deposited.

21,579 G. M. Hayton. Electricity meters and demand indicators.

21,580 B. Gustafson and R. Carlstedt. Contact devices for electric clocks. (Date applied for, Oct. 8, 1903, date of application in Sweden.)*

October 8, 1904.

21,601 S. Williams. Cardiff. Trolley sheaves.

21,622 R. Kennedy. Shettleston. Electric ignition for internal combustion engines and apparatus therefor.

21,629 G. A. Lehmann. Germany. Shade frame for electric lamp, especially pear lamps.

21,639 Marconi's Wireless Telegraph Co., E. Berry and H. A. E. Ewen. Electrical condensers.

21,640 Marconi's Wireless Telegraph Co., E. Berry and H. A. E. Ewen. Apparatus for wireless telegraphy.

21,641 Marconi's Wireless Telegraph Co., E. Berry, and H. A. E. Ewen. Safety devices in connection with radio-telegraphic transmission circuits.

21,642 J. E. Macaulay. Dublin. Electrical apparatus for adjusting tram rail points.*

21,648 H. James and A. West. Sheffield. Trolley heads.*

21,664 R Houghton. Light and heat baths.*

21,672 H. H. Lake (La Société Anonyme le Carbone, France). Batteries.

21,676 & 21,677 E. A. Carolan (G.E. Co., U.S.). Electrodes for arc lamps.

21,678 B.T.-H. Co. (G.E. Co., U.S.). Construction of rotary members for dynamo-electric machines.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

14,269 Pulford. Electric fire alarms and signalling systems.

14,259 Braun. Telegraph apparatus.

18,251 Carolan (G.E Co., U.S.) Processes of insulating coils.

18,319 Ford-Lloyd. Battery jars.

21,027 Hamilton. Electricity meters.

21,309 Kugelmann. Automatic telephonic installations.

21,324 Dawes. Magnetic separators for ores or the like.

21,652 La Croix. Form of accumulator.

21,801 Sayers and Holt. Simultaneous telegraphy and telephony.

22,909 and 22,912 Carolan (G.E. Co., U.S.). Dynamo-electric machines.

24,142 Levis (Davis). Regulating mercury vapour or like lamps.

24,283 B.T.-H. Co. (G.E. Co., U.S.). Switch with indicator.

24,285 B.T.-H. Co. (G.E. Co., U.S.). Switches.

24,286 B.T.-H. Co. (G.E. Co., U.S.). Double throw switch with indicator.

24,806 Hinz. Process for the electrolytic manufacture of peroxides of magnesium and zinc.

25,381 Marconi's Wireless Telegraph Co. and Gray. Circuit breakers and closers for transmitting instruments used in wireless telegraphy.

25,577 Davy. Arc lamps.

25,658 B.T.-H. Co. and Holden. Coin-freed mechanism for pre-payment meters.

25,849 B.T.-H. Co. (G.E. Co., U.S.). Rheostats.

25,853 B.T.-H. Co. (G.E. Co., U.S.). Insulating material.

25,969 Griffiths and Bedell. Safety device for electric traction on the contact stud system.

25,990 Mavor and Mavor & Coulson. Brush-holders.

26,111 Andersson. Microphones.

26,842 Crompton & Co. and Hodgson. Automatic cutouts or switches.

26,843 Crompton & Co. and Hodgson. Arc lamp suspension apparatus.

1904.

26 Curtis & Harvey and Malson. Fuses for blasting purposes.

1,128 Veritys Limited and Ebbutt. Electric light fittings.

1,851 Hewitt. Obtaining flow of current in one direction from an alternating-current source. (Date applied for, Feb. 3, 1903.)

2,459 Creighton. Compensating systems for alternating-current generators. (Date applied for, Jan. 31, 1903.)

4,487 Granier. Manufacture of sulphate of copper and caustic alkalies by electrolysis of alkaline chlorides. (Date applied for, April 6, 1903.)

6,553 Weissl and Harding. Electrical signalling system.

7,562 Nomdedeu. Arc lamps. (Date applied for, April 11, 1903.)

7,642 Lee. Fuses.

8,216 Gin. Electric furnace for converting pig iron into steel. (Date applied for, June 4, 1903.)

9,008 Peters. Self-registering electrically-operated sectional targets.

9,385 A G. Brown, Boveri & Cie. Automatic regulation of current in electric lighting installations. (Date applied for, April 25, 1903.)

10,430 Whalley and Bayles. Cables.

13,779 Dunn. Controlling electric motors. (Date applied for, June 18 1903.)

14,072 White. Transmission of wave sounds messages.

14,520 Everhart and Dossert. Branch connections for cables.

14,617 Lyckett. Terminals for wires and cables.

15,452 Peck. Systems of electrical distribution. (Date applied for, Aug. 8, 1903.)

15,468 Weintraub. Vapour electric lamps, rectifiers and the like. (Date applied for, July 11, 1903.)

15,472 Fery. Incandescent lamps.

15,732 Veritys Limited and Southcott. Electric light fittings.

16,205 Edelmann and Wallin. Electric furnaces and the extraction of zinc by means of the same. (Date applied for, July 23, 1903.)

16,762 Schmidmer. Joining ends of telegraph wires and the like.

16,814 Perret. Electric installation for transmitting the time. (Date applied for, Aug. 11, 1903.)

16,894 Siemens Brothers & Co. and Ferreira. Electrically indicating position of railway signals, points or other gear.

17,167 Boulanger and Smith. Contact breakers.

17,285 Kleinsteuber. High-tension current insulator.

17,339 Heys (Meyrowitz Mfg. Co.). Switch.

17,484 Harrison. Receiving system for wireless communications. (Date applied for, Feb. 8, 1904.)

17,493 Potiewski. Transmitter for telegraphs.

17,527 Siemens Brothers & Co. and Berry. Commutators for dynamos.

17,595 Conduits & Fittings (Ltd.), Edwards & Brown. Bends, elbows and other angle pieces.

17,650 Buttner. Electrolytic rectifier. (Date applied for, Aug. 13, 1903.)

17,879 Schade. Spring terminal clips. (Date applied for, Oct. 29, 1903.)

18,095 Burton and Burlingham. Flexible electric conductors.

18,342 and 18,343 Phelps. Incandescent lamps, connections and switch mechanism.

18,523 Carpentier. Interrupters for ignition coils of internal combustion engines. (Date applied for, Aug. 29, 1903.)

18,598 Westphal. Automatic fire alarm.

COMPANIES' MEETINGS AND REPORTS.

Western Telegraph Co. (Ltd.)

The sixty-second ordinary general meeting was held on Wednesday, under the presidency of Sir John Wolfe Barry, K.C.B.

The SECRETARY (Mr. E. Steer Hodson) read the notice calling the meeting.

The CHAIRMAN said: I am happy to say the report, although a satisfactory one, is uneventful. The message receipts for the half-year ended June 30 last amounted to £216,214, compared with £218,019 for the corresponding period last year, showing an increase of £3,195. Revenue from interest on cash on deposit, rents and transfer fees shows a small increase of just under £50. Interest on investments was £7,322 (after deducting £1,052 which has been credited to the 5 per cent. debenture sinking fund), against £5,935 in the corresponding half of last year. The dividends on our investments in other telegraph companies show an increase of £2,324. Perhaps I may here mention that the investments on account of reserve funds yield an average rate of £3 7s. 5d. per cent. on the cost, and the dividends on investments in other telegraph companies give a return of £8. 17s. 4d. per cent. We also derive considerable traffic revenue from these companies, which act as feeders to our cable system. It is therefore an advantage to us in both ways to hold these latter investments. Turning now to the expenditure accounts, it will be observed that the general expenses in London show an increase of about £4, while those at the stations have increased by a net sum of £5,445, being a balance between 12 items with a total increase of £6,092 and five items with decreases of £647. Analysing these increases of expenditure we find that salaries and wages were higher by £608, principally due to a small increase in the number of the European staff. Travelling expenses were more by £647 on account of a larger number of employés coming home on leave and owing to transfers from one station to another. The maintenance of land lines, &c., caused an increased expenditure of £1,107 for renewals and repairs. Repairs to buildings were rather important, and the amount was higher by £2,078, owing to somewhat extensive repairs to the offices and quarters having been necessary at two of our more important stations. Another item of extra expenditure was the furnishing of our new staff quarters at Rio de Janeiro; this accounted for an excess of £1,168. Seven other accounts show a collective total increase of £484, representing small sums which I need not refer to. This makes a gross increase of £6,092, against which we have to set five items of decrease of £647, making the net increase at the stations of £5,445. Sundry expenses show an increase of £4,945, almost all of which was caused by the extension of duplex and relay working and the attendant extra expenses in the electrical department. Under other headings there is a decrease of £1,501, making a net increase in the sundry expenses of £3,444. On the other side of the account we find that repairs of cables and expenses of ships were less by £4,137, principally due to the small amount we had to expend this year on the charter of steamers for repairs of cables. You will observe that £206 odd, being discount on amount of debenture stock issued during the half-year, has been debited to the reserve fund. This is accounted for by the fact that during the depressed condition of the money market in the first few months of this year we were unable to place our stock on such favourable terms as was possible later on, when it commanded a small premium.

The £206 is really a balance of discounts and premiums on the additional amount of stock issued—namely, £22,435. Since the last report was submitted we have increased our investments by a little over £70,000. After providing £13,668 for debenture stock and debenture interest and sinking fund and £5,893 for income tax, there remains a balance of £122,672; to this is added the sum of £4,939 brought forward from Dec. 31 last, which makes a total of £127,611. A quarterly interim dividend, amounting to £31,189. 10s. has been paid, £22,000 has been transferred to the general reserve fund and £18,000 to the maintenance ships' reserve fund. These, I think, are all the salient points of finance in the report. I may add that the directors now recommend the declaration of a final dividend of 3s. per share, making with the interim dividends a total of 6 per cent. for the year; also the payment of a bonus of 2s. per share, both free of income tax, which together will amount to £51,982. 10s., leaving a balance of £4,439. 15s. 8d. to be carried forward. The dividend and bonus will be payable on Nov. 3. I have nothing else, I think, but these matters to bring before the general meeting. The half-year under review has been, as I said at the beginning, an uneventful one, but I think I may tell the shareholders that since the conclusion of the period under review, ending June 30 this year, the general aspect of trade which is reflected in our receipts has been, on the whole, promising, and that our receipts are better this half-year than they were in the corresponding half of last year. Altogether, I think I may recommend the accounts for your adoption.

Mr. MOUNTCASTLE inquired whether the Chairman had anything to report in regard to wireless telegraphy.

Mr. G ENNIS assumed that the staff assurance, superannuation and pension funds, £2,346, which he could not find in the balance-sheet, was handed over direct to the trustees for those who benefited by the funds.

The CHAIRMAN: With respect to wireless telegraphy, I have nothing to add on the general subject to the remarks which I have made in past years. We have, however, noticed that various companies are now starting with the view of making installations at different points for the local services of particular places. We have been approached by different people—not this Company so much as other companies we are connected with—for the purpose of making some arrangement by which telegrams may be sent to our stations and forwarded from there by wireless telegraphy. A good deal of that was done in the early stages of the war in China. Many people may have seen that in the early stages of the war a good deal of information came to *The Times* through the De Forest system, through an installation made at Wei-hai-wei. Telegrams coming from *The Times* ship were sent to this station and then forwarded by our cables. It all tends to confirm the view which I think we have held for a good many years—that the very interesting developments of wireless telegraphy will be in the nature of proving that system to be a kind of handmaid to the great cable systems of the world. I do not think we need look on the system as competitors, but, on the contrary, in many cases, as friends, bringing us traffic and doing work which could only be done by wireless telegraphy over seas and in inaccessible places, where no one would think of laying a cable or of making a land line. On the question of the staff assurance, superannuation, and pension fund, Mr. Ennis is perfectly correct. The money is handed over to a set of trustees, who take charge of the funds. On the last actuarial valuation we were informed that the fund was in a perfectly solvent and satisfactory position. I cannot give you the exact figures at this moment, but the Secretary will give the details.

Mr. J. NEWTON enquired whether the traffic was not being benefited by the excitement which prevailed in regard to the war and the troubles connected with it. He also thought that the great prosperity of Buenos Ayres and district should be benefiting the Company.

The CHAIRMAN: The prosperity of Argentina is, no doubt, having an effect on our traffic; and, as I said in my opening remarks, the traffic and general prospects of the current half-year are decidedly more promising than those of the corresponding period last year. With respect, however, to the war I do not think the Western Company is much affected by it. Although some telegraph companies may gain by transmitting warlike and diplomatic telegrams, we would much rather welcome a time of profound peace, when trade and commerce can flourish, than the agitating times through which we have lately been going. Although we may gain a little by these voluminous strategical and warlike telegrams, yet on balance we are very much better off—as I think the whole world is—in a time of peace than in a time of war. I now move the adoption of the report and accounts, and that a dividend be now declared of 3s. per share, making, with the interim dividends already paid, a total dividend of 6 per cent. for the year, and also a bonus of 2s. per share, making in the aggregate a distribution of 7 per cent. in respect of the profits for the year ended June 30, 1904, dividend and bonus to be respectively free of income tax.

The DEPUTY CHAIRMAN (Sir J. Denison-Pender, K.C.M.G.) seconded the motion, which was carried unanimously.

The retiring directors, Lord Richard H. Browne, Sir Albert J. Leppoc Cappel, K.C.I.E., and Mr. John Coppen, were afterwards re-elected, as were also the auditors, Messrs. Deloitte, Dever, Griffiths & Co., and Messrs. Gane, Jackson, Jefferys, Wells & Co.

A vote of thanks was afterwards passed to the chairman and directors, and the proceedings terminated.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—At the meeting on Friday, Mr. E. L. Evan-Thomas, who presided, said the capital expenditure recommended some three years ago had produced highly satisfactory results. The earnings from power supply had increased 50 per cent. last year, and were expected in the future to be an even greater source of profit than the lighting or the railway. The largest item of capital expenditure during the year was for lighting extensions, which for Vancouver and Victoria amounted to £14,000. There was also £12,000 for additional rolling stock. At the end of the year they had 69 cars on their railway. The company proposed to purchase the Vancouver Gas Co.'s undertaking and to develop the use of gas for fuel. Of course, gas could not compete with electricity for lighting.

DRAKE & GORHAM (LTD.) At the meeting on Wednesday the directors' report, given in our last issue, was adopted on the motion of the chairman (Mr. B. M. Drake), who said that the company had standardised as far as practicable their electrical apparatus and fittings, and in connection with these a number of patents had been obtained and the combination had been designated the "S.S. system." Clients, by availing themselves of this system, could have installations at a lower price than was possible where a specification required special apparatus. In order to secure the Church Stretton plant contract, it had been necessary to accept part payment in preference shares of the Church Stretton Land Co., but efforts to place these shares elsewhere at an underwriting commission of 5 per cent. had failed. The managing directors, however, took about three-quarters of the amount, thus enabling the company to accept the contract. It was hoped that that contract would lead to others of a similar character for lighting small towns and villages.

RICHARDSONS, WESTGARTH & CO. (LTD.)—At the meeting on Monday the chairman (Sir C. Furness, M.P.) said he thought the Company's turbine shops compared favourably with any in the country. They had dispatched three electrical installations for mines in Australia, and had in progress contracts for various parts of the world. The shareholders would see under test a 750kw. set running at 2,300 revs. per min., which was of special interest from the fact that the generators were continuous current and of a patent compensated type, giving sparkless running, notwithstanding the extremely high speed. Another set under test was a 400kw. three-phase alternator, which was part of the equipment of a power installation for a gold mine in Australia, whilst another set of 3,000 H.P. was for the Hammersmith (London) Council. Steam turbines were eminently suitable for power installations at mines, as not only was the steam efficiency very high, but the cost of transport, foundations, erection, maintenence and supervision compared favourably with the best reciprocating engines.

ROSARIO ELECTRIC CO. (LTD.) The report for the year ended June 30 states that the profit was £6,500. After paying the preference 6 per cent dividend £913 is carried forward. The new station and network at Rosario were handed over by the contractors to the company in August, 1903. Various extensions of the underground mains have been made during the year, and the transfer of private consumers from the old to the new system is practically complete. There were connected at June 30 (including theatres, about 11,300 8 c.p. lamps) 43,749 8 c.p. lamps. In view of the rapid growth of demand for lighting and power the directors have placed an order for an additional 500kw. set. To provide for new plant and further extensions, an issue of 8,000 additional preference shares of £5 each is contemplated.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

FALKIRK ELECTRIC CONSTRUCTION SYND. (LTD.) (5,717.) Reg in Edinburgh on Oct. 24, capital £100,000 in £100 shares, to purchase or otherwise acquire control of the statutory rights and powers for construction and working certain tramways within the burgh of Falkirk and the parishes of Larbert and Falkirk, to construct, equip and maintain any tramway or railway in the United Kingdom or elsewhere, to carry on business of tramway, railway, motor car and mechanical carriage proprietors, also the business of an electric power and light company. First directors, Alex. D. Mackenzie, R. Dobbie, G. M. Brown, J. D. Young, C. Sebag-Montefiore and A. W. Tait. Reg. office, 37, Castle-street, Edinburgh.

PATENTS & INDUSTRIES (LTD.) (82,426).—This company was registered on Oct. 29 with a capital of £1,000 in £1 shares, to carry on the business of electrical engineers and experts, technical advisers, consulting and mechanical engineers, contractors, founders, &c. Reg. office, 10, Serjeants Inn, Fleet-street, London, E.C.

SAXONIA ELECTRICAL WIRE CO. (LTD.) (82,320.)—Reg. Oct. 18, capital £10,000 in £1 shares, to acquire business of manufacturers of cables and insulated electric light and telephone wires, makers of leads, coil wires and picture and sash cords, &c., carried on by F. S. Thomas and S. T. Smith as the "Saxonia Electric Wire Co.," and to carry on said business and that of electrical and mechanical engineers, &c.

W. SISSON & CO. (LTD.). (82,295.)—Reg. Oct. 14, capital £25,000 in £1 shares, to adopt an agreement for acquisition of business carried on as W. Sisson & Co., and to carry on the business of boiler-makers, founders, mechanical and electrical engineers, manufacturers of steam and internal combustion engines, machinery and tools, &c. First directors are W. Sisson (chairman and man. director), J. H. Salter and A. W. Sisson. Reg. office, Quay-street, Gloucester.

STATUTORY RETURNS.

W. H. ALLEN, SON & CO. (LTD.)—According to return to Sept. 19, the capital is £200,000 in £1 shares, of which 151,100 have been taken up. £1 per share has been called up on 1,100 and £1,100 has been received. 150,000 shares are considered as fully paid. Mortgages and charges, £58,000.

CHILIAN ELECTRIC TRAMWAY AND LIGHT CO. (LTD.)—Return to Sept. 7 gives capital as £1,150,000, in 500,000 ordinary and 650,000 preference shares of £1 each, of which 500,000 ordinary and 600,000 preference shares have been taken up. £600,000 has been received in respect of preference and £500,000 is considered as paid on ordinary. Mortgages and charges, £500,000.

DICK, KERR & CO. (LTD.)—Return to Sept. 27 gives capital as £650,000 in 70,000 preference and 60,000 ordinary shares of £5 each, of which 61,000 preference and 52,000 ordinary have been taken up. £5 per share has been called up on 53,000 preference and £265,000 has been received. £300,000 is considered as paid on 8,000 preference and 52,000 ordinary. Debenture stock, £300,000.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—In return to Oct. 13 the capital is £50,000 in 10,000 shares of £5 each, all of which have been taken up and are considered as fully paid. Mortgages and charges, £54,700.

MALAGA ELECTRICITY CO. (LTD.)—The return to Sept. 2 gives capital as £57,000 in 10,000 ordinary shares of £5 each and 7,000 deferred shares of £1 each, all of which have been taken up. £50,000 has been received in respect of the ordinary shares and the deferred are considered as fully paid. Mortgages and charges, £44,738.

WHITE, JACOBY & CO. (LTD.)—The return to Sept. 14 (filed Sept. 19) gives capital as £4,000 in £1 shares, of which 3,207 have been taken up. £1 per share has been called up and paid on 850 and 2,357 are considered as fully paid. Mortgages and charges £1,500.

MORTGAGES AND CHARGES.

BASTIAN METER CO. (LTD.)—Issue on Oct. 20 of £2,500 debentures, part of series created April 21, 1904, to secure £5,000, charged on company's undertaking and property, present and future, including uncalled capital, subject to outstanding first mortgage debentures. No trustees. No previous issue of same series.

BRITISH PROMETHEUS CO. (LTD.)—Debenture dated Oct. 17, to secure £500, charged on company's undertaking and property, present and future, including uncalled capital, has been registered. Holders, A. R. Phipps and J. R. Bedford (trading as Rashleigh Phipps & Co.)

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—Acknowledgment of indebtedness, dated Oct. 13, 1904 (supplemental to trust deed of May 12, 1903), securing a further £150,000 second debenture stock, has been registered. Trust deed empowers company to issue further debenture stock, ranking pari passu with £250,000 therein mentioned, provided total shall not at any time exceed £400,000. Property charged: Present and future assets of company (as floating security), ranking next after deed securing a maximum of £400,000 first debenture stock. Trustees, Electric and General Investment Co.

CUTTING BROTHERS (LTD.)—Issue on Sept. 26, of £200 debentures, part of series created June 20, 1904, to secure £4,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £2,600.

EDISON ORE-MILLING SYNDICATE (LTD.).—Charge reg. Oct. 17, for £7,000, to Standard Construction Corpn., secured on uncalled capital in respect of 42,209 shares.

EMPIRE ELECTRIC LIGHT AND POWER CO. (LTD.)—A first mortgage debenture, dated Oct. 12, 1904, to secure £5,500, charged on certain lands, machinery, works, &c., lighting and tramway orders and acts, and company's undertaking and other assets, including uncalled capital, has been registered. Holder, L. K. Jarvis.

UXBRIDGE AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Issue on Sept. 26 of £28,400 5 per cent. debentures, part of series created July 14, 1904, to secure £35,000. Property charged: Company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series. The previous issue of debentures has been fully satisfied.

WESTMINSTER ENGINEERING CO. (LTD.)—Lien reg. Oct. 20, for £500 5 per cent. debentures, part of £4,000; amount previously issued, £2,900; no trustees; charged on undertaking and all property, present and future, including uncalled capital.

CITY NOTES.

MEMORANDA (Nov. 3).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26 1/16d. per oz. Consols 87¾–87⅞ for money, 87 13/16–88 1/16 for account; 2½ per cent. annuities 87¼–87⅞. Consols Pay Day, Nov. 4; Stocks and Shares Continuation Days, Nov. 9 and 28; Ticket Days, Nov. 10 and 29; Pay Days, Nov. 11 and 30; Mining Share Carry-over Days, Nov. 8 and 25.

INDUSTRIAL STORAGE BATTERY SYND. (LTD.)—The directors have issued a circular explaining to the shareholders proposals for dealing with the loss of £5,556 during the 15 months ended June. The directors are sanguine as to future prospects, provided the shareholders consent to the proposed scheme for placing the syndicate on a sound financial basis.

NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)—Mr. R. Biddulph Martin, M.P., has been selected to fill the vacancy on the board of this company caused by the death of Mr. W. H. Willans, J.P., D.L.

RAND CENTRAL ELECTRIC WORKS (LTD.)—The result of the working for October was 841,000 kw.-hours generated, yielding gross revenue £7,950. For the corresponding period of last year the result was 702,670 kw.-hours generated, yielding gross revenue £6,258.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have been asked to allow a further issue of 2,732 £5 fully-paid ordinary shares of the *Calcutta Tramways Co. (Ltd.)* to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Oct. 29	1,152	– 76	22	34,060	+ 5,610
Airdrie	" 21	201	...	37	7,450	...
Ayr Corporation	" 29	186	+ 2	24	9,234	+ 479
Barnsley	" 21	160	– 15	42	7,164	– 106
Barrow	" 21	199	...	37	7,867	...
Bath Electric Trams, Ltd.	" 26	682	...	43	27,970	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	" 30	961	– 20	...	...	...
Birmingham Corporation	" 29	325	...	42	12,912	...
Birmingham Tramways Co.	" 29	5,823	+ 174	17	52,768	+ 4,139
Blackburn Corporation	" 29	911	+ 133	30	30,173	+ 8,045
Blackpool Corporation	" 27	435	+ 57	30	40,779	+ 5,625
Blackpool and Fleetwood	" 19	338	+ 66	17	19,580	+ 391
Blackp'l, St. Anne's & Lytham	" 27	228	+ 23	58	20,643	+ 7,157
Bolton Corporation	" 30	1,082	– 109	31	56,250	+ 167
Bournemouth Corporation	" 28	954	+ 78	130	35,787	+ 7,088
Bradford Corporation	" 29	4,518	+ 795	30	143,792	+ 25,771
Brighton Corporation	" 30	863	+ 21	30	34,340	+ 3,276
Brisbane Tramways	...	...	...	...	...	...
Bristol Trams & Carriage	" 28	4,533	+ 205	12	128,142	+ 1,060
Buenos Ayres & Belgrano	...	...	...	...	...	...
Burnley Corporation	" 29	1,043	+ 223	5	5,366	+ 1,204
Burton Corporation	" 30	11,109	...	¶20	...	...
Calcutta Tramways Co.	" 29	a33,576	+ a1,555	18	a694,011	+ a79,171
Camborne-Redruth	Nov. 1	115	+ 8	26	11,389	– 104
Cardiff Corporation	...	...	...	...	...	...
Carlisle Tramways Co.	Oct. 29	170	– 30	43	8,639	+ 607
Central London Railway	" 29	6,776	– 80	17	104,026	– 238
Chatham & Dist. Lt. Rys.	" 27	528	+ 24	43	25,677	+ 2,300
City & South London Rly.	" 30	2,618	– 181	18	44,170	– 1,258
Colchester Corporation	" 27	210	...	13	4,062	...
Cork Electric Trams Co.	" 27	451	– 59	43	20,434	– 2,353
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	" 21	490	– 16	42	22,733	+ 3,318
Dover Corporation	" 19	193	+ 9	31	7,459	– 191
Dublin & Lucan Railway	" 23	105	+ 2	17	2,854	– 24
Dublin Southern District	" 30	838	+ 97	17	91,280	– 2,137
Dublin United	" 29	8,741	+ 118			
Dudley—Stourbridge	" 21	546	+ 4	43	37,188	+ 1,426
Dundee Corporation	" 26	819	– 13	...	...	...
East Ham Council	" 29	628	+ 16	30	24,911	+ 1,511
Gateshead & Dist. Trams	" 21	922	– 30	44	38,891	+ 1,431
Glasgow Corporation	" 29	14,610	+ 634	†22	316,017	+ 17,190
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	" 21	273	– 11	43	10,918	+ 566
Gt. Northern & City Rly.	" 19	1,235	...	37	16,563	...
Greenock & Port Glasgow	" 21	607	– 7	43	24,556	+ 1,218
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	" 21	166	+ 7	41	12,614	+ 1,069
Huddersfield	" 29	1,212	– 18	30	42,610	+ 2,774
Hull Corporation	" 29	2,156	+ 300	30	67,001	+ 6,879
Ilford District Council	" 29	383	+ 39	¶30	14,861	+ 699
Ilkeston Corporation	" 26	164	– 16	4	258	– 54
Ipswich Corporation	" 29	413	...	30	13,936	...
Isle of Thanet Co.	" 29	317	...	4	14,568	– 863
Kidderminster & District	" 21	106	– 5	42	5,345	+ 25
Kirkcaldy Corporation	" 26	204	– 30	43	9,303	...
Lanarkshire Trams Co.	" 27	816	+ 230	43	28,116	...
Leeds Corporation	" 29	5,430	+ 112	30	153,915	+ 10,900
Leicester Corporation	...	...	...	...	...	...
Liverpool Corporation	" 29	10,487	+ 406	43	447,169	+ 18,017
Liverpool Overhead Rly.	" 30	1,581	– 67	†18	79,285	– 1,288
London County Council	" 27	13,357	+ 3,406	‡29	378,879	+ 90,026
*Lowestoft	" 29	160	– 15	...	...	...
Maidstone Corporation	...	...	...	...	...	...
Manchester Corporation	" 29	12,078	+ 467	20	376,574	+ 15,966
Mersey Railway	" 29	1,490	+ 160	17	21,765	+ 2,760
Merthyr	" 21	190	– 12	42	8,839	+ 410
Metropolitan Elec. Trams	" 29	1,812	+ 612	17	32,845	+ 8,617
Middleton	" 21	234	...	43	13,956	+ 253
Nelson Corporation	" 29	113	+ 21	31	3,777	+ 1,176
Newcastle-on-Tyne Corp.	" 23	3,540	– 109	17	63,549	+ 3,704
Newport (Mon.)	" 29	465	+ 31	4	1,563	+ 145
Oldham, Ashton & Hyde	" 21	536	– 35	42	24,293	– 196
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams	" 28	1,347	+ 5	43	55,920	+ 6,201
Peterborough	" 21	177	...	43	6,536	– 188
Poole and District	" 21	502	+ 24	43	19,190	+ 23
Portsmouth Corporation	" 29	1,535	+ 30	¶30	64,611	+ 5,961
Potteries	" 21	1,791	+ 113	42	74,114	+ 5,469
Reading Corporation	" 27	625	+ 54	4	2,695	+ 171
Rochdale Corporation	...	...	...	...	...	...
Rothesay	" 21	45	– 1	42	6,641	+ 19
Salford Corporation	" 31	4,081	+ 119	30	137,221	+ 7,580
Sheerness	" 19	56	– 3	42	2,755	– 486
Sheffield Corporation	" 30	4,580	+ 60	§31	147,088	+ 2,925
Southampton Corp'ation	" 27	804	– 60	30	31,027	– 2,071
Southend Corporation	" 26	255	+ 27	30	12,441	+ 1,329
Southport Tramways	" 21	257	– 17	44	11,124	+ 541
S. Staffordshire Trams	" 2	774	– 288	41	3 ,517	– 5,858
Stockport Corporation	" 28	537	+ 129	30	18,310	+ 7,310
Sunderland Corporation	" 30	1,125	+ 51	30	41,142	+ 679
Swansea Trams	" 21	494	– 19	42	18,164	+ 978
Taunton Trams	" 21	47	– 6	42	2,396	– 239
Tynemouth and District	" 21	195	– 65	42	12,043	– 779
Tyneside Trams Co.	" 23	865	+ 64	43	17,049	+ 2,009
Wallasey District Council	" 29	670	+ 85	§30	13,950	+ 1,464
Walsall	" 20	464	...	41	20,912	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	" 27	1,075	...	35	82,096	...
Weston-super-Mare	" 19	54	+ 7	41	5,951	+ 434
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	" 21	347	– 7	42	16,614	– 58
Worcester	" 21	301	+ 178	27	12,044	+ 5,892
Wrexham	" 21	92	– 34	42	4,722	– 727
Yorkshire Woollen District	" 21	104	– 18	42	25,075	+ 8,230

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 8 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 8 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., Nov. 2.	Rate per Cent. Yield. £ s. d.	Dividend Due.	Business Week to Nov. 2. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	3/0	Anglo-Argentine Ordinary Shares	6¾—7¼	4 4 0	April, Oct	7⅛	6⅞
5	2/6	Do. 5% Cum. Pref.	5¼—5¾	4 8 10	..	5⅝	5⅜
St.	6%	Do. Permanent 6% Deb. Stock	139—142	4 4 10	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104—106	4 17 0	—	106½	104½
10	6%	Barcelona Tramways Ord.	9—10	5 0 0	—	..	..
10	6/0	Do. 6% Cum. Pref.	9—10	6 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91—96	4 14 0	—	..	..
100	5%	Do. 5 per Cent. Debs.	96—101	4 19 0	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	½—¾	..	..	¾	..
1	..	Do. 6% Cum. Pref.	1⅛—1⅜	..	..	1	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	3/6	† Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 8	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96—101	4 9 5	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19—20	4 0 0	Feb, Aug	..	..
10	6%	Do. Cum. Pref. (fully paid)	10—10½	5 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106—108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	103—106	5 13 3	—	105	..
St.	5%	Do. Pref. Ord. Stock	102—105	4 15 3	—	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10¾	4 13 0	—	..	..
50	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102%—104%	4 6 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	97—100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	9½—10½	5 17 2	..	10½	9¾
10	6/0	Do. 6 per Cent. Cum. Pref.	11—11½	5 4 4	Feb, Aug	11¼	11⅛
St.	5%	Do. 5 per Cent. Perpetual Debs	116—119	4 4 3	—	118½	117
St.	4½	† Do. 4½ per Cent. 2nd Deb. Stock	94—97	4 12 10	..	..	..
5	1/6	Buenos Ayres and Belgrano Ord.	3½—4	6 12 6	—	3⅞	3¾
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5½—5¾	5 4 4	—	..	..
5	3/0	Do. "B"	5¼—5¾	5 11 6	—	..	..
St.	5%	Do. 5 per Cent. Debs.	105—108	4 12 8	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	102—105	4 16 3	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. 5 Deb. Stk.	96—99	5 2 6	..	..	..
5	3/0	Calcutta Tramways	7½—7¾	4 3 9	—	7⅝	7½
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105—108	4 4 0	—	..	..
1	1/0	Cape Electric Tram Shares	1½—1¾	5 14 3	—	..	..
St.	4%	Central London Ordinary Stock	91—94	4 6 1	June, Dec	93½	..
St.	4%	Do. 4 per Cent. Pref. Stock	100—103	3 18 3	..	..	..
St.	4%	Do. Deferred Stock	81—83	4 16 5	..	82	..
100	4%	Do. 4 per Cent. Debs.	107—110	3 13 4	..	..	..
5	2/6	City of Birmingham Trams.5% Cm. Prf.	4¾—5	5 0 0	..	5	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98—101	3 19 5	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	46—48	4 11 7	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122—125	4 0 3	Feb, Aug	..	..
St.	5%	Do. (1896)	117—120	4 3 6	..	..	..
St.	5%	Do. (1901)	113—117	4 6 0	..	..	..
St.	4%	† Do. 4 per Cent. Perpetual Debs	104—107	3 14 9	May, Nov	106½	..
St.	5%	†Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	101—104	4 16 3	—	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord	13—14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15—16	3 15 0	—	..	..
10	3 0½	Gt. Northern & City Rly. Prf. Ord. (4%)	5½—6½	..	—	..	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9—10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19—20	5 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—15	4 0 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109—111	4 1 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4½	5 17 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90—93	4 7 3	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3½—3¾	3 15 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10—10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—101	3 19 2	Jan, July	..	..
10	6/0	London United Trams. 6% Cum. Pref.	10½—11	4 10 11	..	10¾	10⅝
St.	4%	Do. 4% 1st Mort. Deb. Stock	102—105	3 16 4	..	105	102½
St.	..	Madras Elec. Trams 5% Deb. Stk.	102—105	..	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6—9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10—13	..	..	..	..
1	..	Metropolitan Electric Trams Def	½—¾	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	—	..	..
St.	18/7	Do. 4½ Deb. Stock	103—104	..	..	103½	103
100	5%	Montreal St. Ry. St'g 5% Mrt. Dbs.(1908)	100—103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs.(1922)	105—108	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent.Cum. Pref.	½—1¼	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	102—106	4 15 6	..	..	..
10	10/0	Potteries Electric Traction Ord.	8—9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9¼—9¾	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101—104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	87—90	3 7 0	June, Dec	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 6% Cum. Pref.	⅜—½	5 14 3	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	1⅛—1¼	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	3¾—4	6 13 4	July, Feb	..	..
5	2/0	Do. 6 per Cent. Pref.	5¾—6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101—104	4 6 7	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	100—103	4 8 6	..	101½	..
5	3/0	British Westinghouse 6% Pref.	3½—4	7 10 0	—	3⅞	3¾
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	87—90	4 10 2	..	..	..
1	..	Brush Electrical Engineering	½—¾	..	March	..	..
5	4/6½	Do. 6 per Cent. Pref. Non-Cum.	1—1¼	6 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96—98	4 11 6	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	70—75	6 0 9	Jan, July	..	..
5	5/0	†Callender's Cable Con. Ord.	9—10	6 5 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4 10 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	103—106	4 5 7	Nov, May	106½	105½
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	⅞—1	4 11 6	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	91—96	4 14 9	..	96½	95
1	0/9	Chadburn's (Ship) Telegraph Ord.	¾—1⅛	3 17 6	..	..	..
1	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—2	3 15 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	90—95	5 6 5	Jan. July	..	..
5	10/0	Dick, Kerr & Co. Ord.	6¾—7¼	6 13 0	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	5¾—6¼	5 4 4	Sept	6⅛	..
St.	4½%	Do. 4½% Deb. Stock	103—106	4 5 9	..	..	..
1	..	Edison & Swan United ("A" sh.)(£3 pd.)	½—¾	..	Feb, Aug	⅝	½
5	..	Do. (£5 paid)	1—2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb.Stock(rd.)	78—83	4 17 9	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79—84	6 0 6	..	80½	—
5	4/0	Edmundson's Elec. Corp. Ord.	6¼—6¾	5 9 9	H'lf-yearly	..	..
5	3/0	† Do. 6 per Cent. Cum. Pref.	5½—6½	4 13 6	—	6⅜	6¼
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106—109	4 3 6	..	107½	..
2	1/0½	Electric Construction Co.	1—1¼	6 8 0	July	1⅛	..
2	4/0½	Do. 7 per Cent. Cum. Pref.	2—2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97—100	4 0 0	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90—95	5 5 2	—	..	—
10	6/0	General Electric (1900) 6% Cum. Pref.	6½—6¾	5 2 6	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91—95	4 3 4	..	..	..
2	5/0	Henley's Telegraph Works Ord.	10½—11½	5 1 9	Feb, Aug	..	..
2	2/3	Do. 4½ per Cent. Pref.	9—9½	4 1 10	Feb, Aug	9⅛	..
St.	4½%	Do. 4½ per Cent. Mort.Deb.Stock(rd.)	108—111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	19½—20½	4 17 0	Feb, Aug	19⅞	19½
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99—102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11½	4 5 10	Mar, Sept	..	..
15	12/0	Telegraph Construction & Mainten'ce.	36—39	3 3 1	Mar, July	..	..
100	5%	Do. 5 per Cent. Deb. Bonds, 1909	101—104	3 17 6	Jan, July	..	..
..	..	Willans and Robinson Ord.	1—2	..	Apr, Oct	..	..
..	..	Do. 6 per Cent. Cum. Pref.	2—3	..	Apr, Oct	..	..
..	4%	Do. 4 per Cent. 1st Mort. Debs	74—79	5 3 11	May Nov	..	..

Share.	Last Dividend.	Name.	Price Wed., Nov. 2.	Rate per Cent. Yield. £ s. d.	Dividend Due.	Business Week to Nov. 2. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
..	..	Blackheath & Greenwich Dist. El. Lt. See South Metropolitan Elec. Lt. & Power Co. below	..	..	..	..	..
10	10/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	5 8 0	..	11¾	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	9⅞	..
10	6/0	Do. 6% Cum. Second Pref.	11—12	5 0 0	..	11½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103—105	4 6 9	—	105½	104½
5	2 0	†Bromley (Kent) El. Lt. & Power Shares	5¼—5¾	3 9 7	..	..	..
St.	4½%	† Do. Do. 1st Debs	100—103	4 7 5	—	..	..
5	4/6	Brompton & Kensington Elec.Sup.Ord.	10½—11	4 10 11	..	10⅝	..
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 6 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7½—8	4 7 6	..	7⅝	..
St.	4%	Central Elec. Sup.Co.4%Guar.Db.Stock	106—109	3 14 6	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8½—9	4 8 9	Feb, Aug	8¾	..
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4 0 0	Feb, Aug	5¾	5⅝
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4 10 0	—	4⅞	..
5	2/3	Do. Do. (1903)	4½—5	..	..	4⅞	4¾
St.	4%	Do. 4% Deb. Stock (red.)	103—106	3 17 8	..	104½	..
5	1/3	Chelsea Electric Supply Ord.	6½—7	4 2 2	March	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108—111	4 1 9	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	10½—11	4 10 11	Feb, Aug	10⅝	10½
10	6/0	Do. 6 per Cent. Cum. Pref.	13—14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122—126	4 0 2	Jn, Dec	124½	123½
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	103—106	4 5 9	..	..	..
10	4/0	County of London Elec. Supply Ord.	9—10	4 0 0	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—12½	4 15 9	Mar, Sept	12⅛	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106—109	4 3 9	..	107½	107
St.	4½%	† Do. Second Deb. Stock Prov. Certs.	100—103	4 7 5	..	100½	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88—93	5 7 6	..	..	..
5	2 0	Folkestone Electricity Supply Co. Ord	5½—6	4 11 9	..	5⅝	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101—104	4 7 6	..	..	—
10	..	Havana Electricity Co. Shares	9½—10½	—	..	..	—
5	3 6	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
St.	4½%	†I. of W. Elec Lt. & Power 4½% Db.St (red.)	99—101	4 9 1	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf.	⅛—³⁄₁₆	..	..	..	..
5	5/0	Kensingtn & Knghtsbdge Ord.	12—13	4 12 4	..	12⅞	12⅝
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg.Co.&NottingHill Co.(Joint Station) 4% Deb. Stck.(red.)	101—104	3 17 3	—	103½	..
5	..	London Electric Supply Ord.	2—2½	..	..	2⅜	2¼
5	3/0	Do. 6 per Cent. Pref.	4½—5	5 0 0	..	5⅛	5⅛
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96—99	4 2 0	Mr,Jn,S,D	..	..
10	9/0	MetropolitanElectricSup.Ord.	16¼—16¾	5 10 8	April, Oct	16	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½—5¾	4 1 10	Jan. July	5⅝	5½
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	113—117	3 18 0	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96—99	3 10 6	..	..	..
100	4½%	MidlandElec.Corp.for P.D.1stMort.Db.	93—96	4 13 9	..	..	—
10	6/0	Notting Hill Electric Ord.	14½—15½	3 17 6	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	99—102	3 18 6	..	..	..
5	2/6	Oxford Electric Ord.	6¼—6¾	5 4 0	March	..	..
St.	4%	Do. 4% Deb. Stock	98—101	4 0 0	..	..	..
1	..	Rand Electric	1⅛—1¼	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mt. Deb	98—101	4 9 0	April, Oct	101½	101¼
5	6/0	St. James' & Pall Mall Elec. Ord.	14—15	4 16 8	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	8—9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98—101	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¾—3¼	6 3 1	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83—87	4 12 6	..	..	..
5	3/0	South London Electric Supply Ord.	4½—4¾	3 3 1	—	4⅝	..
1	..	South Metrop'n Elec. Lt. & Power Ord.	¾—1	..	—	..	..
1	0/8½	Do. 7% Cum. Pref.	1⅛—1¼	4 13 4	—	..	..
St.	4½	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&con.	106—110	4 2 3	—	108	..
5	2/6	Urban Electric Supply Ord.	4½—5	5 0 0	..	..	..
5	3/0	Do. 6% Cum. Pref.	4¾—5	5 0 0	..	4⅞	..
St.	..	Do. 4½% 1st Mort. Deb.	101—103	..	..	102½	101½
5	6/6	Westminster Electric Supply Ord.	12½—13½	5 0 0	Mar, Sept	13⅛	13
5	2/6	Do. 5 per Cent. Cum. Pref.	6¼—6¾	3 14 0	—	..	—
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.	98—102	3 19 0	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec	..	..
St.	12/0	Anglo-American	50—53	5 1 3	F,My,Ag,N	..	..
St.	25/0	Do. Preferred	97—99	5 3 6	F,My,Ag,N	98½	97
St.	2/0	Do. Deferred	8½—8¾	1 2 3	F,My Ag,N	8⅝	8½
100	8%	Commercial Cable Capital Stock	170—190	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93—96	4 3 6	Jn Ap,Jy,O	95½	95¼
10	5/0	†Cuba Submarine Ord.	7—8	6 6 0	Feb, Aug	..	..
10	10/0	† Do. Preference 10 per Cent.	14½—15½	6 9 0	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 6	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7—8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98%—101%	4 9 2	Jan, July	..	..
20	2/0	Direct United States Cable	10½—10¾	5 11 3	Ja,Ap,Jy,O	..	..
100	4½%	Direct West India Cable 4½% Rg. Db.(rd.)	100—103	4 9 6	Jn, Dec	..	..
St.	26/0	Eastern Ordinary	132—137	4 2 1	Ja,Ap,Jy,O	135½	133
St.	17/6	Do. 3½ per Cent. Pref. Stock	88—91	3 18 9	Ja Ap,Jy,O	89½	88
St.	4%	† Do. 4 per Cent. Mort. Deb. Stk. (rd.)	104—107	3 14 9	May, Nov	..	..
10	2/6	Eastern Extension	12½—13	5 7 9	Ja,Ap,Jy,O	12⅞	12⅝
St.	4%	Do. 4 per Cent. Deb. Stock	106—108	3 14 3	Feb, Aug	108	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1906	100—103	3 18 6	Feb, Aug	..	..
25	4%	† Do. 4% Mauritius Sub. Debs. (red.)	99%—102%	3 18 5	May, Nov	..	..
10	5/0	Gt. Nrthn.(of Copenhagen)	29½—30½	5 1 9	Jan, July	..	..
100	4½%	Halifax & Bermudas 4½% 1stMt.Db. (red.)	100—102	4 9 6	June, Dec	..	..
25	12/6	†Indo-European	44—47	5 6 4	May, Nov	..	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97—100	4 0 0	June, Dec	..	—
10	6/0	West African Telegraph Shares	6½—7½	5 6 8	..	..	..
20	..	West Coast of America	1—1½	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97—100	4 0 6	Jan, July	..	..
10	..	West India and Panama	¾—1	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6½—7	8 11 5	May, Nov	6⅝	..
10	..	Do. 6 per Cent. 2nd Pref.	5—6	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	100—103	4 17 10	Jan, July	..	..
10	2/6	Western Telegraph	12½—13	5 7 9	Mr,Jn,O,D	12⅞	12⅝
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101—104	4 16 2	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	101—104	3 17 6	—	..	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid)	5½—6½	6 1 9	August	..	..
1	0/7½	†Monte Video Telephone Ord.	⅝—1	..	..	..	..
St.	6%	National Co. Pref. Stock	106—108	5 11 0	..	107½	106¾
St.	6%	Do. Def. Stock	96—98	6 2 6	..	98	96½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13—14	4 5 8	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11—13	4 13 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5¾	4 13 0	Feb, Aug	5⅝	5½
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97—99	3 10 8	June, Dec	98	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104—106	3 16 9	..	105½	104½
..	5/0	Do. Do. Prov.Certs.£35 tobepd.	67—69	..	..	..	..
1	0/7½	†Oriental	1⅛—1³⁄₁₆	6 6 8	April, Oct	1	..
1	0/7½	† Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	..	..	..
5	6/0	United River Plate	6½—6¾	5 18 6	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4½—5½	4 15 3	June, Dec	5⅛	5
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	103—106	4 14 4	June, Dec	..	—
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4½—5½	5 14 4	—	..	..
10	2/0	†Globe Telegraph and Trust	9½—9¾	5 12 8	Ja Ap,Jy O	9⅝	9½
10	3/0	† Do. 6 per Cent. Pref.	13½—14	4 5 8	Ja Ap,Jy,O	14	13¾
100	6%	Submarine Cables Trust (Cert.)	117—122	4 18 4	April, Oct	119½	—
..	30/7	Underground Elec. Rys. Co. of London 5% Profit Sharing Secured Notes	89—90½	..	..	90¼	90⅛

calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

◆

MR. ALEXANDER SIEMENS' Presidential Address to the Institution of Electrical Engineers, delivered last night before a large audience, may be divided into three parts. The first consisted of a string of generalities, concerning the relations between capital and labour and the management of works, which it was hardly necessary to place before a well-educated assembly of electrical engineers. To a true engineer they are self-evident propositions, and we need hardly say that we are in agreement with MR. SIEMENS in these matters. The discussion of them in his Address, however, will have the good effect of obtaining recognition for these views in the daily papers, the more so as MR. SIEMENS wisely avoids the tempting subject of the fiscal controversy. The second part of the Address was a repetition of MR. SIEMENS' opinions on the metric system of measurement. In the concluding part of the address the President called attention to the mistake which our legislature has made in following the footsteps of the United States and Germany in patent law. He rightly contends that the preliminary investigation as to the novelty of an invention should be carried out by the inventor himself and not by the Patent Office. MR. SIEMENS' warning is too late, however, for the new British Patent Act was passed in 1902 and will come into force on January 1st next. We were almost alone in our opposition to this section of the Bill when it was before Parliament, and regret that MR. SIEMENS' recognition of this principle has been so tardy. The Address is printed in full in a later portion of this issue.

◆

WE tender our most hearty congratulations to Sir J. WILSON SWAN, F.R.S., and to the Hon. C. A. PARSONS, C.B., F.R.S. on the honours which have been conferred upon them by the KING on the occasion of His Majesty's birthday. The new Knight is a man whose inventive genius and spirit of research have been of great utility to mankind generally, and to the electrical industry particularly. To him belongs the credit of inventing the incandescent electric lamp, which, in its present form, is very little different to the original lamp exhibited at a meeting of the Newcastle Chemical Society in February, 1879. He is now 76 years of age, and although Royal recognition of his services has been somewhat tardy, yet his merits have long been appreciated by every member of the great electrical profession, of which he may be justly described as one of the fathers. No better proof of this could be found than in the fact that he is an honorary member of the Institution of Electrical Engineers. The honour of Companion of the Order of the Bath conferred upon MR. PARSONS, the inventor of the steam turbine, will receive the approval of every one of his engineering colleagues.

◆

WHEN the Royal Commission on London Traffic was appointed in the early part of 1903, we suggested that, in view of the protracted proceedings which would be inevitable, it would be unwise to prevent the promotion of any new schemes of locomotion for London in the meantime. Our reason for this was that already no fresh means of railway communication in the metropolis had been sanctioned since 1900, owing to the appointment of the Joint Committee in 1901, and the proceedings in Parliament the following year when the Morgan London United Tramways Co. combination broke down and resulted in another barren session. Upon the appointment of the Royal Commission on London Traffic in 1903, however, a statement was made by the Lord Chairman of Committees which had the effect of postponing for that session the new proposals for tube railways already deposited. A similar thing happened prior to the commencement of the 1904 session, and the Board of Trade has now issued a memorandum in reply to inquiries, adopting (with the concurrence of the Parliamentary authorities) the same attitude as regards the 1905 session, the reason being that the Royal Commission has not yet reported. Presumably the report will be presented to Parliament before the session of 1906, but in any case it will be yet many years before Londoners may hope for the practical operation of those travelling facilities which everyone agrees are necessary.

We conclude to-day Mr. R. M. Neilson's theoretical study of the possibilities of gas turbines. The meeting of the Institution of Mechanical Engineers, at which the Paper was read, was crowded to overflowing—a sure indication of the interest taken in the subject. In opening the meeting the Chairman pointed out that purely theoretical Papers were somewhat at a discount at their Institution; but, as this was quite an exceptional case, the Council had decided to give the members the benefit of Mr. Neilson's excellent treatise. This was wise, and it marks the growing tendency of practical engineers in this country to abandon their scornful attitude towards investigations in the realms of theory. The more enlightened of our engineers have always realised, however, that there can be no real antagonism between "theory" and "practice," and no one can doubt the value of a theoretical survey of the ground, and a test of the foundations upon which engineers are anxious to exercise their skill in building a structure of practical utility.

A long list of mathematically-possible gas turbines might, for instance, be conceived, utilising various heat cycles, but Mr. Neilson is able to show at once that a number of these are unpromising on what may be termed practical-theoretical grounds. It is evident, of course, both from the Paper itself and the discussion, that enormous practical difficulties will have to be overcome before a working gas turbine can be realised, but Mr. Neilson has certainly made some headway with the problem—one which it is almost safe to prophesy will be solved before the world is a generation older.

The position in which the London County Council has placed itself with regard to the conversion of the North London tramways to electric traction by reason of Section 23 of the London County Council (Electrical Powers) Act, 1900, and to which we made reference a fortnight ago, has now become so irksome that an endeavour is to be made to improve it. The Highways Committee intend to recommend the Council to seek Parliamentary powers next session, by which it may be relieved of the obligation under the Section of the 1900 Act referred to above. As a matter of fact, such a power ought never to have been given to the borough councils, but it was inserted at a time when no experience had been gained of the conduit system in South London and also with the object of securing an unopposed bill as far as the Borough Councils were concerned. That the County Council, having been constituted the tramway authority, should have an absolutely free hand in deciding upon the system of traction to be employed is indisputable, and it is to be hoped that the Committees of Parliament before which the proposal to remove Section 23 of the Act of 1900 will come may deal with the matter in this spirit. On the other hand, it can very well be argued that it is making a farce of Parliamentary procedure to agree to a certain restriction in 1900 in order to remove opposition to an important scheme, and then to ask to be relieved of the burden four years later. However, the welfare of the people of London should easily outweigh any such consideration as this.

The Postmaster-General did not make any definite statement of policy in his reply to the deputation of municipal telephone authorities on Monday, but some of his statements would indicate that the Government is finding the problem too difficult, and it appears not improbable that nothing will be done with regard to a Government acquisition of the telephone service of the country until the expiration of the National Telephone Co.'s licence in 1911. There was no intention, said Lord Stanley, of cutting short the period of any municipal licences by compulsion, and whatever arrangement might be come to between the Government and the company, it should not interfere with the existing municipal licences. In no circumstances would the purchase of the company's system be partial. Finally, the Postmaster-General hinted that it would not be good policy to allow the larger municipal authorities only to own their telephone systems, and leave the Government to bear the burden of the smaller and less profitable telephone exchanges in small towns. It is difficult to combine these three statements into a definite line of action, and thus it appears that the present Government is unlikely to make any definite movement in the matter.

A writer in the *Daily Telegraph* quotes our recent editorial note with regard to the theory that the heat of the earth is due to a distribution of radium in minute quantities throughout the mass of the earth, and expresses himself opposed to it. The theory, he complains, does not fully account for volcanoes, a point to which we had already alluded in our note. He forgets, however, that an explanation has hitherto been wanted of the enormous discrepancy between the two estimates formed of the age of the earth—that estimated by physicists and that by geologists. The only way to explain this discrepancy is, as Lord Kelvin has pointed out, by the assumption that there was a new source of heat unsuspected by physicists when their estimate was made. Such a new source of heat has been discovered in the phenomenon of radio-activity.

Mr. L. W. Wild, in an article which we publish this week, takes up the question of testing transformer iron, recently dealt with by Mr. Mordey and Mr. Hansard in a joint Paper read before the British Association (see *The Electrician*, Vol. LIII., p. 790), and his observations as to the importance and uncertainty of eddy losses confirm their results. The principal interest, however, in Mr. WILD's article will be found in a method which he advocates of arranging the instruments for the wattmeter test. This, which we believe is quite novel, consists in supplying the electrostatic voltmeter and the shunt of the wattmeter with a transformed pressure, but instead of using a separate transformer, he makes the iron under test act as the transformer itself. The copper losses in the magnetising coil, as well as the drop in the main coil of the wattmeter, may thus be entirely neglected. Moreover, the test allows a great variation in the densities and frequency employed, whilst the readings, nevertheless, are kept well within the accurate range of the instruments. Only one small correction (for the pressure circuit of the wattmeter) has to be applied. The chief assumption that has to be made is that the E.M.F. in the winding which supplies the pressure coil is in exact opposition to the impressed E.M.F. on the magnetising coil,—an assumption which must be true if the magnetic leakage is negligible; and this it is certain to be in all practical cases. Mr. WILD speaks of 5lb. of iron as his standard quantity for tests, but we believe that the method would allow as small a quantity as one or two pounds to be tested, hitherto a very difficult task to perform with accuracy.

◆

ON October 27th a well-known London consulting electrical engineer visited the town of Whitstable, and attended a special meeting of the Urban District Council in order to give them the benefit of his opinion and estimates on the question of electric lighting. According to reports in the *Kentish Observer* and the *Canterbury Journal*, he commenced his address to the Council by pointing out that *his visit would not cost the Council a single penny*. After complimenting the town on the high-class shops he had seen there, he outlined a scheme for the electric lighting of the town, and suggested that immediate application should be made for a Provisional Order. He replied to questions with regard to procedure and the relative prices of electricity and gas. He "was sure that he could write to towns he had been connected with and secure 50 letters from people who had found electricity to be cheaper." Finally, *the Chairman, on behalf of the Council, thanked the electrical engineer for his visit, and stated that if the Council decided to adopt the scheme he would no doubt hear more from them.* We venture to suggest that, although the electrical engineer in question is a Member of the Institution of Electrical Engineers, his line of action, if this report is correct, is contrary to the spirit of the rules for professional etiquette laid down by the Institution. The first of these rules is as follows:—"*No consulting engineer should solicit employment as consulting engineer verbally*, by letter, by agent paid by commission or otherwise, *or by any other means.*"

◆

A ST. LOUIS Congress Paper by Dr. STONE, which we publish in this issue, deals with the theory of the air-wire in wireless telegraphy. Using the methods of HEAVISIDE, the author shows that the damping effect of radiation on the waves in the wire may be allowed for in calculations by the inclusion of a proper fictitious resistance in the circuit. The formulæ arrived at, however, do not seem capable of immediate application, and, therefore, the investigation, in its present condition, cannot be described as fruitful. A complete theory, which will give the state of the field at any point and the values of the currents on a tuned receiving air-wire, remains a desideratum, though the problem has been attacked by more than one of the most eminent physical mathematicians.

◆

CONGRATULATIONS are due to British exhibitors in the electricity section at the St. Louis Exhibition, for practically all of them have received some sort of award. As we have already pointed out, most of the electrical exhibits were instruments and examples of the lighter branches of electrical manufacture, and it is, therefore, exceedingly satisfactory to know that our own makers of this class of apparatus still hold a very high position in the world's markets. Indeed, so admirable are some of the instruments which have been shown at St. Louis, that British manufacturers have succeeded in booking orders in America, even in the face of the high protective tariff on this class of goods.

◆

Llangollen and District Electric Light and Power Co.—The small generating station that has been erected by the Llangollen and District Electric Light and Power Co. was opened on Friday last week. A provisional order was granted to the local authority in 1901, but a company was formed to acquire the powers with a capital of £6,000. Mr. E. Bremner Smith is the engineer to the scheme.

Pacific Cable Conference.—A conference was to have been held in London to discuss Pacific Cable matters, under the presidency of the Hon. A. Lyttelton, Secretary of State for the Colonies. It was originally arranged that the conference should meet in November, but owing to the Canadian elections a postponement has taken place to a time when all parties concerned can meet in the Metropolis.

Institute of Marine Engineers.—This Society, which holds its meetings at 58, Romford-road, Stratford, has arranged weekly meetings on Mondays, at 8 p.m., for the reading and discussion of Papers. The following is the programme:—November 14th, "Fuel Testing"; November 28th, Paper not decided upon; December 5th, "Fuel Testing"; December 12th, "Fuel Economy by Insulation," by Mr. Lyddas; December 19th, "Fuel Testing."

Royal Institution.—At the general meeting of the Royal Institution on Monday, it was announced that the Institution had received a bequest of £100 under the will of the late Miss Harriet Jane Moore. The special thanks of the members were returned to Dr. Ludwig Mond for his donation of £755 for the purpose of erecting a lift from the basement to the second floor of the Institution, and any surplus after the completion of the work to go to the research fund.

Society of Arts.—The 151st Session of the Society of Arts will be inaugurated on Wednesday next, when Sir William Abney, chairman of the council, will deliver an Address. The following Wednesday evening Papers have also been arranged for before Christmas:—November 23rd, "The Systematic Promotion of British Trade," by B. H. Morgan; November 30th, "The British Canals Problem," by Arthur Lee; December 7th, "The International Exhibition at St. Louis, U.S.A.," by Walter F. Reid; December 14th, "The Patent Laws," by C. D. Abel.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne—Pinheiros	**Aug. 13, 1902**	—
Reissi-Issa (Yemen)—Camaran	**Oct. 22, 1903**	—
Tarifa—Tangier	Jan. 18, 1904	—
Cayenne—Paramaribo	July 13, 1904	—
Cap Haitien—Mole St. Nicholas	Aug. 20, 1904	Nov. 8, 1904
Trinidad—Demerara	Oct. 11, 1904	—
Bolama—Bissao	Oct. 13, 1904	—
Jupiter Inlets (Florida)—Nassau (Bahamas)	Oct. 20, 1904	—
Rhodes—Sitia	Nov. 1, 1904	—
Salonika—Lemnos	Nov. 6, 1904	—

Royal Society Medals.—Among the medals awarded by the Royal Society this year are the following :—The Copley medal to Sir William Crookes, F.R.S., for his long continued researches on spectroscopic chemistry, on electrical and mechanical phenomena in highly rarefied gases, on radio-active phenomena and other subjects ; the Rumford medal to Prof. E. Rutherford, F.R.S., for his researches on radio-activity, particularly for his discovery of the existence and properties of the gaseous emanations from radio-active bodies ; the Hughes medal to Sir J. W. Swan, F.R.S., for his invention of the incandescent electric lamp and various improvements in the practical applications of electricity.

Royal Society.—At the meeting of the Council of the Royal Society last week the following were nominated for election as Fellows at the annual meeting on November 30th :—

President : Sir W. Huggins, K.C.B., O.M.
Treasurer : A. B. Kempe, M.A.
Secretaries : Prof. J. Larmor, D.Sc., and Sir A. Geikie, D.C.L.
Foreign Secretary : F. Darwin, M.A.
Other Members of the Council : *Dr. S. Bidwell, Mr. G. A. Boulenger, *Col. D. Bruce, Mr. F. Darwin, Mr. F. W. Dyson, Prof. P. F. Frankland, Sir A. Geikie, *Prof. F. Gotch, Dr. E. W. Hobson, Sir W. Huggins, Mr. A. B. Kempe, *Prof. J. N. Langley, Prof. J. Larmor, *Dr. J. E. Marr, *Sir W. Niven, *Prof. W. H. Perkin, *Prof. J. Perry, Mr. A. Sedgwick, Dr. W. N. Shaw, *Prof. W. A. Tilden and *Sir W. J. L. Wharton.

Those marked * will be new members.

Combustion and Stoking.—An interesting lecture on this subject was delivered by Sir Oliver Lodge on Monday evening at the Birmingham University. After dealing with fuels and their calorific value, Sir Oliver said that insufficient air and imperfect admixture of air were the cause of smoke. A great many open fires were inefficient because they were largely supplied with air already burnt. The proper way of burning coal was to burn the lighter hydro-carbons only and to collect the heavier hydro-carbons as bye-products. Referring to water-tube boilers, the lecturer said that in most cases in which they had been unsuccessful it was because the comparatively cold surface of the tubes caused them to be covered with soot or surrounded by a layer of non-ignited and non-radiating gas which prevented the flame coming into contact with the surface. The formation of this gaseous envelope was one of the chief defects in the ordinary Lancashire or Cornish boiler, and hence the attempts to bring only the hot gases against the heating surfaces. Sir Oliver emphasised the importance of having an incandescent body within the furnace, and illustrated his point by showing that the radiation from a gas jet was greatly increased when a spiral of iron wire was placed in it and heated to redness. It was in this direction that improvements in boiler furnaces would have to be sought. He concluded by saying that so long as water had to be heated by solid fuel stoking would be a fine art, and would have to be performed by men with brains.

St. Louis Exhibition Awards.—The following list has been compiled from the complete list of awards to exhibitors at St. Louis from Great Britain and Ireland organised under the Royal Commission. :—

Photography.—Grand prize : Capt. Sir W. de W. Abney.

Instruments of Precision. Grand prize : Cambridge Scientific Instrument Co. Gold medal : W. F. Stanley & Co., Ltd , Newton & Co. Silver medal : John J. Griffin & Sons, Ltd., Pulsometer Engineering Co. Collaborators.—Bronze medal : Henry Fleuss (Pulsometer Engineering Co.), John Davis & Sons, Ltd.

Chemistry. Grand prize : Prof. Sir William Ramsay, K.C.B., F.R.S., Owen's College, United Alkali Co. and Doulton & Co. Gold medal : Brunner, Mond & Co., Baird & Tatlock, Royal College of Science, London, Prof James Dewar, F.R.S., Dr. L. Mond, F.R.S., J. J. Griffin & Sons, Ltd. Silver medal : Glasgow and West of Scotland Technical College, Prof. W. N. Hartley, F.R.S., Sir J. W. Swan, F.R.S., J. E. Petavel, William Martindale. Bronze medal : F. W. Berk & Co., W. J. Fraser & Co.

Steam Engines.—Grand prize : John Fowler & Co.

Electro-Chemistry.—Gold medal : United Alkali Co. Silver medal : Sherard Cowper-Coles & Co. Collaborators.—Silver medal : Dr. A. R. Garrick (United Alkali Co.).

Electric Lighting.—Gold medal : Consolidated Electrical Co., Geo. Trollope & Sons.

Telegraph and Telephony.—Grand Prize : General Post Office, London. Gold medal : India Rubber, Gutta Percha and Telegraph Works Co., Muirhead & Co.

Various Applications of Electricity.—Grand Prize : Cambridge Scientific Instrument Co., Nalder Brothers & Co. Gold medal : Nalder Brothers and Thompson, Crompton & Co., Everett, Edgcumbe & Co., Robert W. Paul, Newton & Co., Alfred C. Cossor, Elliott Brothers, Kelvin and James White, Synchronome Co. Silver Medal : F. Darton & Co. Collaborators.—Grand prize : Lord Kelvin (for important contributions to electrical engineering). Gold medal : Prof. H. L. Callendar, F.R.S. (Cambridge Scientific Instrument Co.), W. Duddell, Wh. Sc. (Cambridge Scientific Instrument Co.). Silver medal : R. S. Whipple (Cambridge Scientific Instrument Co.), A. C. Heap (Elliott Brothers).

General Machinery.—Grand prize : Davidson & Co., Ltd. Silver medal : Joseph Baker & Sons.

Models and Plans of Public Works.—Gold medal : Stothert & Pitt.

Machine Tools.—Silver medal : Peter Wright & Sons.

Railways.—Silver medal : F. B. Behr.

Metallurgy.—Gold medal : Sherard Cowper-Coles & Co., United Alkali Co.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, November 11th.

Tramways and Light Railways Association.

2 p.m. Visit to the London County Council Tramways. Meet at Greenwich Power Station 2:10 p.m. Book from Charing Cross or Cannon-street to Maze Hill, Greenwich.

Electro-Harmonic Society.

8 p.m. Concert (Ladies' Night) at Holborn Restaurant (King's Hall). Mr. J. S. Raworth in the chair.

Physical Society.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda : (1) "Investigation of the Variations of Magnetic Hysteresis with Frequency," by Prof. T. R. Lyle ; (2) "The Determination of the Mean Spherical Candle-power of Incandescent and Arc Lamps," by G. B. Dyke ; (3) Exhibition of Physical Apparatus by Robert Paul.

SATURDAY, November 12th.

Manchester Students' Section : Institution of Electrical Engineers.

2:15 p.m. Visit to Messrs. Mather & Platt's works, Salford.

Glasgow Technical College Scientific Society.

7:30 p.m. Meeting at 38, Bath-street, Glasgow. Paper to be read : "The Diesel Internal Combustion Engine as applied to Electrical Generation," by A. J. Lawson.

MONDAY, November 14th.

Institute of Marine Engineers.

8 p.m. Meeting at 58, Romford-road, Stratford, when a Paper on "Technical Education" will be read and discussed.

Institution of Mechanical Engineers : Graduates' Association.

8 p.m. Meeting at Storey's-gate, St. James Park, S.W. Paper to be read : "New Electrical Swing Bridge over Flood Course of the River Weaver, Northwich," by T. P. B. Cliff.

TUESDAY, November 15th.

Institution of Electrical Engineers : Manchester Local Section.

7:30 Ordinary Meeting at Owen's College. The Chaiman, Mr. C. D. Taite will deliver his Inaugural Address.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. The Papers on Coast Erosion will be further discussed, and, time permitting, the following Paper will be read :—"Distribution of Electrical Energy," by J. F. C. Snell.

WEDNESDAY, November 16th.

Royal Meteorological Society.

7:30 p.m. Ordinary Meeting at the Institution of Civil Engineers, 25, Great George-street, Westminster. Papers to be read :—(1) "Meteorological Observing in the Antarctic," by Lieut. Charles Royds ; (2) "Decrease of Fog in London During Recent Years," by F. J. Brodie ; (3) "Hurricane in Fiji, January 21-22, 1904," by R. L. Holmes.

Institution of Electrical Engineers : Students' Section.

7:30 p.m. Meeting in the Library of the Institution, 92, Victoria-street, S.W., when an Address will be given by Mr. James Swinburne.

Society of Arts.

8 p.m. First Ordinary Meeting of the Session. Sir William Abney, F.R.S., Chairman, will deliver his Inaugural Address.

THURSDAY, November 17th.

Institution of Electrical Engineers : Students' Section.

2:30 p.m. Visit to the Great Eastern Railway Co.'s Carriage and Waggon Works, Stratford, E.

Institution of Electrical Engineers : Leeds Local Section.

7:15 p.m. Ordinary Meeting at the Leeds University. Mr. W. Emmott, the chairman, will deliver his Inaugural Address, and, time permitting, a Paper on "Large Gas Engines for Central Stations," by H. Campbell, will be read.

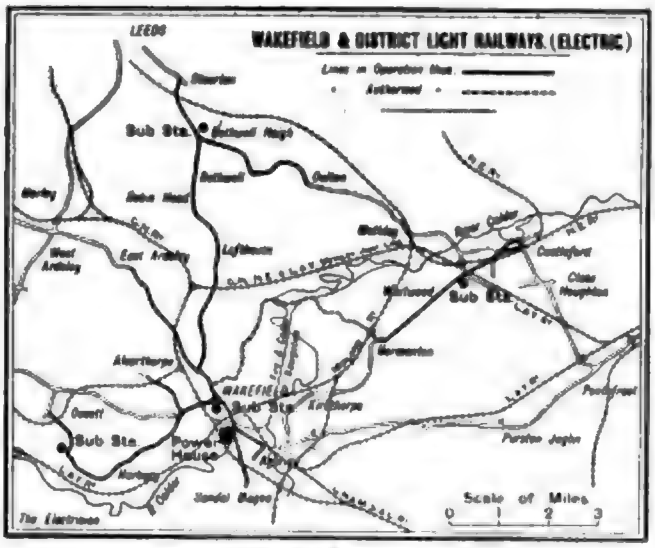
FRIDAY, November 18th.

Junior Institution of Engineers.

8 p.m. Meeting at the Westminster Palace Hotel. Mr. W. H. Lindley, President, will deliver his Address on "Municipal Engineering on the Continent."

THE LEEDS, WAKEFIELD AND WEST RIDING TRAMWAYS.

An extensive electric tramway system, owned by the Wakefield and District Light Railways Co., was formally opened on Thursday last week. Although, at the present time, there is a considerable mileage in operation, the scheme is only partially completed, and when the remaining sections and links are finished, the system will embrace large districts round Leeds and Wakefield, including Horbury, Ossett, Normanton, Castleford, Pontefract, Lofthouse and Rothwell. Eventually there will be some 75 miles of single track, linking together some of the most populous districts in the West Riding of Yorkshire, and on all parts of the system a frequent service of cars will be maintained. The ramifications of the tramways are clearly shown in the accompanying map, from which it will be seen that the most important trunk line runs from Wakefield to Thwaite Gate, and there joins the Leeds Corporation tramways system. Bearing in mind the recent and important discussions on the subject of joint running powers, it is interesting to note that it has been possible for the company to arrive at an arrangement with the Leeds Corporation under which cars can be run to the centre of Leeds. Such an understanding must result in the greatest convenience, and should materially add to the efficiency of the district company's system and prove to be a useful feeder to the Corporation tramways. As a matter of fact, when completed, the company's overhead construction originally ended about 20yds. from that of the Leeds Corporation, and as both parties were convinced that the opportunity of connecting the two systems was not to be missed, the existing arrangement was easily arrived at.



Map of District.

Taking Wakefield market place as the centre, the system branches out into four directions—to Sandal Magna (2 miles), to Agbrigg (2 miles), to Ossett, via Horbury (nearly 5 miles), and to Thwaite Gate (about 7 miles). There is in addition a most important branch line from the Leeds end of the line through Rothwell and Oulton. A considerable portion of track has been constructed between Normanton and Castleford, a distance of about 3½ miles, and eventually this will be linked up to the main system. Other lines are in the course of construction, the total mileage constructed up to date being, roughly, 32½ miles of single track. The entire contract for the work was secured by Messrs. Dick, Kerr & Co. (Ltd.), the consulting engineer for the scheme being Mr. B. D. V. Cooper.

Such a system obviously calls for high-tension transmission owing to there being few routes of great length. The main station is situated at Belle Isle, Wakefield, where alternating current is generated at high pressure. There is a sub-station at Wakefield, about 1 mile from the power station, where three 200kw. rotary converters have been erected. At Rothwell is another sub-station with two 200kw. rotaries, and there will eventually be a third at Castleford, which is about 10 miles from the power station, and a fourth at Ossett. The total length of tramways now in operation is approximately 25 miles of single track, laid to a gauge of 4ft. 8½in. Standard tramway construction has been employed on about 9 miles of single track. The roadway has been excavated to a uniform depth of 12½in. below the upper surface of the rails, to receive an 8in. bed of concrete, which carries the paving for a width of 8ft. for single track and 17ft. for double track. Between the rails and for an average space of 18in. on either side the roadway, both for single and double track, is paved with granite sets 5in. deep and 4in. wide. In the remaining portion, some 16 miles, the roadway between the rails is filled in with screened macadam. The rails are of the girder type, weighing 94lb. per yard, and are laid in 45ft. lengths, with a proportion of shorter lengths to allow for closures. Generally the rails are in accordance with standard tramway practice, 6½in. deep, with a groove of 1¼in.: they are used as a return conductor, the joints being of the plain type, secured with six-holed fish-plates, 24in. in length, and are double-bonded with 4/0 Neptune copper pin bonds.

The construction of the overhead lines is for the most part carried out on the side-pole system, with bracket arms and flexible suspensions. The poles, which have an overall length of 31ft. and are made up in three sections of lap-welded mild steel, are erected about 40yds. apart on the straight, and closer in curves, in holes of a depth of 6ft., and surrounded by from 6in. to 9in. of concrete. In towns and residential districts the brackets are fitted with wrought-iron scroll work of a neat design. The trolley wires are of hard-drawn copper wire 2/0 S.W.G., having a diameter of 0·348in., weighing 1,935lb. per mile, and with a breaking strain equal to 24 tons per square inch. At certain points over the low-tension feeders, switch pillars of the Dick, Kerr standard pattern are erected: each of these contains a white marble panel on which is mounted two 400 ampere quick-break switches, these being connected through vulcanised indiarubber cables directly on to the trolley wire. At all other points the mains are looped into the pole section bases described below.

At every ½ mile along the route, small cast-iron boxes are fitted to the poles, each containing four 150 ampere "no arc" switch fuses. These boxes serve the purpose of dividing the trolley wire into half sections and cross connecting for the parallel running. The cable taken from these connecting boxes from the poles has the same section of copper as the trolley wire, and is insulated with vulcanised rubber.

Three car-sheds have been constructed, the principal depot, which has six tracks and is capable of accommodating 35 cars, being situated at Wakefield; the other two car sheds are at Rothwell and Castleford.

The rolling stock eventually will consist of 55 electric motor cars, of the double deck single truck reversed staircase type, with a seating capacity of 22 inside and 34 outside; they are built in accordance with the most up-to-date designs, and have all the latest improvements in the way of ventilation and finish. The car-bodies were built for Messrs. Dick, Kerr & Co. by the Electric Railway and Carriage Works (Ltd.) of Preston. Floor frames are made entirely of oak and pitch pine; they are designed with the object of combining the greatest strength and stiffness with minimum weight. Special care has been taken in designing the cars to ensure the interchangeability of all the most important parts entering into the construction of the rolling stock; the length of car bodies over the platform is 26ft., and they are about 6ft. wide. Openings are arranged in the flooring over the motors to afford convenient access to the armature brushes and to all bearings requiring frequent inspection and oiling. The platforms are carried on four steel angles, the bearers being extended without interfering with the clearance of the trucks. The main floor is laid with ⅞in. tongued and grooved boards 4in. wide with stripe of deal 2in., by 1⅜in., fixed longitudinally. To prevent the car from sagging, each side frame is trussed by a ¾in. tension rod attached to the bottom sills. The side and end frames are of pitch pine and ash, with white and corner pillars. In each side frame are three large windows, with narrow pivoted ones above for ventilation. Ash is employed for the roof frame, the horizontal members being all in one piece without splices. The cars are fitted with life guards of the trigger pattern.

Each car is wired for 15 incandescent lamps, which are run in series of five off the main circuit, the wires being run inside the walls of the car behind the ventilators, and are thus efficiently protected and completely out of sight and reach. Two 16 c.p. lamps, with reflectors, are fitted as head lights. The cars are mounted on Brill trucks of the 21 E type, suitably built to support the car-bodies and to receive the motors and gearing. Two cross-bars are provided to carry the motor at their centres, and they are cushioned on the side bar with draw and recoil springs. The axles are 3¾in. in diameter, and are made of Siemens-Martin steel, capable of standing a tensile strain of 60,000lb. Each car is fitted with 30in. chilled-iron wheels and with a Dick, Kerr complete standard equipment, including two 25A traction motors and D.B.I. form C type controllers, with metallic shield blow-out. This controller consists of a strong cast-iron frame supporting two vertical cylinders, upon which are mounted the contact segments, one of the cylinders being for controlling the power and speed of the car, and the other for reversing the direction of motion. Means are provided in the controller for allowing either motor to be entirely cut out of service, and the car to be driven by the other. The controllers are arranged with resistances for emergency braking, these devices being operated by the driving handle, and may be brought into action when the car is proceeding either forwards or backwards.

The power station is situated at Belle Isle, Wakefield, the steam plant consisting of four Lancashire boilers, with the usual accessories, including "Lord" furnaces, hand-fired mechanical stokers, a Green economiser, a water-storage tank with a capacity of 20,000 gallons of water, and two feed pumps capable of delivering 24,000lb. of water per hour against a pressure of 150lb. The feed water is drawn from the river Calder and town supply, the water for condensing purposes being taken wholly from the river.

Three "Howden" high-speed triple expansion condensing engines have been supplied, working at a steam pressure of 150lb., and running at 375 revs. per min. Directly coupled to these engines are three Dick-Kerr standard alternators, which generate three-phase current at 6,300 volts and a frequency of 25 ~ per second, each set being provided with a directly-driven exciter. The main alternator shaft is continued beyond the outer bearing, the extension being of the same diameter as the rest of the shaft. It is, therefore, unnecessary to provide a bearing on the side of the exciter remote from the alternator. An extension of the main bed-plate carries the exciter field magnets and yoke. The alternators are star-connected, and each is capable of delivering 400kw. continuously, or 500kw. for one hour with a moderate rise of temperature. All three machines are designed to run in parallel, and means are provided for raising their voltage up to 6,600 to compensate for loss in the mains when running at a constant speed. The rotor spider is made of high quality cast iron, and is of a very strong design; a flange for bolting to the engine flywheel is fitted to the hub, and is pressed on to the shaft by hydraulic pressure, and key seated. Laminated steel pole-pieces are held together between two cast-steel end plates of strong construction. The upper part is of a T-shape construction for holding the field coils in position; the lower part of the pole-pieces is dovetailed for fixing on to the rim of the rotor, and is held in position by means of keys. The removal of the field coils is effected, without disturbing any other part of the machine, by sliding the pole-piece from the dovetailed groove parallel to the shaft. Owing to the design and shape of the pole-pieces, a distribution of lines of force in the air-gap is obtained, which produces an approximately sinusoidal E.M.F. curve. Cast iron is used for the stator frame, which is built in two halves, securely bolted together by means of finished bolts; it is designed to allow complete ventilation of the laminations, and at the same time to secure rigidity of the frame. The armature coils are former wound, are embedded in rectangular slots and are easily and quickly replaced, being held in position by wooden wedges; they are protected outside the laminations by means of a cast-iron shield, cast in sections, bolted to the frame and easily removable. This shield is of a perforated design, and does not in any way interfere with the ventilation.

The switchboard was built by Messrs. Dick, Kerr & Co., and consists of seven marble panels, each supported independently on an iron frame. The board comprises three generator panels, one power panel and three high-tension feeder panels. A great feature of the switchboard is its entire absence of complication. The neutral point of each alternator armature is earthed, and the three cables taken under the floor to the back of the board only a few feet away. Tappings are taken off for the potential transformers whose secondaries are connected through synchronsiing plugs to the synchronising 'bus bars. The alternator leads are then taken through a three-phase hand-operated oil switch, full particulars of which will be found in *The Electrician*, Vol. LIII., p. 264, and after a current transformer has been inserted in one phase they are connected to the 'bus bars through the usual knife disconnecting switches. Bare metal 'bus bars have not been employed, but in their place are three insulated cables, carried by porcelain insulators on iron brackets fastened to the wall above, and behind the board itself. Between the generators and feeders the 'bus bars are brought to the centre panel on the board, and a current transformer is inserted in each. There is also a wattmeter transformer in one phase, so that it is possible to tell the current in each phase at any instant and the kilowatts passing from the generators to the feeders. A recording wattmeter is also fixed on the middle panel. For each feeder the connections are made to the 'bus bars through knife disconnecting switches and oil switches, the three cables then entering a trifurcating box and emerging as a three-core feeder. Between the knife switch and the oil switch is a current transformer, the secondary of which is connected to an ammeter on the front of the board. Red and green lamps on each panel indicate respectively whether the oil switches are closed or open. When one of these switches is opened by hand in the ordinary manner the lamps are of little use, since the switch handle is itself a sufficiently good indication of the condition of the switch; but when the switch is opened automatically the handle remains in the "closed" position, and hence the necessity for the lamps.

The sub-stations are fed from the main station by duplicate three-core high-tension lead-covered cables. At the Wakefield sub-station there are three Dick, Kerr standard 200kw. compound-wound rotary convertors, running at 750 revs. per min., and generating continuous current at 500 to 550 volts. Each rotary has its complement of single-phase oil-cooled step-down transformers, and is capable of dealing with an overload of 25 per cent. for one hour.

For starting up, a small induction motor is provided, which may be bolted to either of two rotaries. It is, of course, also possible to start up from the continuous-current side or from the alternating-current side in the usual way. The switchboard consists of 15 white marble panels and is similar, on the alternating-current side, to that at the power station. On the continuous-current side, it is so much in accordance with Messrs. Dick, Kerr & Co.'s standard practice that detailed description is quite unnecessary. Five feeders emanate from this station, and each is protected by a circuit breaker.

THE TESTING OF TRANSFORMER IRON.

BY LANCELOT W. WILD.

It is now generally acknowledged that the best way of measuring the losses taking place in transformer iron is to make the measurements by means of a wattmeter. The method of measuring the hysteresis loss with a ballistic galvanometer or by means of Prof. Ewing's hysteresis tester is interesting, but unfortunately of little practical value in the case of transformer iron, unless some independent method of measuring the eddy current losses in the iron can be devised.*

The wattmeter method of testing transformer iron determines the total loss taking place in the specimen under test.

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* "Energy Losses in Magnetising Iron." Paper read before Section G British Association at Cambridge, 1904. *The Electrician*, Sept. 2, 1904.

So far, no means has been found of separating the hysteresis loss from the eddy current loss with more than approximate accuracy. As, however, it is only the total loss that is required to be known in practice, the separation of the two losses from each other is not of any great importance. The total loss is frequently about double the hysteresis loss alone, and the ratio of the two cannot be taken as constant, but depends upon the frequency, induction, thickness of plates and the quality of the iron.

There is considerable evidence to show that hysteresis varies proportionally to the frequency and as the 1·6 power of the induction. It would appear from experiments carried out on iron rolled from the same bulk but to different thicknesses that hysteresis increases as the thickness of the plates is reduced. This is probably due to the larger proportion of magnetic oxide of iron on the thinner plates as the hysteresis loss in magnetic oxide of iron is very large.

Eddy current losses are sometimes considered to be proportional to the square of the induction, the square of the frequency and the square of the thickness of the plates. This three-square law would hold if the local self-induction of the eddy currents could be neglected. Unfortunately, however, for those who like their mathematics to be simple, the self-induction of the eddies is by no means negligible.

For example, if hysteresis varies as $(\text{induction})^{1 \cdot 6}$ and eddies varies as $(\text{induction})^2$, then the total loss should vary as some power of the induction of greater value than 1·6 and less than 2. In practice it is frequently found, however, that the total loss varies at less than the 1·6 power of the induction, and sometimes even as low as the 1·4 power of the induction. The evidence from tests carried out with the ballistic galvanometer is so strongly in favour of the supposition that hysteresis varies as $(\text{induction})^{1 \cdot 6}$ that it can only be concluded that the eddy current loss varies as something less than the square of the induction. By assuming that hysteresis varies as frequency it can also be shown by experiment that the eddies are proportional to something less than the square of the frequency.

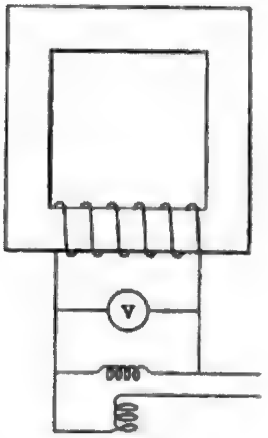

Fig. 1.

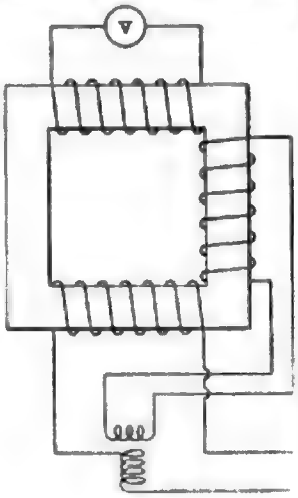

Fig. 2.

Eddies vary at something less than the square of the thickness. This, however, is not so well established as their variation with induction and frequency. It is evident on consideration that the fact of the eddies possessing local self-induction would account for the departure from the three-square law, and that the departure would be in the direction indicated above.

It would appear to be impossible to reduce the laws governing the total loss in transformer iron to a simple formula. It is necessary, therefore, that tests should be carried out under the actual conditions as to induction and frequency with which the iron will be used in practice. It is often found, in comparing two samples together, that the one which is the better at a certain induction and frequency is the worse specimen of the two when the conditions are changed.

In using a wattmeter for testing transformer iron it must always be remembered that the instrument includes in its measurement part of the watts consumed in the instrument itself, either that consumed in the series coil or that consumed in the shunt. It is advisable that the correction necessary from this cause should be reduced to the smallest possible dimensions. This is best attained by connecting the wattmeter so that the wattmeter registers the loss in its shunt coil. The auxiliary resistance in the shunt circuit should be reduced to the smallest value permissible, bearing in mind that there must be sufficient resistance in the circuit to completely drown the self-induction of the shunt coil itself, otherwise the wattmeter will not read correctly. By winding the transformer iron under test with few turns only, it is possible to arrange that the watts consumed in the shunt coil of the wattmeter shall be quite small.

The simplest way of arranging the circuit for testing a sample of transformer iron is as shown in Fig. 1. An electrostatic voltmeter is connected across the terminals of the winding. The shunt coil of the wattmeter is connected in parallel with the voltmeter and the series coils of the wattmeter are connected in series with everything. The induction is calculated from the voltmeter readings. From the wattmeter reading has to be deducted the loss in the shunt coil of the wattmeter, and, what is more difficult, the C^2R loss in the winding of the transformer. This loss is by no means negligible, and may be actually greater than the loss in the iron itself if only a few pounds of iron are being tested.

It is far better to arrange the circuit as shown in Fig. 2. The iron under test is wound with three circuits—namely, one primary and two secondary circuits. An electrostatic voltmeter is connected across one secondary. This measures the induction. The shunt coil of the wattmeter is connected across another secondary winding. The series coil of the wattmeter is connected in series with the primary winding. By this arrangement the C^2R loss in the primary winding is eliminated from the wattmeter reading. The shunt loss can be made small and is easily calculated from the ratio of the windings, the reading on the voltmeter and the known resistance of the shunt circuit. Another great advantage is that by varying the windings the wattmeter constant can be varied to obtain good readings on the wattmeter under all conditions.

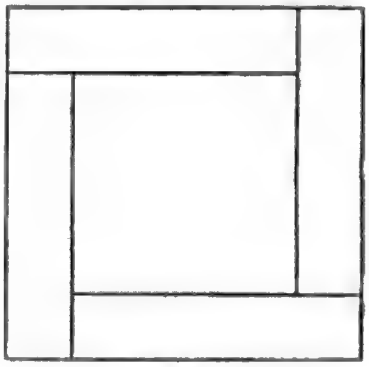

Fig. 3.

This is the method employed at the Westminster Electrical Testing Laboratory. The apparatus used is as follows:—

A set of standard coils wound on square bobbins are permanently fixed on to a wooden base. There are six voltmeter coils, three wound with 2,000 turns each and three with 500 each. The coil for the shunt of the wattmeter consists as a rule of 20 turns. The primary coil consists of two turns only and carries up to 50 amperes. The wattmeter is of the reflecting pattern, and, with 160 ohms in series with its shunt coil and the above winding on the iron to be tested, reads up to 11 watts. By varying the windings good readings can always be obtained on both the wattmeter and the voltmeter.

The iron is obtained in the form of strips 7in. long and 1in. wide. They are arranged in the standard coils, as shown in Fig. 3, with butt joints and breaking joint in alternate layers.

Guides are provided to keep the stampings in position. The apparatus takes about 5lb. of iron.

Before commencing a series of tests it is necessary to determine the physical dimensions of the sample.

We require to know the weight and mean cross-section of the iron. The mean thickness of the iron cannot be satisfactorily measured with a micrometer, as it is generally too small to admit of such measurements being made with more than approximate accuracy.

The mean cross-sectional area of iron is best determined from particulars of the weight, specific gravity and length of each piece. The formula is as follows:—

$$\text{Area in sq. cm.} = \frac{\text{Weight of iron in grammes}}{\text{Specific gravity} \times \text{length of magnetic circuit}}$$

The specific gravity should be obtained by weighing the whole mass of the iron in both air and water. It is not sufficient to take the specific gravity of a single stamping, as there is always a considerable variation between the stampings.

The R.M.S. value of the induction may be calculated by the formula $\mathbf{B} = \frac{V \times 10^8}{2 \times N \times A \times T}$, where $\mathbf{B}$ = R.M.S. value of the induction, V = reading on electrostatic voltmeter, N = periodicity, A = area of iron, T = turns on voltmeter secondary winding.

The iron loss is generally expressed as so many watts per pound for various values of $\mathbf{B}_{max}$. Where the alternator employed gives a sine wave form, $\mathbf{B}_{max}$ may be found from the R.M.S. value of $\mathbf{B}$ by multiplying by 1·41.

For the sake of uniformity, transformer iron tests should always be carried out with current from a sine wave alternator. If this is not practicable, the form-factor of the alternator—*i.e.*, the ratio of R.M.S. voltage to maximum voltage—should always be stated. Since hysteresis is probably the more dependent upon the maximum voltage, and eddies upon the R.M.S. voltage, it is evident that similar results cannot be expected when tests are carried out on widely differing waveform.

ASSOCIATION OF TRAMWAY AND LIGHT RAILWAY OFFICIALS.

(Concluded from p. 111.)

On Thursday, November 3rd, Mr. F. Coutts (Ayr) read a Paper, entitled "Is our Present System of Ticket Check the Best?"

In introducing this subject, the author said it was not his intention to go into the details of common practice in ticket inspection, but merely to throw out a few suggestions with a view to ascertaining the views of other members in the discussion. He was not in favour of the employment of uniformed inspectors, but proposed the employment of ordinary passengers, who for a small annual payment would be willing to play the part of plain clothes detectives, in addition to following their ordinary vocations. Another suggestion made by the author was that all municipal and company tramway undertakings should form a detective staff of specially-trained men and women, who would travel about over the various systems, never remaining long in one town. These detectives would not be recognised by the men, and they would be able to report favourably on honest employés as well as unfavourably on dishonest ones.

Various contradictory opinions were expressed in the discussion, one member expressing the opinion that private detective staffs were usually recruited from a class which was not to be trusted. He considered that the majority of the men were honest. Another speaker condemned the proposition to employ the public, and supported the "inter-company" system of checkers already suggested. He thought that if conductors really made very much dishonestly they would not be so anxious to be drivers at ½d. per hour more. Other speakers expressed the opinion that, as a rule, passengers were more dishonest than conductors. Mr. Coutts, in his reply, said he did not believe in the private detective system, nor in judging a conductor by averaging his receipts. Conductors wanted to be drivers because the latter did not come so much in contact with the public.

The next and last item on the agenda was a Paper by Mr. John I. Hall on the J. S. Raworth regenerative control system. In the absence of Mr. Hall, however, the subject was introduced by Mr. Alfred Raworth, who referred to descriptions of the system which have appeared from time to time in various technical journals, and to remarks which were made in the discussion on Mr. Hall's Society of Arts Paper (*The Electrician* of October 28th, p. 68). Very few members appeared to be familiar with the system, and those who were preferred to reserve criticism until it was further developed. One speaker expressed the opinion that the chief saving was not in energy, but in brake blocks. Another thought that the employment of "one-man" cars in hilly districts was not safe, but he recommended that boys should be employed as conductors on very small cars. A member who had had experience with Mr. Raworth's system, expressed a conviction that it effected considerable economy, and that one other great point in its favour was the absence of force required in regulation. Cars fitted with regenerative control ran very smoothly, and it was very convenient to be able to mark speeds on the controller notches, since one particular position of the controller always corresponded to one particular speed, no matter whether the car was going up or down hill. There was great economy in brake gear; on his tramways, which were situated in a hilly district, it was no uncommon thing for a series-parallel car to wear out a pair of slipper blocks in a single day, during the season. The great disadvantage of the system was its slow speed up hill, and if it were attempted to go more than 5 or 6 miles per hour up a gradient of 1 in 12 there was sparking at the commutators and the armatures got very hot. Reliable drivers were a necessity, and, on the whole, he did not consider that the system was yet out of the experimental stage. Other speakers expressed dislike of the "one-man" car, and thought that its adoption would not effect a saving in labour so great as the corresponding loss in traffic.

In his reply, Mr. A. Raworth said it was impossible to reverse from the front of the car, and this was considered advantageous. Regenerative motors were about 8 per cent. heavier than series motors.

It was then proposed, seconded and carried, that the next meeting of the Association be held at Bristol in April, 1905, and after a vote of thanks had been accorded to the Mayor and Corporation of Wakefield and to the chairman, Mr. H. England, the meeting concluded.

NOTES ON PERMANENT WAY FOR TRAMWAYS.

The following is an abstract of the discussion which followed Mr. A. N. Connett's Paper on the above subject read before the Tramways and Light Railways Association at the Society of Arts on Thursday, November 3rd. The Paper itself was published in our last issue, p. 89:—

The **PRESIDENT** (Mr. Alfred Baker) congratulated Mr. Connett on his excellent Paper, but regretted that the author had said nothing about corrugation of rails. On the old horse tramways the corrugation of rails was unknown, but on some of the modern electric systems it was often these corrugations which determined the life of the rails rather than failure at the joints.

Mr. **R. J. HOWLEY** joined in with Mr. Connett in his praise of standardised rails, but he thought it a pity that the Standards Committee had decided upon rail standards in which the width at the top varied with different sizes of rails. This would mean that different wheels with different flanges would have to be used in conjunction with the various sizes of rails. He was of the opinion that a standard width of 2in. should be adopted. He was in favour of inspecting the joints periodically, as recommended by Mr. Connett. In a certain system he had the joints inspected after six months' service, and had found that the nuts were so loose that it required from half to one turn to tighten them. The cost of this inspection worked out at about 2s. 6d. per joint. He emphasised the importance of attending to a loose joint at once. Joint-boxes had the disadvantage of accumulating water. He regretted that Mr. Connett had not referred to the construction of the permanent way in outlying districts, as this was of some importance.

Mr. **G. CONATY** favoured the laying of the rails on wood; longitudinal sleepers could be used with advantage for this purpose. It was impossible to hold down the rails at every point by means of anchors. He agreed with Mr. Howley that a uniform tread for all the sizes of standard rails would be desirable. A continuous rail, he thought, might lead to distortions of the track, and he was not, for this reason, in favour of such a rail. On the other hand, a fish plate, with half-a-dozen bolts was the best we had. Tramway trucks with rigid wheel bases caused much wear and tear at the curves, owing to the axles not being able to take up a radial position with regard to the curve through which the car was passing. In order to reduce the wear and tear as much as possible the wheel base had to be kept comparatively short, but this in its turn conduced to pitching and to a jerky motion of the car when rounding curves. To avoid these disadvantages he had designed a truck, the two axles of which had a certain amount of play, so that they could take up a radial position with regard to the curve. The wheel base of this truck was 8ft. 6in., and it had been in use at Birmingham for over a year. Each axle might be regarded as a bogie in itself.* The speaker was not in favour of wood paving. In one instance he had observed that the soft wood paving of a certain tramway had risen in some places to as much as 1½in. within three months. Hard wood, however, was better in this respect.

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* Some further particulars of this truck and an illustration of it are published on p. 132 of this issue. A note on a tramway truck constructed on a similar principle by a Continental firm will be found in *The Electrician*, Vol. LIII., p. 419.—*Ed. E.*

Mr. MILLER agreed with the other speakers regarding the question of standard rails, and he was of opinion that the heavier sizes of rail ought to be the same in tread as the lighter rails, but deeper. If we came back to splice-bar joints, after having looked for years for a substitute, we were retrograde. He had seen the thermic process of welding 40 years ago in Essen, and he thought the continuous rail a decided advantage. It was preferable to lay the concrete foundation first, and to pack up the rails afterwards.

Mr. McGREGOR said that a 9in. rail was a good rail all round, and especially so with regard to paving. He favoured the continuous rail.

Mr. BROWN confirmed Mr. Connett's observations that two bogie cars require more power than single truck cars. He drew attention to the necessity of taking centrifugal forces into account when dealing with the problem of curves. Manganese rails were remarkable in that the car wheels did not cut into them.

Mr. H. M. SAYERS described a Continental permanent way which he had recently had the opportunity of inspecting. No concrete was used, but the rails were supported on sleepers, which were laid on a bed of broken stone. The rails weighed from 95lb. to 100lb. per yard, and the joints, which were cast welded, gave every satisfaction. No trouble was experienced from expansion and no corrugation phenomena were observed. Mr. Sayers thought that the corrugations might be explained by the stiff anchor points; between these points the rail was flexible to a certain amount, but the anchor points themselves must be considered rigid.

Mr A. N. CONNETT, in reply, confessed that he could not explain the corrugations, but as he did not consider this phenomenon serious, he did not trouble himself much about it. With regard to the question of standard rails, he thought that—wherever different sizes of rails were employed on one and the same system—the difficulty introduced by the different widths of treads might be overcome by adapting the wheel flanges to the smallest size of rail used. He agreed with some of the speakers that deep rails give good results and are conducive to good joints.

LARGE INDUCTION MOTORS AT ST. LOUIS.

By reason of the exceptional size of the operating motors, the centrifugal pumping plant that supplies water to the cascades in the St. Louis exhibition grounds may be classed as one of the most interesting of the many exhibits to which electricity is allied.

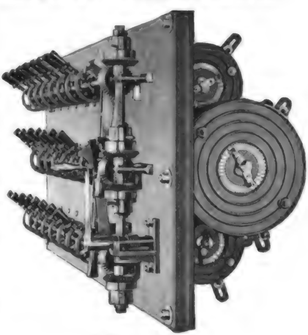
One of Three 2,000 h.p. Westinghouse Induction Motors in Cascades Pumping Plant, Festival Hall, St. Louis Exhibition.

Three Worthington centrifugal pumps are installed and each of these is directly coupled to a 2,000 h.p. Westinghouse induction motor supplied with three phase current at a pressure of 6,000 volts and a frequency of 25 ∿ per second. These motors run at a speed of 365 revs. per min. and it is said that they are the largest in the world. The frame of each is composed of a circular iron casing surrounding a core made up of overlapping punchings of soft steel laid so as to break joints. The core is slotted to receive the winding which is composed of copper strip threaded through partially-closed slots and retained in place by the overhanging tips of the teeth.

A laminated core mounted upon a cast-iron spider, into which the punchings are dove-tailed, constitutes the rotor. The windings are made up of coils of copper strip arranged for three phase working and connected through collector rings of the spider type to grid resistances, operated by a hand controller of 54 stops. Each motor is provided with its own switchboard placed in the pumping station, the controlling and measuring equipment consisting of ammeters and voltmeters of the Westinghouse type F pattern, and automatic type D circuit breakers, the latter being interlocked with the motor starters in such a manner that it is impossible to close them unless all the resistance is in circuit. A current of 35 amperes is required for starting, and at no time between start and full speed does the current exceed that required for normal working. They are entirely self contained, the bearings being supported by end brackets bolted to the frames, and connection to the pumps is made by flexible couplings. Each pump is capable of delivering between 35,000 and 40,000 gallons of water per minute, an amount that has been found amply sufficient for the operation of the cascades. Current is supplied by the 14,000 h.p. service plant installed by the Westinghouse Co. in the Machinery Hall.

A NEW "DIMMER" FOR THEATRE WORK.

We had an opportunity of inspecting a new type of "dimmer" at Messrs. J. Defries & Sons' works on Tuesday. It has recently been the custom to employ liquid resistances in place of wires for varying the brilliancy of electric lamps used in stage lighting, and although such resistances are fairly satisfactory they obviously possess certain disadvantages. Electrical and mechanical gear used in a theatre is subjected to rather rough treatment and is given very little attention indeed; naturally, therefore, a device which employs a liquid is not so useful as one that does not. Moreover, liquid "dimmers" are usually situated in a small room away from the switchboard, whereas metallic dimmers may be placed—if there be room—quite close to the board itself. On the other hand, some of the existing metallic dimmers are so badly designed as to get exceedingly hot, and for this reason they are not viewed with favour by the public authorities exercising control over the management of theatres. Some of them also do not enable the operator to lower or raise the lights except by a series of unpleasant jerks, entirely absent with the liquid dimmer.



New Dimmer as Erected.

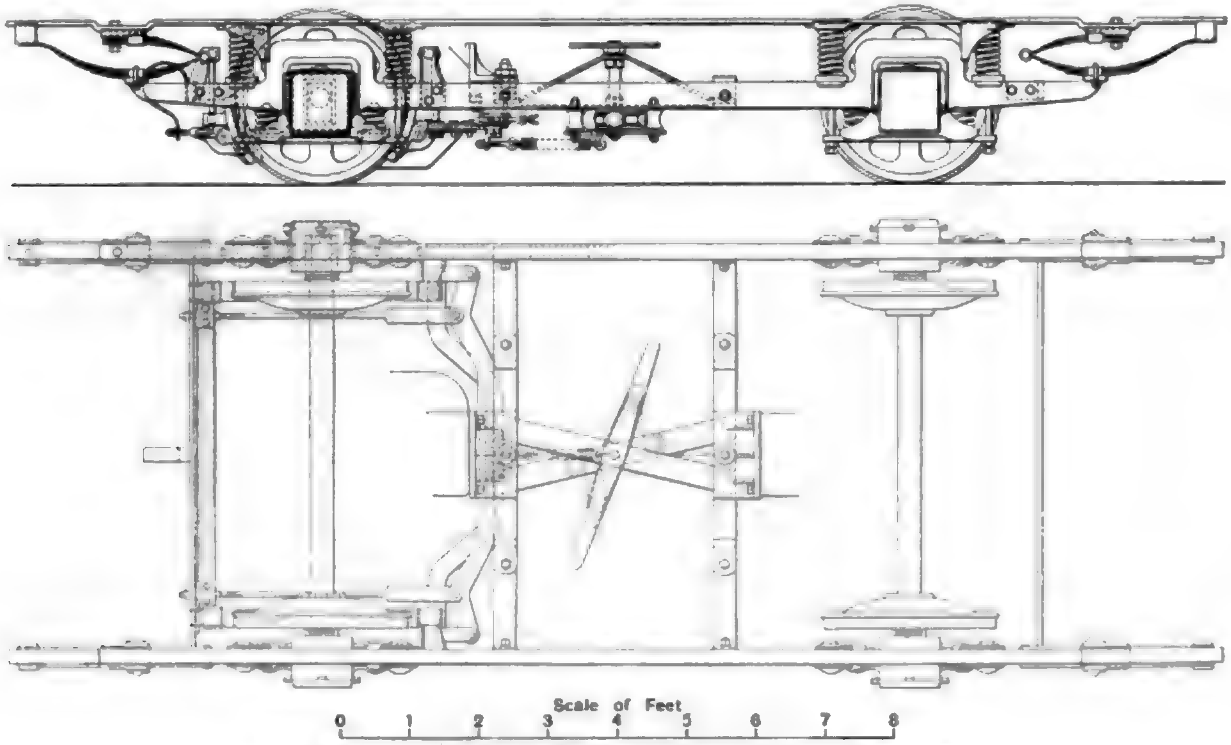
It is claimed that the apparatus shown by Messrs. Defries & Co. combines the advantages of both metallic and liquid dimmers, and at the same time possesses none of their disadvantages.

The novelty lies in the fact that the resistances, which hitherto have been made in a large number of pieces connected together by separate joints and sometimes embedded in enamel, are constructed out of a single jointless ribbon of metal wound into as many coils as the number of graduations of brilliancy that are required (in the present case 50). Every turn of these coils is insulated with flake mica, and the whole series of them is arranged between mica discs, which are encased between pressed steel plates by means of a single jointless band. The ribbon, which is in some cases as much as 50ft. long, is continuously tapered from end to end, and varies the light by quite imperceptible graduations. An absence of joints, enamel, &c , enables the apparatus to stand its load, however suddenly the need for an abrupt change of illumination may occur. This avoids not merely the risk of interruption to the performance, but also of fire, and it is a curious circumstance that of the entire equipment of the ill-fated Iroquois Theatre, Chicago, the only parts that remained uninjured were the Wirt dimmers, which are now operating in the new theatre.

This type of apparatus will be put in at Maskelyne and Cook's new theatre, and the installation will comprise 27 dimmers for the control of the fixed lights, in addition to others for regulating the movable arc lamps.

A FLEXIBLE WHEEL BASE TRUCK.

Mr. G. Conaty, of Birmingham, sent us at our request some particulars of the flexible wheel base truck referred to by him in the discussion on Mr. A. N. Connett's Paper, reported on another page. The flexibility of the axles is obtained by employing radial axle boxes, as shown in Fig. 1. With such an arrangement longer wheel bases may be employed than is generally the case, without affecting the ease with which the cars run over curves. A longer wheel base, too, reduces the pitching of the car and also minimises the jerks which cars are often subjected to when passing over sharp curves. We are informed that a truck with a wheel base of 8ft. 6in. has been running on the Birmingham lines in ordinary traffic, doing 130 miles per day for some months past, and that it has safely been run round curves of 35ft. radius at from 10 to 12 miles an hour. By means of an endless chain arrangement, indicated in the drawing, an equal pressure is exerted on all the eight brake blocks. Comparative consumption tests between the flexible truck and the rigid truck were carried out recently, the course covered by the cars being from Selly Oak to Birmingham and back, a total distance of 6 miles 5 furlongs. Car No. 240, with a rigid truck, is stated to have consumed 0·754 units per car-mile, while cars Nos. 227 and 161 fitted with flexible trucks are said to have consumed 0·664 and 0·633 units per car-mile respectively. The first cost of these new trucks is somewhat greater than that of an ordinary four-wheel truck, but it is less than that of a pair of bogies. We understand that over 110 trucks are now running or on order.



Plan and Elevation of Lycett and Conaty's Flexible Wheel Base Truck.

Tramways and Light Railways Association.—On Thursday, December 1st, Mr. Stephen Sellon will read a Paper on "Running Powers," and in January (date not yet fixed) Mr. H. M. Sayers will read a Paper on "Overhead Equipment."

A SCIENTIFIC INVESTIGATION INTO THE POSSIBILITIES OF GAS TURBINES.[*]

BY R. M. NEILSON.

(Concluded from page 106.)

Cycle II. could be modified in the same way as cycle I. was modified by combining steam with the gas. A case of this nature has not been worked out, but case 1 of cycle II. could probably be modified in this way. Case 2 of cycle II. could not be so treated on account of the high ratio of negative work to gross work that would occur. One might try to improve on all these cycles, by extending the adiabatic expansion line of the gas below atmosphere, instead of stopping it at atmospheric pressure. It would, of course, be necessary to compress the fluid back again to atmospheric pressure; but, if this compression is isothermal or between the isothermal and adiabatic, there will be an increase in efficiency. Carnot's cycle is, in fact, being approached in the lower part of the diagram.

Figs. 15 and 16 are respectively pressure-volume and entropy-temperature diagrams of cycle I., case 8, modified by continuing the adiabatic expansion to a pressure of 2lb. per square inch abs. The scale for volumes in Fig 15 has for convenience been made half of that of the other diagrams. *Kb* represents the addition to the adiabatic line of expansion, and *bc* represents isothermal compression of the gas from 2lb. abs. at *b* to 15lb. abs. at *c*. There should be no difficulty in a turbine in extending the expansion from K to *b*. There may be difficulty, however, in getting isothermal compression from *b* to atmospheric pressure at *c*. As the volume at *b* is 14 times the initial volume, it will be desirable to get the fluid discharged as quickly as possible. A rotary compressor will probably be best for this purpose. A compression sufficiently near to the isothermal and sufficiently remote from the adiabatic to appreciably raise the efficiency should be obtainable. The temperature at *b* is 270° C. (543° abs. C.), and if the compression is isothermal, this will of course be the temperature all along the line *bc*. The gases could be passed through or around water-cooled tubes to keep down the temperature during compression. With the gas at a temperature of 543° abs. C. it would not do to spray water into it, unless sufficient water were sprayed to cool the gas below the boiling point of the water, which is 326° abs. C. at this pressure. If compression takes place along the isothermal line *bc*, a net amount of work will be gained, represented by the area *Kbc*. The gas will be discharged into the atmosphere at *c*, the volume at discharge being 1·874 of the original volume (at A). Even if the compression is not isothermal an amount of work may be gained which will wipe out the extra losses in the machine, provide for pumping out the cooling water, and may leave a margin of net gain.

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[*] Abstract of a Paper read before the Institution of Mechanical Engineers, October 21st.

In Fig. 16 the heat absorbed by the fluid is represented by the area *a*GH*k*, the heat rejected by the area *a*A*cbk*, and the heat converted into work by the area AGH*bc*. As the heat absorbed remains unchanged, while the heat converted into work is increased by the area K*bc*, E is of course increased.

$$E = \frac{\text{area AGH}bc}{\text{area AGH}k}.$$

This enlarging of the diagram of course affects the ratio of negative work to gross work. Referring to Fig. 15 gross work = area *z*ZHK*ebc*; negative work = area *z*ZGA + area K*eb*; net work = area AGH*bc*.

If this continuation of the adiabatic expansion below atmospheric pressure is not found to be advisable to the extent that has just been described, it may be found advisable to a less extent. If it is found advisable in any case, it is more likely to be so in a case in which the high pressure of the gases after combustion is reduced to a low pressure in divergent nozzles, before the gas is allowed into the turbine casing, than in a case in which the whole fall of pressure takes place in the turbine casing. In the former case very high vane speeds are necessary, and the friction between the rotating parts and the fluid in the casing is an extremely important matter. The reduction of the pressure within the turbine casing from atmospheric pressure (or above that) to one-quarter or one-eighth of that amount may, therefore, very much reduce the frictional losses. It is true that the rotary pump, if such is employed for completing the cycle, has to deliver at atmospheric pressure, but the rotating parts of the pump can revolve at a much lower speed, and the friction, therefore, be of much less consequence. With such high-speed turbines there is another question to be considered. It has been stated in discussing cases 3A and 4A of cycle I. and 1A and 2A of cycle II. that the velocity of the gases escaping from the divergent nozzles would be over 4,000ft. per second. It is supposed by some that there is a maximum limit to the velocity of a gas leaving a divergent nozzle and escaping into a given medium which is at a given pressure, &c., and that this limiting velocity is dependent on the pressure in the medium into which the nozzle discharges, and is less when the pressure in this medium is greater, and vice versa. The author does not express any opinion himself on this point, but if it should be found that the reduction of the pressure inside a turbine casing below atmospheric pressure enables us to convert the heat energy of our gas into kinetic energy more effectively, this will be a further argument in favour of so reducing the pressure.

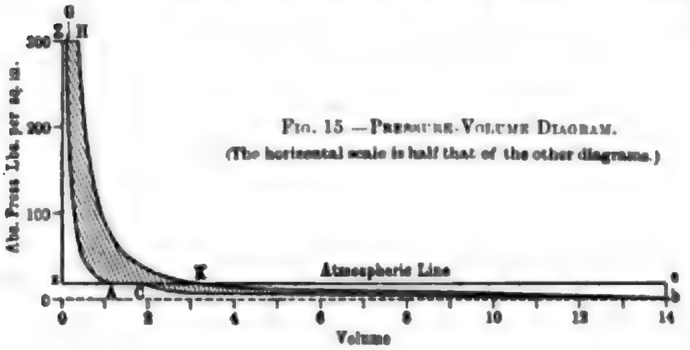

Fig. 15.—Pressure-Volume Diagram.

(The horizontal scale is half that of the other diagrams.)

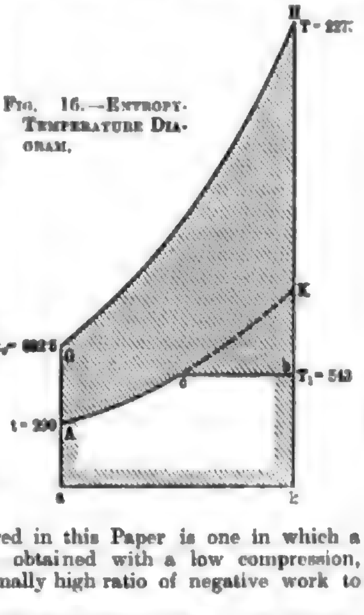

Fig. 16.—Entropy-Temperature Diagram.

Cycle IV.—The fourth cycle which will be considered in this Paper is one in which a high ideal efficiency can be obtained with a low compression, and without having an abnormally high ratio of negative work to gross work.

Figs. 17 and 18 are, respectively, pressure-volume and entropy-temperature diagrams for an engine working on this cycle. In explaining the cycle it is best to start at E′. At this point the temperature of the fluid is 1,592°C. (1,865° abs. C.), and the pressure is 80lb. abs. Let the fluid be heated by combustion at constant pressure along the line E′C′ till the temperature reaches 2,000°C. (2,273° abs. C.). Now let the gas expand adiabatically from C′ to D′ till the pressure is atmospheric. The temperature will then be 1,592°C. (1,865° abs. C.). Now let the gas pass through a regenerating chamber and be cooled at a constant pressure from D′ to F′ till the temperature is 80°C. (353° abs. C.). The gas escapes at F′ into atmosphere, and thereafter cools at constant pressure to 17°C. (290° abs. C.) at A. A new charge is taken at A and compressed adiabatically to B′ where the pressure is 80lb. abs. and the temperature 80°C. (353° abs. C.). The fluid is now passed through the regenerating chamber, and is heated at constant pressure along the line B′E′, taking back the heat given up by the last charge. This will raise its temperature to 1,592°C. (1,865° abs. C.) and place the fluid in the condition it was at the start.

Referring to Fig. 17, the gross work is represented by the area *g*′G′C′D′, the negative work by the area *g*′G′B′A, and the net work by the area AB′C′D′.

$$\therefore \quad \frac{\text{neg. work}}{\text{gross work}} = \frac{\text{area } g'\text{G}'\text{B}'\text{A}'}{\text{area } g'\text{G}'\text{C}'\text{D}'} = 0{\cdot}16 \ (0{\cdot}1558).$$

The heat absorbed by the fluid (other than that obtained in the regenerator which was given up by a previous charge) is represented in Fig. 18 by the area *e*E′C′*d*. The heat rejected (other than that given to the regenerator) is represented by the area *a*AF′*f*. The heat converted into work is represented by the difference of these two areas. We have

$$E = \frac{\text{area A}'\text{B}'\text{C}'\text{D}'}{\text{area } e\text{E}'\text{C}'d} = 0{\cdot}84.$$

The ideal efficiency is high, but the highest actual efficiency which could practically be obtained would be very much below this.

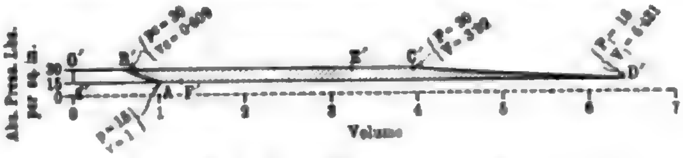

Fig. 17.—Cycle IV. Pressure-Volume Diagram.

Besides the losses in the motor proper and in the pump, there would be a very great loss in the regenerator. It would not be practicable to reduce the temperature of the exhausting gases in the regenerator to 80°C., or to raise the temperature of the fresh gases in the regenerator to 1,592°C. If the losses in the regenerator and in the passages leading to it and from it amounted to 50 per cent. of the heat which is ideally given to or taken from the regenerator, these losses would have to be made up by extra heat given to the fluid by combustion, and the efficiency would fall to 0·8. This does not take into account the losses in the motor proper and in the pump. The heat losses in the motor would probably be very great. This cycle may, however, when used with turbines give results sufficiently good to justify its use. It certainly seems to promise better results with turbines than with reciprocating engines on account of the lower frictional losses that might be expected with turbines.

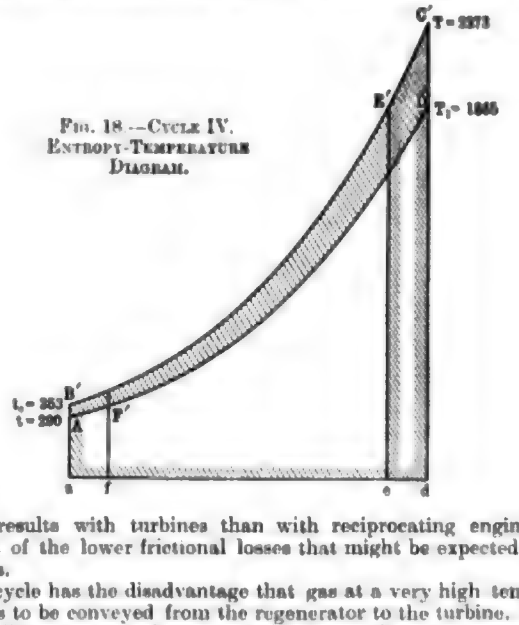

Fig. 18.—Cycle IV. Entropy-Temperature Diagram.

The cycle has the disadvantage that gas at a very high temperature has to be conveyed from the regenerator to the turbine. This practically forces us to have the turbine quite close to the regenerator. It would seem to be necessary to build the regenerator of brickwork, and to build the turbine into this brickwork. The several cases can be compared in the table p. 134. It will be seen that high ideal efficiency is, as a rule, accompanied by a high ratio of negative work to gross work. Cycle IV. is, however, an exception to the rule. It might be possible to use the exhaust gases from a turbine working

Table Comparing the Several Cycles and Cases.

Cycle.	Case.	Compression.		Max. temp. abs. C.	Max. press. lbs. per sq. in. abs.	Ideal efficiency. (E)	Ratio of neg. work to gross work.
		Temp. abs. C.	Press. lbs. per sq. in. abs.				
I.	1	389·0	42	973	42	0·25	0·40
I.	2	389·0	42	2,273	42	0·25	0·17
I.	3 & 3A	682·5	300	2.273	300	0·58	0·30
I.	4 & 4A	909·0	818	2,273	818	0·68	0·40
II.	1 & 1A	500·0	101	2,273	459	0·55	0·23
II.	2 & 2A	750·0	417	2.273	1,265	0·68	0·38
III.	2	682·5	300	2,273	300	0·33	0·41
IV.	..	353·0	30	2,273	30	0·84	0·16

according to cycle I., cases 1 and 3, or cycle II., case 1, to heat the fluid after compression and so to save fuel. Consider Fig. 4. The heat supplied to the fluid is represented by the area *a*BC*d*. Part of this heat might be obtained from the hot exhaust gases and the efficiency of the cycle thus raised, as will be clear from the description just given of cycle IV. With cycle I., cases 1 and 3, and cycle II., case 1, there should be no necessity to use a regenerator of brick or such like refractory material. The exhaust gases could be passed through tubes and the fresh air passed over the outside surfaces of the tubes, or some equivalent construction employed. Many other cycles or modifications of cycles might have been investigated; but the author has considered it inadvisable to burden the Paper with them. As regards the Carnot cycle, an engine working on this cycle would have the same value for E as one working on cycle I. for the same values of t and t_c; and, if the isothermal expansion were carried far enough, it would (under ideal conditions) do the same work per cycle for the same amount of fluid, and have the same ratio of negative work to gross work. The maximum volume of the fluid would, however, be very much greater, and although this is not such a serious matter with a turbine as with a reciprocating engine, it is, nevertheless, not a condition to be accepted without due recompense.

If an engine working on cycle I. has $T_1 = t_c$, then an engine working on the Carnot cycle with the same values of t and t_c would require, in order to do the same work, to commence its adiabatic expansion at the point where the engine working on cycle I. leaves off. If p and P_1 on the cycle I. engine are atmospheric pressure, then on the Carnot cycle engine the whole of the adiabatic expansion would take place below atmospheric pressure. It is interesting to compare the Carnot cycle with other cycles, but it hardly seems useful in the present investigation to devote any more space to this.

The power of a gas turbine could be effectively varied with an insignificant variation of speed by cutting out one or more of the nozzles or admission ports which admit the fluid to the turbine buckets or first set of buckets when several are employed in series, the fluid being passed through the acting ports or nozzles at a uniform pressure and with a uniform velocity. It is hoped by the author that this comparison of the several cycles treated on will be of some use in showing what may be expected from any of these, and which will be best suited for a motor which is required to work under given conditions and which it is important should have given characteristics. One cannot, however, compare the several cycles and estimate the actual efficiencies, &c., which one could expect to obtain in practice in anything like so satisfactory a manner as could be desired, without having more information obtained by experiment on the following three points:—(1) Losses in pneumatic compression to high pressures: (*a*) with reciprocating compressors, (*b*) with rotary compressors, (*c*) with a combination of reciprocating and rotary compressors. (2) Expansion of hot gases in divergent nozzles. (3) Radiation losses and transference of heat from gases to metals at high temperatures.

The following is an abstract of the discussion which took place in connection with the Paper:—

Mr. **HENRY DAVEY**, after congratulating Mr. Neilson on his able Paper, described some experiments he had undertaken with the object of supplying a prime mover with a mixture of steam and products of combustion. To this end he had employed a water-jacketed cylinder, into which he pumped a mixture of air and gas, which was subsequently ignited. The water in the jackets gave off steam which, together with the products of explosion, passed on to the engine. If something went wrong, however, with the pumps or the ignition, violent explosions might ensue. This was a weak point of the system, which otherwise seemed to be a good one.

Prof. **F. W. BURSTALL** thought the author too optimistic with regard to gas turbines. They might at some future date become a commercial success, but that was a long way off. The great difficulty which confronted the designer of gas turbines consisted in the necessity of a pump for compressing the explosive mixture. Not many data were available as to the efficiency of rotary pumps, but he thought that at present their efficiency was only some 40 per cent. A gas turbine of the Parsons type would be impossible because of the huge cooling surface offered to the gas, which cooled much more readily than steam. The chances were best, he thought, for a gas turbine in which the gas was first expanded in a divergent nozzle before acting on the turbine wheel. Unfortunately, the efficiency of this type of engine was small.

Mr. **JAMES ATKINSON** drew attention to the fact that very high temperatures in turbines were out of the question because oxidation set in at 752°F.

Mr. **H. M. MARTIN** mentioned that an air compressor, consisting of a turbine running backwards, had shown an efficiency of 61 per cent.

Prof. **ROBERT SMITH** agreed with one of the previous speakers in that oxidation was a very serious matter in turbines working with a fluid at high temperatures. He directed the attention of students to the valuable pioneer work done by Prof. Stodola, as described in his book "Die Dampfturbinen."* Gas turbines for motor cars would be of little practicability, as it was next to impossible to carry an adequate supply of gas on the car.

Mr. **NEILSON** having replied briefly, the meeting adjourned.

THE THEORY OF WIRELESS TELEGRAPHY.†

BY DR. JOHN STONE STONE.

The theory of modern wireless telegraphy may be treated in at least two widely different ways depending upon whether it be the object to produce a simple mental picture of the phenomena involved, or whether it be the object to lay the foundations for engineering calculations and quantitative research. The first mode of treatment leads to what may be termed the popular theory, and the latter to what may be termed the working or engineering theory. In this Paper only that form of wireless telegraphy shall be considered in which electrical vibrations are set up in electrical oscillators whose axes are normal to the earth's surface, and which are connected to the earth's surface at their lower extremities.

Popular Theory.—If the equations for the moving field produced by Dr. Hertz's dumb-bell oscillator be examined, they will be found to show that, in the equatorial plane of the oscillator, the potential is everywhere zero, that there is no component of magnetic force normal to that plane, and that there is no component of electric force parallel to that plane. From this it would follow that if a perfectly conducting sheet, which is initially at zero potential, be passed through the equatorial plane of the oscillator, no currents will be induced in it by the field of the oscillator. In other words, the presence of the conducting sheet should not distort or otherwise affect the field of force produced by the oscillator.

On each surface of the conducting sheet will exist currents which, in their reaction upon the electric and magnetic field on the corresponding side of the sheet, will be the exact equivalent and take the place of the field of force on the other side of the sheet. These currents will extend radially from the point of intersection of the axis of the oscillator with the conducting sheet, and at any point in the sheet will be equal in amplitude, but opposite in direction or phase on the two surfaces of the sheet. For a radial distance measured along the sheet from the point or intersection with the axis of the oscillator, approximately equal to one-quarter of the length of the wave radiated by the oscillator, there will be a gradually diminishing difference in phase between the currents on the sheet and the electric force at the corresponding surface of the sheet, the result of which will be that within this radius the energy of the currents will travel out from and a portion of it back to the oscillator in the time of each oscillation, whereas for points beyond this radius the energy will all flow away from the oscillator, never to return to it, provided only the conducting sheet be infinitely extended in all directions.

Since the infinitely conducting sheet is a complete barrier between the two regions it separates, it is easy to see that each half of the Hertz oscillator, with its appropriate infinitely conducting and infinitely extensive surface, is a complete oscillating system entirely independent of anything which may take place on the other side of the conducting sheet, and that the field of force at or above the conducting sheet is the same as that which would be found at or above the equatorial plane of the complete Hertz oscillator were the conducting sheet absent. These considerations lead to a very simple and popular theory or means of explaining the manner in which the electromagnetic waves of wireless telegraphy are developed and propagated.‡

This theory regards the vertical transmitting oscillator of wireless telegraphy as one-half of a Hertz oscillator normal to the earth's surface, which must be regarded as practically infinitely conductive in the immediate neighbourhood of the oscillator, or for about a quarter of a wave-length from the point at which the oscillator is connected to the surface of the earth. By this theory, therefore, the waves of wireless telegraphy are developed in exactly the same manner as if the vertical oscillator and its electrical image below the surface of the earth together formed the real oscillator of which the surface of the earth is the equatorial plane. A graphical representation of this theory is given in Figs. 1 and 2.

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* See *The Electrician*, Vol. LIII., p. 993.

† Paper read before Section G of the St. Louis International Electrical Congress.

‡ André Blondel, Association Francais pour l'Advancement des Sciences, Congress of Nantes, 1898.

This theory, which for convenience may be termed the electrical image theory, bears a close resemblance to that mode of treating a single wire or grounded telegraph or telephone circuit as one-half of a two-wire or metallic circuit which was first suggested by Mr. Oliver Heaviside.[*] He conceives a metallic circuit such as that shown in Fig. 3, cut in half longitudinally by an infinitely conducting plane at zero potential, as shown in Fig 4. Since the points on the metalllic circuit cut by the plane would normally be at zero potential, no change in the distribution of currents results from the connection with the infinitely conductive plane. A little consideration will also show that the electrostatic capacity and inductance of the circuit will, moreover, remain unchanged. The surface of the earth is not infinitely conductive, however, and therefore neither the assumptions made in the electrical image theory of the transmitting oscillator of wireless telegraphy or the electrical image theory of the grounded telephone line are completely justified, though the conditions of the theory may be more nearly approximated in the case of wireless telegraphy, as will become apparent later.

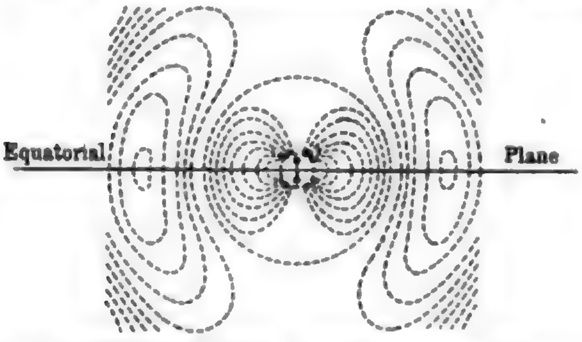

FIG. 1.—Graphical Representation of the Electrical Image Theory of Wireless Telegraphy.

Before proceeding to a consideration of a more comprehensive theory, some of the more obvious conclusions to be drawn from this theory may well be stated. These are:—

1. The waves which emanate from the vertical oscillator are horizontally polarised electromagnetic waves.

2. The energy of these waves will diminish as the square of the distance from the oscillator if the surface of the earth be assumed to be flat.

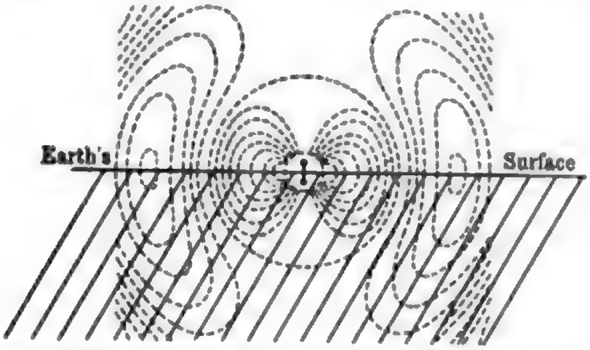

FIG. 2.—Graphical Representation of the Electrical Image Theory of Wireless Telegraphy.

3. The energy of the waves is greatest at the earth's surface, and diminishes gradually as the point of observation is raised above the earth's surface.

4. The waves do not induce currents in the earth's surface, except when the surface deviates from the equatorial plane of the system formed by the vertical oscillator and its electrical image.

5. At points where the earth's surface is at an angle to the equatorial plane of the system formed by the oscillator and its electrical image, the currents which will be induced in the earth's surface tend to bend the wave-front at the earth's surface into a position normal to that surface.

6. In consequence of the tendency of the wave-front at the earth's surface to maintain itself normal to that surface, the waves will not necessarily travel in straight lines, but will tend to follow the earth's surface, whatever be its contour.

7. Owing to the fact that when the waves meet irregularities in the earth's surface currents are developed in that surface which dissipate a portion of the energy of the waves, the energy of the waves will in general be better conserved when the transmission takes place over the surface of the sea than when it takes place over land, and more particularly when the land is mountainous or heavily wooded.

The first four consequences of the electrical image theory, above cited, follow directly from the ordinary theory of the Hertz oscillator, while the sixth and seventh consequences, cited above, are self-explanatory. It, therefore, remains to consider the fifth consequence. For this purpose it will be sufficient to consider what happens to the wave front when a plane polarised electromagnetic wave falls upon a conducting surface inclined at a definite angle to the plane of the electric force and at a definite angle to the plane of the magnetic force. Under those conditions, only that component of the electric force which is parallel to the conducting surface is effective in producing a current in the surface, and the energy of this component of the electric force is, therefore, dissipated or redistributed, partly in the form of heat in the surface, and partly in a reflected wave which travels off in a direction normal to the surface. The remainder of the electric force of the primary wave at the conducting surface is, therefore, normal to that surface.

That component of the magnetic field at the conducting surface which is normal to that surface likewise tends to develop a current in the surface, and its energy is likewise redistributed in the form of heat and in the production of a reflected wave. The remaining magnetic force of the primary wave at the conducting surface is therefore parallel to that surface. The direction of motion of the primary wave must be normal both to the magnetic force and to the electric force, and will, therefore, be parallel to the conducting surface. It follows, therefore, that the electromagnetic waves of wireless telegraphy emanating from a vertical oscillator grounded at its lower extremity will pass over and around hills and other irregularities in the surface of the earth, and that they will also follow the general curvature of the earth.

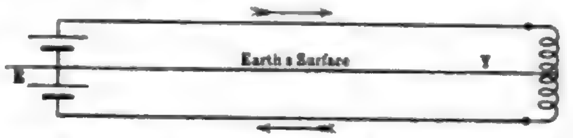

FIG. 3.—Graphical Representation of Grounded Metallic Circuit.

The electrical image theory lends itself to the explanation of most of the phenomena of wireless telegraphy in a gross and qualitive way, for it is not in general a very difficult task to make the surface of the earth in the immediate neighbourhood of the oscillator highly conductive, and at greater distances from the oscillator the current density in the surface of the earth is so slight that the conductivity need be but slight in order to guide the waves without great loss of energy. This theory is, however, ill-adapted to give quantitative results, and particularly the class of quantitative results most desired by the wireless telegraph engineer, for he is as much, if not more, interested in the currents and potential in the vertical oscillator as he is in the field surrounding the oscillator. Moreover, the vertical oscillators best adapted for wireless telegraph purposes are quite different from the Hertz dumb-bell oscillator, and the field produced by the electrical oscillations of a system formed of one of these oscillators and its electrical image would in many instances be difficult to predetermine.

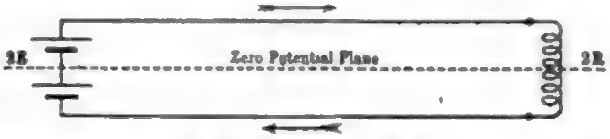

FIG. 4.—Metallic Circuit Cut in Half Longitudinally by an Infinitely Conducting Plane.

Some roughly quantitative results which may be predicted by this theory are: The rate of radiationis, *caeteris paribus*, proportional to the square of the length of the oscillator, the square of the quantity of electricity set in motion in the oscillator and the fourth power of the frequency of the oscillations. If we assume that the receiving vertical oscillator is exactly similar to the transmitting oscillator, and is as good an absorber as it is a radiator, then the energy received should be directly proportional to the fourth power of the lengths of the oscillators and inversely proportional to the square of the distance separating them, and we should therefore expect that with a receiver of a given sensitiveness—*i.e.*, requiring a given amount of energy to operate it—the distance to which transmission could be carried on between these two stations would,

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[*] "Heaviside's Electrical Papers," Vol. II., p. 326.

caeteris paribus, be proportional to the square of the lengths of the oscillators at the two stations.*

Working Theory.—When the effects of radiation may be neglected, it is in general not excessively difficult to predetermine the electrical vibrations in simple electrical systems. The problem is then much the same as that of determining the mechanical vibration of mechanical systems, and the modes of attacking such problems have been exhaustively treated and are to be found collected in "The Theory of Sound," by Lord Rayleigh, and in "Electrical Papers" and "Electromagnetic Theory," by Mr. Oliver Heaviside. In wireless telegraphy, however, the damping of the vibrations in the vertical oscillator is almost wholly due to the radiation of energy from the oscillator and the effect of this radiation can not be neglected whether the oscillator considered be a transmitting or a receiving oscillator. It is often possible, however, to use the same mathematical methods in treating those cases which involve radiation as are applicable in the study of cases with no radiation, and in order to illustrate this point a very simple system may first be considered.

Let a source of E.M.F. be connected in a straight uniform wire at a point distant a from the end of the wire, which end shall be assumed to be insulated, and let the wire extend to infinity on the other side of the source. Such a system is illustrated diagramatically in Fig. 5. In order to exclude the possibility of radiation from this wire, it may be assumed to lie in the axis of a perfectly conducting cylindrical shell. The conductor will then have uniformly distributed resistance, inductance, leakage and permittance as in the case of a single wire cable. If now the E.M.F. of the source vary abruptly by changing from one constant value to another, two waves of potential and current will be developed in the wire. This, of course, means two waves of electric and magnetic force about the wire. One of these waves will travel off from the source to infinity along the wire, carrying with it a portion of the energy developed by the source, while the other wave travels from the source to the insulated terminal of the wire, is there reflected and returns along the wire past the source and on to infinity along the wire, taking with it the remainder of the energy developed by the source with the exception of that which has been converted into heat in the wire.

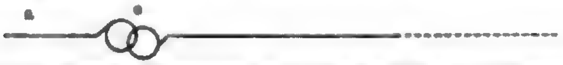

FIG. 5.—Graphical Representation of Working Theory of Wireless Telegraphy.

The distance apart of the two waves as they travel off to infinity will be four times the distance from the source to the insulated end of the wire, or if the distance between the two waves' fronts be designated by λ, then $\lambda = 4a$. It will be readily seen that the infinite wire to the right of the source shown in the system illustrated in Fig. 5, draws off the energy from the source and the rest of the system in much the same way as that in which the conducting surface of the earth is supposed to draw off the energy from the vertical oscillator in the electrical image theory considered in Part I. of this Paper. The wire to the left of the source may therefore be likened to the vertical oscillator and the infinite wire to the right may be likened in its function to the infinite conducting plane of that theory.

The operational solution of the problem just considered in the case of pure diffusion has been given by Mr. Heaviside† who also shows how such operational solutions may be readily converted into the ordinary algebraic form, both in the case in which the impressed E.M.F. varies as a simple harmonic function of the time, and in the case in which it abruptly changes from one constant value to another. Let the impressed E.M.F. be e. Let the resistance, inductance, leakage conductance and permittance per unit of length of the wire be respectively, R, L, K and S. Then if distances along the wire be measured from the insulated end of the wire and be designated by x, the potential for points to the right of the source will be :—

$$\mathrm{V}_1 = \frac{e}{2}(\epsilon^{-q(x-a)} - \epsilon^{-q(a+x)}),$$

and for points to the left of the source the potential will be

$$\mathrm{V}_2 = -\frac{e}{2}(\epsilon^{-q(a-x)} + \epsilon^{-q(a+x)}),$$

where $$q = \{(\mathrm{K}+\mathrm{S}p)(\mathrm{R}+\mathrm{L}p)\}^{\frac{1}{2}}$$

The corresponding currents are :—

$$\mathrm{C}_1 = \frac{1}{2}e\sqrt{\frac{\mathrm{K}+\mathrm{S}p}{\mathrm{R}+\mathrm{L}p}}(\epsilon^{-q(x-a)} - \epsilon^{-q(a+x)}),$$

to the right, and

$$\mathrm{C}_2 = \frac{1}{2}e\sqrt{\frac{\mathrm{K}+\mathrm{S}p}{\mathrm{R}+\mathrm{L}p}}(\epsilon^{-q(a-x)} - \epsilon^{-q(a+x)})$$

to the left.

At the source the current is

$$\mathrm{C}_0 = \frac{1}{2}e\sqrt{\frac{\mathrm{K}+\mathrm{S}p}{\mathrm{R}+\mathrm{L}p}}(1 - \epsilon^{-2qa}).$$

At the source, the potential on the right and left of the source is

$$\mathrm{V}_{01} = \frac{1}{2}e(1 - \epsilon^{-2qa})$$

to the right, and

$$\mathrm{V}_{02} = \frac{1}{2}e(1 + \epsilon^{-2qa})$$

to the left.

The resistance operator of the wire measured from the source to the right is

$$\mathrm{Z}_1 = \frac{\mathrm{V}_{01}}{\mathrm{C}_0} = \sqrt{\frac{\mathrm{R}+\mathrm{L}p}{\mathrm{K}+\mathrm{S}p}},$$

while the resistance operator measured to the left from the source is

$$\mathrm{Z}_2 = \frac{\mathrm{V}_{02}}{\mathrm{C}_0} = -\sqrt{\frac{\mathrm{R}+\mathrm{L}p}{\mathrm{K}+\mathrm{S}p}\,\frac{1+\epsilon^{-2qa}}{1-\epsilon^{-2qa}}}.$$

If e be a simple harmonic function of the time and of frequency $n/2\pi$, it is sufficient to substitute $n\,i$ for p in the above expressions in order to algebraise them.

In this case, therefore,

$$\mathrm{Z}_1 = \left(\frac{\mathrm{RK}+\mathrm{LS}n^2}{\mathrm{K}^2+\mathrm{S}^2n^2} + in\frac{\mathrm{KL}-\mathrm{RS}}{\mathrm{K}^2+\mathrm{S}^2n^2}\right)^{\frac{1}{2}},$$

which shows that so far as the currents and potential in the rest of the system are concerned, the infinite length of wire to the right of the source may be replaced by any device having dissipative resistance

$$\left\{\frac{1}{2(\mathrm{K}^2+\mathrm{S}^2n^2)}\left(\sqrt{(\mathrm{R}^2+\mathrm{L}^2n^2)(\mathrm{K}^2+\mathrm{S}^2n^2)} + \mathrm{RK} + \mathrm{L}n\right)\right\}^{\frac{1}{2}}$$

and reactance

$$\left\{\frac{1}{2(\mathrm{K}^2+\mathrm{S}^2n^2)}\left(\sqrt{(\mathrm{R}^2+\mathrm{L}^2n^2)(\mathrm{K}^2+\mathrm{S}^2n^2)} - \mathrm{RK} - \mathrm{L}n\right)\right\}^{\frac{1}{2}},$$

such device being grounded as shown in Fig. 6. Another arrangement which is the exact equivalent of the systems shown in Figs. 5 and 6, is shown in Fig. 7.

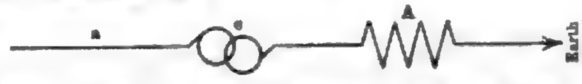

FIG. 6.—Modified Graphical Representation of Working Theory of Wireless Telegraphy.

If the wire be of copper and the frequency of e be sufficiently great, a condition always present in the vertical oscillators of wireless telegraphy, Z_1 reduces to $(\mathrm{L}/\mathrm{S})^{\frac{1}{2}}$ or by the relation $\mathrm{S} = 1/\mathrm{L}c^2$ it further reduces to $\mathrm{L}c$ where c is the velocity of light. Under these conditions, the device A of Figs. 6 and 7, which takes the place of the infinite wire to the right of the source in Fig. 5, becomes a simple resistance of value $\mathrm{L}c$. This resistance is such as completely to absorb the energy of the waves which emanate directly from the source, and of those which are reflected from the insulated end of the wire to the left of the source. It corresponds exactly, therefore, in its reaction on the rest of the system, to the reaction produced by the infinite extension of the wire to the right of the source in drawing away the energy from the rest of the system. It may be likened to the reaction produced on the system by the complete radiation of its energy in each half period.

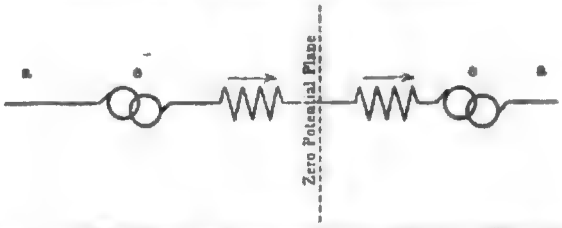

FIG. 7.—Modified Graphical Representation of Working Theory of Wireless Telegraphy.

To illustrate the application of the foregoing considerations to an oscillator of known form, they may be employed to determine the relation between the impressed force and current in the Hertz dumb-bell oscillator.

In the case of this oscillator the energy radiated per second is $\phi^2 n^4/3c^3$ where ϕ is the maximum electrical moment of the oscillator expressed in absolute electrostatic units. The amplitude of the current is $\phi n/2a$ in the same units, $2a$ being the length of the oscillator, therefore the value of the resistance which must be conceived to be placed in the oscillator in order to simulate the effect of radiation from the oscillator is $8/3\ a^2n^2/v$ in absolute electromagnetic units or $8a^2n^2\ 9 \times 10^{19}$ ohms. The oscillator may now be treated as if it were a circuit from which there is no radiation, but having resistance $2Ra + R' = 2Ra + (8a^2n^2/3v)$, inductance $L' = 4a\left(\log_e\frac{4a}{\rho} - \frac{3}{2}\right)$ and permittance $S' = r/2v^2$, where ρ is the radius of the wire connecting the two spheres of the oscillator and r is the common radius of the spheres. If, then, e_0 be the amplitude of the impressed simple harmonic force which maintains the oscillations of periodicity $n = 2\pi/T$ and c_0 be the amplitude of the resulting current

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* This relation between the lengths of the vertical oscillators and the distance to which transmission may be successfully carried has been empirically determined by Mr. Marconi, and is termed "Marconi's law" by Prof. Fleming.

† Heaviside's "Electromagnetic Theory," Vol. II., p. 69.

$$e_0 \left\{(2Ra + R')^2 + \left(L'n - \frac{1}{S'n}\right)^2\right\}^{\frac{1}{2}} c_0$$

which suggests the more general expression

$$e = \left(2Ra + L'p + \frac{1}{S'p} - \frac{8}{3}\frac{a^2}{v}p^{-1}\right)c.$$

Where, as before, p stands for the operation of differentiation with respect to time, p^{-1} for the inverse operation of integration with respect to the time, and where R is the true dissipative resistance per unit of length of the wire connecting the spheres of the oscillator. It should be carefully noted, however, that the mathematical solutions so far obtained for the field of force about a Hertz oscillator are only applicable when the length of the oscillator is a small fraction of one-half of the length of the wave radiated by it into space. When this condition is fulfilled, the oscillator may be regarded as a straight current element of length $2a$, the current at every point of which is $\phi n/2a$. The expressions for the field at great distances from the oscillator are then applicable, as are, therefore, also the expressions for the energy radiated.

Since a straight linear oscillator is the equivalent of an infinite number of such current elements varying in lengths from zero to the full length of the oscillator, the field at a distance from such an oscillator may be determined as the vector sum of the fields produced by the separate uniform current elements. By considering the straight linear oscillator as composed of a limited or finite number of uniform current elements the field at a distance from the oscillator and the energy radiated may be determined to any desired degree of precision for any given or assumed distribution of current along the oscillator. The value of R', or what may be termed the resistance equivalent of the radiation, may then be determined and the relation of impressed E.M.F. to the currents and potentials along the oscillator may thereafter be treated as if there were no radiation from the oscillator, as in the case of the Hertz oscillator considered above.

The exact predetermination of the distribution of current and potential in a linear oscillator consisting of a straight wire of length $2a$ alone in space, or of a straight wire of length a normal to the earth's surface and connected to the earth at its lower extremity, presents grave difficulties which as yet have not, as far as I am aware, been completely overcome. Fortunately, however, a great variety of cases in modern wireless telegraphy may be readily treated with sufficient precision for engineering purposes upon the assumption that the waves of potential and current travel along the conductor of the vertical oscillator with a constant velocity, v. The distribution of current and potential in a straight wire grounded at its lower extremity through a source of E.M.F., e, and through a system, A, whose resistance operator is Z_0 as illustrated in Fig. 6, may next be considered under the above-mentioned assumption. In this instance it will be convenient to regard distances as measured from the earthed terminal of the oscillator.

The circuital equations for the wire are then

$$-(dV/dx) = LpC \text{ and } -(dC/dx) = SpV,$$

from which flow

$$d^2V/dx^2 = p^2/v^2V \text{ and } d^2C/dx^2 = Cp^2/v^2.$$

The most general solution of these equations is

$$V = A\cosh px/v + B\sinh px/v.$$

$$C = -\frac{1}{Lv}\left(B\cosh\frac{p}{v}x + A\sinh\frac{p}{v}x\right).$$

At $x = a,\ C = 0, \quad \therefore \quad B = -A\tanh pa/v.$

At $x = 0,\ V_0 = A$ and $C_0 = \frac{A}{Lv}\tanh\frac{p}{v}a$, $V_0/C_0 = Lv\cosh pa/v$.

This is the resistance operator measured from the source in the direction of the insulated end of the wire, and shall be designated by Z.

It follows that

$$C_0 = e/(Z + Z_0) \quad \therefore \quad A = eZ/(Z_0 + Z) \text{ and } B = -eLv/(Z_0 + Z).$$

$$V = \frac{eZ}{Z_0 + Z}\left(Z\cosh\frac{p}{v}x - Lv\sinh\frac{p}{v}x\right)$$

$$C_0 = e/Lv(Z_0 + Z)(Lv\cosh px/v - Z\sinh px/v).$$

In the simple harmonic regimen, $p = in$ and the hyperbolic functions are converted into the corresponding circular functions.

The chief interest to the engineer lies in the function Z and Z_0, and more particularly in the former which becomes $-Lv\cot\frac{na}{v}$ or $-\frac{1}{Sv}\cot\frac{n}{v}a$. We see that Z vanishes when $n = m\frac{\pi v}{2a}$, where m is any integer. This corresponds to the case of $m\lambda = 4a$, where λ is the length of the waves on the wire. For the fundamental or gravest mode of vibration of the oscillator, $m = 1$ and $\lambda = 4a$.

It appears, therefore, that for oscillations graver than the fundamental of the oscillator formed by the wire *per se* and its electrical image, the reactance Z is negative, or a capacity or permittance reactance, whereas, for periodicities higher than that of such fundamental the reactance of the oscillator becomes positive, or an inductance reactance. In other words, the reactance of the wire measured at the source or driving point of the system may be the equivalent of a condenser of capacity.

$$S' = \frac{1}{Lvn}\tan\frac{n}{v}a = \frac{Sv}{n}\tan\frac{n}{v}a,$$

or of an inductance.

$$L' = \frac{Lv}{n}\cot\frac{n}{v}a = \frac{1}{Svn}\cot\frac{n}{v}a.$$

depending upon whether $\cot na/v$ is positive or negative respectively.

Curve 1, Fig. 8, shows the variation of the reactance Z—*i.e.*, the reactance of the wire a of Fig. 6 *per se* for different periodicities n of the impressed force.

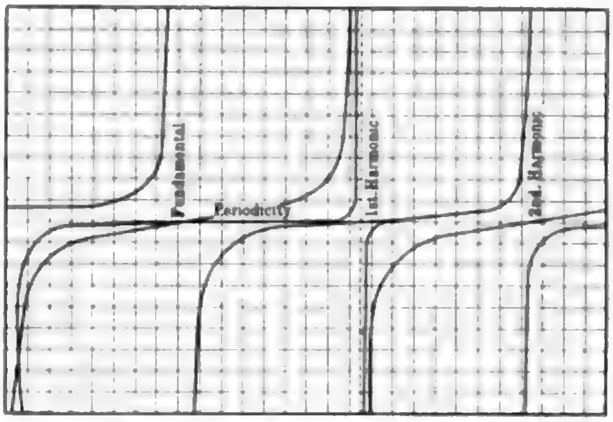

Fig. 8.—Values for Varying Periodicity.

Curves 2 and 3 of Fig. 8 show the equivalent capacity and equivalent inductance of the same wire for different values of the periodicity n of the impressed force, the equivalent capacity being shown by curve 3, and the equivalent inductance being shown by curve 2.

With regard to the resistance operator of the system A of Fig. 6, if this be a simple dissipative resistance R_0, then $Z_0 = R_0 + R'$. If it be coil of resistance R_0 and inductance L_0, $Z_0 = R_0 + L_0p + R'$. If there be a condenser of permittance, S_0, in sequence with the coil, then $Z_0 = R_0 + L_0p + \left(\frac{1}{S_0p}\right) + R'$, and if the condenser be in parallel with the coil, $Z_0 = \frac{(1 + R_0S_0p + L_0S_0p^2)}{(R_0 + L_0p)} + R'$. In every case the resistance equivalent of radiation must be added to the resistance operator of the system A. For the high values of the time rate of change of current employed in wireless telegraphy,

$$Z_0 = R' + R_0,$$
$$Z_0 = R' + L_0p.$$
$$Z_0 = R' + L_0p + 1/S_0p.$$

or $\quad Z_0 = R' + (R_0S_0/L_0) - S_0p.$

for the four cases considered above.

For more complex systems the resistance operator may be readily determined by the simple operational method devised by Mr. Oliver Heaviside. The algebraizing in the case of a simple harmonic regimen is also easily accomplished by the substitution ni for p.

The foregoing treatment applies more specifically to a transmitting linear oscillator. In the case where the oscillator is employed for receiving, the circuital equations become

$$E - (dV/dx) = LpC \text{ and } -(dC/dx) = Spv,$$

in which E is the induced E.M.F. per unit of length of the wire.

From these equations result

$$d^2V/dx^2 = p^2V/v^2 \text{ and } d^2C/dx^2 = (p^2C/v^2) - ESp.$$

The general solution is

$$V = A\cosh px/v + B\sinh px/v\ C = 1/Lp.$$

$$\left\{E - \frac{p}{v}\left(B\cosh\frac{p}{v}x + A\sinh\frac{p}{v}x\right)\right\}.$$

$$\text{At} \qquad x=a,\ C=0 \quad \therefore \quad B=\frac{E-A\frac{p}{v}\sinh\frac{p}{v}a}{\frac{p}{v}\cosh\frac{p}{v}a}.$$

$$\text{At} \quad x=0,\ V_0=A=-Z_0C_0 \quad \therefore \quad C_0=E\frac{\cosh\frac{p}{v}a-1}{Lp\cosh\frac{p}{v}a+Z_0\sinh\frac{p}{v}a}.$$

In the foregoing the explicit assumption has been made that the inductance and capacity are uniformly distributed along the oscillator and that the velocity of propagation of the waves along the oscillator is equal to that of light. This was done in order to simplify the mathematical analysis, and to present the theory in a concrete and easily understood form; but these conditions do not completely limit the applications of the formulæ deduced, for it is capable of demonstration that even when L and S are functions of x provided only that the ratio of L/S be independent of x, then, though the velocity of the waves will vary from point to point along the oscillator, yet there will be no reflection of the waves except at the ends of the wire, and the most important function—namely, Z—the resistance operator of the oscillator does not change its form. It is sufficient, under these circumstances, to substitute a' for a in the expressions for Z and C_0 where $a/v=a'/v'$, v' being the average velocity of the waves along the oscillator.

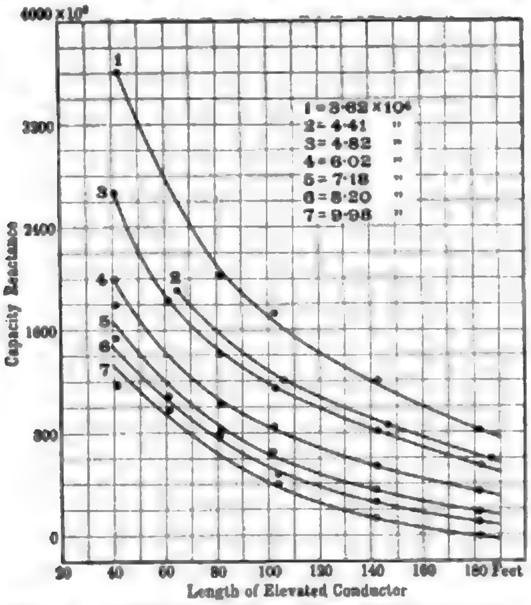

FIG. 9.—Resistance with Varied Lengths of Conductor.

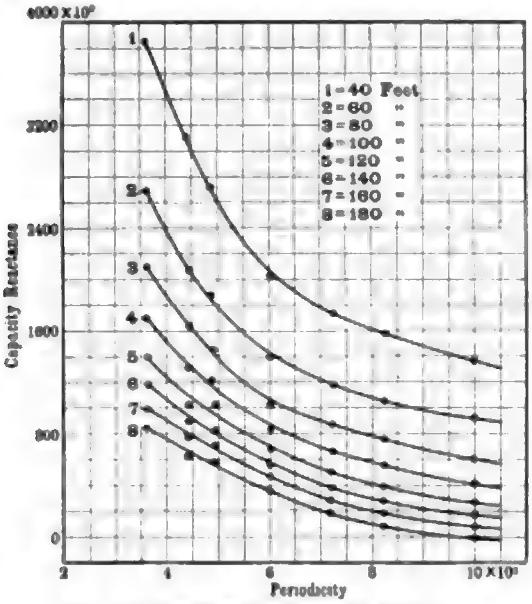

FIG. 10.—Periodicity and Capacity Resistance.

Another important case which may occur is that in which L and S are both functions of x, but in which the product LS is constant. Under these conditions the quantity $1/\sqrt{LS}$ which is of the nature of a velocity, is constant along the oscillator, but reflection takes place at every point, giving rise to a variable wave velocity. The solution in this case is no longer of the same form as that considered above, but may be readily obtained in the form of cylindrical harmonics, provided L and S are respectively proportioned to x^m and x^{-m} where m is any quantity integral or fractional, positive or negative. Some writers have regarded the vertical oscillator as a simple capacity area. This is obviously inadmissible.

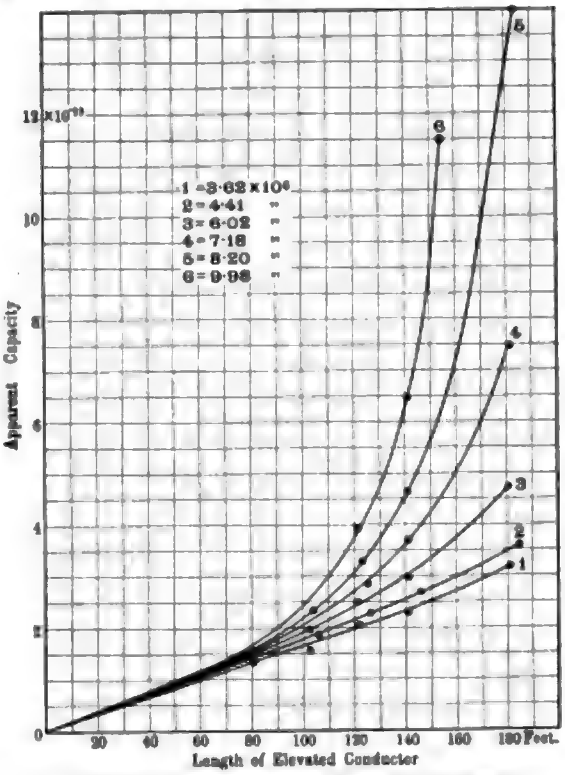

FIG. 11.—Apparent Capacity and Length of Conductor.

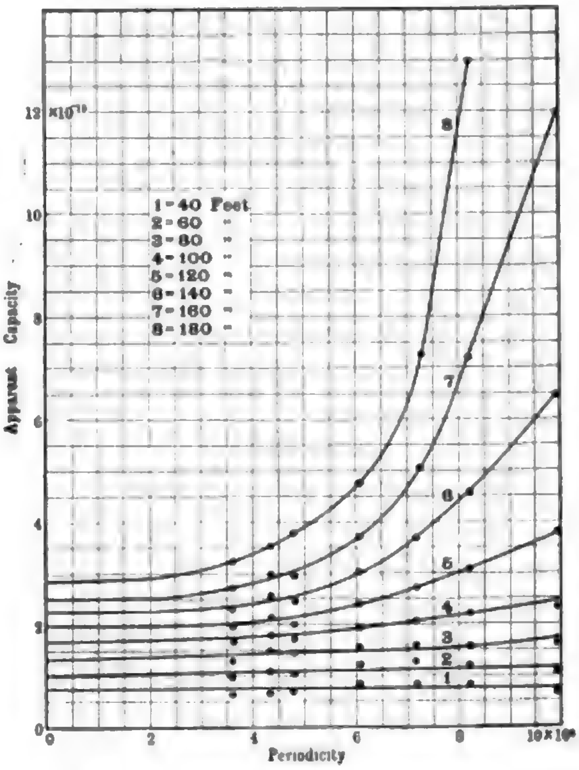

FIG. 12.—Periodicity and Apparent Capacity.

The first approximation to a more complete theory is to regard the vertical oscillator as a capacity area connected to the earth through an inductance. This mode of treatment corresponds to the first approximation to the theory of the transverse vibration of a stretched string in which the mass of the string is assumed to be collected at its centre. The theory here outlined corresponds to the second approximation to the complete theory of the transverse vibrations of a stretched string in which the mass is assumed to be uniformly distributed along the length of the string. It is not to be expected that the results of experiments should verify in all details the conclusions to be drawn from the theory which has been presented, but all the most important characteristics of the behaviour of a vertical oscillator as indicated by this theory are found to be confirmed by certain experiments the results of which are presented to you in the form of curves in Figs. 9, 10, 11 and 12. These curves need no explanation, the title of each showing sufficiently clearly its purport. Figs. 11 and 12 are the most instructive, showing as they do very clearly the increase of the apparent capacity of the oscillator as the frequency of the oscillations is gradually increased and the tendency of this apparent capacity to become infinite as the frequency of the oscillations approaches the frequency of the fundamental of the oscillator *per se*.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

The Electric Arc.—C. D. Child formulates a theory of the arc which is a revised version of his older theory, and is based upon the ionisation by impact as studied by Stark, Thomson, and Townsend. There is a great similarity between a discharge in a vacuum tube and an arc, except that in the latter the temperature is very much higher, the current much greater, the drop in potential at the cathode much smaller, and the drop at the anode usually greater. The difference at the cathode is the most fundamental. Instead of being 300 volts, the cathode fall may be but 5 volts. Instead of being sufficiently great for positive ions to ionise by impact, it appears to be too small for any kind of ionisation by impact. Therefore, the cathode must be very hot, so as to provide ions by incandescence or by the rapid motion of gaseous atoms. At the boundary surface of the anode, there may be ionisation by the impact of negative ions. The electric force must be sufficiently great at all points so that the energy transformed will produce the required temperature. The current in the arc cannot be conveyed by particles of ordinary matter, since these would move 1,000 times too slowly, and the arc would be more or less opaque. The vapour from the electrodes has often much to do with the passage of the current, but it is not until the heat has vaporised the electrode, and the gas is ionised as any other gas, that it plays any part in the phenomena. Even in the mercury arc the mercury vapour must be ionised, and the process of ionisation may be easier in mercury vapour than in most gases. The theory explains both the existence of the counter E.M.F. and its sudden disappearance after removing the impressed E.M.F. The charge on a sphere may produce a potential of thousands of volts and yet can cause no appreciable current. In the same way the ions in the arc may cause a considerable apparent counter E.M.F. and yet re-combine after the current ceases without producing any apparent effect. What is left unexplained is the behaviour of the non-arcing metals, the unidirectional character of the iron-mercury arc, and the velocities of the ions in the arc.

[C. D. Child, *St. Louis Congress Papers*, Section A, 1904.]

Magnetostriction.—H. Nagaoka reviews the progress made in the study of magnetostriction since Joule in 1842 discovered that iron changes its dimensions by magnetisation. A singular characteristic of magnetostriction is its reciprocity with the effects of stress on the magnetisation of different ferromagnetic substances, so that some of the effects, such as the Villari critical point in iron, seem to foreshadow the nature of the strain, which would be wrought by magnetisation. The correlation between stress and strain in the magnetisation of ferromagnetic substances opened a new field of research, which resulted in laying the foundation for the dynamical discussion of the phenomena. The hyteresis attending the magnetostriction is generally complicated, and presents great difficulty in establishing a really satisfactory theory of the subject. The effect of longitudinal stress, of hydrostatic pressure and of twist on the magnetisation of ferromagnetic substances, stands in reciprocal relation with the elongation, the change of volume and the twist produced by magnetisation respectively. Thus, longitudinal magnetisation produces a continuous diminution of length in nickel up to high fields; and, on the other hand, longitudinal pull produces a diminution of magnetisation in nickel up to high fields. The sound emitted by magnetising an iron wire by intermittent or alternate current was long known, but the actual measurement of the change of length was undertaken quite recently by Honda and Shimizu. With a given wire the amplitude varies with the frequency; generally there are two maxima in iron and nickel as the frequency is increased. The phenomenon is evidently due to magnetostriction. No experiment has as yet been tried on the magnetostriction of ferromagnetic crystals. The axial behaviour of crystals would be the most interesting subject of investigation. Probably there are a good many problems on the magnetoelastic properties which still remain untouched, and which are intimately connected with magnetostriction.

[H. Nagaoka, *St. Louis Congress Papers*, Section A, 1904.]

Radiation of Hydrogen Peroxide.—Gelatine plates sensitised in the ordinary way and then exposed in the neighbourhood of hydrogen peroxide are affected in the same way as by light. On development they turn black. This effect is not due to the vapour of the peroxide, since a powerful air blast fails to intercept it. L. Graetz has shown that the effect is capable of penetrating thin metallic films and ebonite. He has further found a very remarkable effect. Bodies can be photographed without being placed in the path of the rays at all. It suffices to expose the gelatine side of the plate to the rays from the peroxide, and lay the objects to be photographed on the glass side. They then appear on development either lighter or darker than the background. Whether they appear lighter or darker depends altogether upon their temperature relatively to the plate. Hot bodies appear white, cold bodies black. In other words, those portions of the silver salt which are called upon to give off heat during exposure are more quickly reduced on development. This is contrary to the usual chemical effect of heat. The author supposes that since there is a conduction of heat as well as some unknown kind of radiation, there is also a transfer of electrons, and that these have something to do with the development. The author has, however, not succeeded in observing any electric effects of the rays, though he believes they might be observed with the aid of more delicate instruments.

[L. Graetz, *Physikalische Zeitschrift*, October 20, 1904.]

Earth-air Currents.—L. A. Bauer, in the course of his investigations on "The Physical Decomposition of the Earth's Permanent Magnetic Field" discusses the existence of vertical earth-air electric currents. Schmidt announced as a result of his careful mathematical analysis of the entire magnetic field of the earth, that a small portion could not be referred to a potential, and hence the existence of vertical earth-air electric currents was indicated, these currents, according to his calculation, amounting on the average, for the entire surface of the earth, to $\frac{1}{8}$th of an ampere per square kilometre. Owing to the difficulties raised by certain investigators as to the existence and possibility of harmonising currents of this average strength with the known phenomena of atmospheric electricity, Schmidt was led to doubt the validity of his general conclusion and to express the opinion that possibly the results derived by him were to be ascribed to systematic map errors. To resolve these doubts, the author has derived the values of these currents from the Y components contained in the best magnetic charts for 1840-45, 1880 and 1885 (Sabine's, Creak's and Brumayer's). He finds that all of the modern magnetic charts—*i.e.*, since those of Sabine for 1840-45—unite in indicating the probable existence of vertical earth-air electric currents of the average intensity over the region 45° N. to 45° S. of one-thirtieth of an ampere per square kilometre of surface. These currents proceed upward (from the earth into the air) near the equatorial regions where there are ascending air currents, and downward near the parallels 25° to 30°—*i.e.*, in the regions of descending air currents. Near the parallels 40° the electric currents are again upward, thus corresponding once more with the general atmospheric circulation. Beyond the parallels 45° the results appear too uncertain to warrant drawing a definite conclusion.

[L. A. Bauer, *Terrestrial Magnetism*, September, 1904.]

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TRAMWAY PERMANENT WAY.

Mr. A. N. CONNETT's Paper on "Tramway Permanent Way," read to a meeting of the Tramways and Light Railways Association, provoked a discussion which shows that there are many opinions on this important subject. An abstract of the Paper was published in our last issue, and a report of the discussion will be found on another page this week. It appears that the Standardising Committee's efforts have not produced a result satisfactory to all. Mr. HOWLEY's criticism that all the standard sections should have had the same width of tread seems unanswerable, and Mr. CONNETT's suggestion in his reply, that on a system with different weights of rail one should use a wheel to suit the minimum width, does not meet the difficulty. The additional weight might have been more usefully located in depth of head, and in thickening the very thin flanges of the heavier rails, to the roller's advantage.

Mr. CONNETT's suggestion that physical tests make chemical composition specification unnecessary was partly answered by Mr. HOWLEY, who pointed out that there is no satisfactory physical test for hardness, hence the need for specifying high carbon. Mr. CONNETT thinks the tensile test "pretty good" for hardness. The hardness wanted in a tramway rail is the quality that resists abrasion, and the relation between high tensile strength and that quality has not been formulated. The "Brinnell" test is rather more to the point, but there is a lack of quantitative relation between its results and the quality needed. It is conceivable that a grinding test, or a measurement of the resistance of a test piece to a light cut from a sharp tool might be useful; the difficulty is to ensure standard conditions. Another reason for the retention of the chemical composition clause is that undue proportions of phosphorus and sulphur, especially the latter, may result in segregation and growing flaws, such as probably caused the St. Neots' accident some years ago. If these points could be met by physical test—and perhaps the microscope will serve for the last mentioned—the engineer would have no desire to dictate to the steel maker.

A somewhat startling suggestion in the Paper, which found some confirmation in the debate, is that bogie trucks cause more wear of rails than rigid wheel base single trucks. Mr. Connett gave an instance where the excessive wear on certain curves is attributed to cars with 7ft. wheel base, but in his opinion it is the maximum traction trucks that run over it that do most of the mischief. We know a line corresponding in all particulars given, and, moreover, built under Mr. Connett's supervision, which may be the one referred to. On watching some of the curves on which the rails are cut very rapidly indeed, we put the damage to the debit of the single truck cars. They certainly emitted the more piercing shrieks, and on calculation it is apparent that their wheel flanges must be jambed across the grooves, and the truck frames considerably sprung until the grooves are worn very wide. We have tested power consumption of maximum traction and single truck cars on the same routes, and generally found a marked economy in power per ton-mile with the bogie cars. Mr. Connett seems to have found the contrary, and some other speakers agreed. The cause of this contradiction was, however, clearly indicated by Mr. Connett in referring to the excessive frictional resistance to the swinging of the bogies on their side bearings. Obviously, in the limit such stiffness makes a bogie car the equivalent of a car with a rigid wheel base equal to the distance between bogie centres, and with an enormous wheel diameter and consequent great length of flange in the groove. This can only be due to defective design or poor maintenance of the pivots and bearing surfaces. Railway experience is conclusive as to the advantages of bogie stock, and we believe just as eloquent testimony could be found on tramway systems where well-designed bogies are properly looked after.

Mr. Conaty's radial axle truck illustrated on another page is another interesting attempt to solve the radial axle problem, and combine the advantages of bogies and single truck construction. Its simplicity is in its favour, and if the pivoting or swinging action can be maintained in free condition, it should have a useful future. Radial axle trucks are almost out of memory now, but quite a few have been invented and some made in large numbers; they have not survived, however.

The very vexed question of rail "corrugation" (*i.e.*, hog-backing of the rail between joints or anchors) came up in the discussion. Mr. Connett seemed a little worried by it. He owed his first visit to London to this trouble appearing on the Brixton cable line, but his mission to find cause and cure was not successful. And he is still at the same place, "for," he says, "as soon as you form a theory about it some new fact comes up and overthrows it." He did not think it very important, anyhow, but there the meeting was against him, having evidently reason to take a more serious view of broken-jointed paving and water pumping through the joints than the reader of the Paper. The evidence on this trouble is not yet sufficient for useful discussion, and badly wants collecting and collating.

REVIEWS.

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Les Accumulateurs Electriques. By L. Jumau. (Paris: Vve. Ch. Dunod.) 27.50fr.

This work, comprising some 926 pages, is probably the fullest exposition of storage-battery work that has ever been written. It is divided into three parts: (1) General Theory and Practice, (2) Description of Various Types, (3) Applications. The opening chapter of Part I. is historical, while in subsequent chapters are discussed the numerous theories and hypotheses which have been advanced from time to time to account for the changes that go on within a lead accumulator. Later on, the author discusses the question of the E.M.F., and describes two or three methods of measuring this. He also shows the construction of some good forms of supplemental electrodes (cadmium, mercury, &c.) for determining the state of the plates themselves. Considerable space is devoted to the measurement of internal resistance, but the author points out that although this is somewhat difficult to determine exactly, yet it is seldom required in actual practice, whereas the determination of the terminal P.D. is exceedingly easy and of considerable practical utility. The chapter on "Capacity" contains some very valuable matter, but it is to be regretted that the table giving the Peukert coefficient of different cells is so brief, none but accumulators of foreign manufacture being given. As a conclusion to Part I., M. Jumau describes several accumulators whose principles have not depended upon lead and sulphuric acid. Although none of these can be said to have achieved commercial success, and although the author considers all of them inferior to the lead battery, yet he does not think it impossible to improve upon present practice by employing other elements and compounds.

Existing types of commercial accumulators are described in Part II., the early chapters being devoted to the processes for the manufacture of plates by machinery and other means, and the composition of the active material. The details of construction of many English and foreign storage cells are given, and a few pages are devoted to the Edison cell.

Part III. goes somewhat extensively into the various uses to which storage batteries may be put. The author shows how to calculate the capacity of a battery required for any particular purpose, and describes several forms of automatic switches and regulators for use in connection with batteries. The employment of boosters, automatic and otherwise, is dealt with, but, if dealt with at all, this branch of the subject deserved fuller treatment. Automobile batteries have a chapter to themselves, as have also those used for the propulsion of vessels: "Accumulators are employed for the propulsion of pleasure boats and warships (submarines); their applications to commercial navigation are less numerous."

On the whole, the book is an excellent one which may serve as an admirable work of reference, but its great length and the enormous quantity of matter with which it deals render it less valuable than other books on the same subject to all except battery experts and those who intend to confine their studies to the practice of electrochemistry.

Life and Energy: An Attempt at a New Definition of L'fe, with Applications to Morals and Religion. By Walter Hibbert, F.I.C., A.M.I.E.E. (London: Longmans, Green & Co.) 2s. 6d.

In less than 200 pages Mr. Hibbert throws as much light upon the insoluble problem of the philosophical meaning and nature of life as all the theologians have done during the past twenty centuries. The author has given us a singularly fresh, coherent and lucid re-statement of the time-worn formula—"His ways are not our ways," but he has not abated by one jot the puzzle of puzzles. Nevertheless, the energy which has been expended in the production of this curious little book has not been wasted. The world is weary of the conventional methods of attack and defence of the regular theologians, and turns with interest to the utterances and writings of men of science, in hopeful anticipation that at least fresh points of view may be opened up, even though the end be made no clearer. And in this instance there need be no disappointment. What, for instance, can be more refreshingly naive than the likening of the office of prayer to the removal of a distorting force *w* from a viscous substance, such as a rod of sealing wax SS, fixed on two supporting blocks *bb*. But although theology recovers some of its old interest in the hands of physicists and chemists and biologists, we cannot see that they negative in any degree the final gloomy retrospect of the late W. R. Greg:—

> Generation after generation of the young rush sanguinely into the arena, confident that *they* can solve the puzzle, confident that *they* can win the victory. Generation after generation of the old step down into the grave baffled and bewildered, vexed at the dreary retrospect, mortified at the memory of long years eagerly wasted in following "light that led astray"; mourning over brilliant banners torn and soiled, over heights still unscaled, over fields and trenches filled with martyrs of Humanity. The drama can be only half discerned, or half played out; or it may be that we have not yet got the clue to the meaning of the most High.

Alternating Currents. By GEORGE T. HANCHETT. (New York: John Wiley & Sons.) 4s. 6d. net.

This is essentially a book for elementary students and it commences with explanations of the fundamental phenomena met with in alternating-current working, these explanations being made fairly clear with the assistance of the usual hydraulic analogies. The language is not always quite so lucid as it might be; for instance, when referring to the load in an alternating current circuit, the author says, "It may be all lamps or it may be all coils and motors, in the one case involving practically unity power-factor, and in the other perhaps a very appreciable power-factor." Of course, the meaning is obvious to an engineer, but the method of expression is not a happy one to place before students. Considerable space is devoted to vector diagrams, but mathematical treatment of alternating current problems is not attempted. The principles underlying the measurement of alternating currents are expounded in simple language, and there are chapters on transformers, rotary converters, induction motors, &c.

Machine Drawing. By A. P. HILL. (London: Messrs. P. S. King & Son.) 2s. 6d. net

This is an excellent little book which has been got out to enable engineering students to obtain a practical knowledge of machine drawing, and at the same time to study the elementary calculations connected with simple machines. On each right-hand page are examples taken from commercial drawings, while on the left hand page is a large amount of information relating to the subject, together with instructions for calculations, and some worked examples. We can recommend this book to evening students of engineering and to those commencing a course of drawing-office instruction.

Le Turbine a Vapore ed a Gas. By GIUSEPPE BELLUZZO. (Milan: Ulrico Hoepli.) 1905. L.12.

The author commences with a treatise on the thermodynamics of steam and gas, this being followed by a theoretical investigation into the principles, properties and peculiarities of different kinds of turbines. The third part of the book contains the illustrated descriptions of some eight patterns of steam turbines, amongst which are all the well-known designs. A chapter on the application of steam turbines to marine work concludes the book, which is clearly written and profusely illustrated. A peculiarity of the book is that most of the theoretical problems are solved by diagrammatic means, the mathematics employed being quite elementary. Numerous tests of various turbine plants are recorded, but we miss such original matter as would distinguish the book under review from the series of similar books which have recently been published. As a compilation in Italian, however, the book is worthy of attention.

EXPERIMENTS ON SELECTIVE WIRELESS TELEGRAPHY.

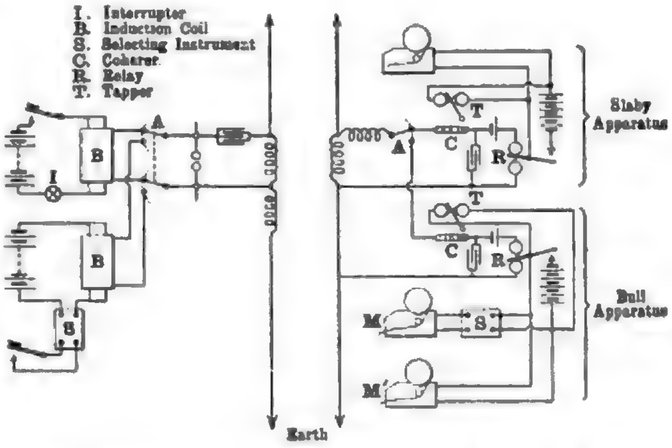
BY ANDERS BULL.

The following is an account of some tests made last spring before the U.S. Navy with the author's system of selective wireless telegraphy (described in *The Electrician*, Vol. XLVI., p. 573, Vol. L., p. 418 and Vol. LI., p. 963). The tests were undertaken between the Government stations at Highlands of Navesink, N.J., and Brooklyn Navy Yard, the distance being about 35km. The field is considered a rather difficult one for experimental work, as the waves have to pass the greater part of Brooklyn; moreover, the stations are very much troubled by interference from several other wireless installations in the neighbourhood, the interference lasting sometimes without interruption for hours.

The regular service between the said two stations is performed by means of the Slaby-Arco system, which has been provisionally adopted by the U.S. Navy. It was decided to try our selective instruments in connection with the existing installation. The same instruments were employed as are fully described in my former articles on the subject. The voltage used at Navesink and Brooklyn is 80 and 110 volts respectively; as, however, our transmitter was only constructed for low voltage and small power, we were only able to use a fraction of the energy generally employed for signalling between the stations. Thus, while the spark is usually about $\frac{3}{4}$in. long, our tests had to be made with $\frac{1}{16}$in. spark. In order to get good communication we had only one way left—viz., to make the receiving arrangement very sensitive. This, however, made the conditions for the tests rather unfavourable, as sensitive instruments are much more exposed to disturbances of all kinds, and do not work with the same exactness and rapidity as less sensitive ones. Of course difficulties of this nature can be easily overcome, as the transmitter can be constructed for any energy required; but for the tests in question we had no other apparatus at hand.

The transmitter was installed at Navesink, the receiver at Brooklyn Navy Yard. Lack of apparatus prevented us from signalling selectively in both directions. At both places switches (A) were provided (see Figure), so that either the Slaby instruments or our apparatus could be connected up to the oscillation circuits and aerials.

The experiments were conducted chiefly with a view to demonstrating the *secrecy* of the correspondence, a problem that, so far as I know, has not been solved by any other system of wireless telegraphy. Arrangements were, therefore, made at the receiving station so that the messages could be simultaneously registered by the selective inker M and another one M' which was connected up to our relay in the ordinary way, thus enabling a comparison to be made between the two records. Secrecy was obtained by using a series of three impulses at intervals of 0·063 and 0·295 second, the interval between successive series being 0·2 second.



The official demonstration took place on May 12th before the Wireless Telegraph Board. The sending was carried out by the chief electrician at the Navesink station. During the tests there were slight atmospheric disturbances which seemed strongly to affect the communication with the Slaby-Arco instruments while they had only very little effect on the selective signalling. A message which could not be read in spite of its being repeated some four or five times with the Slaby instruments was easily deciphered when sent once by ours. The reason is obvious, as interference is to a certain extent eliminated by the author's system. In order to put the selective inker in action at least three wave impulses, correctly timed, are necessary. As long as, therefore, the interference is only moderate it does not affect the selective receiver, although it may be strong enough to make correspondence with ordinary wireless instruments an impossibility. To prevent misunderstanding it should be observed that the Slaby instruments were using the full energy the whole time. Very long dispatches were after this satisfactorily transferred with our instruments, the operator at times working the key without interruption for 15 minutes. Some tests were also performed for the purpose of ascertaining the influence of a difference in the speeds of the transmitting and receiving instruments respectively. The speed of the disperser was kept constant at 57 revs. per min. while the collector was made to run with speeds varying between 53·5 and 61 revs. per min. During the whole time the V's sent by the Navesink station came out very clearly on the tape of the selective inker. Thus, even deviations from the normal speed as great as 8 per cent. could be allowed; as I have stated in my former articles it is advisable, however, in order to get a distinct tuning, that the variations should be the smallest possible.

Comparisons between the tapes unrolled by the selective inker M and the ordinary one M′ proved the complete impossibility of outsiders tapping the messages. On this occasion some remarks ought to be made on the advantages of a secret communication on the principles of the author's system. Some people write and also seem to think that equal results can be obtained by any wireless system simply by using code. This is, however, a great mistake. Any wireless signalling is apt to be interfered with, especially when carried out over long distances. Some dots may fail, new ones may appear (for instance, by atmospheric disturbances) or a dash may be split up into dots; in this way letters may easily be mistaken. As long as ordinary language is used scattered faults of this kind are not of much importance, as they are generally easily detected by the context of the message. When code is used the case is different. The mistake of a few letters may here make the whole message illegible. Besides, the use of code requires skill and is very time-wasting work, even if the messages come in perfectly clear, and there may be occasions where the minutes are valuable; for instance, during war.

Finally, I wish to call attention to the fact that the instruments used were originally designed for laboratory work, no alterations having since been made on them. They are, however, open to numerous improvements. I am indebted to Mr. Alfred Kielland for his assistance during the tests described.

THE MEASUREMENT OF THE POTENTIAL OF THE ELECTRODES IN STATIONARY LIQUIDS*

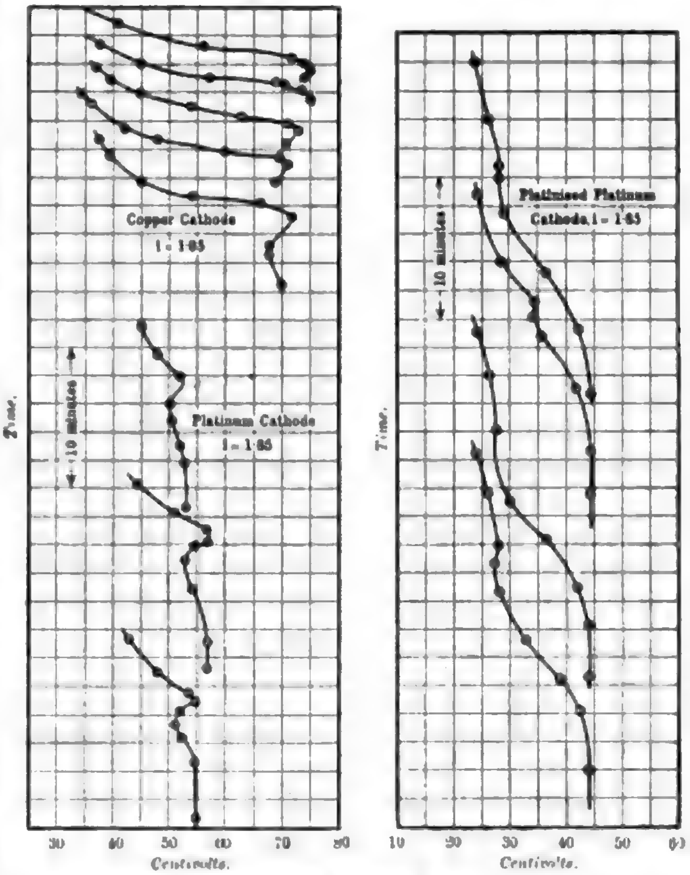
BY HENRY J. S. SANDS, PH.D., M.SC.

(Concluded from page 108.)

Acid Solutions of Nitrobenzene.—We now come to the discussion of curves obtained when the solution of an organic substance—namely, nitrobenzene—was reduced under varying conditions. Two solutions were experimented upon with different electrodes and current-densities, other conditions remaining unchanged as nearly as possible. Stock solutions of accurately known composition were mixed in known proportion, the composition of the resulting liquids working out as follows:—

1 litre acid solution used for experiments of Figs. 7, 8, 9, 10 contains	5 grammes nitrobenzene. 107 grammes H_2SO_4. 425 cubic cm. ethylalcohol. Remainder water.
1 litre alkaline solution used for experiments of Fig 11 contains	5 grammes nitrobenzene. 82 grammes NaOH. 425 cubic cm. ethylalcohol. Remainder water.

The anode for the experiments on acid solutions was, as a rule, one of copper in contact with a solution of 80 grammes cuprous chloride in 200 cubic cm. strong hydrochloric acid and 100 cubic cm. 95 per cent. alcohol. For the experiments on the alkaline solution the anode was mercury in contact with a solution of 100 grammes mercurous nitrate and 35 cubic cm. strong nitric acid in 500 cubic cm. water, the solution interposed containing 125 grammes ammonium nitrate in 500 cubic cm. The curves obtained show, firstly, the degree of coincidence yielded by a repetition of experiments, and, secondly, they exhibit both interesting similarities independent of the material of the electrode and characteristic differences due to it. The abscissæ again denote the experimentally-found values of the potential of the standard electrode, the potential of the cathode being taken as zero. A small correction may be made for the difference of potential due to the resistance overcome by the current between the cathode and the junction T by taking the value 3½ ohms for this resistance in the case of the acid solution and 6 ohms for the alkaline solution. All the curves representing the results of experiments on acid solutions exhibit first a rise of potential. After this it recedes, or becomes almost stationary, then increases once more, and finally becomes stationary again. Bubbles of hydrogen may now be observed on the cathode. It may, perhaps, be premature to attempt to explain definitely the first retrogression of potential in the curves. The most probable cause seems to be a temporary change in the nature of the electrode resulting from electrolysis. Such changes have been recently shown to occur frequently by Russ,* Luther and Brislee,† and others. As a rule, they tend to make cathodes more efficient—*i.e.*, they enable them to accomplish reduction with the expenditure of a smaller amount of energy. The electrodes are also certainly permanently changed under certain conditions in such a manner that they become less efficient. This is very notable with the cathode of smooth platinum when small current densities are employed. If an electrode is used which has been freshly cleaned with ligroin, boiling strong nitric acid and boiling caustic soda solution, the potential of the standard electrode shows a comparatively low value throughout the experiment, the results being similar to those obtained with a cathode of platinum coated with platinum black. On repetition the cathode is, however, found to have become less efficient, the potential being considerably higher than in the first experiment. Further repetitions yield curves almost identical with the second, the potential, however, still becoming slightly higher. When the cathode is cleaned after this, as before the first experiment, it again yields a curve similar to the first. In Fig. 10 the first curve and one of its repetitions are shown.



Difference of Potential between Standard Electrode and Cathode.

FIG. 7.—ACID SOLUTION OF NITROBENZENE.

FIG. 8.—ACID SOLUTION OF NITROBENZENE.

Fig. 7 illustrates results obtained with a copper and a platinum cathode respectively. The experiments with the copper cathode were stopped after the first retrogression of potential. It will be seen that the latter occurs approximately at the same time in the experiments with the copper as in those with the platinum electrode. The difference between the actual values of the potentials is, however, very marked, the standard electrode at the beginning of the copper experiments showing a lower value than at the beginning of the platinum experiments. This corresponds to a greater efficiency—*i.e.*, a smaller expenditure of energy in the case of the copper than in that of the platinum electrode. In accordance, however, with the greater E.M.F. required for the liberation of hydrogen on a copper cathode than on one of platinum,‡ the copper curves attain higher values of potential than the platinum curves at the end of the experiment. Fig. 9 represents experiments with a copper cathode carried out until evolution of hydrogen takes place. In Fig. 8 results are shown obtained with an electrode of platinum thickly coated with platinum black, the current-density being the same as in the experiments of Fig. 7. The low values of the potential represent the most conspicuous feature of these experiments. As the electrode is not smooth, the time values are not comparable with those of Fig. 7.

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* Paper on "The Measurement of the Potential of the Electrodes in Stationary Liquids; the Determination of Changes of Concentration at the Cathode during Electrolysis" read before the Faraday Society, Oct. 25th.

* Russ, *Zeitschrift Phys. Chem.*, Vol. XLIV., p. 641 (1903).

† Luther and Brislee, *Zeitschrift Phys. Chem.*, Vol. XLV., p. 216 (1903).

‡ Caspari, *Zeitschrift Phys. Chem.*, Vol. XXX., p. 89 (1899).

Alkaline Solutions of Nitrobenzene.—Fig. 11 represents results obtained with the alkaline solution of nitrobenzene. As the solution at the cathode becomes heavier during electrolysis in an alkaline electrolyte, owing to accumulation of alkali, the cathode was placed horizontally at the foot of the cell in these experiments (Fig. 2). At the points of maximum voltage hydrogen begins to be evolved. The differences between the experiments with copper and platinum electrodes are similar to those observed in acid solution. The time which elapses until hydrogen is evolved by a current of given density is considerably smaller than in acid solution. This points to the conclusion that the diffusion coefficient of nitrobenzene is considerably smaller in alkaline than in acid solution, and possibly also that the reduction does not proceed quite so far before hydrogen is evolved.

in which C_0 is the original concentration of the substance electrolysed, C its concentration after the time t, k its diffusion coefficient, and F the amount removed by electrolysis at the electrode per unit of surface and time. From this equation we find the following value for the relative change of concentration at the electrode:—

$$\frac{C_0-C}{C_0}=\frac{2F}{C_0}\sqrt{\frac{t}{\pi k}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Proceeding according to the second plan and indicating the distance from the electrode at which no change of concentration takes place by δ, we have the following relation according to Fick's diffusion law:—$F=k(C_0-C)\,\delta$, from which we obtain for the relative change of concentration at the electrode the value

$$\frac{C_0-C}{C_0}=\frac{\delta F}{kC_0}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

When the current is employed solely for reduction, we have

$$F=\frac{i}{96{,}540}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

concentrations being expressed in gramme-equivalents or milligramme-equivalents per cubic centimetre, and current densities in amperes per square centimetre or milliamperes per square centimetre respectively. In order to eliminate k from these equations we may calculate its value from the experiments we have described in the present Paper. For this purpose we must assume that nitrobenzene has been completely removed from the electrode by reduction to azoxybenzene when hydrogen is evolved. We then find k by applying equations (1) and (4) to our experiments. We thus obtain

$$k=\left(\frac{2i'}{96{,}540C'_0}\right)^2\frac{t'}{\pi}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

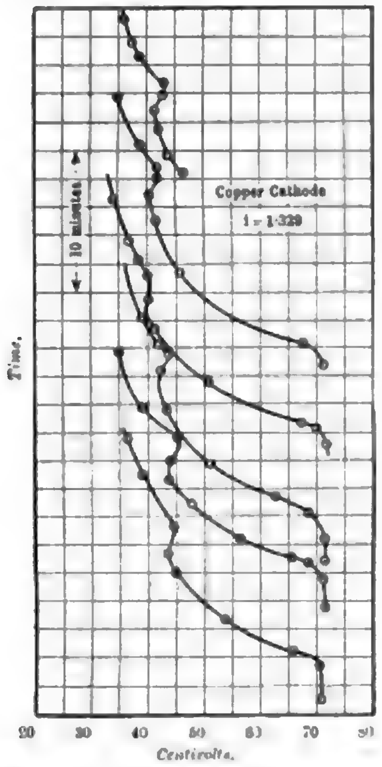
quantities referring to our experiments being distinguished by dashes. The values for k derived from this equation are no doubt often vitiated by the fact that hydrogen may come off before complete reduction of the nitrobenzene has taken place, so that the values found for k are too small and those for $(C_0-C)/C_0$ too large. This does not matter seriously, however, as we only desire to find an upper limit for the latter quantity. Eliminating F and partly k from the equations (2), (3), (4), (5), we find the following relations:—

$$\frac{C_0-C}{C_0}=\frac{i}{i'}\,\frac{C'_0}{C_0}\sqrt{\frac{t}{t'}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

and

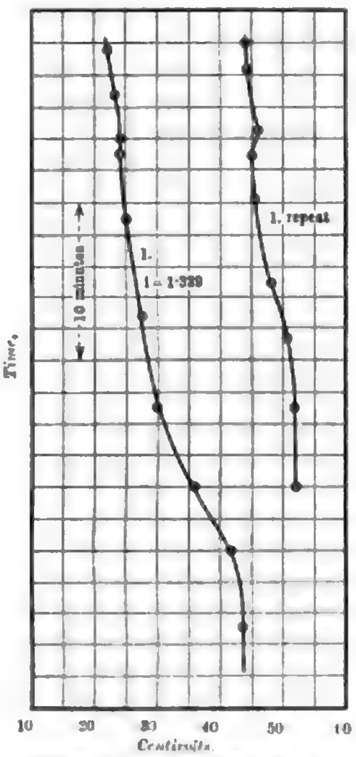
$$\frac{C_0-C}{C_0}=\frac{i}{96{,}540}\,\frac{\delta}{kC_0}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

As an example, by which to test whether concentration changes played an important part in Haber's results, we take numbers from the Paper recently published by him in conjunction with Russ.[*]



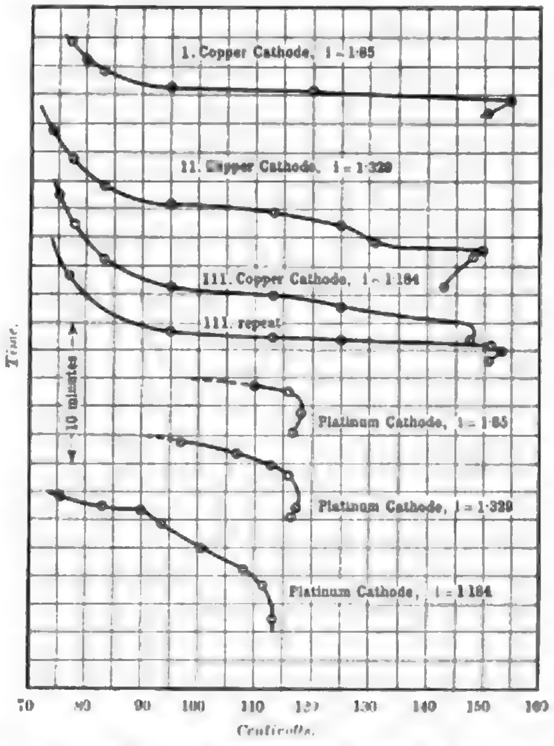
Difference of Potential between Standard Electrode and Cathode.

FIG. 9.—ACID SOLUTION OF NITROBENZENE.



Difference of Potential between Standard Electrode and Cathode.

FIG. 10.—CURVES TO SHOW CHANGE IN PLATINUM CATHODE BROUGHT ABOUT BY USE.



Difference of Potential between Standard Electrode and Cathode.

FIG. 11.

Example of Application of Results.—In conclusion, we have to show how experiments carried out according to the method described may be employed in order to arrive at an estimate whether results that have been obtained in electrochemical investigations are due simply to concentration changes at the electrode that take place so rapidly that they cannot be neutralised by stirring, or whether they are really properties of the solution originally made up by the experimenter. As an example, we shall investigate whether concentration changes can have taken place during the experiments by Haber, referred to in the introduction, with sufficient rapidity to explain his results. We may approach such questions from two points of view. Firstly, we may make an arbitrary assumption regarding the time that must elapse until artificial stirring can completely renew the layer of liquid touching the electrode. For example, we might assume that such a renewal takes place completely after the lapse of one second, or of one minute, and then calculate what is the maximum change of concentration that can have taken place. Secondly, we may assume that owing to stirring the concentration of the electrolyte is always left unaltered at some definite distance, say $\frac{1}{10}$mm., from the electrode, and then calculate the maximum change of concentration that is conceivable on this assumption. Proceeding on the first plan, we have the equation[*]

$$C=C_0-2F\sqrt{\frac{t}{\pi k}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

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[*] Sands, *loc. cit.*, p. 53.

[*] *Loc. cit.*

According to Table II., when a current of density 4·5 milliamperes/1·5 × 10 centimetre² was passed through a vigorously stirred alkaline solution of nitrobenzene of the concentration 0·8 milligramme equivalent cubic centimetre, an absolute potential of 0·0737 volt was observed; whereas when the current had a density of 86 milliamperes/1·5 × 10 centimetres², the potential was 0·1171 volt, the difference being 0·0434 volt. Now, according to the Table VII.A, when a current of the density 5 milliamperes/1·5 × 10 centimetres² was employed in a solution of the concentration 0·8 milligramme-equivalent/cubic centimetre, the potential 0·0093 volt was recorded. In order to obtain a rise of potential of 0·0434 volt by reduction of the concentration of nitrobenzene, the current strength being left unchanged, we can infer by interpolation from numbers given in the same table that the concentration must be reduced to 0·115 milligramme-equivalent cubic centimetre—*i.e.*, to 14 per cent. of its former value. If the first experiments are to be explained as a result of local reduction of concentration at the cathode, such reduction must therefore amount to at least 86 per cent.

Now, in order to obtain an estimate of the magnitude of depletion at the cathode that actually took place, we refer to one of our experiments represented in Fig. 11. Taking, for example, curve 4, we have $i = 1{\cdot}184$ milliamperes centimetres², $t = 480''$, $C_0' = \frac{5 \times 8}{123} \frac{\text{milligramme-equivalent}}{\text{cubic centimetres}}$. Employing equation (6), we find that if the liquid touching the cathode is renewed completely after every second by stirring, the lowering of concentration could never go below 1·4 per cent. I have shown formerly* that under more unfavourable circumstances—viz., when the cathode was mercury contained in a cup—it is possible to prevent depletion, which would require 0·4 second if the liquid were stationary; it seems improbable, therefore, that the lowering of concentration in Haber's experiment went below the above value. By employing equations (5) and (7), we find that if the concentration of the liquid be maintained continually at its original value by stirring at [illegible] mm. distance from the cathode, the utmost lowering that could take place would amount to 5½ per cent. Brunner† calculates the distance from the electrode to which he was able to keep the concentration unchanged in his experiments to have been [illegible] mm. to [illegible] mm., so that, adopting his values, we should conclude that the lowering of concentration did not amount to more than about 1½ per cent. Starting from other curves on Fig. 11, we obtain similar values. In any case, the results show that we cannot assume changes of concentration amounting to 86 per cent. to have taken place in Haber's experiments, and that the variations of electrode potential with current density observed by him can, therefore, not be explained as the result of concentration changes at the cathode. In carrying out the foregoing investigation the author has been assisted by grants from the Chemical and Royal Societies, for which he desires to express his indebtedness.

ELECTRIC LIGHTING MATTERS IN DUBLIN.

At a meeting of the Dublin Corporation on Monday Mr. Robert Hammond's offers to take over the electricity works under certain conditions, contained in a letter dated August 25th, came up for discussion. Since Mr. Hammond's period of superintendence at the Pigeon House Fort works expired on July 31st last, quite a number of reports by the consulting engineer and resident engineer have been presented to the Lighting committee, and these will be found at length in our issues for September 16th and 23rd. The offers by Mr. Hammond, dated August 25th, remained in abeyance until Monday, but on Thursday last week, November 3rd, Mr. Hammond addressed a further communication to the Corporation in consequence, he says, of his previous offers to take over the undertaking having been much misunderstood. The position on Monday, therefore, was that the Corporation had before it for consideration the offers contained in the communication dated August 25th (see *The Electrician* for Sept. 16th), and the letter of November 3rd explaining and making more favourable to the Corporation the original proposals.

In this latter document Mr. Hammond says that it was in consequence of his original estimate that the cost of generating and delivering electrical energy in Dublin, exclusive of capital charges, would not exceed 1½d. per unit having been so much derided, that he made the offer in his letter of August 25th. That offer he now repeated—viz.: "To enter into an arrangement with the Municipal Council for the supervision of the working of the undertaking during a period of seven years, guaranteeing the cost of 1½d. per unit, my remuneration for my supervision and for my guarantee being the difference between 1½d. per unit and the lowest figure at which I may be able to generate and distribute." In view, however, of the evidence which he gave at the recent Local Government Board enquiry, in reference to decreased costs consequent upon the continued progress of the new systems he was willing to make the offer even more favourable. He had stated at the above enquiry that he estimated an increased output of 320,000 units beyond the output named in his original report could be generated and distributed at 1½d. per unit, and an increase of 880,000 units at 1d. per unit. Under these circumstances, in the event of the Corporation giving him the supervision of the undertaking for seven years, he was willing to guarantee the Corporation the lower prices named in his evidence. His proposal was to charge the Corporation, not for units generated, but for units actually delivered to the consumers. Under these conditions, the average cost to the Corporation for 3,525,000 units per annum, the total of his estimates, would be 1·375d. per unit.

Dealing with his alternative offer to take over the working of the electricity undertaking for a period of not less than 14 years, Mr. Hammond offers now to have the period extended to 21 years, and a guarantee would be given that the plant would be properly maintained during that period, and a further guarantee that it would be handed back to the Corporation in proper working order. With reference to the criticism that his offer to run the works under these conditions would take away from the ratepayers the benefit of any profits on the undertaking, Mr. Hammond replies that, should the council consider the offer favourably, he would be willing to amend it to the extent of giving the Corporation half the profits after the payment of a fair fee to cover supervision, guarantee, &c. In the event of either offer being accepted, Mr. Hammond is further prepared to deposit in the hands of the Corporation securities of a reasonable amount which would be subject to forfeit in the event of the guarantees not being fulfilled. Finally, Mr. Hammond points out that the favourable consideration of his offers would in no way interfere with his responsibilities and duties as consulting engineer to the Corporation.

In presenting the report of the Lighting committee on these matters to the Corporation on Monday,

Mr J. IRWIN, the chairman, stated that the committee did not see its way to recommend the Corporation to part with the control of the electricity undertaking in any way, and respectfully suggested that Mr. Hammond be informed to this effect. These offers of Mr. Hammond had been termed "sporting offers," but where did the sporting element come in so long as Mr. Hammond was in the position to draw his present remuneration of 5 per cent. commission upon all the increased capital outlay which must be incurred before the additional 880,000 units referred to by him could be secured by the undertaking? He complained that Mr. Hammond had taken no step to cope with the increasing demand until the city electrical engineer had requested the committee to take the necessary steps to safeguard the interests of the Corporation in his reports of August 8th and 22nd, after Mr. Hammond's period of superintendence had expired. It was in consequence of these reports that Mr. Hammond made his offer of August 25th. Speaking for himself, he believed that Mr. Hammond's offers were not the proposals of a man who sought to carry through an ordinary business transaction, and he said deliberately that in their present form they were not all that they seemed.

After a long discussion a proposal that the report of the Lighting committee should be placed before a committee of the whole Corporation was carried.

CORRESPONDENCE.

TRAMWAYS ASSOCIATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I read with interest the article in your last issue suggesting the advisability of forming an association which would be representative of all tramway and light railway interests in the United Kingdom, instead of having three distinct associations, as at present. With some of your views I am in entire agreement. The Tramways and Light Railways Association, of which I have the honour of being this year's president, is the oldest of the three tramway associations in this country, and is doing useful, if quiet, work. Its members consist of those who are engaged in tramway enterprise, whether municipal or private, and, whatever may have been the case in past years, the association is now honestly endeavouring to further the interests of tramway industry regardless of politics. A tramway managers' section has recently been formed, and it is propose to hold a convention of managers in the autumn of each year.

The Association of Tramway and Light Railway Officials also embraces as its members officials engaged in both public and private enterprise, and is thus doing, but on a somewhat smaller scale, exactly the same kind of work as is being performed by the older association. It seems to me a pity that these bodies, whose interests are identical, should be acting apart, even though it be in friendly rivalry.

With regard to the Municipal Tramways Association, which is probably the strongest of the three, the case is somewhat different. Its members are exclusively engaged in municipal work. Problems peculiar to municipal tramways have constantly to be dealt with. These are of such frequency and importance as to render its existence imperative, quite apart from any other body. My own opinion is that the time has not arrived, and probably never will, when this association can usefully be merged into one central organisation. I believe there is ample room for two associations—viz., one dealing with tramway matters of general interest (say the Tramways and Light Railways Association) and another (the Municipal Tramways Association) dealing with matters purely municipal. —Yours, &c., ALFRED BAKER.

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* *Loc. cit.*, p. 77.

† *Zeitschrift Phys. Chem.*, Vol. XLVII., 39 (1904).

General Manager,
Birmingham Corporation Tramways.

Birmingham, Nov. 8.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with interest your editorial note on the subject of consolidating the various tram and light railway associations now existing into one strong association. I sincerely hope that your suggestion may bear fruit. However powerful the tramway interests may be, they are not sufficiently so to afford the scattering of their efforts through three different associations. It ought not to be a difficult matter to weld the three associations into one, provided that such an association as a body refrains from expressing any opinion on what may be called the political side of the tramway question in this country.—Yours, &c.,

Nov. 9. A. N. CONNETT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: This matter has been very fully discussed on many occasions. It appears to be difficult, however, to combine municipal and company interests, especially when one considers the way in which municipal trading is criticised by company promoters. The suggestion which is now being made was made at the first meeting of the Association of Tramway and Light Railway Officials, and it was in order to attempt to effect a combination of municipal and company officials that this association was formed and has been kept going. Conditions, however, are so different that this can only be done by avoiding many subjects which might otherwise be usefully dealt with.—Yours, &c., A. R. FEARNLEY,

General Manager,
Sheffield, Nov. 8. Sheffield Corporation Tramways.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. England and you have not spoken too soon in advocating the amalgamation of the three bodies now purporting to represent tramway officials. There is no reason for the existence of more than one association concerning itself with technical and operating matters, and evidently one such society would be much more useful than three for the collection of data and comparison of experiences. Why municipal tramway officers should object to join an open association I cannot imagine. It would be as sensible to have Conservative and Liberal Institutions of Civil or Electrical Engineers as Municipal and Anti-Municipal Tramway Associations.

That the objection suggested is not very real or strong seems to be proved by the mingling of municipal and company officers on the Council of the Tramways and Light Railways Association, of which Mr. A. Baker is the president for the current year. That a strong central body is necessary for the progress of the industry is every day more apparent. I therefore hope, Sir, that your widespread advocacy will lead to an immediate and successful movement for amalgamation.—Yours, &c., HENRY M. SAYERS.

London, Nov. 7.

ALTERNATING v. CONTINUOUS CURRENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of October 28th you have printed in full a Paper by Dr. Stern, which was read before the St. Louis Electrical International Congress, and to which you have devoted considerable and respectful attention in your leading article.

As one of those who were present at the discussion which followed on Dr. Stern's Paper I take the liberty of telling you that you have certainly erred on the side of courtesy in your criticisms. I think that other engineers who were present will agree with me that the Paper was considered by the audience simply as a humorous production and was not attempted to be seriously criticised, in fact, it fell to my lot to move a vote of thanks to the Chairman for having obtained the Paper from Dr. Stern, and thereby having given the meeting so much pleasure, as was shown by the frequent bursts of laughter which attended the reading of it, in fact, in St. Louis I think we all considered Dr. Stern to be an electrical Rip van Winkle.—Yours, &c.,

London, Nov. 7. R. E. CROMPTON.

[We are glad that Col. Crompton agrees with us in disagreeing with Dr. Stern's views. Col. Crompton's condemnation is strong, but perhaps not too strong for a Paper which, as we have said, is based on a fallacy. Some of our readers are too ready to accept as gospel all that comes from the Continent, and we trust that the criticisms of Col. Crompton and ourselves will force them to realise that erroneous views may be prevalent on the Continent—with regard to electrical engineering as well as with regard to Japanese torpedo boats.—ED. *E.*]

THE WALTER-EWING MAGNETIC DETECTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In Dr. de Forest's Paper on "Receivers for Wireless Telegraphy," printed in your issue of the 4th inst., I notice he refers to the Ewing magnetic detector. As this is the second time such a statement has appeared, Dr. Fleming having made a similar statement in his Cantor lectures last year, I shall feel obliged if you will allow me to state that the detector referred to was invented by me; Dr. Ewing is, however, a co-patentee. In the first case the error very possibly arose from the fact that in a joint Paper read before the Royal Society the name of an author who is also a member is placed first.—Yours, &c.,

London, Nov. 7. L. H. WALTER.

MR. SIEMENS' PRESIDENTIAL ADDRESS TO THE INSTITUTION OF ELECTRICAL ENGINEERS.[*]

In taking the chair for the coming year, I am placed at a disadvantage compared with my predecessors, in so far as I cannot begin my address by thanking you for having elected me, but have to explain how it has come about that I occupy this honoured position. The late lamented death of our secretary induced the council to consider how a continuous policy in the management of the affairs of the Institution could be best insured; and as a result certain alterations in the bye-laws have been suggested by the council, and have been sanctioned by you in due course. This revision was, however, not formally completed in time to propose a president-elect at our last annual general meeting, and the expedient was adopted of proposing Mr. Robert K. Gray for a second term of office, to which he agreed, on condition that he might resign in favour of a president-elect as soon as the alteration of the constitution had been duly carried out. As our new secretary had been only a short time in office, the council decided to elect a past president as the successor of Mr. Gray, and did me the honour to select me, when Mr. Gray formally intimated that he did not wish to serve a second time as president. During the recess Mr. Gray, with a numerous party, went to the United States, as you all know, and during his absence it has been my sad duty to represent you at the funeral of our hon. member and past president, Major-Gen. Webber, who has the further claim on the regard of the Institution, that he was the last surviving founder. Members of council know better than the other members of the Institution how indefatigable Gen. Webber was in promoting the interests of the Institution in every possible way, not only by attending meetings of councils and of committee, but by suggesting improvements wherever he thought imperfections existed. He notably took an active part in all the negotiations connected with the acquisition of a suitable site for an Institution building, about which the council reported at the last meeting. In him we have lost a true friend of the Institution, and his memory will be held in honour as long as the early days of our Institution are remembered.

It would, perhaps, appear natural to take this opportunity of comparing the status of the Institution, or rather of the Society of Telegraph Engineers, at its inception, with the position now occupied, but this has been done so recently in presidential addresses that my words would be only a superfluous addition to the remarks more ably expressed by my predecessors. On the other hand, the causes which influence the growth of industries, and thereby the rise of institutions connected with them, will bear further discussion, as they are of the most varied character, and are an apt illustration of the interdependence of all factors of modern civilisation. Considering the features of this civilisation generally, it will be acknowledged, after a short reflection, that its true foundation is the lowering of the cost of production—in other words, the progress of civilisation is in proportion to the cheapening of articles of consumption. Although this may sound purely materialistic, the process of lowering the cost of production, which implies the employment of all the knowledge we can acquire, and of all the training the best schools can give us, results in greater ease of acquiring the necessaries for keeping alive, and therefore it gives us more time to cultivate other aspects of our existence. This general principle has manifested itself as much in the electrical industry as elsewhere, and further progress appears to be dependent on further lowering of the cost of its products. When we come to inquire into the means for carrying out this principle we soon recognise that the solution of the problem depends upon a variety of circumstances which all influence the result, although they may be investigated and discussed separately. For "internal working," if I may say so, every industry depends upon three principal factors:—(1) The capital which provides the works and the raw material. (2) The workman who converts the raw material into the finished product. (3) The management.

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[*] Delivered last night.

It is quite idle to try to establish the relative importance of these three factors, for each one is indispensable, and likewise the prosperity of each one is inseparable from the prosperity of the others; so that no industrial establishment can flourish where these three factors do not co-operate heartily and harmoniously. As a first condition for further progress we should, in fact, recognise the identity of interest between the capitalist, the workmen, and the management, as any measure which is intended to unduly favour any one of these three factors would inevitably increase the cost of the produce beyond what it ought to be and thereby restrict its sale, thus damaging all three. When we examine, in detail, in what way each of the three factors can contribute to the lowering of the cost of production we find ample confirmation of the intricacy of the problem.

Taking capital first, its share in the value of the finished article is proportionate to: (*a*) The cost of the depreciation and maintenance of the works and of their outfit. (*b*) The cost of the raw materials. (*c*) The profit, representing interest on the total capital invested in the undertaking.

In order to minimise the first item the works ought to be carefully planned and equipped, so as to be careful of turning out the maximum quantity of produce, and their machinery should be selected and laid out in such a way that its wear and tear is only due to its legitimate working, and that the handling of all materials is reduced to a minimum. The second item, the cost of raw materials, is too intimately connected with fiscal questions for treatment in this address; but incidentally it should be noticed that practically there is no such thing as "raw material," at least the Royal Commission on Trade declared itself unable to define what is "raw material." It is true that each industry works up what it designates as "raw material," but this, in turn, is the finished product of some other industry; even the products of nature, whether minerals, plants or animals, form the basis of great industries, and are more correctly called finished articles than raw materials. In any case for the natural progress of industries the cost of the materials, which they work up, should be kept as low as possible, and every increase of it is a hindrance to their proper development. There is apparently not much difficulty in diminishing the third item, the profit on the capital invested; but it stands to reason that the interest earned by the capital could not fall below a certain amount without the industry in question losing the support of capitalists and collapsing. The rate of interest may, therefore, be considered a fixed quantity; and in order to diminish the amount payable under this head, it is important to avoid burdening an undertaking with more capital than is required for setting it up as a going concern and for providing a reasonable amount of working capital.

A particularly dangerous way of increasing capital expenditure is buying patents, as the best inventions may be superseded at any time either by better ones or by a change in trade requirements, for in such cases the capital invested in the patent would be quite unproductive, while the interest would still have to be paid. It is much more equitable to remunerate an inventor by a royalty, so that his reward may be in proportion to the success of his invention, and to charge the amount that may have to be expended in developing the invention to revenue account. When considering the influence of the second factor, the workman, on the value of the product, it becomes clear very soon that the amount of work turned out in a given time has a twofold influence on the result, as the time occupied in producing an article not only regulates the amount of the wages, but also the proportion of the dead charges to be debited to the article. It is, therefore, quite certain that in order to contribute his share to the lowering of the cost of production of an article the workman has to turn out a greater number of these articles in a given time, and the problem is how to attain this object without endangering the interest of any one of the three principal factors. This sounds almost as if slave labour would prove an economic plan in the carrying on of industries; it can, however, hardly be contended that the interest of the workman is considered under such conditions, and for this reason alone it should be condemned, even if there were no other objections to it. There are, however, legitimate ways in which the amount of wages to be charged against an article can be diminished. Most important among them is the substitution of machine work for hand labour, and where this is done unskilled labour should be utilised for running the machines under the supervision of a few skilled artisans. Here again the interests of the workman appear to suffer, and whenever he is confronted with a new labour-saving machine he airs his old grievance that machines will deprive the working man of his living, just in the same way as he opposed the use of all machinery a hundred years ago. The lesson taught by experience has evidently not made an impression; but nobody can deny that, instead of making skilled labour superfluous, the introduction of machinery has resulted in more skilled workmen being employed, and at better wages than before, and similar developments are likely to follow when the workman is further relieved from hard toil by his best friend the labour-saving machine. Another feature of machine work is the greater accuracy that can be attained so that, while the cost of production is lowered, the quality of the product is improved, and at the same time the interchangeabity of parts is secured, which in itself contributes to the lowering of cost. It is not easy to convince workmen that "increase of output" is of advantage to them; if we are to accept statements published in the newspapers, they rather believe in the direct opposite, "restriction of output," although their official organs repudiate the idea.

This desire to do as little work as possible is, in a way, ingrained in us all, but in the workman it is, in addition, a reminiscence of the mediæval guilds, those ideal trade unions which have been abolished everywhere as incompatible with modern industries. In their time they have filled a useful purpose, but the conditions which made them appropriate have entirely passed away, and any attempt to revive them or their principles is doomed to failure. According to their constitution nobody was allowed to exercise a trade, or even to sell its products, who had not been brought up to it in accordance with strict regulations, first serving an apprenticeship, then becoming a journeyman, and finally advancing to be a member of the guild if he could produce a satisfactory masterpiece. The number of apprentices taken on was prescribed, and the number of masters in each community was limited, so that every craftsman was tolerably certain of constant employment. No wonder that such a condition of things has a great attraction for the modern workman, especially when he happens to be out of work, and that he thinks he can improve the position of his class by restricting output and by insisting on a minimum rate of wages, after the manner of the old guilds. His reasoning apparently is that modern conditions of living require a number of things to be done every day; consequently the less work each individual does the more individuals have to be employed, and if a minimum rate of wages is enforced the question of the unemployed is satisfactorily solved. In the Middle Ages, when each community was to a great extent self-contained, and the intercourse, even between neighbouring towns, was hampered by bad roads and insecure travelling, it was possible to adopt this solution of the problem, especially as the style of living was very much the same for the great majority of people, while their requirements did not include much beyond their bodily wants. During this time the workmen, when they had become full members of the guild, were practically chained to the soil, and in return for this immobility their number in a community was limited. They had to do all their travelling, if they were that way inclined, while they were journeymen, and most of them used that time for picking up information useful for their trade, even in foreign countries. As the facilities for travel increased, and with it the intercourse between distant countries, the prices of products fell which formerly had been obtainable only by the very rich, and gradually the great majority of people have become accustomed to surround their daily life with luxuries, meaning thereby everything that is not absolutely required to keep body and soul together. This alteration in the way of living has been further accentuated and extended by the substitution of machine work for manual labour; in fact, this change of the mode of production is still going on to the great advantage of the consumer: in other words, everybody is sharing in the great benefit of the cost of production being lowered.

On the position of workmen the further circumstance has exercised an important influence that, by the facilities of intercourse and by the employment of machinery, huge factories are enabled to undersell works on a small scale, so that for successful competition in modern industries capital has become a necessary adjunct. It is, therefore, no longer possible to insist on masters being selected only from the class of workmen, nor is the work which is absolutely necessary for the daily existence of mankind sufficient to keep all workmen in constant employment, so that the old remedy of the guilds can no longer be applied. Restricting the output has in fact nowadays exactly the opposite effect to what it is intended for. When the price of an article is raised owing to this supposed remedy, a number of consumers begin to do without it, and the demand for it diminishes, so that less people can be employed on its production.

Instead, therefore, of securing employment for more men, it will endanger the continuance of work for those who restrict output under the mistaken impression that they are benefiting their fellow-workers. How far this restriction of output is carried sometimes can be illustrated by the action of the workmen in shipyards and boiler shops, who either refuse to work pneumatic riveting machines or insist on doing no more work with the machines than could be done by hand, exacting the same price per rivet as for hand labour. It escapes their attention that they handicap their employers in competition with others who are free to utilise such labour-saving devices to their full extent, and that unsuccessful tendering means no work at all. On the other hand, a good example of the beneficial effect of lowering the cost of production is furnished by the trade in glow lamps. At first, when they were made by a few highly-skilled workmen and sold at 25s. each, there were very few consumers able to indulge in the luxury of electric light, and the number of hands employed was correspondingly small. That condition of things has been absolutely changed since the price has been lowered to its present level; thousands of skilled workers are employed in the production of lamps, in addition to the tens of thousands of unskilled people who attend the machinery used in the manufacture and perform the manifold functions connected with this trade. Such a result could not have been attained without the use of labour-saving machinery of the most varied description, and it seems incredible that, in spite of this and similar demonstrations of the beneficial influence of increased output at lower cost, the workman should remain blindly hostile to this principle and cling to his exploded remedy of restriction of output. This attitude is illustrated by a remark which a leading workman made when the importance was impressed on him of diminishing the amount of wages chargeable to each individual article, because in this way the article became cheaper, more customers could be found to purchase it, and consequently more workmen would be required to produce it. His observation was that he fully understood the argument, and that it meant, in his opinion, when carried out to its full extent, that everybody would find employment if no wages were paid at all. It is rather sad to think that such a man, who has been elected by his fellow-workers to a high office in his trade union, should not be able to discriminate between the rate of wages paid to a workman and the proportion of such wages chargeable to each article produced by that workman.

Workmen have also a rooted objection to seeing machines worked by unskilled men, which is apparently based on the mistaken notion that such unskilled men are replacing skilled workers. They, however, overlook the fact that labour-saving machines are only introduced where the same articles produced by hand labour would be too expensive for sale, consequently no skilled workmen could be employed instead of labour-saving machinery. Another fetish of the working man is his desire that all workers should be treated alike and no preference given, absolutely ignoring that the capable and industrious are more deserving than the lazy and careless workers. How disastrously this tendency sometimes operates I can tell from a personal experience when I started the first continuous working tank glass furnace in Leeds about 25 years ago. Up to that time all glass for bottle making was melted in pots and the glass-blowers were never certain when their services would be required, as it was almost impossible to melt the batch in a given time. Again, their work was frequently interrupted if the furnace man was unable to control the heat properly, so that the melted glass was either too hot or too cold. In any case, the working out of the last portion was very troublesome, as the pipes had to be dipped far into the furnace to reach the bottom of the pots. All these drawbacks are overcome in the tank furnace, where the melted glass is always ready for the blower; its temperature is under perfect control and its level is always the most convenient for the workers. As it happened the secretary of the trade union worked at the furnace and expressed repeatedly his great satisfaction at this complete solution of all their difficulties. His union consented to the prices of bottles being lowered, but in spite of that the men succeeded in earning higher wages than before, owing to the greatly increased facilities of working. Encouraged by the success, the firm desired to establish three shifts of workers in order to utilise to the full the continuous working of their plant, but the trade union would not give their consent, alleging that the firm were making enough profit working two shifts. The firm then resolved to build some more furnaces of the same kind, but, to everybody's astonishment, the trade union threatened to withdraw all their members if another furnace were built. I asked the secretary for an explanation, and reminded him that he had nothing but praise for the improved system of glass melting. In reply he said that he had nothing to take back, but that it was precisely the very great advantage that men enjoyed who worked at these furnaces which induced his Council to prohibit their further building, as it was not likely that all the Yorkshire employers would follow suit, and they did not wish to have some of their men working under better conditions than others. To this decision the trade union adhered for nearly 20 years, and the consequence has been that hardly any glass bottles are now made in England. I was reminded of this story when I saw in the newspapers, a short time ago, the bitter complaint of the glass workers that foreign bottles were dumped in this country to the detriment of the native workmen. If these men had understood, 25 years ago, the principle that to lower the cost of production is to facilitate and increase the sale of an article, and thereby to benefit the whole community, themselves included, they would not have opposed the introduction of the tank furnaces, and they might also have remembered that competition would have forced all employers very soon to adopt this improved method of glass melting, so that all the members would have worked under the same favourable conditions. Such a glaring case of shortsightedness does, perhaps, not occur very often, but this particular one has done irreparable injury to the manufacture of glass bottles in Yorkshire. Similar mistakes on the part of the trade unions can only be prevented by enlightening the workman as to the necessity of lowering the cost of production, so that he uses his best endeavours to increase the output by adopting the latest methods and the best labour-saving machinery, and by convincing him that restricting the output means restricting employment.

However important capital and labour are to an industry, the third factor, "Management," is none the less essential for its satisfactory progress. Under this term everything is included which appertains to: (*a*) The selection of site for works, their planning and their equipment. (*b*) The commercial work connected with the business. (*c*) The arrangements for carrying on operations. (*d*) The designing of new apparatus and the investigation of new methods of manufacture.

It is easy to understand that in every one of these directions good management can do much to lower the cost of production, but this is hardly the time to discuss all these points in detail. Only on the last I venture to make a few remarks, as the proper design is a matter in which the members of this Institution are interested, more particularly those who have only recently graduated from a college. A good design should have for its aim the lowering of the cost by employing simple component parts which can either easily be obtained or cheaply manufactured. The first requirement is fulfilled by utilising standard sizes, and in this respect the work of the Engineering Standards Committee is of the greatest possible importance to the industries of this country. In addition to these "public standards" much can be done to facilitate work by adhering to standard parts in each factory, so that it is not necessary to carry an immense variety of parts in stock. A number of graduates do not realise that the object of their working practically in the various shops, in addition to studying at a college, is to teach them by their experience what the difficulties of the various operations really consist of. It is not so important that they learn to overcome these difficulties as easily and as quickly as a skilled workman, but that they acquire the habit of thinking how to avoid these difficulties when they are designing new work, and how to take advantage of the material at their disposal. In other words, a designer should have an intimate acquaintance with the scientific principles that come into play and with the ways in which they are applied, and he should know, if possible from personal experience, the capabilities and the limitations of the workman and of the machinery by which the operations are carried out. It is, however, by no means sufficient for preparing suitable designs to be well acquainted with the means employed to execute them: it is just as important to form an accurate conception of the problem that has to be solved, and to possess a thorough knowledge of previous attempts in the same direction, and of the causes of their success or failure. Another branch of knowledge required for the good management of factories is a careful training in the way of conducting experimental investigations, coupled with the good judgment as to which investigations are worth taking up. No doubt the list of qualities that ought to be found in a good manager could be extended still further, but enough has been said about all the three principal factors to show the great number of different points which have to be considered in connection with the internal working of modern industries.

Besides these internal factors, there are all the external circumstances which influence the well being of the industries, and it is easy to see, even without entering at length into further details, that no true picture of the state of an industry can be arrived at if only a few features of their complicated constitution are to be taken into consideration. These remarks about industries in general apply naturally to the young electrical industry quite as much as to the oldest established one; there are, however, some features of its development which have greatly contributed to its rapid rise, and could, perhaps, be imitated in other industries to their great advantage. At first the long time during which weak battery currents alone were employed, chiefly for telegraphic purposes, permitted the completion of important scientific investigations which in the end led to the discovery of those fundamental laws which form the basis of all practical applications of electricity. Nor has science deserted the industry when it began to deal with powerful currents. I will only remind you of Dr. John Hopkinson's mathematical demonstration in this room, that alternate-current machines can be worked in parallel. This example is particularly interesting, as in this case science has pointed out to the engineer how he could solve one of his problems; usually the function of science has been to prevent its followers from being deceived by appearances or by plausible fallacies. By such negative indications alone science can give definite answers, while its deductions of a positive character cannot be accepted without further proof, owing to the uncertainty whether all premises necessary for the correct solution of the problem have been taken into consideration. For this reason deductions arrived at theoretically should be tested by practical applications before further conclusions are based upon them. Here again the electrical industry has had the great advantage of possessing from its very beginning most sensitive instruments, which, in addition, are easily handled, so that the verification of theories has been a comparatively easy matter, and it has been possible to control by accurate measurements all operations not only in the laboratory but also in the workshop.

One feature of electrical measurements has contributed more than anything else to the rapid rise of the industry, and that is the adoption of the same units of measurement in all countries. The idea of such a system originated with Prof. Wilhelm Weber, of Gottingen, about 70 years ago, but the British Association for the Advancement of Science has the honour of having taken the first step to realise the proposal of Weber by appointing a committee to suggest practical electrical units. This committee, after due deliberation, chose as the basis of their system the centimetre, the gramme, and the second, and I should like to know why they chose the metrical units, unless they had convinced themselves that these were the best for the purpose. At that time (1861) there was no question of international units, nor had the metrical system been adopted as universally as it is now; all the more weight ought, therefore, to be attached to the decision of this committee, which consisted of eminent scientific men and prominent engineers, so that both the theoretical and the practical aspects of the question were kept in view during their deliberations. Certainly there is no doubt about the beneficial effect of the adoption of this system by all countries, and I have no recollection of ever hearing that the decimal division adopted in it has given rise to any difficulties. It is true some modifications have become necessary, which were discussed and accepted at a series of International Congresses called for the purpose, but so far as I am aware nobody has ever suggested that it would be to the advantage of any country to start a system of electrical units of its own. In spite of this favourable experience, we all know that there exists still an obstinate resistance against the general introduction of the metrical system into this country, although it has been shown over and over again that the reasons advanced for this obstruction are based on fallacies and are opposed to the experience of other countries. Such an attitude is very largely due to want of practice with a thoroughly consistent system of weights and measures. In this connection it is significant that all engineers who have had to deal for any length of time with metrical measurements unhesitatingly prefer them to the English want of system. I am, of course, aware that some prominent engineers profess to have tried to work with metrical units, and have been unable to work as quickly and easily with them as they could with their accustomed units. About them one is tempted to say that their conclusion in this particular matter is about as reliable as that of a man who tries to skate, and, after his first attempt, gives it as his opinion that you cannot move faster by skating than by walking. Another big outcry is raised against the metrical system on account of the great disturbance of all business transactions that would result from the change of weights and measures, and appalling figures are marshalled as to the expense of giving effect to it. It does not appear that other countries have been ruined by discarding obsolete weights and measures, nor should the expert opinion of the inspectors of weights and measures be ignored, who unanimously consider the introduction of the metrical system to be a pressing need to put an end to the existing confusion, and advocate, in addition, that such an introduction should be made compulsory. The very same thing has been recommended by two or three Parliamentary Committees, after hearing innumerable witnesses for and against the change. Why should such well-considered opinions be calmly ignored, and why should the bogie of expense be trotted out before the public, when the real sentiments of the opponents about the disturbance of trade, caused by a change of weights and measures, are disclosed by the fact that they themselves advocate a revised British system, based on the inch, the introduction of which would have the same disturbing influence as that of the metrical system, but would lack the advantage of making the international metrical system the universal one? For it cannot be doubted that the example of Great Britain would immediately be followed by the British colonies and by the United States, so that the whole community in all civilised countries would enjoy the same advantages as the electrical engineers already possess.

Against this argument the opponents of the metrical system usually point out that even in France some instances can be found where the old measures are used in preference to the metrical ones, but on examination it turns out that only the old names are preserved in some districts and in some trades, but that in reality the measures in use are based upon metrical units. The few exceptions are only proving the rule; and it would be as wrong to say that the metrical system is not universally used in France or Germany, as it would be to contend that English is not the language of the United Kingdom, because you can find people in some remote parts who do not know that language. As a last resort the expense of changing the screw-threads is urged against the change to the metrical system, and the Continental practice of calling their system "Whitworth Thread" is considered an incontrovertible proof that the metrical screw-thread is impracticable. If all taps and dies and leading screws had to be exchanged at once, it would certainly be a costly affair, but such a measure is not likely to be adopted, as no advantage could result from it. For the real difficulty with screw-threads is that giving dimensions on paper is not sufficient to insure that the screws, manufactured according to such instructions in different works, are really interchangeable. This subject has been investigated by a committee of the War Office, and their conclusions throw a very interesting light on the controversy. In their opinion it is only possible to obtain interchangeable screws, if the leading screws by which they are made have all been cut on the same screw-cutting lathe, or are at least cut on benches which are fitted with a leading screw manufactured on the original bench. If another link is interposed differences in the screw turned out become perceptible. As a consequence of the finding of this committee a screw cutting lathe has been set up at the National Physical Laboratory, where leading screws for screw-cutting lathes are to be manufactured. The same experience has been made in other countries, where nominally "Whithworth's Threads" are used. It is not possible to make screws interchangeable by prescribing their dimensions, the only way is to obtain taps and dies or leading spindles cut by the same tools. If it is not a case of extreme accuracy, there is no difficulty in cutting English thread by means of a metrical leading screw or vice versa. By using a wheel with 127 teeth on the driving axle an accuracy of 1 : 6350 can be obtained, which is sufficient for ordinary purposes. In any case it is much to be regretted that such a useless encumbrance of our daily life, and such an obstacle to foreign trade, as the English system of weights and measures, has not yet been abolished.

Among other external factors which influence the technical side of industries are the patent laws of the various countries—a subject on which the most divergent opinions have been pronounced. It would lead me too far if I attempted to discuss all the features connected with the patenting of inventions, but I should like to draw your attention to the fallacy of considering a preliminary examination, as practised in the United States, for instance, to be of any advantage to an inventor. That system of examination involves as much trouble and expense as a lawsuit, but it is no bar to a lawsuit being commenced later on, and then the same case has to be argued over again. A favourable result of such an examination is, therefore, in no way a guarantee of the validity of the patent—on the other hand, I willingly admit that anticipations may be detected by this search. It is, however, the business of an inventor to find out for himself what has been done before, and to make himself thoroughly acquainted with his subject before he begins to suggest improvements. In this work he should be assisted by the staff of the Patent Office, where a reference library for technical subjects should be at his disposal, containing not only patents, industrial designs or models and trade marks, as prescribed by Art. XII. of the International Convention for the Protection of Industrial Property, but also files of the principal technical and scientific periodicals and transactions. Searching such records will prove to be a liberal education, and will in the end be of greater advantage to the inventor than having this work done for him by the members of the staff, who cannot be as well qualified to make the search as the inventor himself, as their acquaintance with the essential features of a new device is necessarily inferior to his.

Other branches of legislation, besides the Patent Laws, affect industries directly or indirectly, either by prescribing measures for safeguarding health and life or by laying down rules for the building of factories, or by dealing with the liability of employers in case of accidents. With all these I do not propose to deal in further detail as I hope that by merely outlining the influences under which industrial work is carried on, I have made it clear that they are very numerous and of the most varied character. It is, therefore, extremely difficult to foresee what consequences a serious alteration of some of the existing conditions will entail, while it would be quite wrong to draw conclusions about them from a comparison of the industrial state of a country at the present time with its position before railways, telegraphs and other modern contrivances revolutionised the intercourse between nations. By their aid manufacturers in any country are now in a position to make themselves quickly acquainted with the latest improvements affecting their business that may have been discovered anywhere, and they can also ascertain without much delay and with very little trouble what the requirements are of the remotest communities. In this respect manufacturers of all countries are now competing on an equal footing, where formerly those of one country may have had great advantages over the others. Another cause of change has been the desire of many countries to createtheir own industries instead of depending on foreign supplies, and it is not very wonderful that the British industries have new rivals where 60 years ago they had absolute command of the markets. If complaints are now raised that this foreign competition is ever increasing, and proposals are made to protect British industries against it, two points require particular attention. One is that it is hopeless to endeavour to re establish the former monopoly, and the second that it might be useful to investigate whether the former industrial supremacy has not led to neglect in many respects, for which we now have to suffer. Whatever remedies may be proposed to enable British industries to hold their own in the general competition, there is, in my opinion, only one safe test for selecting the right ones, and that is that their adoption should lower the cost of production for the benefit of the whole community.

WIRELESS TELEGRAPH NOTES.

Prof. Slaby contributes another article on wireless telegraphy to the *Elektrotechnische Zeitschrift* of October 27th, this being the third of a series of which the two former parts have been noticed in this column. The present communication deals mainly with the energy dissipation due to ohmic resistance in the metal and in the spark-gap of a transmitting air-wire. First, he shows that the damping in—for example, a 120ft. air-wire of copper 3mm. thick—amounts per period to about 0·8 per cent. of the energy of the oscillations, and is, therefore, negligible. Then he describes his method of measuring the resistance of the spark-gap. This method consists in forming an oscillating circuit containing in series the ordinary spark of fixed length, a spark-gap of variable length, a condenser and inductance, a variable resistance of graphite rod and a delicate hot-wire ammeter. The variable spark-gap is shunted with an electrolytic resistance, so that the final potential at the fixed spark-gap is not affected by alterations of the length of the second. The variable spark-gap is then slowly lengthened from zero, and at various positions ammeter readings are taken. Thus the current is obtained as a function of the spark-length. Next, the gap is shorted and the graphite resistance varied, with the result that the current is plotted as a function of the spark-length. These two curves, at equal ordinates, express spark-lengths in ohms. This result plotted as a curve shows that the resistance rises parabolically with spark-length for small lengths, and afterwards increases linearly. By different series of experiments, using different values of the capacity included in the oscillating circuit, Prof. Slaby finds that with increasing capacity (which implies diminishing oscillation frequency) the resistance per millimetre of spark-gap is decreased at all lengths. These noteworthy results are exhibited in another way by plotting the conductance of the gap on an oscillation-period base. The curves show that as the period increases the conductance of the gap diminishes, linearly at first and afterwards more rapidly—the more rapidly, besides, the smaller the spark-gap. Thus for all periods, with the same spark-voltage, small gaps have more than proportional conductivity as compared with long gaps. For this reason the author believes that ohmic waste at the gap could, in wireless telegraphy, be mitigated by replacing a long gap by several shorter gaps. As an example, a 10mm. gap, with a discharge potential of 30,000 volts and having an effective resistance of 15 ohms, can be replaced by three gaps in series each 2·5mm. having, together, the same discharge voltage, but a total resistance of only 0·6 ohm.

It appears that a new wireless telegraph burglar alarm has been fitted by the Chubb Lock Co. to a safe, and is so arranged that any tampering with the door at once causes an oscillator to send out Hertzian waves which actuate alarms in all parts of the building. In addition to this useful function the apparatus also delivers an unpleasant shock to the burglar. We are inclined to think that old-fashioned devices worked by wires will be substituted after the establishment has been unnecessarily alarmed by a few nocturnal thunderstorms.

It is reported that the Canadian authorities are disposed to adopt the lead of the United Kingdom in connection with national control of wireless telegraphy.

LEGAL INTELLIGENCE.

Chepstow Gas & Coke Consumers Co. v. Chepstow Electric Light & Power Co.

In the High Court on Friday last, the Lord Chief Justice, Mr. Justice Kennedy and Mr. Justice Ridley heard an appeal on behalf of the Chepstow Electric Light Co from a conviction and fine by the Justices of Monmouth. It appeared that on May 31 last, complaint was made by the Gas Co. that on and since Oct. 2, 1903, the Electric Light Co. had made default in complying with certain requirements of sec. 18, sub-sec. 1 of the Electric Lighting (Clauses) Act, 1899, in having laid down and constructed certain new electric lines and other works in undue proximity to the mains or pipes belonging to the Gas Co. and had not conformed to the requirements of the Gas Co. for protecting their mains, &c., from injury. A summons was issued against the Electric Light Co. and was heard on June 17, when the Electric Light Co. were convicted. Before the opening of that case the Electric Light Co. objected that the Court had no jurisdiction inasmuch as there was a special method of recovery provided under sec. 18 of the Electric Lighting Act, 1899, that the complaint was not made within six calendar months of the time when the matter of the complaint arose, that the matter of the complaint had already been the subject of arbitration, that the arbitrator's award was final, and that the Gas Co. were barred from proceeding for the recovery of penalties. The magistrates overruled these objections and heard the evidence, when it was proved that the Electric Light Co. did not give the Gas Co. notice, as provided by sec. 18 of the Act, before commencing to dig trenches for their lines near the mains of the Gas Co., and that the cables of the Electric Light Co. were laid in undue proximity to the gas mains, and not in accordance with the requirements of the Gas Co. It was also proved that the Electric Light Co. had not altered the situation of the lines since the date of the arbitration, and that the work of laying the electric lines was completed by Oct. 31, 1903. The Justices considered the complaint and information sustainable in addition to the arbitration proceedings, and accordingly convicted the Electric Light Co., and fined them £1 and costs, and a daily penalty during default of £1. The question for the opinion of the High Court was whether their decision was right in point of law.

Mr. SHIRESS WILL, K.C., for the Electric Light Co., contended that there could not be a conviction for daily penalties until after there had been a conviction, and took the various points mentioned.

Mr. M. MACMORRAN, K.C., for the Gas Co., said that penalties in addition to compensation was one of the means of enforcing the requirements. The complaint was that the electric lines were laid in some cases over the gas pipes. So long as the requirements of the Gas Co. were not fulfilled they had a grievance, and the offence arose from day to day. Under these circumstances there was a necessity for a continuing penalty.

In giving jugment, the LORD CHIEF JUSTICE said the Court was of opinion they could not interfere with the conviction. The proceeding was commenced by information and summons under sec 18 of the Act against the Electric Light Co for that they had laid down and constructed certain new electric mains in undue proximity, and had not conformed with such requirements as were made on behalf of the Gas Co. He saw, of course, how that statement was made as to laying down the mains in undue proximity got into the summons. There had been arbitration proceedings before Major Cardew with regard to the cables, and Major Cardew had found as a fact that the cables were in undue proximity, and that the Electric Light Co. had not obeyed the requirements of the Gas Co. The offence here was not an offence of laying down wires in any given position, but machinery was provided whereby certain people whose interests were affected (as, for instance, the Gas Co.) might make requirements, on notice being given, that they had a means of recovering any damages done, and there was a provision for arbitration. But sec. 5 made the substantive offence default in complying with any of the requirements of the section. And so far as this was concerned the only requirement of the section was not conforming with reasonable requirements made by the officers of the company for protecting the gas pipes. Therefore they had to consider whether or not the time limit of six months in Jarvis's Act, which was relied upon in this case, applied so as to make the conviction either bad upon the face of it or bad on the facts stated by the magistrates, showing that there had been a complete offence for more than six months. The point that there could be no summons for a penalty because the matter had been referred to Major Cardew, was not a good point. Not only did the section say the penalty was to be in addition to compensation, but it was obvious the provision for a penalty had no necessary relation to the compensation. It might very likely be the penalty was for the purpose of enforcing obedience to some requirement which did not involve compensation at all, and yet might be found to be reasonable, as, for instance, the putting of the mains at any given distance from the gas pipes, found to be right by the arbitrator. That, he thought, had been made clear because there was a daily penalty added showing that the provision regarding penalty had nothing to do with the compensation to be paid to the Gas Co. It had been contended that the conviction was bad, because, in addition to a £1 penalty, it went on to say "and £1 for every day in default." They all thought that was a matter which did not affect the conviction, and the only result of their order on that would be that that be struck out from the conviction, and no effect would be given to it in the event of any effort being made to enforce the penalty. The difficult point was that the information was laid too late. The question was whether the contention was right that, because the conviction related to something done as far back as Oct. 22, or mentioned on its face that the company on and since Oct. 2 made default in obeying the requirement, the conviction was bad. He was clearly of opinion that was not an objection to be taken to make the conviction on the face of it bad. There was a broader view to be taken of the case that this requirement was for the purpose of that offence—assuming it to be a proper requirement put in the position of disobedience. It seemed to him it was possible the magistrates might have thought that the offence namely, disobedience to the order—was of such a character that there was a completed offence at a certain time Having regard to the language of the order and the facts as found by the magistrates the question could not arise and could not be relied on in that particular case. The appellants were disputing that the mains were too near for more than 4½ months after the question was raised, and then there was a requirement to them to comply with what the gas company wanted after the date of the award. It was not possible for them to allege this conviction as alleging a completed offence on Oct. 2, in respect of which the penalty might have been inflicted, but there was nothing to show the offence was complete or not conforming to the requirements more than six months before the summons was taken out. He was, therefore, of opinion that the appeal must be dismissed with costs.

The other judges concurred.

Lincolnshire Tramways Co. v. Dickinson.

Last week a Divisional Court (the Lord Chief Justice, Mr. Justice Kennedy and Mr. Justice Ridley) heard this appeal from a decision of the Lincoln County Court Judge, Sir G Sherston Baker. (The facts of the case were reported in our issue of June 24.) Defendant, a well-known consulting engineer, was retained by plaintiffs to report on their lines. He did so, but was unable to give evidence in the then impending arbitration. After his initial fee of 50 guineas had been paid, plaintiffs alleged that he was bound to give evidence, and that as he had failed to do so they were entitled to recover back the fee paid him. The arbitration never became necessary, as the parties came to an agreement. Meanwhile, Mr. Dickinson had declined to give evidence, and plaintiffs called in another gentleman in view of the possible arbitration, paying him also 50 guineas.

Defendant contended that there was no contract to give evidence at the arbitration, and pleaded that he had done what he was paid for namely, made an examination and reported upon the lines, with a view to assisting plaintiffs to see what price they ought to ask for their property. The County Court judge decided in favour of plaintiffs, and defendant now appealed.

After argument, their Lordships allowed the appeal, entering judgment for defendant, with costs.

Thompson v. Mackie & Co.

In the King's Bench on Wednesday, before Mr. Justice Lawrance and a jury, William Thompson, a liftman employed at Mann, Crossman & Co.'s brewery, was awarded £80 damages for personal injuries against W. Mackie & Co., electrical engineers. Defendant firm was employed to re-wire the electric lifts at the brewery in February, and plaintiff, who was cleaning out a pit, was seriously injured.

Defendants contended that plaintiff must have known what was being done, and should have avoided the lift.

Attorney-General v. Urban Electric Supply Co.

This case was in the list for hearing before Mr. Justice Joyce in the Chancery Division on Monday, when Mr. Hughes, K C (for the Attorney-General) said he required time to consider the matter and, possibly, to put in further evidence. He asked for an adjournment until next week. It was arranged that his Lordship should hear the case on the 19th inst.

Sanders v. Reid Bros. & Co. and Others.

Before the Lord Chief Justice and a Special Jury yesterday (Thursday), plaintiff (a carman) sought to recover damages against London County Council, and their contractors, Messrs. Reid Bros. & Co., electrical engineers, for personal injuries sustained on July 14 last by reason of his being thrown from his seat while driving a lorry past a manhole which had been constructed for the purposes of the electrification of the Council's South London tramway system. Reid Bros. & Co., who were employed by the Council to provide and lay conduits, denied that they had been guilty of negligence or that they were responsible, for having performed their work they gave notice to the Highway authorities (Southwark Borough Council) to permanently replace the road.

In the result the jury found that the accident was caused by the negligence of Reid Bros. & Co., and returned a verdict for plaintiff for £125.

Judgment was given with costs against both defendants.

The Aston Meter Trouble.

On Friday, at Aston police court, the test case against one of the malcontent electricity consumers was decided. A consumer named W. Hunter was summoned for non-payment of £2. 10s. 10d. for electrical energy consumed and 11s. 1d. for rental of fittings. (The evidence given on the last occasion was abstracted in our issue of 28th ult.) The Bench now made an order for the payment of £1. 16s. 6d.

Tramway and Electric Lighting Assessment.

The arbitrator (Mr. P. Michael Faraday) appointed to deal with the question of the increased assessments of Hull Corporation tramway and electric lighting undertakings has issued his award.

The old assessment of the tramways was £12,685, the new assessment £23,281 and the arbitrator's award is £16,636. The old assessment of the electric lighting undertaking was £2,591, the new assessment £7,081, and the arbitrator's award is £2,714.

Mr. Faraday held that the principle of the "Mersey Docks and Harbour Board v. Liverpool Overseers," does not apply to municipal tramways.

Re Elmore's Trust (Ltd.)

On Tuesday Mr. Justice Warrington dismissed the petition of Miss A. J. Reynolds and Mr. Allan Reynolds, for the compulsory winding-up of this company.

Damaging Fuse-boxes.

At Bootle Police Court last week two boys, named Reddington and Howitt, were summoned for damaging a fuse-box belonging to Bootle Corporation. Mr. F. M. Farmer, for the Corporation, said that on Oct. 7 the two defendants were seen to put a wire into a fuse-box in Rimrose-road. This resulted in a total derangement of the electricity supply of the borough, and in several of the large works much inconvenience was experienced by the temporary failure. One of the defendants said he put the wire into the box to get an electric shock.

The bench said the boys had indulged in a most dangerous practice, and they would have to pay the costs of the summons.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An assistant electrical engineer is required for Hull Corporation electric tramways department. Salary £120. Applications to the tramways electrical engineer (Mr. J. Wilkinson), Tramway Power Station, Osborne-street, Hull, by Nov. 14. See advertisement.

A shift engineer is wanted immediately at Worksop electricity works. Applications to the clerk to the Council (Mr. Geo. H. Featherstone) by Nov. 17. See advertisement.

Oldham Electricity committee require a junior assistant electrical engineer with previous experience in central station work. Salary £75. Applications to Mr. S. Wilmott Newington by 14th inst.

Poplar (London) Borough Council require a mains superintendent. Salary £120. Applications by 18th inst. to the town clerk (Mr. Leonard Pottel, Council Offices, High-street, Poplar, E. See also advertisement.

Notice is given in connection with the forthcoming examination for assistant examiners in the Patent Office that Dec. 15 is the latest date on which applications can be received on the official forms.

A lecturer in electricity and physics is required in January at the Municipal Technical School, Birmingham. Commencing salary £140. Particulars from Mr. G. Mellor. Applications by Nov. 19.

Battersea (London) Council require an electrical engineer Salary £400. Applications by noon Nov. 15.

Battersea Council also require an assistant superintendent for town hall buildings. £2 per week and uniform. Applications by noon Nov. 16.

Chester Corporation want a station superintendent. Salary £130, rising to £180. Applications by 14th inst.

Blackburn Electricity committee require a mains assistant. Applications by Nov. 18.

Patent Office.—An open competitive examination for not fewer than 20 situations as assistant examiner in the Patent Office, London, will be held by the Civil Service Commissioners, to commence on Jan. 2. Forms of application for admission from the Secretary, Civil Service Commission, Burlington-gardens, London, W.

Mr. D. M. Kinghorn, electrical engineer and manager of Leigh (Lancs.) electricity works, was on Wednesday appointed chief engineer and manager to Southwark (London) Council's electrical undertaking. There were 93 candidates.

Mr. J. E. Teasdel, chief assistant electrical engineer at Cardiff, has been appointed resident electrical engineer and manager of the Pontypridd electric tramways at a salary of £300 per annum.

For the position of mains superintendent Marylebone (London) Council selected the following three candidates from the applications received :—Mr. C. H. Smyth, chief electrical assistant at Willesden ; Mr. C. M. Davis, mains superintendent at Barrow-in-Furness ; and Mr. W. Chamberlain, mains superintendent at Oldham. Ultimately the Electric Supply committee selected Mr. Smyth, who has been appointed at £230 per annum.

Mr. W. H. Allen, at present chief assistant engineer, has been appointed chief engineer and manager of Loughborough electricity works, and Mr. G. H. Saunders has been promoted to the position of chief assistant.

Australasia.—The "Australian Mining Standard" states that Sydney Electric Lighting committee recently decided to recommend the City Council to seek parliamentary powers to borrow £250,000 for the extension of their electricity undertaking and to carry out various extensions of the mains recommended by their electrical engineer (Mr. T. Rooke.)

What is claimed to be the first electric pneumatic signalling apparatus has been recently installed at the central railway station, Brisbane, at a cost of about £3,000.

The Goldfields Diamond Drilling Co. have now 26 Sullivan electric diamond drills at work in Australasia.

In the course of his recent examination by the South Australian Royal Commission on the electrical equipment of the Islington railway workshops, Mr. E. Noyes said he estimated that the proposed electric power plant would pay interest and redeem the capital expenditure in about 10 years. There was a loss of 20 per cent. with the present system. It was proposed to instal 36 motors, 13 crane equipments and three sets of boilers. Mr N. I. Price, representative of the General Electric Co. (N.Y.), also considered the workshops highly suitable for electric driving, and that the cost could be wiped off in 10 years. Mr. Price, however, advocated a mixed drive, so as to make the whole system as flexible as possible.

Birmingham Electric Club.—Mr. J. W. Innis presided over a meeting at Birmingham on Saturday to further consider the question of organising an electric club for Birmingham and district. The committee appointed at the last meeting reported in favour of the project and submitted certain proposals.

It was decided that a club should be formed to be called the Birmingham and District Electric Club, with the object of disseminating knowledge and information on electrical engineering and scientific subjects by the reading and discussion of Papers, visits to works and other places of interest, and for social intercourse between members. It was further resolved that ordinary membership should be open only to those engaged in the electrical profession, and who have had three years' experience, either applied or theoretical. The club house for the present will be the Colonnade Hotel, New-street, Birmingham. Mr. J. W. Innis was elected president, and Mr. M. G. Waggott, engineering branch, Post-office, Birmingham, hon. sec.

Brentwood.—The Council will not oppose the proposed application of a company for a provisional order.

Brighton.—The accounts of the Corporation tramways department for the year ended March 31 show capital expenditure £242,811. 4s., an increase of £37,769. 7s. 7d. on the year.

Total receipts amounted to £46,264. 8s. 10d. and expenditure (including traffic and management expenses, repairs and renewals, &c.) were £40,355. 12s. 9d., balance £5,908. 11s. 1d. Interest absorbed £7,199. 10s. 9d. and sinking fund £3,487. 16s. 8d., leaving a deficit of £4,778. 16s. 4d. The adverse balance is attributed to the fact that the fares are too low—viz., 1d. for 2½ miles, with 54 per cent of the route mileage (over 18 miles) on a gradient averaging 1 in 17. There are 60 double-deck single-truck cars in use, each capable of carrying 50 passengers. 10,999,046 passengers were carried during the past year and 1,151,477 car-miles were run. The income per car-mile was 9·642d. and the expenditure 8·412d. The average fare per passenger was 1d. and the cost of power per unit 1¼d., 1·54 units being consumed per car-mile.

Bristol.—Owing to the demand for electric current in the Broadmead neighbourhood, a sub-station is to be erected and another high-tension feeder and power cable laid. The question of laying mains in the chief thoroughfares in Stoke Bishop and in Henleaze district is under consideration.

Burgess Hill.—Owing to the condition of the money market the Council cannot see their way to establish electricity works at present, and have asked the Board of Trade to extend the period of their 1901 order.

Burslem.—The Council have received authority to borrow money for electricity supply and refuse destructor works.

Burton-on-Trent.—The Council decided on Wednesday to re-arrange the charges for electricity, so as to give shopkeepers a reduction in price.

Castleford.—The Council have applied for an extension of time to carry out the terms of their provisional electric lighting order.

Cheltenham.—Mr. James Swinburne, who was recently called in to report upon the working and management of the electricity supply undertaking, has issued his report.

Mr Swinburne points out that Cheltenham is spread over a large area in proportion to its population. The private houses of the most well-to-do residents are generally in their own grounds, so that the most profitable customers are also spread over a large area. Street lighting is carried out in a more elaborate manner than usual. He finds that depreciation should be charged in the case of a municipal undertaking, but that, other things being equal, it should be less than a private company's depreciation by the amount of the repayment. In practice, the case is much more complicated by the borrowing of more money before the original loan is paid off for extensions of plant, &c. The obvious way of keeping matters straight, Mr. Swinburne thinks, is to pay off the first loan when taking up the second. But that method was not adopted, and so the capital accounts became a tangle of loans redeemable at different dates, at all sorts of rates of interest, and having no traceable relation to the plant actually in existence. At Cheltenham plant had been discarded, and the result was that the sinking fund was partly to pay off loans whose corresponding plant was not there. The real state was thus worse than the accounts alone could show, but only to a small extent. He suggests (1) that interest and sinking fund should be charged as usual; (2) that a depreciation and antiquation fund on the present value of the plant, &c., be charged at a percentage rate that would be charged in private concerns, less percentage rate for sinking fund, repairs and other maintenance charges to come out of that fund; (3) that a rent should to charged for the works, such as the Council would have obtained had they let the ground; (4) properly speaking, the works should be charged with the same rates as they would have paid had they been a private concern.

As regards distribution, Mr. Swinburne finds that the main cause of the present position of the undertaking is that it has been managed too much with a view to a rosy future than a matter-of-fact present. Supply of energy was commenced about May, 1895, from works costing £16,800, but in July of the same year it was decided to apply for a loan of £10,000 for extensions, and in February of the following year for a further loan of £15,000. It would have been (Mr. Swinburne thinks) more prudent to have accepted the view expressed in Mr. Hall's report until there were distinct indications that the undertaking would pay. Mains had been extended in a way which pointed to a complete absence of consideration of their really probable revenue. Expensive outlying consumers appear to have obtained the light on the same terms as those in the compulsory area. That must have been a source of loss. The result was that the system of mains in Cheltenham was a sort of skeleton, with very little on it. The 37 public arc lamps in 1898 had been increased to 388, and it appeared to him that a town of 50,000 inhabitants could hardly afford to spend the £6,698 allocated to public lighting in the accounts of 1903-4, to say nothing of the larger sum of £8,610 necessary to make the undertaking pay expenses. From an engineering point of view the arc lighting was carried out satisfactorily. With regard to the price charged for energy supplied to the tramway company, Mr. Swinburne considers it is too low, and that it might be raised without approaching too nearly the cost of generating by the company themselves. Apart from the question of policy in the rapid extension of mains and the construction of sub-stations to deal with a much larger future consumption, and of the policy in putting down so many arcs, Mr. Swinburne holds that the engineering has been carried out well and without extravagance, and a certain quantity of plant has been discarded for adequate reasons. Mr. Swinburne suggests that a system of energetic house-to-house canvassing for customers be put in hand, and particularly in streets which already have mains, so as to increase the revenue without a corresponding increase in capital expenditure. The capital sunk in the public arcs could not be recovered, but in many of the streets the public would be satisfied with less light, and he recommends that Nernst lamps be put on the arc standards.

Chelsea (London).—In the application for a loan of £29,000 to erect baths in King's-road, £2,600 is included for electric lighting.

Chertsey.—The Council have withdrawn their opposition to the Woking Electric Supply Co.'s application for an extension of their electric lighting order so as to include Chertsey and Addlestone. It was stated at the Council meeting last week that the Board of Trade would not sanction a shorter period for compulsory purchase than 38 years.

City of London.—The Charing Cross and Strand Electricity Supply Corpn. have asked the Corporation's consent to a change of pressure for electricity supply in the western area of the City from 100 to 200 volts, and the request has been referred to the Streets committee.

Colchester.—An inquiry has been held into the application of the Council for permission to borrow £16,500 for electric lighting extensions. It is proposed to put down an additional 500 H.P. steam dynamo, boiler, steam and exhaust pipes, &c. Technical details were supplied by the borough electrical engineer (Mr. A. R. Sillar), who stated that the undertaking had been a financial success and that the profit on last year's working was £1,280. No call had never been made upon the rates. There was no opposition.

Croydon.—An inquiry was held last week into the application for sanction to borrow, among other sums, £29,765 for extensions of the electricity supply undertaking. The borough electrical engineer (Mr. A. C. Cramb) said that he estimated the loan would carry them over a year for mains and two years for generating plant. In reply to the inspector, he said that the demand for electric current was satisfactory, and submitted a chart showing the increase in the demand. There was no opposition.

Defective Lamps and Fittings.—The City of London Electric Lighting Co. have issued a notice to their consumers that the company will, free of charge, inspect consumers' lamps and advise them as to which are the best makes of electric lamps for their particular requirements. The company further offer, for a small fee, to make a test of the insulation resistance on consumers' wiring and fittings and to advise as to alterations and repairs thereto.

Dover.—An inquiry was held on Monday into the application of the Corporation to borrow £24,475 for electric lighting extensions.

The town clerk (Sir Wollaston Knocker) said the undertaking had been purchased by the Corporation for £150,000, and £7,715 of the proposed loan was for capital expended by the company in 1903; £11,260 was for capital expenditure from January, 1904, to March, 1905; £2,000 for costs of mortgage, £2,000 for meters for three years, and £1,500 for "free" wiring for three years.

The INSPECTOR (Mr. R. H. Bicknell, M.Inst.C.E.) said that there seemed to be some legal difficulty as to "free" wiring, and pointed out that the Local Government Board did not sanction loans for such purposes, and sec. 12 of the Corporation Act, 1903, appeared to preclude the Corporation from carrying out such work.

The TOWN CLERK said the words referred to, after giving the Corporation powers to supply electric fittings and meters, were: "The Corporation or their servants shall not be entitled to enter consumers' premises for the purpose of undertaking wiring or installation work," and this they did not propose to do. But it would not prevent contractors working under them or being employed by arrangement with consumers We do not propose to make the contractors our servants, but the servants of the consumer.

The MAYOR: As a matter of fact, the insertion of that clause was due to the wiring contractors themselves, who desired to prevent our supplying these things, so that it might be done through the regular trade.

The INSPECTOR: At any rate, you say it does not prevent contractors doing the work, and that that is what is intended?—Yes.

The borough electrical engineer (Mr. L. W. Woodman) supplied the necessary technical details.

Dundee.—Councillor Urquhart called attention at the Council meeting on Monday to the recent report of the city electrical engineer (Mr. H. Richardson) on the temporary wiring of large halls in the city, and inquired whether it was proposed to take any further steps in the matter.

Mr. Brownlee said the tramways committee were of opinion that directing the attention of the proprietors of the halls to the matter would be sufficient to bring about all that was desired. It was not sufficient, the committee would cut off supply. They would not allow the use of temporary wiring in the halls unless the fittings were approved of by their engineer.

Ealing.—An inquiry was recently held into the application of the Council for permission to borrow (amongst other sums) £20,000 for extensions of the electricity undertaking.

The business manager (Mr. A. E. Lewis) said there were over 80,000 8 c.p. lamps in use in the district, and the present demand was equal to 85 per cent. of the capacity of the works. £11,000 was needed for additional plant and the remainder was required for mains.

East Barnet—The Council have decided, by 5 votes to 3, not to proceed with the consideration of a proposed agreement with the National Electric Construction Co. for the establishment and running of electricity works. A deputation has been appointed to wait upon the North Metropolitan Electric Power Supply Co. to discuss terms for undertaking supply in bulk.

Egypt—The Société Electrique d'Ismailia, owners of the supply works at Suez, have commenced supply with a connection equal to 1,300 8 c.p. lamps including 6 H.P. for motors. The customers on the company's mains include the Suez Canal Co., the Government buildings, and the Eastern Telegraph Co.'s establishments, besides 24 private consumers. There is no street lighting at present. The station is gas driven. The charge for current for lighting in the area served ranges from 1s. 0½d. to 1s. 1½d. per kilowatt-hour, and for power 3½d. The number of 8 c.p. lamps connected at the end of the year is expected to reach 2,500. Current is supplied to Terre Plein, a suburb of Suez about 2½ miles distant.

Electric Lighting Notices.—*Little Lever* District Council are applying for a provisional electric lighting order, with liberty to transfer their undertaking to a company or corporation, &c.

Surbiton District Council are also applying for an extension of the area of their 1891 order, including the parishes of Tolsworth and Hook.

Farnham.—The Council have assented to the application of the Farnham & District Electric Supply Co. for a provisional order.

German Electrical Trade Prospects.—Business in the German electrical industry is reported as rather active, but complaint still continues of the low-selling prices of all classes of electrical goods. Recent developments and the introduction of electrical machinery and apparatus for running operations and in agriculture are having their effect, and orders are coming in for both branches of work in increasing numbers. The export trade for electrical goods is reported to continue satisfactory.

Gillingham.—It was reported at the meeting of the Council last week that there were 210 consumers, representing the equivalent of about 12,000 8 c.p. lamps connected.

The RESIDENT ENGINEER (Mr. A. D. Chalmers) reported as to the hiring out of radiators by the Corporation, and it was recommended that the Council purchase radiators as required on the basis of £3. 1s. for a four-light radiator, to be let at a rental of 7s. 6d. per quarter.

Glasgow.—The general manager of the tramways department has been requested to report upon the question of obtaining powers to carry parcels on the tramways.

In a recent report by Mr. John Young on tramcar roof covers he states that, with the aid of a local architect (Mr. J. J. Burnet), the tramways department have now obtained a design of top-covered car which meets all the requirements of passengers, and at the same time presents an artistic appearance. 32 passengers can be seated under the top cover, and there is also seating accommodation for 5 passengers at each end for those who may prefer to sit in the open. That, with 24 passengers inside, gives a total seating capacity of 66. Mr. Young suggests that that type be adopted for 100 standard cars authorised to be covered, and also for the 100 new cars.

Halifax.—The collision recently on the Corporation tramways in Horton-street between two one-man cars was the subject of an official inquiry on Tuesday. The proceedings were private.

Horsham.—The District Council have increased the salary of the electrical engineer (Mr. J. B. Morgan) from £175 to £225.

Hull.—Hitherto the tramways have been controlled by a subcommittee of the Works committee. An independent tramways committee has now been created.

Kilmarnock—The electricity works commenced to give supply of current on Saturday, and arrangements have been made to open the tramways for traffic on 10th prox., when the inaugural ceremony will be performed by Lord Howard de Walden. The consulting engineers are Messrs. Kennedy & Jenkin and the borough electrical engineer is Mr. A. H. Burbidge, who superintended the erection of the works under Messrs. Kennedy & Jenkin.

Knutsford.—The Council have decided to dispose of their electric lighting order.

Lancashire.—The Lancashire Electric Power Co. have lodged a memorial with the Board of Trade praying for consent to the opening and breaking up of certain throughfares within their area of supply which are not repairable by the local authorities. These thoroughfares are in the districts of Radcliffe, Ramsbottom, Kearsley, Little Lever, Farnworth, Hindley and Abram. Objections to the Board of Trade by Dec. 10.

Lectures.—At the first meeting of the ninth session of Glasgow University Engineering Society on Thursday, last week, the city electrical engineer (Mr. W. A. Chamen), who has been elected hon. president of the Society, delivered his opening address.

Mr. Chamen dealt with the possible and probable developments of electricity supply The various electric power companies, he said, had the prospect of being able to supply power to existing factories dotted about the country, and even to coal pits for driving winding and other machinery, both above and below ground, at a cost below that at which the various separate industries could generate for themselves. The South Wales Co. was already making satisfactory progress in that way, and there was no reason why others, such as the Clyde Valley Co., might not in time be equally successful. Those companies also rendered the running of tramways and light railways in country districts an easier and more economical matter, while it would become practicable to run electric accumulator motor cars in which the accumulators could be made comparatively small and easily removable for charging after quite short runs, to be replaced by other sets ready charged. The possibility of applying electricity to agricultural purposes was well worthy of consideration. Experiments had been made by a few people, among others the late Lord Salisbury at Hatfield, but probably a good deal more might be done. Ploughing, mowing, reaping, threshing and many other operations might all be economically done electrically. Electricity and gas between them could bring about the abolition of the smoke nuisance in cities.

Prof. C. A. Carus-Wilson will commence a special course of lectures to senior students of the Electrical Standardizing, Testing and Training Institution, Faraday House, Charing Cross-road, London, W.C., on Thursday next, Nov. 17, upon "Direct-Current Motor Construction."

Ledbury.—At the Council meeting on Monday a sub-committee (including all members except gas company shareholders) was appointed to consider the question of lighting and the advisability of erecting electricity works.

Library Lighting.—It has been decided to light Hull public libraries electrically.

Light Railway.—It is proposed to construct a line 49¼ miles in length between Ackworth, near Pontefract, and Immingham, Lincs. The scheme appears to meet with the general approval of landowners and others on the proposed route.

Llanelly.—A deputation from the Council and the Llanelly Tramways Co. recently waited upon Mr. H. Graham Harris, consulting engineer to the South Wales Electrical Power Distribution Co., to induce the company to undertake the supply of electricity and the construction and working of electric tramways in the district.

London County Council.—At Tuesday's meeting the Highways committee recommended an expenditure of £1,000 for the purchase of a motor break down van and motor car for the use of the tramway department.

L.C.C. Tramways (Electrical Power) Act, 1900.—A report was submitted by the Highways committee as to the above Act, sec. 23 of which gives to each borough council absolute power of vetoing the use of any overhead system of electric traction in its district. The committee urged that this was not a position in which the tramways authority should be placed. Such a veto tied the hands of the tramways authority in the management of its business. Serious practical difficulties had arisen, as was to be expected. The important question as to the localities in which and the extent to which overhead traction should be employed was a matter for subsequent decision by the Council. The report proceeds to deal with the difficulties experienced in regard to the electrification of the tramways north of the Thames. In this connection they had made proposals to adopt both the overhead and the conduit systems, their general policy being to have conduit for the central portions and the overhead in the outlying districts. They found, however, that a number of the local authorities were not agreeable to have the overhead system. As a result of the present state of affairs, a large number of thickly-populated districts in which tramway development is urgently required will be seriously prejudiced. Under these circumstances the committee asked for the standing orders to be suspended to allow of Parliamentary powers being sought to relieve the Council of the obligation laid upon it by sec. 23 of the L.C.C. Electrical Power Act, 1900, of obtaining the consent of the several road authorities concerned to the use of an overhead system of electric traction.

The report was agreed to.

Tramways in Norwood.—In connection with an intimation from Croydon Corporation, that body proposes to seek powers to extend its tramways to the boundary of the County of London at a point opposite the high level entrance to the Crystal Palace (257yds. of which would be in the County of London). The committee recommended that the Council obtain Parliamentary powers to construct this portion and afterwards enter into an arrangement with Croydon for working it.—Agreed.

St. Marylebone Electric Lighting.—Consent was given to the application of St. Marylebone Council for permission to increase the pressure of supply from the 50 to 200 volts on the alternating and continuous-current systems to a uniform continuous-current supply at 240 volts.

Tramways over Blackfriars Bridge, &c.—The recommendation by the Highways committee that application be made to Parliament to enable the Council to construct tramways across Blackfriars Bridge and along the Victoria Embankment as far as Waterloo Bridge (a total length of 1¾ miles) at an estimated cost for construction on the conduit system of £103,000; cost of cars, generating station, &c., £43,600; total, £146,600, was held over.

New Vauxhall Bridge Tramway.—The Highways committee recommended that application be made to Parliament for powers to construct the line of tramways authorised under the L.C.C. (Vauxhall Bridge Tramways) Act, 1896, over the new Vauxhall Bridge for electric traction, at a cost of £16,000, and this was approved.

Manchester District Tramways.—Manchester Corporation have given official notice to the Manchester Southern Tramways Co. of intention to acquire the company's powers in relation to the construction, maintenance and working of tramways in Bucklow, Cheadle and Gatley.

Mexico.—No country in the world gives higher promise of electrical development than does Mexico, where, over its large extent, water power is awaiting application to every class of industry for which power is required. Several of the larger towns which were only a few years ago almost exclusively agricultural are now becoming large manufacturing centres, chiefly owing to the proximity of water power. This particularly applies to Guadaljara, the capital city of Jalisco, where the proximity of the Juanacatlan Falls of the river Lerma are being utilised for the generation of electric current. This city is becoming an important railway centre on the Mexican Central system. Oaxaca is another town of growing importance where electric power is transmitted from water-generating plant in the neighbourhood. This town is lighted electrically, and is the centre of much tourist traffic.'

Mexico City, again, has vastly developed of late years, and is a conspicuous example of the improvements which can be effected by means of electric lighting and electric power at reasonable charges. Of late a Canadian enterprise (the Montreal Mexican Light & Power Co.) has acquired a controlling interest in a German company operating in Mexico City, and a London company (the Mexican Gas & Electric Light Co.) has recently completed a new modern electricity supply station at San Lazaro. The street tramways of the city are controlled by an English company, although both American and German Interests are considerable in this venture.

At Tampico it is stated that the local electric lighting company, which was formed some years ago to take over a concession granted by the State and by the city authorities, has given only an indifferent service, and that recently a new local company has been formed, with a subscribed capital of £23,000. This company has a station in course of erection, which will shortly be opened for supply.

A concession has been granted to Señor Luis Ugarte for the appropriation of water power of a portion of the river Lerma (in the States of Michoacin and Guanajuato). Under the concession Señor Ugarte is empowered to import, free of duty, all necessary machinery, apparatus, instruments, &c.

A similar concession has been applied for by Señor D. Ituarte for the waters of the river Thalnepantla, near the town of San Luis Ayucin. The "Diario Official" of Oct. 12 and 15, which contains particulars of these concessions, can be inspected at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

These electrical developments in Mexico cause a considerable demand for electrical plant, apparatus, accessories, material and sundries, and British manufacturers, in spite of the nearness of their American competitors, are not out of the running in regard to these supplies.

The figures of the imports into Mexico are not available later than 1902, and show that 3,220 tons of electric light wires and cables were imported from the United States, Germany and the United Kingdom in this year. Primary and secondary batteries to the value of £8,664, incandescent lamps and globes £7,600, turbines and pumps and large imports of machinery being also listed. While the former class of goods were imported chiefly from the United States, the United Kingdom stands easily first for such articles as steam engines, cranes and lifts and certain classes of machinery.

Morpeth.—The Local Government Board have intimated to the Council that they cannot sanction the granting of a lease of land on the Low Stanners to the Northern Counties Electricity Supply Co. for a power station until they are assured that smoke-consuming apparatus has been installed and is working satisfactorily. A covenant is to be inserted to this effect in the lease, and the Council also reserve the right of re-entry in case of breach.

Municipal Telephony.—On Monday a deputation of representatives of Municipal Corporations owning and working telephone exchanges waited upon the Postmaster-General (Lord Stanley) to lay before him their views of the proposed acquisition of the National Telephone Co.'s undertaking by the Government.

Lord Provost Sir John Ure Primrose (Glasgow) acted as chairman of the deputation, and was accompanied by Bailie J. Alexander, convener of Glasgow Telephone committee, Mr. John MacFee, general manager at Glasgow, and several others, including representatives from Guernsey, Hull, Brighton and Swansea.

THE LORD PROVOST said that the deputation were in a state of considerable anxiety and doubt as to the future and that tended to restrict their efforts and prevent them entering fully into the development of their enterprise. They desired to be in perfect line and co-operation with the Government in what they did, and if the Government were acquiring the undertaking of the National Co., they thought that, by elaborating the trunk lines and perhaps seeking the larger communities to work out the local administration, there might be a line of co-operation which would be extremely beneficial. They dreaded that, through a partial acquisition—say of the London system of the National Co.—a condition of things might arise that would be full of difficulty, doubt and danger for the municipalities, because they could at once conceive the company freed and equipped with additional capital from the sale of the London concern, entering the provinces and giving them a bad time by making the conditions on which they might work out their eventual salvation more difficult than they were even at present. As they felt that it was in response to the recommendations of Mr. Hanbury's Select Committee that they entered into competition to break down the monopoly, and to that extent, as they believed, to strengthen the hands of the Government for large operations in the future, they thought they were entitled to consideration. A solution of the matter would be for the great municipalities to have such working in concert with that of the Government, giving a lease perhaps for a number of years. They would welcome any indication of policy that would make their course clearer and would strengthen their hands.

Ald. CARDEN, chairman of Brighton Telephone committee, also spoke in similar strain, and in reply,

Lord STANLEY said that as to whether or not the Post Office was to purchase the National Telephone Co.'s undertaking he could not express an opinion or say how the negotiations stood. He had promised to the House of Commons the first report as to whether negotiations could or could not be successfully concluded, and he had further promised that a committee of the House should consider the terms of any agreement. He was under a disadvantage in arguing as to what the arrangements with the municipalities would be if they were able to arrive at a decision to purchase, which he did not say they were. There was one thing he could say, and that was that it had never been contemplated that there should be any question of stopping the licences of those who were at present licensed before the end of their licence, except with their own consent; and whatever arrangement the Post Office should come to with the National Co., it would not interfere with the licences that existed at present. Under no circumstances should he contemplate any purchase of the National Co. which would be partial in character. He looked upon it as essential that it should not only be the London area, but that it should be a general and comprehensive purchase of the National Co. He must remind them that it had been contemplated that if the Government did purchase the National Co. they were also entitled to purchase, even if they did not do so, from the various municipalities, because in every lease there had been inserted a proviso to the effect that, at the termination of such lease, the Government might buy, and if they wished the Corporation should sell, such telephone apparatus as they had got on what were known as tramway terms. He therefore felt that, in making any arrangements for purchasing the National Co., they could leave out of account to a certain extent the various municipalities, because the arrangements with regard to them were, so to speak, cut and dried. He might point out that while Mr. Hanbury's committee recommended competition, Mr. Hanbury foresaw that there was a chance, and that it might be the duty of the Government to purchase the very undertakings which were brought into existence for the purpose of competition. The telephone, like the telegraph, was not only concerned with local affairs but went outside. There were certain cases where much of the business was done outside the town. Under the proposal of the deputation they would have many municipalities each with its own employés. Supposing a municipality put up its wages to a very high point, that would at once be used as a lever in every municipality to put up the wages to exactly the same point. How would they be able in various towns to differentiate between the wages of men doing precisely the same kind of work? There it seemed to him they would have no more control over the employés and their wages than the Post Office. It was difficult to go into all such questions, because he had not the figures. The amount of municipal enterprise in the matter was very small indeed. Excluding Guernsey, only six municipalities were using their powers, eight others had applied for permission, but not one of them had carried out its licence. Ald. Carden had mentioned the Brighton figures, but of 40,000 householders there only 1,400 took the telephone. In those matters the great question of expense must come into play. Ald. Carden had said that he thought he would not enforce a rule that all municipalities should work their own telephones. If permission were given to municipalities the Government would have to transfer the profitable part of the whole undertaking to the municipality, and the Government would be saddled with the unprofitable parts in the smaller towns and villages. The question of the purchase of the National Co. must be considered as a whole, and any arrangement that might be made or considered advisable for the transfer of such powers to municipal authorities must be equal in its entirety and not in part, and every municipality that wished for the telephone would have to take it over and work it whether it liked it or not, leaving in the hands of the Government solely of the trunk lines. He did not know, of course, what Parliament would decide, but personally he would never himself support any view different from that, and he could not say, in present circumstances, that he thought the transfer of any portion of the business to municipalities had conduced to cheapness or to efficiency. Under no circumstances did he contemplate any interference with existing licences, and under the very worst of circumstances they had certainly seven years to decide what policy should be adopted towards municipal corporations.

Newcastle-on-Tyne.—The Tramways committee have been authorised to obtain sanction to a loan of £9,678 for land and buildings, fitting shop equipment and street improvements. This loan will bring the total amount borrowed for tramways to £270,000.

North London Tramways.—St. Pancras Council have determined to adhere to their decision to only consent to the adoption of the underground conduit system of electric traction.

Oldham and Rochdale Tramways.—The new line (6¼ miles in length) in Royton and Crompton, connecting the Oldham and Rochdale systems, was opened last week.

Oxford.—The Oxford Division of the British Medical Association have installed the electric light in the Pitt Rivers Museum as a mark of appreciation of the generosity of the University in allowing the association to make use of their buildings, &c., during the meeting of the association in July.

Paisley.—Col. Von Donop has officially inspected the permanent way of the Renfrew and Abbotsinch extension of the Paisley and district tramway system.

Perth (W. Australia).—The present electricity supply works of the Perth Gas Co. being now fully loaded, new works are being erected. The company has 1,800 consumers on its books at the present time.

Plymouth.—Sanction to a loan of £20,000 for electric lighting extensions has been obtained by the Corporation.

Pontypridd.—The Council have received sanction to a loan of £6,000 for the purchase of the local tramways.

Prestwich.—Salford Corporation has received sanction to borrow £5,000 for an electricity project, and it is anticipated that supply will be started in about a month.

Railway Motor's Record Life.—Mr. J. Anderson, manager of the Sandwich, Windsor & Amherstbury Railway, Ontario, recently reported on a Westinghouse 12 A railway motor under his charge which had been in constant operation for eight years, covering during that time a distance of approximately 450,000 miles. Beyond replacement of brushes, remetalling of bearings and turning up of the commutator the motor had not cost a penny for repairs. The armature and field coils are intact, and the only signs of wear are on the commutator, which has been reduced ¼in. by truing up. The wearing depth of the segments is ¾in., so that if the winding holds out the motor should last another eight years, and double its already remarkable mileage. It is said that there are several other motors of the same type working on the line that hold nearly the same record and have been equally free from serious repairs. They are all operated in single equipment and under 18ft. cars. As the road is practically level and without sharp curves, the conditions of working are, of course, favourable.

Reading.—The Tramways committee recently received an account from Mr. I. E. Winslow, joint consulting engineer for tramways, for £2,520. 12s. 6d. commission (less £1,600 paid on account), and (on the recommendation of the committee) the Council have denied liability to pay Mr. Winslow commission (included in the account) upon Messrs. Dick, Kerr & Co.'s recent contract for additional cars.

Redcar.—Messrs. J. & J. S. Enright have submitted, on behalf of Messrs. Johnson & Phillips, a proposal for the erection and working of electricity supply works.

Messrs. Johnson & Phillips would submit a tender for providing a complete electric lighting installation for Redcar, based on specifications to be prepared by Messrs. Enright, the contractors to pay cost of preparing the specifications, and to lease from the Council a site for the works (or alternatively purchase a site, the cost to be included in the capital expenditure). The Council to pay to the contractors the amount of tender, 80 per cent. of total contract price being paid during progress of work, 10 per cent. on completion, and the remaining 10 per cent. one year after completion of the work. The price to be charged for electrical energy is not to exceed 5d. per unit for private lighting, 4d. for public lighting and 2½d. for power.

Though the Council have decided not to borrow money as suggested, they offer to consider alternative proposals.

Ripon.—A request from Messrs. Foote & Milne, asking the Council's assent to an application for a provisional electric lighting order has been referred to the Gas and Electric Lighting committee.

Runcorn.—The agreement for the transfer of the Runcorn Provisional Order, 1899, to the Mersey Electric Supply Co. has been sealed.

South Africa.—The "British and South African Export Gazette" states that

The Umtala electical scheme prepared by Mr. E. G. Clifford Jones and Mr. W. T. Olive provides for utilising the water-power available at the Umtala Falls (which have a fall of 71ft., and will supply 20 cubic ft. per sec.) in the generation of electric current. Two three-phase generators are to be put down at the power station, and current will be transmitted at 5,000 volts to a sub-station in the town and to the waterworks for pumping. It is anticipated that 2,000 8 c p. lamps will at the outset meet the demand for lighting, including 200 public lamps.

The Kingwilliamstown Council are being urged to acquire the undertaking of the King Electric Power Co., and to borrow £25,000 for that purpose.

Plant and material for the Aliwal North electric lighting scheme is on its way out from England, and includes two 45kw. dynamos, two 5kw. boosters and a balancer supplied by the Industrial Engineering Co., a Hart storage battery of 300 ampere hours' capacity, Crompton switchboard, British Insulated & Helsby armoured cables and a Carrick & Ritchie travelling crane. Nernst lamps for public lighting are to be supplied by the New British Engineering Co., meters by Chamberlain & Hookham, and house wiring material by Baxter & Caunter. The generators are to be driven by turbines, operated by water from the Orange River. The three wire continuous-current system, with a pressure of 460 volts between the outers, has been adopted, and the voltages at consumers' terminals will be 230 for lighting and 460 for power.

Pretoria Municipality have agreed to pay the lighting company £115,000 in 5 per cent. bonds for their undertaking, and are seeking legislative authority to raise £1,000,000 for this purchase and for the extension of the undertaking and other public works.

As the Concessionaire has failed to carry out the terms of his concession for the electric lighting of Queenstown, the Council have now decided to invite tenders for electric (or gas) lighting for 15 years.

Potchefstroom Council have received sanction for the purchase of the local Electric Light & Power Co.'s undertaking.

Kroonstad electricity works, which are in course of equipment, will probably be extended, in accordance with recommendations by the Council's consulting engineer (Mr. Saunders), in order to supply current for tramways and power for pumping water.

Included in the rolling stock for which orders are being placed by Durban Corporation in connection with their electric tramways, are two funeral tramcars.

Tariff Changes.—The Norwegian Legislature has under consideration a revision of the Norwegian customs tariff, the new proposals including a duty of 50 kroner per kilo on electric cables (covered) in lieu of the present free entry. The duty on railway and tramway vehicles, which now bear a tax of 15 kroner per kilo, is to be increased to 12 per cent. ad val.

Telephone in China.—According to the Canton correspondent of the "China Mail," an imperial edict was issued recently urging upon the people the adoption of, and giving instructions in regard to, the use and advantages of the telephone. It is said that whilst the Chinese language could furnish equivalents for the word telegraph no ready-made substitute could be found for telephone. The telephone is, it is stated, being adopted in Canton to a considerable extent, and the imperial officials control it.

Tonyrefail.—The local electricity works commenced the supply of electric current on Friday last.

Trade Union Wages.—At Liverpool Corporation meeting on Monday a proposal was made to alter a standing order requiring Corporation contractors to pay trade union wages in the locality in which the work was to be completed.

The object of the proposal, it was said, was to prevent work which could be done in Liverpool being done outside.

Sir Charles Petrie said the proposal would necessitate the Corporation having inspectors all over the country wherever they gave out contracts, to see that certain wages were paid.

The proposition was, however, carried by 49 to 42.

Tottenham.—Four companies have submitted offers for taking a transfer of the Council's provisional order—viz., the North Metropolitan Electric Power Supply Co., the Industrial Engineering Co., the National Electric Construction Co., and Foote & Milne.

The North Metropolitan Co.'s proposal includes the supply of electricity from one of its existing stations, the company being prepared to provide all necessary capital and refund the cost incurred by the Council in obtaining their order, &c., the period of purchase by the Council being fixed at 26 years, or any subsequent period of seven years. If the company are granted a lease of the order for 26 years, they will divide the net profits equally between the Council and themselves after 5 per cent. has been paid upon the capital expended.

The offers of Foote & Milne and the National Electric Construction Co. are based upon an arrangement under which the Council would provide the capital expended, the companies erecting and maintaining the station for 25 years, and paying interest and sinking fund, but the agreement could be determined at 15 years on certain conditions.

The Industrial Engineering Co. are prepared to erect the station and maintain the undertaking for five years and to agree to the contract being determined at any time within that period upon payment of such a sum as would bring up the profits to an amount equal to 3 per cent. over and above sinking fund and interest paid on the capital expended.

The consideration of these offers has been deferred.

Tunbridge Wells.—At the Council meeting on Wednesday it was reported that a sub-committee had examined the electric lighting accounts and had found that the financial accounts had been satisfactorily prepared by the electrical engineer (Mr. H. Boot), who had done his best to make electricity supply a success. Consumers had been fairly dealt with, and all complaints reasonably attended to by the department. Figures prepared by the borough accountant proved conclusively that there was no shadow of truth in the suggested charges that accounts are altered by the electricity or any other department to the detriment of consumers.

Tunstall.—The District Council will support the application of Burslem Corporation for a provisional order authorising them to supply electrical energy in Tunstall on the same terms as to Burslem.

Chatterley Whitfield Collieries and the Potteries Electric Traction Co. have requested the Council to withdraw the conditions imposed upon the construction of a tramway junction to enable the tramway company to convey coal over their system.

University College of North Wales.—The calendar of this college for the year 1904-5 contains particulars of the courses of instruction, teaching staff, fees, &c. A special course of lectures and experimental work, suitable for those who desire to become electrical engineers, and extending over two sessions, has been arranged. There are well-equipped laboratories for practical work in physics, chemistry, &c. The calendar is published by J. E. Cornish, Manchester.

West Bromwich.—The Electricity committee have devoted two sittings to the investigation of the complaints made against Ald. Pitt, chairman of the committee, and a foreman fitter, of unnecessary interference with the department's workmen. The employés of the department who lodged complaints were cross-examined by Ald. Pitt, and afterwards a sub-committee was appointed to draw up a report on the evidence given, the report to be submitted to the electricity committee for approval.

Whitby.—The Council last week decided to charge in future a flat rate of 5d. per unit for electric current, less ¼d. per unit for payment within 14 days of demand.

Wigan.—The Council have decided to increase the salary of the borough electrical engineer and tramways manager (Mr. J. Slevin) to £450 per annum. The salary of the accountant of the electricity department has been increased to £220.

Willesden (London).—Main extensions estimated to cost £815 have been authorised by the Council. The Fire Brigade committee report in favour of the adoption of the "Gamewell" fire alarm system. The installation and maintenance of this by the Post Office will involve an annual rental of £252.

Wolverhampton.—In the annual report of the Tramways Committee it was stated that

> The operation of the Lorain surface-contact system during the last 12 months had been entirely satisfactory, and had more than justified its reputation for safety and reliability. The maintenance costs were being reduced, and the committee had reason to believe that the total working costs for the present year would be considerably below the average of other towns where the overhead system was installed. The department had grown very considerably during the past six months. There were now 20 miles of single track open against 6½ last year, and the staff had been increased from 90 to 149. The total number of cars in stock was 30 and 10 more are about to be delivered.

Workhouse Lighting.—The electric light is to be installed at Bedwellty workhouse at an estimated cost of £2,000.

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BUSINESS NOTICES, &c.

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The first meeting of creditors of Arthur E. Brooks, electrical engineer, 110, Cheapside, London, E.C., was held on Monday.

Debtor stated that he was now a wine merchant's manager. He carried on business in partnership with E. K. Law as Law's Peach Bitters Co. In 1899 F. C. Warter became a partner and brought in £700, Law retiring. Debtor and Warter continued the business until October, 1899, when they assigned all the assets to a trustee for the benefit of creditors. In 1901 debtor entered into partnership with S. O. Cook, and they traded together as electrical engineers until 1903 at 110, Cheapside. Cook then left him and debtor continued the business alone. He had also been interested in another business. Liabilities £5,874. 12s. 1d., of which £2,327. 1s. 1d. was unsecured, and £2,257. 11s. contingent and not expected to rank, assets estimated at £37. 15s.

A. J. Hollington, electrical engineer, Barclay Oval, Woodford Green, has been adjudicated bankrupt.

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Plant for Sale.—An eight-pole compound-wound dynamo of 150kw. (230 v., 612 amp., 145 revs.) for direct-coupling to engine is advertised for sale, owing to alteration of original scheme of driving. Applications to Messrs. Andrew Handyside & Co., Britannia Iron Works, Derby, or to Messrs. Greenwood & Batley, Leeds. See also advertisement.

A 12½ B.H.P. Hornsby-Akroyd oil engine and a 61kw. Crompton dynamo are for sale owing to supply being taken from local company. Applications to "Engineer," Dean Wood, Newbury. See advertisement.

A complete second-hand electric lighting plant, suitable for installation of 200 lamps, is for sale. Full particulars from Mr. W. P. Adams, M.I.E.E., 28, Victoria-street, Westminster, S.W. See advertisement.

Sale by Auction.—Messrs. W. Dew & Son will sell by auction on 18th inst. the whole of the electric installation, comprising oil engine, dynamo, accumulators, a quantity of artistic electric light fittings, &c., at Anglesey Castle, N. Wales. Catalogues, 1s. each, of the auctioneers, Caxton-buildings, Bangor, N. Wales. See also advertisement.

Premises, &c., to Let and for Sale.—There are three fine shops, with basements, to let in the Strand, London, on a 21 years' lease. Particulars from the secretary's office, Room 41, West Block, Hotel Cecil, Strand, London, W.C. See advertisement.

Three rooms are to be let, separately or as a whole, in a third floor flat in 64, Victoria-street, Westminster, S.W. See advertisement.

Stores for Sale.—Messrs. Horne & Co., 8, Delahay-street, Storey's-gate, Westminster, S.W., will sell by auction at the Royal Arsenal, Woolwich, on Thursday, 24th inst., at 11 a.m., some obsolete and unserviceable stores, including a quantity of copper and other metals, machinery, electrical stores, telephone and telegraph appliances, 50 tons of underground cable, &c. Catalogues at the War Office, Pall Mall, S.W.; the Ordnance Office, Tower, E.C. ; and the Ordnance Office, Royal Arsenal, Woolwich, S.E., London.

Catalogues, &c.—Messrs. Crompton & Co., London and Chelmsford, have prepared for publication a useful pamphlet dealing with electrical instruments of the moving coil type for continuous currents. This type of instrument was described generally and illustrated in *The Electrician*, Vol. LIII., p. 9, on April 22 last, in the course of the discussion upon Messrs. Edgcumbe and Punga's Paper on "Direct-reading Measuring Instruments for Switchboard Use," read before the Institution of Electrical Engineers, where Mr. W. A. Price described the instruments as being constructed in such manner as to enable a station engineer to verify with a considerable degree of precision, and with little difficulty and small appliances that his instruments are accurate. Since that time, Messrs. Crompton inform us, improvements have been introduced.

Taking one of these instruments, it may be stated that the mechanism consists of two principal parts, the permanent magnet with its pole pieces and the moving coil of fine wire mounted on pivots and fitted with a controlling spring. The first mentioned part consists of a horseshoe magnet with pole pieces of mild steel, which are rigidly connected together by non-magnetic metal in form of a pair of brass cheeks. A mild-steel cylinder is fitted centrally within the bore, in the same manner as the armature of a dynamo lies within the bore of the magnet frame. Between this mild-steel cylinder and the two magnet poles of the instrument is an annular air-gap in which the coil moves. It is noteworthy that the frame upon which the coil is wound is of copper. It is well known that eddy currents are generated in such a frame when it moves within a magnetic field. The retarding action on the coil increases with its speed, and, if the copper frame be suitably dimensioned, the pointer of the instrument will move up to its proper reading without passing beyond it or oscillating about it. The holes in the pole-piece blocks and the moving coil are made to gauge, so that each part of the moving system fits any magnet, and the parts are mechanically interchangeable in all instruments. Similarly-wound coils are also electrically interchangeable, subject to an adjustment of the controlling spring. The coils are wound in different ways, according as they are to be used for ammeters or voltmeters. The design of the instruments has been worked out with the direct object of their easy verification and adjustment by the user as well as in manufacture. The pamphlet just issued gives a number of illustrations and full particulars of the construction and calibration of the instruments, as well as methods of mounting them on switchboards, &c.

"Flexduct" is the name given to a new flexible conduit for electric wires, consisting of a stout fibre spiral interwoven in one continuous separable tube with flexible warp passing through and under the spiral. This is treated with a special moisture-proof compound and covered with a strong outer tube. It is claimed that "Flexduct" does not stretch and has very high insulating qualities.

The Industrial Engineering Co. are prepared to erect the station and maintain the undertaking for five years and to agree to the contract being determined at any time within that period upon payment of such a sum as would bring up the profits to an amount equal to 3 per cent. over and above sinking fund and interest paid on the capital expended.

The consideration of these offers has been deferred.

Tunbridge Wells.—At the Council meeting on Wednesday it was reported that a sub-committee had examined the electric lighting accounts and had found that the financial accounts had been satisfactorily prepared by the electrical engineer (Mr. H. Boot), who had done his best to make electricity supply a success. Consumers had been fairly dealt with, and all complaints reasonably attended to by the department. Figures prepared by the borough accountant proved conclusively that there was no shadow of truth in the suggested charges that accounts are altered by the electricity or any other department to the detriment of consumers.

Tunstall.—The District Council will support the application of Burslem Corporation for a provisional order authorising them to supply electrical energy in Tunstall on the same terms as to Burslem.

Chatterley Whitfield Collieries and the Potteries Electric Traction Co. have requested the Council to withdraw the conditions imposed upon the construction of a tramway junction to enable the tramway company to convey coal over their system.

University College of North Wales.—The calendar of this college for the year 1904-5 contains particulars of the courses of instruction, teaching staff, fees, &c. A special course of lectures and experimental work, suitable for those who desire to become electrical engineers, and extending over two sessions, has been arranged. There are well-equipped laboratories for practical work in physics, chemistry, &c. The calendar is published by J. E. Cornish, Manchester.

West Bromwich.—The Electricity committee have devoted two sittings to the investigation of the complaints made against Ald. Pitt, chairman of the committee, and a foreman fitter, of unnecessary interference with the department's workmen. The employés of the department who lodged complaints were cross-examined by Ald. Pitt, and afterwards a sub-committee was appointed to draw up a report on the evidence given, the report to be submitted to the electricity committee for approval.

Whitby.—The Council last week decided to charge in future a flat rate of 5d. per unit for electric current, less ½d. per unit for payment within 14 days of demand.

Wigan.—The Council have decided to increase the salary of the borough electrical engineer and tramways manager (Mr. J. Slevin) to £450 per annum. The salary of the accountant of the electricity department has been increased to £220.

Willesden (London).—Main extensions estimated to cost £815 have been authorised by the Council. The Fire Brigade committee report in favour of the adoption of the "Gamewell" fire alarm system. The installation and maintenance of this by the Post Office will involve an annual rental of £252.

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> The operation of the Lorain surface-contact system during the last 12 months had been entirely satisfactory, and had more than justified its reputation for safety and reliability. The maintenance costs were being reduced, and the committee had reason to believe that the total working costs for the present year would be considerably below the average of other towns where the overhead system was installed. The department had grown very considerably during the past six months. There were now 20 miles of single track open against 6½ last year, and the staff had been increased from 90 to 149. The total number of cars in stock was 30 and 10 more are about to be delivered.

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The Sir Hiram Maxim Electrical and Engineering Co. (Ltd.) is to be wound up voluntarily. Mr. A. Hardie, Cyprus-road, Finchley, London, N., has been appointed liquidator.

Plant for Sale.—An eight-pole compound-wound dynamo of 150kw. (230 v., 612 amp., 145 revs.) for direct-coupling to engine is advertised for sale, owing to alteration of original scheme of driving. Applications to Messrs. Andrew Handyside & Co., Britannia Iron Works, Derby, or to Messrs. Greenwood & Batley, Leeds. See also advertisement.

A 12½ B.H.P. Hornsby-Akroyd oil engine and a 61kw. Crompton dynamo are for sale owing to supply being taken from local company. Applications to "Engineer," Dean Wood, Newbury. See advertisement.

A complete second-hand electric lighting plant, suitable for installation of 200 lamps, is for sale. Full particulars from Mr. W. P. Adams, M.I.E.E., 28, Victoria-street, Westminster, S.W. See advertisement.

Sale by Auction.—Messrs. W. Dew & Son will sell by auction on 18th inst. the whole of the electric installation, comprising oil engine, dynamo, accumulators, a quantity of artistic electric light fittings, &c., at Anglesey Castle, N. Wales. Catalogues, 1s. each, of the auctioneers, Caxton-buildings, Bangor, N. Wales. See also advertisement.

Premises, &c., to Let and for Sale.—There are three fine shops, with basements, to let in the Strand, London, on a 21 years' lease. Particulars from the secretary's office, Room 41, West Block, Hotel Cecil, Strand, London, W.C. See advertisement.

Three rooms are to be let, separately or as a whole, in a third floor flat in 64, Victoria-street, Westminster, S.W. See advertisement.

Stores for Sale.—Messrs. Horne & Co., 8, Delahay-street, Storey's-gate, Westminster, S.W., will sell by auction at the Royal Arsenal, Woolwich, on Thursday, 24th inst., at 11 a.m., some obsolete and unserviceable stores, including a quantity of copper and other metals, machinery, electrical stores, telephone and telegraph appliances, 50 tons of underground cable, &c. Catalogues at the War Office, Pall Mall, S.W.; the Ordnance Office, Tower, E.C.; and the Ordnance Office, Royal Arsenal, Woolwich, S.E., London.

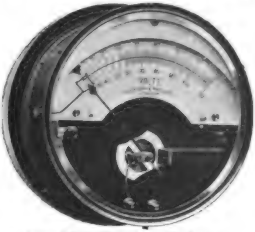
Catalogues, &c.—Messrs. Crompton & Co., London and Chelmsford, have prepared for publication a useful pamphlet dealing with electrical instruments of the moving-coil type for continuous currents. This type of instrument was described generally and illustrated in *The Electrician*, Vol. LIII., p. 9, on April 22 last, in the course of the discussion upon Messrs. Edgcumbe and Punga's Paper on "Direct-reading Measuring Instruments for Switchboard Use," read before the Institution of Electrical Engineers, where Mr. W. A. Price described the instruments as being constructed in such manner as to enable a station engineer to verify with a considerable degree of precision, and with little difficulty and small appliances that his instruments are accurate. Since that time, Messrs. Crompton inform us, improvements have been introduced.

Taking one of these instruments, it may be stated that the mechanism consists of two principal parts, the permanent magnet with its pole pieces and the moving coil of fine wire mounted on pivots and fitted with a controlling spring. The first-mentioned part consists of a horseshoe magnet with pole pieces of mild steel, which are rigidly connected together by non-magnetic metal in form of a pair of brass cheeks. A mild-steel cylinder is fitted centrally within the bore, in the same manner as the armature of a dynamo lies within the bore of the magnet frame. Between this mild-steel cylinder and the two magnet poles of the instrument is an annular air-gap in which the coil moves. It is noteworthy that the frame upon which the coil is wound is of copper. It is well known that eddy currents are generated in such a frame when it moves within a magnetic field. The retarding action on the coil increases with its speed, and, if the copper frame be suitably dimensioned, the pointer of the instrument will move up to its proper reading without passing beyond it or oscillating about it. The holes in the pole-piece blocks and the moving coil are made to gauge, so that each part of the moving system fits any magnet, and the parts are mechanically interchangeable in all instruments. Similarly-wound coils are also electrically interchangeable, subject to an adjustment of the controlling spring. The coils are wound in different ways, according as they are to be used for ammeters or voltmeters. The design of the instruments has been worked out with the direct object of their easy verification and adjustment by the user as well as in manufacture. The pamphlet just issued gives a number of illustrations and full particulars of the construction and calibration of the instruments, as well as methods of mounting them on switchboards, &c.

"Flexduct" is the name given to a new flexible conduit for electric wires, consisting of a stout fibre spiral interwoven in one continuous separable tube with flexible warp passing through and under the spiral. This is treated with a special moisture-proof compound and covered with a strong outer tube. It is claimed that "Flexduct" does not stretch and has very high insulating qualities.

It is imported by Mr. C. R. Heap, 46, Victoria-street, London, S.W., of whom printed particulars can be obtained.

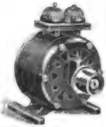
The accompanying illustration shows the latest type of differential hot-wire voltmeter supplied by Messrs. Johnson & Phillips. The instrument is equally serviceable on continuous as well as alternating current circuits of any periodicity. It is fitted with two independent instruments, one above the other, in one case, and with two scales on one dial, the two pointers being opposite each other and close together, a great advantage; as is also the fact that the instrument occupies only the same space as a single voltmeter. Many supply stations are using these instruments, particularly for paralleling alternators.



Johnson & Phillips Differential Hot-Wire Voltmeter

The Crypto Electrical Co., 3, Tyers-gateway, Bermondsey-street, London, S.E., have ready a list of new pattern alternating current reduction and repulsion motors. A sample of these motors will be shown at the Stanley Show, to be held at the Agricultural Hall, London, from Nov. 18 to 26, as will also the company's small dynamos, &c., for charging motor bicycles, &c. Two of the Crypto machines are illustrated herewith. The starting of the Crypto induction motor is effected by closing the switch and pressing the button shown on the top of the machine in the accompanying illustration. All the user has to do is to connect his mains to the terminals, and then close the tumbler switch, holding down meanwhile the button switch. In this way the usual starting switches and resistances are dispensed with. The repulsion motor for variable speed follows the lines of the ordinary repulsion motor, consisting of a compound wound stator, fitted with a rotor and commutator. Upon the latter rest two or more short-circuited brushes, and the stator only is connected to the mains. It is claimed that the Crypto machine has, however, certain special features, some of which are shown in the illustration; and that by special winding a greater output, a better power factor, and less tendency to race at light loads has been secured. To run the machines the mains are connected through a switch to the terminals shown on the top of the motor.

Crypto Repulsion Motor for Variable Speed.



Crypto Induction Motor for Constant Speed.

A "Criton" water softening plant is illustrated and described in a pamphlet issued by the Pulsometer Engineering Co., Reading. Some useful information on this subject is given

Messrs. G. Pidduck & Co., 2, Bury-street, London, E.C., who recently secured an order for covering boilers at Lot's-road station of the Underground Electric Railways, have ready a circular list of non-conducting compositions.

Lists of (1) small motors for driving sewing machines, (2) drilling machines of strong construction, (3) E.C. contact clocks for operating two-rate meters of any make, and (4) "Luna" carbons, are issued by the Electrical Co., 121-125, Charing Cross-road, London, W.C. Each list is illustrated and contains all essential information regarding the various items.

Brush Bulletin No. 8, just issued, deals with small size open and protected direct-current generators.

A new catalogue of electric mining machinery and apparatus is issued by Messrs. John Davis & Son, of All Saints' Works, Derby.

New Resistance Material for Electric Heating.—Particulars are published of an electric resistance material called "Kryptol," which is being introduced in Germany in connection with apparatus for electric heating. It is a mixture of graphite, carborundum and clay, so bound together as to form a loose, granular mass or powder of four grades of coarseness, which are said to be severally well adapted to different heating operations. Kryptol is said to develop heat of any desired intensity, from a gentle warmth up to 3,000 C., and is, further, claimed to be clean and free from dust or from impurities. Moreover, it obviates the use of platinum, nickel or other metallic wires or foils.

In Fig. 1 a kryptol cooking stove is illustrated, and comprises a chamotte or earthenware plate enclosed at its edges in a wooden frame bounded at two opposite sides by carbon electrodes, which rest upon the plate and are connected by insulated wire conductors with the source of supply, forming, when the break between the electrodes is closed, an electric circuit. Upon the chamotte plate (usually about 2ft. square, but may be of any convenient size) is loosely strewn the granulated kryptol to a depth of about an inch. When the kryptol is laid continuously across the plate, it forms the electrical connection between the two electrodes and closes the circuit. When, however, the kryptol is brushed or scraped aside so that an open, uncovered space is formed through the layer across the plate, the circuit is broken. If, now, the kryptol is brushed into the open space, so as to form a connection between the two masses lying against the electrodes on either side, the circuit is at once restored, and the kryptol forming this thin connecting layer begins to sparkle and glow, becoming in a few moments incandescent and generating a heat that will raise cold water to boiling in a few minutes. A peculiarity is that incandescent action takes place only at places where the layer of kryptol on the plate is thinnest, and it is therefore easily possible to produce heat just in the place where it is wanted and not elsewhere. The finer the grains of kryptol the less active the incandescence, and it is for this reason that the four different grades of material are made, to be used as may be required in generating different temperatures. For heating train cars and similar vehicles, halls, rooms, laboratories, &c., where a continuous uniform warmth is essential, the apparatus shown in Fig. 2 is employed. This includes a cast-iron flanged radiator, the interior lining glazed so as to insulate the kryptol mass with which it is filled. At each end is a carbon electrode, connected by wires carrying a current of from 4 to 5 amperes at about 120 volts. This type of heater can be put under a car seat or beneath the floor, where it is out of sight, and will, it is said, generate and maintain indefinitely any desired temperature without refilling for weeks together. The radiator is made with a close-fitting cover, as kryptol is said to endure unimpaired much longer in a closed chamber than in the open air. A radiator in constant use requires filling with fresh kryptol about every three months, the makers say. Some of the steel and cutlery manufacturers in Westphalia are said to be experimenting with kryptol with a view to its employment for tempering, annealing and case hardening steel and iron bars, knives,

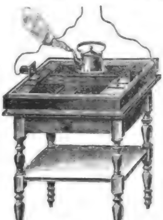


Fig. 1.
"Kryptol" Cooking Stove.

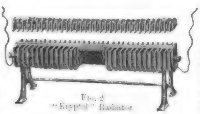


Fig. 2.
"Kryptol" Radiator.

scissors and other implements. For chemical laboratories the new material has already been adopted by the University of Berlin, the Technical College at Aix-la-Chapelle, the Imperial health office at Berlin and other State institutions. In elementary organic analysis it is frequently necessary to heat parts of the substance under examination to different temperatures and to leave other portions unheated. For this purpose simple apparatus has been devised, consisting of an iron frame on which is laid a fire-brick trough or gutter, glazed inside and filled with kryptol. In this is laid the combustion pipe (which may be a glass tube) containing the material to be treated. Current sent through the even mass of kryptol heats the tube uniformly throughout its length, but when it is desired to heat one portion to a high temperature, it is only necessary to scrape the kryptol aside and reduce the thickness of the layer under that part of the tube, when it at once begins to glow at a higher temperature than the remainder. If it is desired to withdraw or exclude the heat entirely from the central part of the tube, two copper forks, which slide along a brass conductor, are introduced into the kryptol. These take up the current and pass it through the conductor over the intervening space, leaving the kryptol and that section of the tube cold and excluded from the heating operation.

Motor-driven Compressors.—Messrs. Reavell & Co., of Ipswich, inform us that the demand for their small motor-driven central station compressor for cleaning purposes has led to the introduction of improvements in manufacture which have reduced its cost. For sub-station work a still smaller machine, called the Simplex, with half the capacity of the Duplex, has been introduced.

To Manufacturers of Electric Current Consuming Apparatus.—A circular letter with regard to advertisements has been sent out by the Westminster Electric Supply Corpn. (Ltd.) to manufacturers of electric current-consuming apparatus (other than incandescent lamps and fittings), and we are asked to state that any manufacturer who may not have received this letter will have a copy sent to him immediately on making notification to the company of the fact. The letter is addressed to manufacturers only and not to their agents.

Micanite Patents.—We are informed that the Supreme Court of Germany has, by judgment of Nov. 5, 1904, confirmed the validity of German Patent No. 73,830, owned by the Mica Insulator Co. (Ltd.), Empire Works, Walthamstow, for the manufacture of micanite plates, and has dismissed with costs an appeal of Messrs. Meirowsky & Co., of Cologne, for the withdrawal of the patent.

Imports.—The following are official values of imports of electrical machinery, material and apparatus into this country during October:—

Electrical machinery, £53,133 (an increase of £15,413 compared with October, 1903); telegraph cables and apparatus, £7,316 (increase £1,897); other electrical goods, £63,113 (decrease £547). The total imports of the three classes during the 10 months ended 31st ult. were respectively £410,352 (decrease £9,817), £477,061 (increase £9,323) and £639,078 (decrease £30,066).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Nov. 2 to Nov. 8, with the ports of destination:—

Africa—Alexandria, £30; Beira, £105 (telegraph material); Cape Town, £65; Chinde, £39; Delagoa Bay, £13; Durban, £1,262 (including £91 telegraph material); Port Elizabeth, £2,538 (including £2,271 telegraph material); Port Said, £15. *Argentina*—Buenos Ayres, £385 (including £100 telegraph material); Rosario, £161. ***Australasia***—Adelaide, £39; Brisbane, £483 (including £44 telegraph material); Fremantle, £222; Lyttelton, £222; Melbourne, £86; Perth, £1,972; Port Darwin, £17; Sydney, £880; Wellington, £636. *Belgium*—Ostend, £16. *Brazil*—Rio Janeiro, £65. *Burma*—Rangoon, £907. *Canada*—Montreal, £80; St. John (N.B.), £16; Vancouver, £25. *Ceylon*—Colombo, £31. *Channel Islands*, £7. *China*—Shanghai, £893 (including £157 telegraph material). *Denmark*—Copenhagen, £134. *France*—Paris, £105. *Germany*—Hamburg, £120 (including £14 telegraph material). *Gibraltar*, £8. *Holland*—Flushing, £20; Amsterdam, £391 (including £336 telegraph wire); Rotterdam £147. *Hong Kong*, £276. ***India***—Bombay, £272 (including £26 telegraph material); Calcutta, £3,391 (including £340 telegraph material). *Italy*—Genoa, £35 (telegraph material). *Japan*—Kobe, £160; Nagasaki, £1,603; Tokio, £126; Yokohama, £1,520. *Russia*—St. Petersburg, £120 (telegraph material). *Siam*—Bangkok, £228. *Straits Settlements*—Penang, £29; Singapore, £939 (including £93 telegraph material). *Spain*—Barcelona, £15. *Sweden*—Gothenburg, £27; Stockholm, £30 (including £10 telegraph material). *West Indies*—Bermuda, £26. *U.S.A.*—New York, £33. *Zanzibar*, £29. Total, £20,924 against £10,896 in the corresponding week last year (Nov. 4 to 10).

TRAFFORD PARK ESTATES (LTD.)—In the report for the year ended June 30 it is stated that Manchester and Salford Corporations have entered into an agreement to run their electric cars over the company's tramways for 20 years, paying the company the profits earned thereon. The Trafford Park Act, 1904, provides for the transfer of the West Manchester light railways to the statutory company. Direct connection has been completed between these railways and those of the Cheshire Lines Committee, and arrangements have been concluded for the use of the junction by the Midland, Great Northern and Great Central Railways.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 6 per cent. for abroad or for foreign books.)

"Elements of the Mathematical Theory of Electricity and Magnetism." 3rd edition. By Prof. J. J. Thomson, F.R.S. (London: C. J. Clay & Sons.) 10s.

"The Cultivation and Preparation of Para Rubber." By W. H. Johnson. (London: Crosby Lockwood & Son.) 7s. 6d.

"Fowler's Electrical Engineer's Year Book and Directory." 1905. (Scientific Publishing Co.) 1s. 6d.

"Private House Electric Lighting." By F. H. Taylor. (London: Percival Marshall & Co.) 1s.

"A Pocket Book of Electrical Rules and Tables." By J. Munro and Andrew Jamieson. 17th edition. (London: Charles Griffin & Co.) 8s. 6d.

"Obituary Notices of Fellows of the Royal Society." Part I. With an Index to the Obituaries published in the "Proceedings" from 1860 to 1899. (London: Harrison & Sons). 4s.

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70, Chancery lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

October 10, 1904.

21,684 UNION ELEKTRICITÄTS-GES. Alternating-current motors. (Date applied for, Oct. 9, 1903, date of application in Germany.)*
21,694 H. V. JAMES. Manchester. Electric motor controllers.
21,722 R. H. RADFORD. Sheffield. Rail joints and bonds.
21,726 A. E. COOPER. Rugby. Suspending conductor wires for distribution of Electrical energy.
21,729 E. B. PHILLIPS and T. C. PARKIN. Swivelling coupling for cables.
21,780 R. STARKE. Automatic thermal and magnetic circuit-breakers.
21,784 P. F. CORNHILL. Liverpool. Automatically opening or breaking electric circuits at predetermined times.
21,796 R. VON LIEBEN and E. REISZ. Electric clutch.*
21,796 A. CHURCHWARD. Controllers for electric motors. (Date applied for, Oct. 10, 1903, date of application in U.S.)*

October 11, 1904.

21,819 A. M. BULLARD. Automatic telephonic exchanges for a small number of lines.*
91,846 T. A. CAMERON. United States. Switches.*
21,848 W. J. ROUSSEL and A. KING. United States. Telegraph recorder.*
21,889 K. A. LINDSTRÖM. Alternating-current machines. (Date applied for, Oct. 16, 1903, date of application in Sweden.)*
21,892 F. M. LEWIS. Arc lamps.
21,894 W. H. GREGORY. Regenerative dry batteries.*
21,895 SIEMENS BROTHERS & CO. and G. S. GRIMSTON. Telegraphs.
21,902 B.T.-H. Co. and R. C. CLINKER. Dynamo electric machines.
21,903 B.T.-H. Co. and W. J. LLOYD. Electricity meters.
21,911 P. MARINO. Batteries, electrolytic apparatus or the like.
21,913 R. ZIEGENBERG. Manufacture of galvanic cells.*

October 12, 1904.

21,960 R. W. BILL and S. BILL. Handsworth. Electric heat alarms.
21,995 I. B. BIRNBAUM and H. G. WHITE. Inter-communication telephone systems.
22,000 P. JIGOUZO. Electric motors. (Date applied for, Oct. 21, 1903, date of application in France.)*
22,003 T. E. DEVONSHIRE. Conduits for cables or conductors.

October 13, 1904.

22,022 P. READER. Nottingham. Operating switches or points of tramways and overhead cables in connection therewith.

October 14, 1904.

23,085 F. P. REID. Glasgow. Wireless telegraphy receiver recording or printing only waves of a given strength.
22,100 ELECTRIC & ORDNANCE ACCESSORIES CO. and R. F. HALL. Birmingham. Circuit breakers and automatic switches.
22,118 W. R. EVANS. Manchester. Automatically operating the points of electric tramways.
22,145 D. MURRAY. Keyboard tape perforator.
22,156 B.T.-H. Co. (G.E. Co., U.S.). Commutators for dynamo electric machines.
22,157 B.T.-H. Co. (G.E. Co., U.S.). Dynamo electric machines.
22,164 A. F. BERRY. Apparatus for use in the distribution of alternating current.
22,171 ELEKTRIZITÄTS ACT.-GES. vorm. W. LAHMEYER & CO. Switchboards to protect persons from injury. (Date applied for, Dec. 31, 1903, date of application in Germany.)*
22,173 F. E. STOW. Electric heating.

October 15, 1904.

22,206 Sir B. Scott, Knight, E. H. Quarrington and T. H. Hodgkinson. Carlisle. Electromagnetic press.
22,210 C. M. Stead. Leeds. Dry voltaic cells and primary batteries.
22,213 G. R. Cartmel. Halifax. Wire terminal clip.
22,228 J. R. Craig, Jun. Glasgow. Manufacturing and extracting ozone from atmospheric air.
22,236 A. J. Bonnella. Electric lamp fittings.
22,246 C. Gibbs. Distribution of electricity for electric traction.
22,247 A. K. Baylor. Electric lamps.
22,258 C. Rigola. Means for the application of electricity to the human body.*

October 17, 1904.

22,287 A. P. Lundberg and G. C. Lundberg. Switches.*
22,290 J. Hawley Limited and R. R. W. Hardman. Liverpool. Safety devices for the trolley poles of electric cars.
22,296 P. Richardson. Electrical ignition apparatus for internal combustion engines.
22,326 P. M. Justice (Voltage Controller Co., U.S.). Controllers for electric motors.*
22,343 Körting & Mathiesen Akt. Ges. Arc lamp electrodes. (Date applied for, Oct. 31, 1903, date of application in Germany.)*
22,348 J. T. Szek. Formation and utilisation of ozone.
22,355 Deutsche Telephonwerke R. Stock & Co. G.m.b.H. Telephone installations. (Date applied, for Aug. 25, 1904, date of application in Germany.)*
22,362 Crompton & Co. and E. W. Abbott. Arc lamp hoisting gear and fittings.
22,364 Crompton & Co. and E. W. Abbot. Switches.
22,358 F. W. Howorth (M. P. Ryder, U.S.). Generating intermittent currents for igniters of oil engines and other purposes.*
22,369 A. F. Berry. Regulating differences of potential between portions of electric current distributing systems.

October 18, 1904.

22,372 R. C. Sayer. Bristol. Means for trolleys or vehicles to pick up and return current and obtain motion.*
22,401 C. J. Jewell. Automatic signalling apparatus for electric tramway.
22,404 W. C. Kirwan and K. Quaney. Dublin. Device for preventing broken trolley wires from falling.
22,413 A. H. Anderson. Combined telephone and sounding telegraph.
22,470 E. A. Carolan (W. R. Whitney, U.S.). Filaments and processes of manufacturing same.
22,475 C. W. Wilson. Liverpool. Overhead live wires or conductors.

October 19, 1904.

22,479 E. T. Pierce and W. Tice. Electric lamp.
22,511 H. Beck. Germany. Blowing magnet arrangement for arc lamps.
22,515 J. Orme. Leytonstone. X-ray apparatus.
22,519 W. Morgan and W. H. W. Preston. Coventry. Circuit-makers and breakers.
22,522 J. M. Wellington and W. F. Daniell. Arc lamps.
22,529 H. V. Howard. Electrical connections.
22,536 Siemens Brothers & Co. (Siemens-Schuckertwerke G.m.b.H., Germany). Auxiliary appliance for the prevention of excess pressures on switching on and off installations of high voltages.*
22,544 S. W. Mitchell. Overhead trolley wires.
22,574 J. S. Raworth. Electric steering gear.

October 20, 1904.

22,616 A. P. Hanson. Wiring of telephone or other electrical plants.
22,628 J. Brockie. Arc lamps.
22,631 M. Latour. Exciting electromagnets by alternating currents. (Date applied for, Oct. 20, 1903, date of application in France.)*
22,637 A. J. Boult (L. Macquaire, France). Sparking plugs for explosion engines.
22,647 E. F. Moy and P. H. Bastie. Resistances.
22,652 F. R. McFeatters and A. F. Christmas. Circuit breakers.*
22,653 Siemens Brothers & Co. (Siemens Schuckertwerke G.m.b.H., Germany). Electric motors.*
22,659 Morgan Crucible Co. and C. W. Speirs. Compound for brushes of dynamo electric machines, bearings, &c.
22,665 F. R. McFeatters and A. F. Christmas. Circuit breakers.*

October 21, 1904.

22,690 R. E. Workman. Manchester. Electric generators and motors.
22,706 Chamberlain & Hookham and S. H. Holden. Birmingham. Electricity meters.
22,731 C. A. Schierwater. Liverpool. Electric traction overhead conductor equipment.
22743 B.T.-H. Co. (G.E. Co., U.S.). Apparatus for the electrical treatment of gases.
22,744 B.T.-H. Co. (G.E. Co., U.S.). Switches.
22,752 G. Faget. Transforming alternating currents of constant voltage and frequency into continuous currents of variable voltage.*

October 22, 1904.

22,768 R. W. Scott. Darlington. Live rails for electric railways.
22,789 Siemens Brothers & Co. and J. G. Wilson. Dynamo electric machinery.
22,793 G. H. Hooke. Starting and controlling rheostats for electric motors.
22,808 R. Lundell. Alternating-current motors.*
22,813 E. H. Geist Electricitäts Akt. Ges. Scraper for electromagnetic separator. (Date applied for, Jan. 18, 1904, date of application in France.)*
22,817 B.T.-H. Co. and B. Hopps. Electric power transmitting mechanism.
22,818 B.T.-H. Co. (G.E. Co., U.S.). Systems of control for electrically-operated doors.
22,819 and 22,822 B.T.-H. Co. (G. E. Co., U.S.). Alternating current motors.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1904.

11,219 Nusch (Hölscher). Switch for intermittently illuminated electric signs.
11,542 Sahulka. Transforming single-phase alternating current into single-phase or polyphase alternating current of lower frequency.
12,168 Tournaire. Producing electric energy by the utilisation of the chemical energy of suitable combustible without employment of thermal engines. (Date applied for, June 11, 1903.)

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

◆

NEW COMPANIES.

BRITISH CONTRACTING SYND. (LTD.) (82,429).—Reg. Oct. 31, capital £5,000 in 48 preferred shares of £100 each and 200 deferred shares of £1 each, to carry on the business of contractors for tramways, railways, harbours, docks, &c. Reg. office, 101, Leadenhall street, London, E.C.

FIREPROOF CELLULOID SYND. (LTD.) (82,451).—Reg. Nov. 2, capital £15,000 in £1 shares, to adopt an agreement with A. Luft, H. C. Woltereck, James Swinburne, W. R. Cooper and G. H. Baillie, and to carry on the business of manufacturers of and dealers in fireproof celluloid, chemical compounds, varnishes, &c. Reg. office, 82, Victoria-street, London, S.W.

IMMISCH LAUNCH & BOAT CO. (LTD.) (82,454).—Reg. Nov. 2, capital £10,000 in £1 shares, to acquire from Immisch Electric Launch Co. (Ltd.) their electric launches, charging stations, &c., and to carry on the business of electrical and mechanical engineers, electricians, &c. Reg. office, Donington House, Norfolk-street, London, W.C.

RAWORTH'S TRACTION PATENTS (LTD.) (82,432).—Reg. Oct. 31, capital £30,000 in £1 shares, to acquire from J. S. Raworth certain patents and inventions in connection with electrical or mechanical traction, and to carry on the business of manufacturers of electrical cars, electric plant and accessories, constructors and owners of railways and tramways, &c. The subscribers are:—J. S. Raworth, C.E. (400 shares), T. Browett, engineer (100 shares), C. S. Hilton (200 shares), E. G. F. Metzger, engineer (125 shares), A. K. Baylor, electrical engineer (125 shares), J. L. Hall, electrical engineer, and D. Macdonald (25 shares each). Reg. office, 2, Queen Anne's-gate, Westminster.

W. & E. SUMNER (LTD.) (82,446).—Reg. Nov. 1, capital £1,000 in £1 shares, to carry on the business of electrical and mechanical engineers, patentees and manufacturers of and dealers in electrical appliances and other articles, general merchants, importers, exporters, agents, &c.

TRACTION CORPORATION (LTD.) (82,477).—Reg. Nov. 4, capital £100 in £1 shares, to acquire any patents and rights relating to the production, treatment, storage and use of any motive or mechanical power and any apparatus therefor, and to carry on the business of manufacturers of and dealers in tramcars, carriages, trucks, locomotives, accumulators, dynamos and machinery, suppliers of electricity, &c.

STATUTORY RETURNS.

BRITISH CONTINENTAL ELECTRICITY CO. (LTD.)—In return to Aug. 11 (filed Nov. 4), the capital is £20,000 in 1,000 preference and 1,000 ordinary shares of £10 each, of which 1,000 preference and 906 ordinary have been taken up. £10 per share has been called up on 790 preference and 756 ordinary and £15,460 has been received. £3,600 is considered as paid on 210 preference and 150 ordinary. Mortgages and charges, nil.

BRITISH ELECTRIC TRACTION CO. (LTD.)—Return to July 23 (filed Sept. 15) gives capital as £4,000,000 in 200,000 ordinary and 200,000 preference shares of £10 each, of which 133,301 ordinary and 156,437 preference have been taken up. £10 per share has been called up on 117,926 ordinary and 137,500 preference, and £2,551,246 has been received, in addition to £1. 10s. on three forfeited shares. £343,120 is considered as paid on 15,375 ordinary and 18,937 preference shares. Mortgages and charges, £1,527,830.

KEIGHLEY ELECTRICAL ENGINEERING CO. (LTD.) Return to Oct. 4 gives capital as £10,000 in 8,000 ordinary and 2,000 preference shares of £1 each, of which 4,100 ordinary and 1,000 preference have been taken up. £1 per share has been called up on 3,188 shares and £3,188 has been received. £1,612 is considered as paid. Mortgages and charges, £3,000.

NEW PHONOPHORE TELEPHONE CO. (LTD.) Return to Oct. 7 gives capital as £10,000 in 9,000 ordinary and 1,000 founder's shares of £1 each, of which 5,111 ordinary and 1,000 founder's have been taken up. 10s. per share has been called up on 5,111 ordinary, and £2,555. 10s. has been received. 1,000 founder's shares are considered as fully-paid. Mortgages and charges, nil.

MORTGAGES AND CHARGES.

BURNAND TRANSFORMER CO. (LTD.) £1,000 second debentures, created Aug. 31, 1904, charged on the company's undertaking and property, present and future, including uncalled capital, subject to £1,000 prior debentures, have been registered. No trustees.

OTTO ELECTRICAL MFG. CO. (LTD.)—Issue on Oct. 21 of a £500 debenture, part of series created Jan. 22, 1904, to secure £5,000, charged on company's undertaking and property, present and future, including uncalled capital. Holder, J. Deakin. No trustees. Previously issued of same series, £2,000.

A. REYROLLE & CO. (LTD.)—Memorandum of satisfaction in full of debenture, dated March 31, 1903, to secure £5,000, has been filed.

CITY NOTES.

MEMORANDA (Nov. 10).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26⅝d. per oz. Consols 88$\frac{1}{16}$—88$\frac{3}{16}$ for money, 88$\frac{1}{16}$—88$\frac{3}{16}$ for account; 2½ per cent. annuities 87½—88. Consols Pay Day, Dec. 1; Stocks and Shares Continuation Days, Nov. 28 and Dec. 13; Ticket Day, Nov. 29; Pay Days, Nov. 11 and 30; Mining Share Carry-over Days, Nov. 25 and Dec. 12.

CAPE ELECTRIC TRAMWAYS (LTD.)—The directors' report for the year ended June 30 states that, after providing for interest and redemption of debentures, the net balance is £57,080. 9s. 7d., from which 10 per cent. has been paid (two interim dividends of 5 per cent. each). Reserve has also been credited with £8,000, making a total appropriation of £56,000, and leaving £792. 16s. 6d. to be carried forward. Passenger and revenue returns for the Cape Town system for the 12 months both show a slight increase over the previous year, and the expenditure account a small decrease. An increase of passengers and revenue has also been experienced in Port Elizabeth, but the expenditure account has had to bear several heavy charges, due principally to the necessity for constructive repairs to permanent way, to a serious increase in coal account and to other special items, amounting in all to about £6,000. At the commencement of 1904 the board appointed Mr. J. A. Barkley independent general manager of the Port Elizabeth system, and the improved condition of that system and the decreasing expenditure have fully justified this course. During the year the important Hanover-street extension was opened to traffic at Cape Town. At Port Elizabeth the board extensions have been sanctioned. At the Port Elizabeth power house an additional unit has been completed and is working in a satisfactory manner. The Camps Bay leased line has not hitherto proved the success anticipated, the growth of the Camps Bay suburb having been practically at a standstill. The loss on the year's working (including rent paid to the lessee company) was about £9,000.

DEUTSCH-ATLANTISCHE TELEGRAPHEN GESELLSCHAFT.—This company, which has taken over the undertaking of the Deutsche See Telegraphen Gesellschaft, is making a fresh issue of £200,000. The subsidy receivable from the German Government for the two Atlantic cables will amount to £81,000 in 1905, £82,500 in 1906 and £84,000 in 1907.

EASTERN EXTENSION AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended June 30 last states that the gross receipts amounted to £300,057. 18s. 7d., against £265,099. 5s. 5d. for the corresponding half-year of 1903. In the former figure, however, is included interest on investments (£13,125. 6s. 9d.), which in 1903 was carried direct to general reserve. Working expenses, including £25,712. 11s. for maintenance of cables, absorb £141,707. 4s. 9d., against £138,516. 13s. 10d., leaving a balance of £158,350. 13s. 10d. From this is deducted £2,923. 10s. 10d. for income tax, and £12,048. 6s. 2d. for interest, leaving £143,378. 16s. 10d. as net profit for the half-year. Adding £41,890. 18s. 1d. brought forward there is an available balance of £185,269. 14s. 11d. Two quarterly interim dividends of 1¼ per cent. each absorb £75,000, leaving £110,269. 14s. 11d. to be carried forward. During the half-year a further partial renewal of the Hongkong-Foochow cable has been effected, and the cost (£6,273. 10s.) is charged against general reserve. The c.s. "Restorer" has been sold to replace the Commercial Pacific Cable Co.'s c.s. "Scotia," and a small steamer (the s.s. "Magnet") has been purchased for effecting repairs to the many cables which the company possesses in shallow waters of less than 400 fathoms. The subsidy arrangement in connection with the Tonquin cable expired in February last, and a new agreement has since been arranged, subject to Parliamentary approval, by which the French Government will acquire the ownership of that cable.

ELECTRICITY SUPPLY CO. FOR SPAIN (LTD.)—The third drawing of 5 per cent. debentures for redemption at par on Jan. 2 will take place on 21st inst.

MORECAMBE TRAMWAYS CO.—The report for the past year states that the question of the adoption of electric traction has again been under consideration, and the directors hope to report progress at an early date.

RHODES ELECTRICAL MFG. CO. (LTD.)—The directors have declared an interim dividend for the quarter ended Aug. 31 at the rate of 6 per cent. per annum on the ordinary shares.

ROSARIO ELECTRIC CO. (LTD.)—At the meeting on Monday the chairman (Mr. W. T. Western) said the company had completed the alteration of its system and the results had been satisfactory. The new engines and cables were taken over in August, 1903. Up to last Christmas the local staff had been practically occupied in transferring customers from the old to the new system, so that the company did not get much benefit from the new machinery during that period. After deducting running expenses in Argentina, the profit for the first six months of 1903 was £2,700, and for the six months to Dec. 31, 1903, it was £2,800, while for the six months to June 30, 1904, it had advanced to £5,100. For the first two months of the current financial year the figure was over £2,400. The number of customers had risen from 800 in December, 1903, to 936 in September last. Besides new consumers for lighting, the company had made a beginning in the supply of power.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have been asked to appoint a special settling day in, and grant a quotation to, £135,000 4½ per cent. first mortgage debenture stock of the *Bath Electric Tramways (Ltd.)*.

WESTINGHOUSE ELECTRIC & MFG. CO. (U.S.A.)—The directors have authorised the sale of $15,000,000 5 per cent. 20-year debenture bonds, at such times and in such amounts as the board shall decide.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Nov. 5	1,166	+ 87	23	35,276	+ 5,087
Airdrie	Oct. 28	226	...	38	7,676	...
Ayr Corporation	Nov. 5	199	+ 7	25	9,473	+ 496
Barnsley	Oct. 28	168	− 8	43	7,332	− 510
Barrow	" 28	201	...	28	7,564	...
Bath Electric Trams, Ltd.	Nov. 2	561	...	41	28,553	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	" 6	1,022	+ 31	...	...	...
Birmingham Corporation	" 5	308	...	45	18,281	...
Birmingham Tramways Co.	" 5	5,371	+ 803	18	98,133	+ 4,434
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	" 3	360	+ 19	31	41,199	+ 5,631
Blackpool and Fleetwood	" 5	334	+ 118	18	19,374	+ 619
Blackp'l,St.Anne's&Lytham	Oct. 30	276	...	¶53	20,596	—
Bolton Corporation	Nov. 6	1,694	+ 7	32	59,944	+ 874
Bournemouth Corporation	" 2	872	− 22	31	36,809	+ 1,941
Bradford Corporation	" 5	3,916	+ 430	31	147,718	+ 25,672
Brighton Corporation	" 6	864	+ 12	31	34,194	+ 3,330
Brisbane Tramways	Sept. 14 " 21	2,290 2,942	− 26 + 146	12	29,612	+ 140
Bristol Trams & Carriage	Nov. 4	4,613	+ 134	18	138,801	+ 1,196
Buenos Ayres & Belgrano	Oct. 2 " 9	3,574 3,331	+ 26 − 7	36	81,300	+ 3,034
Burnley Corporation	Nov. 5	955	+ 177	6	6,331	+ 1,391
Burton Corporation	" 6	310	+ 27	¶31	11,418	...
Calcutta Tramways Co.	" 5	a36,254	− a1,049	19	a670,379	+ a76,473
Camborne-Redruth	" 7	116	+ 8	1	116	− 104
Cardiff Corporation	" 5	1,896	− 24	31	65,658	+ 1,627
Carlisle Tramways Co.	" 6	171	− 11	44	8,910	+ 196
Central London Railway	" 5	6,531	− 95	19	110,859	− 277
Chatham & Dist. Lt. Rys.	" 3	534	− 25	44	25,201	+ 2,148
City & South London Rly.	" 6	2,331	− 135	19	46,971	− 1,734
Colchester Corporation	" 3	183	...	14	4,148	...
Cork Electric Trams Co.	" 3	434	− 6	44	20,898	− 2,540
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	Oct. 28	521	+ 65	43	23,253	+ 3,378
Dover Corporation	Nov. 5	185	+ 9	31	7,645	− 192
Dublin & Lucan Railway	" 4	111	+ 17	13	2,445	− 8
Dublin Southern District	" 4	639	+ 35	18	93,898	− 2,123
Dublin United	" 4	8,736	− 44			
Dudley—Stourbridge	" 28	311	− 10	43	37,944	+ 1,414
Dundee Corporation	Nov. 2	817	− 25	...	...	...
East Ham Council	" 5	636	− 31	31	21,317	+ 1,493
Gateshead & Dist. Trams	Oct. 28	906	− 31	43	39,797	+ 1,401
Glasgow Corporation	Nov. 5	14,539	+ 510	†45	330,516	+ 18,501
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	Oct. 28	211	− 34	43	11,120	+ 544
Gt. Northern & City Rly.	Nov. 5	1,252	...	89	57,835	...
Greenock & Port Glasgow	Oct. 28	637	+ 58	43	25,163	+ 1,278
*Halifax Corporation	Nov. 3	2,629	+ 82	31	48,271	+ 2,594
Hartlepool Tramways	Oct. 28	261	− 10	43	12,896	+ 1,049
Huddersfield	Nov. 5	1,163	+ 44	31	43,351	+ 3,821
Hull Corporation	" 5	2,171	+ 378	31	64,365	+ 9,153
Ilford District Council	" 5	372	...	31	14,933	+ 659
Ilkeston Corporation	" 2	116	− 21	5	619	− 75
Ipswich Corporation	" 5	370	...	31	16,303	...
Isle of Thanet Co.	" 5	318	− 38	5	11,846	− 401
Keighley Corporation	Oct. 18 " 25 Nov. 1	138 139 124	—	3	401	...
Kidderminster & District	Oct. 28	106	− 3	43	5,631	+ 23
Kirkcaldy Corporation	Nov. 5	198	− 29	41	10,101	...
Lanarkshire Trams Co.	" 5	723	+ 129	41	[illegible]	...
Leeds Corporation	" 5	5,351	+ 627	31	139,274	+ 10,031
Leicester Corporation	...	...	...	...	...	...
Liverpool Corporation	Oct. 29	10,117	− 43	41	457,315	+ 18,038
Liverpool Overhead Rly.	Nov. 6	1,488	− 117	‖19	9,573	− 1,343
London County Council	Oct. 29	12,902	+ 3,291	‡11	1,672	+ 84,289
*Lowestoft	...	...	...	...	...	...
Maidstone Corporation	Oct. 27 Nov. 3	136 135	... ...	16	2,701	...
Manchester Corporation	" 5	12,080	+ 656	31	299,471	+ 16,742
Mersey Railway	" 5	1,518	+ 65	19	26,314	+ 2,115
Merthyr	Oct. 28	189	− 15	43	8,727	+ 74
Metropolitan Elec. Trams	" 4	1,794	+ 621	18	34,631	+ 9,340
Middleton	Oct. 29	311	+ 42	43	14,907	+ 275
Nelson Corporation	Nov. 6	103	+ 16	32	3,889	+ 1,183
Newcastle-on-Tyne Corp.	" 5	5,392	+ 44	18	66,181	+ 3,744
Newport (Mon.)	" 5	482	+ 61	5	2,435	+ 306
Oldham, Ashton & Hyde	Oct. 24	541	− 9	43	21,868	− 1,004
Oldham Corporation	" 24 " 30	1,345 1,157	+ 51 − 31	31	37,509	...
Perth (W. A.) Elec. Trams	Nov. 4	1,237	− 55	41	57,176	+ 6,145
Peterborough	Oct. 25	135	+ 3	44	6,661	− 124
Poole and District	" 24	181	+ 23	41	13,171	+ 45
Portsmouth Corporation	Nov. 5	1,513	+ 12	§31	65,155	+ 5,573
Potteries	Oct. 29	1,791	− 40	43	73,005	+ 5,419
Reading Corporation	Nov. 3	507	...	5	3,004	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	Oct. 28	41	− 4	43	6,643	+ 13
Salford Corporation	Nov. 7	3,597	+ 130	21	131,121	+ 7,934
Sheerness	Oct. 26	58	− 3	43	2,813	− 490
Sheffield Corporation	Nov. 6	4,471	− 6	§32	151,559	+ 2,919
Southampton Corp'ation	" 3	885	− 81	31	31,912	− 2,153
Southend Corporation	" 2	215	+ 5	31	12,644	− 1,335
Southport Tramways	Oct. 24	275	− 1	43	14,339	+ 620
S. Staffordshire Trams	" 28	767	− 251	44	35,181	+ 6,047
Stockport Corporation	Nov. 4	471	+ 125	31	16,731	+ 7,475
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	Nov. 6	1,117	+ 23	31	41,066	− 730
Taunton Trams	Oct. 28	41	− 13	43	2,435	− 251
Tynemouth and District	" 28	311	− 17	43	13,173	− 795
Tyneside Trams Co.	Nov. 3	311	+ 29	44	17,390	+ 2,918
Wallasey District Council	" 5	682	+ 61	§31	24,642	+ 1,028
Walsall	" 5	461	...	42	21,373	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	" 3	1,074	...	36	83,771	...
Weston-super-Mare	Oct. 26	80	+ 11	43	6,067	+ 503
Wigan Corporation	...	...	...	...	...	—
Wolverhampton District	" 24	370	− 13	43	16,984	− 70
Worcester	" 28	291	+ 159	36	12,136	+ 6,043
Wrexham	" 24	97	− 14	48	4,450	− 511
Yorkshire Woollen District	" 28	520	− 15	43	25,376	+ [illegible]

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. ‖ Fortnight.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., Nov. 9.	Rate per Cent. Yield.	Dividend Due.	Business Week to Nov. 9. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	2/0	Anglo-Argentine Ordinary Shares	6¾—7¼	4 4 0	April, Oct	7⅛	6¾
5	2/6	Do. 5% Cum. Pref.	5⅛—5⅜	4 12 0	..	5¼	5⅛
St.	6%	Do. Permanent 6% Deb. Stock	141—144	4 4 0	—	142	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	105½—106½	4 16 0	—	106½	106¼
10	6%	Barcelona Tramways Ord.	9—10	3 0 0	—	..	..
10	5/0	Do. 5% Cum. Pref.	9—10	5 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91—96	4 14 0	—	..	..
100	5%	Do. 5 per Cent. Debs.	98—101	4 19 0	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	¼—⅜	..	..	—	..
1	..	Do. 5% Cum. Pref.	1—1⅛	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 8	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	98—101	4 9 3	..	99½	..
20	5%	Bristol Tramways and Carriage Ord.	19—20	4 0 0	Feb, Aug	..	—
10	4%	Do. Cum. Pref. (fully paid)	10—10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107—109	3 13 4	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	103—105	5 13 3	—	..	..
St.	5%	Do. Pref. Ord. Stock	102—105	4 15 3	—	104	103½
10	5/0	Do. 5% Cum. Perp. Pref.	10¼—10½	4 12 0	—	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102%—104%	4 6 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	97—100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	9¾—10¼	5 17 3	..	10½	10⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼—11½	5 5 6	Feb, Aug	11⅜	11¼
St.	5/0	Do. 5 per Cent. Perpetual Debs	117—119	4 4 3	—	118½	117½
St.	4½	Do. 4½ per Cent. 2nd Deb. Stock	95—97	4 12 10	..	96½	96¼
5	1/6	Buenos Ayres and Belgrano Ord.	3½—4	5 12 6	—	4	3¾
5	5/0	Do. 5 per Cent. "A" Cum. Pref.	5½—5¾	5 4 4	—	5⅝	..
5	2/0	Do. "B"	5¼—5½	5 11 6	—	..	..
St.	5%	Do. 5 per Cent. Debs.	105—108	4 13 3	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	102—105	4 16 3	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. 5% Deb. Stk.	96—99	5 2 0	..	..	..
5	3/0	Calcutta Tramways	7½—7¾	4 2 9	—	7⅝	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106—108	4 4 0	—	108	107½
1	1/0	Cape Electric Tram Shares	1¼—1½	5 14 3	..	1⅜	..
St.	4%	Central London Ordinary Stock	91—94	4 5 1	June, Dec	93¼	91½
St.	4%	Do. 4 per Cent. Pref. Stock	100—103	3 18 3	..	..	..
St.	4%	Do. Deferred Stock	83—86	4 13 6	..	..	..
100	4%	Do. 4 per Cent. Debs.	108—110	3 13 4	..	109½	108½
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98—101	3 19 3	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	46—47	4 15 3	Feb, Aug	47	46
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122—125	4 0 3	Feb, Aug	124	121
St.	5%	Do. (1896)	117—120	4 3 0	..	..	..
St.	5%	Do. (1901)	113—117	4 5 0	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104—107	3 14 9	May, Nov	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	101—104	4 16 3	..	—	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13—14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15—16	3 15 0	—	..	..
10	3/0½	Gt. Northern & City Rly. Prf. Ord. (4%)	5½—6½	..	—	..	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9—10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19—20	4 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	110—112	4 0 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4½	5 17 8	..	3¾	3½
St.	4%	Do. 4 per Cent. Deb. Stock	90—93	4 7 3	—	92½	92
10	1½%	Liverpool Overhead Railway Ord	3½—3¾	3 15 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10—10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—101	3 19 3	Jan, July	..	..
10	6/0	London United Trams. 6% Cum. Pref.	10½—10¾	4 12 0	..	10⅝	10½
St.	4%	Do. 4% 1st Mort. Deb. Stock	103—106	3 16 4	..	105	104½
St.	..	Madras Elec. Trams 5% Deb. Stk.	102—105	..	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6—9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10—13	..	—	10	..
1	..	Metropolitan Electric Trams Def	⅛—¼	..	—	⅛	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	—	⅞	..
St.	13/7	Do. 4½ Deb. Stock	102—104	..	..	103½	103
100	5%	Montreal St. Ry. St'g 5% Mrt. Dbs. (1908)	100—103	4 17 3	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103—105	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—1½	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	103—106	4 16 9	..	..	..
10	10/0	Potteries Electric Traction Ord.	8—9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	9¼	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101—104	4 6 7	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	—
St.	3%	Waterloo and City Ord.	88—90	3 7 0	June, Dec	88	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	½—⅝	5 14 3	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	¾—⅞	..	..	¾	..
5	4/0	British Insulated & Helsby Cables Ord.	5¾—6	6 13 4	July, Feb	6⅛	..
5	3/0	Do. 6 per Cent. Pref.	5½—6	5 0 0	Jan, July	..	—
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101—104	4 6 7	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	100—103	4 8 3	..	..	..
5	3/0	British Westinghouse 6% Pref.	3½—3¾	6 0 0	—	3⅝	3½
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	88—90	4 10 2	..	..	..
2	..	Brush Electrical Engineering	½—⅝	..	March	½	..
2	2/6½	Do. 6 per Cent. Pref. Non-Cum.	1—1¼	9 12 0	Mar, Sept	1¼	1⅛
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	93—96	4 14 6	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	69—73	6 6 8	Jan, July	73	72½
5	5/0	Callender's Cable Con. Ord.	9½—9¾	6 3 2	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5¼	4 19 11	Jan, July	5	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104—106	4 6 7	Nov, May	105½	104½
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1½—1¾	4 18 9	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	94—96	4 13 4	..	..	..
1	0/9½	Chadburn's (Ship) Telegraph Ord.	1—1⅛	3 17 6	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1¾—2	3 15 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	90—95	5 5 5	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	6¾—7¼	6 18 0	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	6½—6¾	4 4 4	Sept	6⅝	6½
St.	4½%	Do. 4½% Deb. Stock	104—106	4 5 9	..	105½	..
5	..	Edison & Swan United ("A" sh.) (£3 pd.)	½—¾	..	Feb, Aug	⅝	..
5	..	Do. (£5 paid)	1—1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	78—83	4 17 9	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79—84	6 0 6	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6½—6¾	6 9 9	H'lf-yearly	6⅝	6½
5	3/0	Do. 6 per Cent. Cum. Pref.	5¾—6¼	4 16 0	—	6⅛	6
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106—108	4 4 3	..	..	..
2	1/7½	Electric Construction Co.	1—1¼	6 6 0	July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2—2¼	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98—100	4 0 6	Jan, July	99½	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90—95	5 5 3	—	..	—
10	6/0	General Electric (1900) 6% Cum. Pref.	9½—10	6 0 0	—	9⅞	9¾
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91—96	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½—11½	6 4 4	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4 3 9	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	109—111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	20—20½	4 17 6	Feb, Aug	20½	20
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99—102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 6 per Cent. Cum. Pref.	10½—11½	5 5 10	Mar, Sept	11⅛	11½
10	12/0	Telegraph Construction & Mainten'ce.	37—39	6 3 1	Mar, July	38½	38
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	102—104	3 17 6	Jan, July	..	..
1	..	Willans and Robinson Ord.	1—2	..	Apr, Oct	..	..
		Do. 6 per Cent. Cum. Pref.	2—3	—	Apr, Oct	..	..
		Do. 4 per Cent. 1st Mort. Debs.	74—79	5 3 11	May, Nov	..	..

Share.	Last Dividend.	Name.	Price Wed., Nov. 9.	Rate per Cent. Yield.	Dividend Due.	Business Week to Nov. 9. Highest.	Lowest.
		ELECTRICITY SUPPLY.		£ s. d.			
..	..	Blackheath & Greenwich Dist. El. Lt. See South Metropolitan Elec. Lt. & Power Co. below	..	..	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11¾—12¼	6 8 0	..	12½	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10	4 10 0	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11—12	5 0 0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104—106	4 5 0	—	105½	105
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5¼—5¾	3 9 7	..	..	..
St.	4½%	Do. Do. 1st Debs	100—103	4 7 5	—	102	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..	10⅞	..
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 5 1	Mar, Sept	..	..
5	4/0	Calcutta Electric Supply Ord.	7¼—7¾	4 9 0	..	7½	7⅜
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106—109	3 14 0	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8½—9	4 8 0	Feb, Aug	8⅞	..
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4 0 0	Feb, Aug	5⅝	5½
St.	4%	Do. 4% Deb. Stock (red.)	103—106	3 17 0	..	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	—	..	..
5	2/3	Do. Do. (1903)	4¾—5	..	..	..	..
5	2/3	Chelsea Electric Supply Ord.	6¼—6½	4 5 2	March	6⅜	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109—111	4 1 9	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	10½—11	4 10 11	Feb, Aug	10⅞	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13½—14	4 5 9	Jan, July	13⅝	13½
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123—127	4 0 0	Jn, Dec	124	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	104—106	4 5 9	..	104½	..
10	4/0	County of London Elec. Supply Ord.	9—9½	4 4 2	..	9¼	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12—12½	4 16 0	Mar, Sept	12¼	12⅛
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106—109	4 3 9	..	..	..
St.	4½	Do. Second Deb. Stock Prov. Certs.	101—103	4 7 5	..	..	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88—93	5 7 6	..	..	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101—104	4 7 0	—	..	—
10	..	Havana Electricity Co. Shares	9½—10½	—	—	..	—
5	3/6	Hove Electric Lighting Ord.	7¾—8	5 5 3	..	..	..
St.	4½%	I. of W. Elec Lt. & Power 4½% Db. St. (red.)	98—101	4 9 1	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅛—¼	..	—	..	—
5	5/0	Kensingtn & Knghtsbdge Ord.	12—13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6¾—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102—104	3 17 3	—	102	..
5	..	London Electric Supply Ord.	2—2½	..	..	..	..
5	3/0	Do. 6 per Cent. Pref.	5¼—6¼	5 2 1	..	6⅛	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	97—99	4 2 0	Mr, Jn, S, D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	15¾—16¼	5 10 8	April, Oct	16⅛	16
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½—5¾	4 1 10	Jan, July	5⅝	5½
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	112—117	3 18 0	Jn, Dec	114½	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97—99	3 10 6	..	97½	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	93—96	4 13 9	..	..	—
10	6/0	Notting Hill Electric Ord.	14½—15	4 0 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	101—103	3 18 2	..	..	..
5	2/6	Oxford Electric Ord.	6—6½	5 4 0	March	..	..
St.	4%	Do. 4% Deb. Stock	99—101	4 0 0	..	..	..
1	..	Rand Electric	1⅛—1⅜	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mt. Deb	100—102	4 8 9	April, Oct	101½	..
5	5/0	St. James' & Pall Mall Elec. Ord.	14¼—14¾	4 18 4	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	8½—9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	99—101	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¾—3¼	6 3 1	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83—87	4 12 6	..	..	..
5	2/0	South London Electric Supply Ord.	4¼—4½	3 6 8	—	4⅜	4⁵⁄₁₆
1	..	South Metrop'n Elec. Lt. & Power Ord.	½—1	..	—	..	..
1	0/8½	Do. 7% Cum. Pref.	1⅛—1⅜	4 16 9	—	..	..
St.	4½	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. Accm.)	107—110	4 2 3	—	..	..
5	2/6	Urban Electric Supply Ord.	4¾—5	5 0 0	..	..	..
5	2/6	Do. 6% Cum. Pref.	4½—5⅛	4 18 0	..	5	4⅞
St.	..	Do. 4½ 1st Mort. Deb.	103—105	..	..	103½	..
5	6/6	Westminster Electric Supply Ord.	12¼—12¾	5 2 0	Mar, Sept	12½	12⅜
5	2/6	Do. 5 per Cent. Cum. Pref.	5¾—6¼	3 14 0	—	..	—
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.	99—102	3 19 0	Jan, July	..	..
10	..	Amazon Telegraph	2½—3	..	Jn, Dec	..	..
St.	12/6	Anglo-American	52—54	5 5 10	F, My, Ag, N	53	52½
St.	25/0	Do. Preferred	99—102	5 10 0	F, My, Ag, N	99	98
St.	2/0	Do. Deferred	9½—10	1 0 0	F, My, Ag, N	9½	9¼
100	82	Commercial Cable Capital Stock	170—190	4 4 2	Jn, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93—96	4 3 6	Jn, Ap, Jy, O	93½	..
10	5/0	Cuba Submarine Ord.	7½—7¾	7 15 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	14½—15½	6 9 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7½—7¾	6 9 1	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	99%—101%	4 9 2	Jan, July	..	..
20	3/0	Direct United States Cable	10½—10¾	5 13 0	Ja, Ap, Jy, O	10⅝	10½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100—102	4 9 6	Jn, Dec	..	..
St.	22/0	Eastern Ordinary	133—136	5 2 10	Ja, Ap, Jy, O	135	132½
St.	17/6	Do. 3½ per Cent. Pref. Stock	88—90	3 18 0	Ja, Ap, Jy, O	89½	87½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105—107	3 14 9	May, Nov	..	..
10	2/6	Eastern Extension	12½—12¾	5 9 6	Ja, Ap, Jy, O	12⅝	12½
St.	4%	Do. 4 per Cent. Deb. Stock	106—108	3 15 3	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1906	101—103	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%—102%	3 18 6	May, Nov	..	..
10	5/0	Gt. Nrthn. (of Copenhagen)	28½—29	5 3 5	Jan, July	28½	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100—102	4 9 6	June, Dec	..	..
25	12/6	Indo-European	44½—46½	5 7 6	May, Nov	44½	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	98—100	4 0 0	June, Dec	..	—
10	6/0	West African Telegraph Shares	7—7½	5 6 8	..	..	..
2½	..	West Coast of America	⅞—1⅛	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	98—100	4 0 6	Jan, July	..	..
10	..	West India and Panama	⅞—1⅛	..	May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	6½—7½	9 8 9	May, Nov	7⅛	6⅞
10	..	Do. 6 per Cent. 2nd Pref.	5½—6½	..	May, Nov	6⅛	..
100	5%	* Do. 5 per Cent. Debs.	101—103	4 17 10	Jan, July	..	..
10	3/0	Western Telegraph	13—13½	5 6 9	Mr, Jn, O, D	13¼	13⅛
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101½—103½	4 18 6	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101½—103½	3 16 5	—	103½	102
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid)	5½—5¾	5 19 8	August	5½	5½
1	0/7½	Monte Video Telephone Ord.	½—1¼	..	..	..	..
St.	6%	National Co. Pref. Stock	106½—107½	5 11 7	..	107½	106½
St.	5%	Do. Def. Stock	97—98	5 2 0	..	97½	96½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13—14	4 5 8	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12—13	4 12 4	Feb, Aug	12½	12
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—6½	4 13 0	Feb, Aug	5⅞	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97½—98½	3 12 3	June, Dec	97	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104½—105½	3 17 2	..	..	..
..	5/0	Do. Do. Prov. Certs, 85% to be pd.	87½—88½	..	..	..	..
1	0/7½	Oriental	1—1⅛	6 6 3	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	..	..	..
5	5/0	United River Plate	5¾—6¼	6 5 6	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5½	4 17 7	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104—106	4 14 4	June, Dec	105½	—
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5—5½	5 9 1	—	..	..
10	2/0	Globe Telegraph and Trust	9½—9¾	5 13 0	Ja, Ap, Jy, O	9⅝	9½
10	3/0	Do. 6 per Cent. Pref.	13½—13¾	4 6 0	Ja, Ap, Jy, O	13⅝	13½
100	6%	Submarine Cables Trust (Cert.)	118—121	4 19 0	April, Oct	119½	..
..	86/7	Underground Elec. Rys. Co. of London 5% Profit Sharing Secured Notes	99—99½	..	..	100	98½

* In calculating the yield, allowance has been made for accrued interest but not for redemption. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

ALTHOUGH Mr. SWINBURNE's Address to the students of the Institution of Electrical Engineers is excellent in many respects, it is to be hoped that all who listened to it and read it will not be so misled by the author's high reputation and standing as to regard it in nothing but a serious light. Obviously, Mr. SWINBURNE does not intend that it should all be taken seriously, and there is not the least danger that those who are familiar with his writings and sayings will do so. But with the great majority of students the case is different, and it would be regrettable if they were taught to hold in light regard the value of scientific and engineering knowledge.

◆

MR. SWINBURNE is serious in this, however: He urges his hearers and readers to cultivate the business side of engineering, as this is more remunerative than purely technical or professional work. He points out that business men and not engineers or "raw scientists" are at the head of large industrial concerns:

> If you look round the electrical industry, or round the industries generally, who are at the top? Always the business men. . . . The business man at the top, the practical engineer in the middle, and the unpractical engineer, or the raw scientist at the bottom. . . . A man's value to the world at large may generally be roughly estimated by the income he earns. . . . The business man comes out far away above the engineer. He employs the engineer; the scientific man is his servant.

This is true, but it is a dangerous point of view to place before students who are not yet engineers. Does Mr. SWINBURNE desire to discourage them from being engineers, to discourage them from studying pure science and mathematics, or merely to exhort them not to adopt a "superior" attitude to business men who have not had the advantage of scientific training? We believe that Mr. SWINBURNE has merely the last-mentioned end in view, and that his intention is to incite young engineers to view engineering problems from a scientific business attitude, and to take a greater interest in the problems from which a profit and loss balance-sheet is inseparable. The most successful engineers have, doubtless, a thorough knowledge of business methods, but it must not be forgotten that this knowledge cannot be acquired by a student at college; a student will be well advised to devote his entire time to the study of technical matters while he is at college, and to defer his acquisition of business qualifications until he enters the commercial arena.

◆

WE print in another column a number of amendments which are suggested in the Home Office regulations for factories in which "medium" electric pressures are employed. The suggestions are on the whole reasonable, and we trust that they will receive due consideration by those in authority. Although some of the points raised may be debatable, we think that the majority of engineers will agree that there will be little danger in a relaxation of the rules so far as desired by our correspondent. Clause 2, for instance, in which both a main switch and cutout are called for on every installation, should certainly be altered to allow of the use of a switch with a tripping coil, or any of the well-known forms of circuit-breaker, without a second switch in series with it. The proposed alternative would, in fact, be safer than the employment of two separate pieces of apparatus.

◆

PROF. RUTHERFORD has followed up vigorously and successfully his conception that the complexity of the radiations from radium indicates the presence of several radioactive substances in radium salts as we usually meet them. In the Bakerian lecture, a few months ago, Prof. Rutherford gave an account of the methods by which he had established the existence of three short-lived transitional radioactive forms, named the A, B, C forms, in the solid deposit which the gaseous emanation of radium leaves on most objects it touches. He showed them that radium atoms, by the evolution of α-particles become emanation atoms, which by repeated emission of α-particles assume successively the A and B forms. The B atoms appear to pass without any radioactive manifestations into the C form—a form which produces α, β and γ rays. Now, in the current number of the *Philosophical Magazine*, Prof. Rutherford traces the products of the C atom. He has discovered two further successive transmutations, which he names radium-D and radium-E. Our abstract in this week's Contemporary Electrical Science columns gives the principal properties of these most recently discovered products. These D and E substances are separable in two ways; either by a process of fractional distillation at about 1,000°C., or by immersing in a sulphuric solution a plate of bismuth, which, it is found, collects on itself the D atoms.

Thus in a sample of old radium salt there are no less than seven generations of radio-active substances, usually existing simultaneously, each disintegrating as quickly as it is formed. Whether more transmutations intervene before the final stable stage—helium—is reached is a matter for further investigation. Again, in radium-B we have a substance which undergoes a transmutation without radio-active display—the first discovered instance. But perhaps the most striking outcome of these remarkable researches is the identification of radium-D with "radio-lead," and of radium-E with "radio-tellurium" and "polonium." It constitutes a welcome simplification in the list of radio-active substances, and raises the hope that in a similar study of the products of uranium and thorium a clue may be found to the genesis of radium itself.

The hardening and tempering of tools electrically, as described by Mr. J. M. Gledhill elsewhere in this issue, possesses over the older methods the obvious advantages of cleanliness and quickness, and it also permits a more accurate localisation of the heat than is possible with either the Bunsen flame, the carbon fire, the molten lead bath, or any other of the time-honoured methods. In the first method mentioned, one pole of the supply is formed by an electrolyte, and as this is also used for cooling purposes, no time need be lost in plunging the tool into the cooling fluid. In the second method an arc is formed between a carbon electrode and the tool, which is connected to the other pole of the electric supply. This method is particularly suitable for concentrating the heat at predetermined points. In the third method an alternating current is used for tempering the tool itself, forming part of the secondary of a transformer. The author does not compare the cost of hardening by electricity and the older methods; but, since the electric current is switched on only when it is wanted, it is possible—at least where the process of hardening and tempering is not carried on continuously—that cheapness of operation may also be added to the other advantages of the electric method.

The Address delivered to the Society of Arts on Wednesday by Sir Wm. Abney, as Chairman, constituted a strong appeal to the Government for funds to carry on the Meteorological Office and the National Physical Laboratory. We have previously referred to the financial position of the latter institution and called attention to the fact that unless adequate funds are forthcoming the possibility of its continuance will have to be seriously considered. Sir Wm. Abney expressed himself doubtful as to whether it could ever become self-supporting, and appealed for State control in any event, such control giving an impress to decisions, and acting as a pledge that gain is not its only object.

As a solution to the difficulty, he proposes that this and similar institutions should be attached to some State department, that this department should take the advice of a scientific advisory board on all matters of government, and that there should be a clear distinction drawn between grants for research, equipment and material, and those for staff. In the event of the Board of Education being unable to undertake this duty, Sir William suggests the Board of Agriculture, which might be advised by the Royal Society. All such advice would be gratuitous, the department merely refunding out-of-pocket expenses. Each branch of the department should have for its head an eminent scientific man who would be able to appreciate the advice given and see that it was properly followed. Another function of the Department would be to receive addresses from scientific societies when matters affecting public interest are brought before them. This proposal of Sir Wm. Abney's is, in many respects, an excellent one, for, as he says, the department would be the link connecting the Government with the world of science, a link which is non-existent at present, but which is much needed. We think, however, that the control of the National Physical Laboratory should be allocated to the Ministry of Commerce rather than to the Board of Agriculture, while the latter department would be well fitted to take over the financing of the Meteorological Office.

Mr. Chas. Taylor's Paper on permanent way construction, which we publish in abstract elsewhere in this issue, deals with the subject in a more detailed manner than was the case with the Paper on the same subject, printed in *The Electrician* a fortnight ago. In the recent discussion on Mr. A. N. Connett's Paper at the Society of Arts, and also on Mr. A. N. Banister's Paper at Wakefield, the question of the corrugation of rails was brought forward. It is rather remarkable that this phenomenon of corrugation—the definition of which is not even settled, as will be seen by reference to Mr. Connett's letter in our correspondence columns this week—should, as far as we are aware, have been discovered quite late in the day, after electric trams have been running in this country for a good number of years. Many engineers, certainly, attach little or no significance to corrugation effects, and, since Mr. Taylor does not mention anything about corrugations in his Paper, we may safely assume, that in his experience, too, the corrugation effects are of minor importance.

Chancellor of the Glasgow University.—On Tuesday, November 29th, Lord Kelvin is to be installed as Chancellor of the Glasgow University in succession to the late Earl of Stair. The ceremonies of installation are to commence at 12 noon at the Bute Hall, when representatives of other Scottish universities and many scientific societies will be present.

Royal Society.—Among the Papers down for reading yesterday were "Theory of Amphoteric Electrolytes," by Prof. J. Walker, F.R.S., and "The Electrical Conductivity and Other Properties of Sodium Hydroxide in Aqueous Solution, as Elucidating the Mechanism of Conduction," by W. R. Bousfield, K.C., and Dr. T. M. Lowry, communicated by Prof. H. E. Armstrong, F.R.S.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne—Pinheiros	**Aug. 13, 1902**	—
Beissi-Issa (Yemen)—Camaran	**Oct. 22, 1903**	—
Tarifa—Tangier	**Jan. 18, 1904**	—
Cayenne—Paramaribo	July 18, 1904	—
Trinidad—Demerara	Oct. 11, 1904	—
Bolama—Bissao	Oct. 13, 1904	Nov. 15, 1904
Jupiter Julets (Florida)—Nassau (Bahamas)	Oct. 20, 1904	—
Rhodes—Sitia	Nov. 1, 1904	—
Salonika—Lemnos	Nov. 6, 1904	Nov. 13, 1904
Marseilles—Barcelona	Nov. 11, 1904	—
Santa Cruz (Teneriffe)—Tejita (Teneriffe)	Nov. 11, 1904	—
Sitka—Valdez (Alaska)	Nov. 11, 1904	—
Mozambique—Majunga	Nov. 15, 1904	—

Oil and Waste-Saving Machine.—A recent issue of the *Street Railway Journal* contains the following description of an apparatus which is claimed to be capable of extracting 98 per cent. of the oil or grease from waste or any other fabric. The oily waste is placed in a perforated metal basket surrounded by an outer casing and mounted on a vertical steel shaft, running in phosphor bronze bushings and on ball-bearing steps. Attached to the shaft and at the bottom of the basket is a series of turbine blades. A jet of live steam striking these blades causes the basket to revolve at the desired speed, after which the exhaust steam passes up into the basket, through the waste and out of an exhaust pipe. The exhaust steam from the turbine heats the waste and liquefies the oil, which is extracted by centrifugal force. The complete separation of the oil and waste is said to be accomplished in less than 30 minutes with a steam consumption equal to 15lb. of water on a machine with 20in. basket, and 30lb. of water with 36in. basket.

Opening of the Heston and Isleworth Electricity Works.—The electricity works which have been erected by the Heston and Isleworth Urban District Council, under a provisional order obtained in 1900, were opened on Monday. Messrs. J. and J. S. Enright have been consulting engineers for the scheme, the contract for the whole of the works having been given to Messrs. Davey, Paxman & Co., who, however, only supplied the engines. A dust destructor manufactured by Messrs. Hughes and Stirling is run in conjunction with the works. The power house equipment includes three water-tube boilers, two of which are fired by the destructor and two 200 H.P. engines directly coupled to 150kw. dynamos. A further high-speed engine of 400 H.P. capacity is on order, and this will complete the station as at present constructed, although there is plenty of room for extensions of the buildings; the station also contains a Tudor battery. Henley's lead-covered single cables are employed for feeders, distribution being carried out by concentric mains laid solid in earthenware troughs. The voltage is 480 between outers. Mr. F. Bond is the resident engineer.

Cooper-Hewitt Rectifier.—In his English patent No. 1,851 of 1904, Mr. P. C. Hewitt describes some recent developments in his mercury-vapour rectifier. (Information on the principles, tests and earlier forms of such rectifiers will be found in *The Electrician*, Vol. L., p. 509, and Vol. LII., p. 447.) The chief point of novelty brought out in the patent consists in the observation of Mr. Hewitt, that part of the receptacle which contains the mercury vapour may be made of metal without interfering with the action of the rectifier. This discovery is of importance, inasmuch as its application allows the heat generated in the apparatus to be more readily dissipated than was the case with the glass receptacle employed hitherto. Accordingly, Mr. Hewitt now proposes a receptacle of two parts, the lower one (containing the mercury) being of metal, while the upper one is of glass. The two parts are made to fit tightly, and are firmly held together by the atmospheric pressure. In order to prevent leakage through the joint, a seal of mercury or other substance may be employed. A pump, too, may be permanently connected up to the rectifier, so that any air, &c., leaking into the bulb can be extracted without interrupting the service of the rectifier.

Electric Light for Bombay.—According to *The Indian Electrical, Mechanical and Textile News*, the plant of the Bombay electric generating station comprises one 300kw. 5,500 volt three-phase steam alternator and one 500kw. 5,500 volt three-phase turbo-alternator, which are excited by two 100kw. directly coupled dynamos. The frequency is 50~ per second. The 300kw. set is coupled to a Brush engine and runs at 333 revs. per min. when supplied with steam at 150lb., superheated by 150 F. It is to be capable of dealing for short times with an overload of from 10 to 15 per cent., and to work either condensing or non-condensing. The cylinders are 16½in. and 23in. diameter, respectively, by 10½in. stroke. It is specified that the speed is to keep within 2½ per cent. up or down, and all bearings have forced lubrication, the oil being cooled by passing through a coil placed in running water. The 300kw. alternator has a stationary armature and revolving multipolar field, and is to be capable of running in parallel with the turbo set. Carbon brushes running on phosphor bronze collecting rings are employed. The turbo set runs at 3,000 revs. per min., and is of the Brush-Parsons parallel flow multifold expansion type, using steam through the full range from boiler pressure to the vacuum. There is a bye-pass to allow of high-pressure steam being admitted to the low-pressure portion for large overloads. The lubrication is by two motor-driven three-throw oil pumps, each capable of supplying oil to all the bearings of three such sets. The armature is stationary with former-wound coils and the field-winding is in slots in the laminated revolving field.

Magnetic Storms.—In a paper on the cause of magnetic storms, read by Mr. Andrew Elvins before the Canadian Institute, the author expressed the idea that sun spots, auroræ and magnetic storms are caused by matter forming in space, and passing sunward in orbits more or less elliptical, which, when they cross the earth's orbit, produce auroræ and magnetic storms, pass on sunward, and by planetary perturbations and collisions fall in part on the sun and produce solar disturbances. Supposing the theory to be correct, he then attempted to show how it is that magnetic disturbances are more numerous at times when the earth is near the equinoxes than at other times. Whilst the earth is making its annual revolution, it is also rotating on its axis, and this axis is not at right angles to the plane in which the earth moves—*i.e.*, the plane of the ecliptic, but about 24 deg. from it. If the poles were at right angles to the plane of the earth's path, each of the poles would be equally exposed to matter coming sunward from without in each month in the year (and as the planets move near this plane, and reach outward into space, their action on incoming cosmic matter will cause the larger part of it to move in this plane also; (cosmic matter will be more abundant near the ecliptic than elsewhere); the earth in passing through it will have one pole more exposed to this matter during one half of its orbit, and the other pole more exposed during the other half. But at the equinoxes both poles will be equally exposed, and at any given point, except, perhaps, near the equator, the plus of cosmic matter which produces magnetic disturbances will fall on the outside hemisphere of the earth when it is near the equinoxes. On this theory cosmic matter passing by the earth going sunward is the cause of auroræ and magnetic disturbances; the plus of such matter caused by the action of Jupiter and Saturn, on incoming cosmic matter, is encountered by the earth when it passes us going sunward, and this is the cause of the long 11-year period. The moon's revolution, combined with the earth's motion, is the cause of the 25-day period, and the inclination of the earth's axis is the cause of the plus of disturbances at the equinoxes.

The Union Engineering Building of America.—The *Electrical World* of New York reports that at a recent meeting of the American Institute of Electrical Engineers Mr. Charles F. Scott, as one of that institute's conferees, made a statement concerning the architectural design of the Union Engineering Building. This building will be situated on Thirty-ninth-street, midway between Fifth and Sixth-avenues, facing south. The entrance floor will have a large central corridor, with offices for administration, &c.; in general it is to be a large assembling place for audiences coming in to find their way upstairs, and audiences upon being dismissed will not be crowded in a small corridor, but will have a large circulating place for leaving the building. There will be a carriage drive around the whole building, covered on one side, and the building itself will be practically free and open on all sides. At the east side Mr. Carnegie has generously purchased a lot and put a building restriction on it, so that there will be no house on the lot higher than four storeys. On the west there is a 10ft. space left vacant, and on the rear there is a little space for the carriageway at the back, so that, with the exception of a small area on one side, there will be air and light on all sides of the building. On the second floor there will be a large auditorium capable of seating from 1,200 to 1,500 persons. Corridors will be provided around the meeting room for the circulation of visitors and for those who wish to talk, without disturbing the meeting. Above will be some smaller lecture halls. One of these will be in amphitheatre style, so that any experiments or demonstrations can be readily seen. Others will be suitable for a large convention, with several sections going at once or several independent separate conventions. The upper floor will be set aside for the various societies, for the use of secretaries, board rooms, &c. One or two rooms may be fitted up in club style. A number of general engineering societies communicated with last year were found anxious to take up their quarters in the building. At the top will be a large library and reading room, with overhead light and a stack room just below. At the suggestion of the general building committee the several societies have appointed a general committee on the idea of bringing the libraries of the various societies together and making them the nucleus for a great engineering library.

Glasgow Local Section of the Institution of Electrical Engineers.—The third annual dinner of the Glasgow Local Section of the Institution of Electrical Engineers was held on October 28th. The chair was occupied by Mr. Robert Robertson, the chairman of the Glasgow Local Section, while the croupiers were Prof. F. G. Baily, Messrs. W. A. Chamen, Henry A. Mavor, Prof. Magnus MacLean and Mr. John H. W. Munro. Covers were laid for 170 persons. After the loyal toasts, Prof. Archibald Barr proposed the toast of "The Imperial Forces," and Engineer-Commander Onyon, R.N., and Surgeon-Captain MacFarlane replied. Sir David Richmond, in proposing the toast of the "Lord Provost and the Corporation of the City of Glasgow," said that in Glasgow they had the finest tramway in Great Britain. He also referred with regret to their loss of Mr. John Young, whose place it would be difficult to fill. Sir John Ure Primrose, Lord Provost of the City of Glasgow, in reply, said that he was greatly struck by the wealth of youth he saw around him that night. The industry with which they had associated themselves was itself in its very youth, but they had brought great possibilities into common life. Mr. R. D. Munro, in proposing the toast of "The Institution of Electrical Engineers," said that the Institution had already earned its right to the recognition of not only social assemblies, but of the civilised world. Mr. R. Kaye Gray, in reply, said he and the Council felt that it was only by visits of officials from headquarters that they kept these local sections in proper touch with the Institution, and that was one of the reasons he had for coming there that night. Along with some members of the Institution, he had lately returned from America, where they had visited Boston, New York, Chicago, St. Louis and Pittsburg. He thought these were fairly representative towns, but he could tell them that when he came to Glasgow and saw the Glasgow tramway system, he certainly thought it was the finest system in the world. He had only one objection to it, and that was the overhead wires. Another point that struck him in America was that electrical engineers had a great deal more support than they had in this country. Mr. G. C. Lloyd, in proposing the toast of "The Glasgow Local Section," said that the formation of the local sections was entirely justified by the results, as statistics would serve to show. The Glasgow Section was established in 1900, and at the end of the first working year its membership was, according to their London records, 52, while at the present time there were 210 members. The growth of the Institution in the past year had been such that before long they might anticipate that they would not only be the largest institution in the United Kingdom, but possibly the most powerful of all. Mr. Robert Robertson, in reply, said that he had to convey the thanks of the Section to Mr. Lloyd for the way in which he had submitted the toast. He then asked for a vote of thanks to their hon. secretary and Mr. E. George Tidd replied.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, November 18th.

Institution of Electrical Engineers: Manchester Local Section.

7:30 p.m. Meeting in Owens College. Mr. C. D. Taite, Chairman, will deliver his Inaugural Address.

Junior Institution of Engineers.

8 p.m. Meeting at the Westminster Palace Hotel. Mr. W. H. Lindley, President, will deliver his Address on "Municipal Engineering on the Continent."

SATURDAY, November 19th.

Institution of Electrical Engineers: Leeds Local Section.

10 a.m. Visit to Messrs. W. T. Glover's Works, Trafford Park, Manchester, and the Formby Power Station of the Lancashire and Yorkshire Railway Co.

MONDAY, November 21st.

Junior Institution of Engineers.

9:30 p.m. Visit to Dudley Port and Birmingham to inspect the Central Station of the South Staffordshire Mond Gas Co. and the Nechells Gasworks of the Birmingham Corporation. Train leaves Euston at 9:20 a.m

Institution of Electrical Engineers: Newcastle Local Section.

7:30 p.m General Meeting in the Chemical Lecture Room, Durham College of Science. Mr. Eugene Brown, Chairman, will deliver his Inaugural Address.

Institute of Marine Engineers.

8 p.m. Meeting at Romford-road, Stratford, when a Paper on "Fuel Testing" will be read.

TUESDAY, November 22nd.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. Paper to be read: "Distribution of Electrical Energy," by J. F. C. Snell.

WEDNESDAY, November 23rd.

Institution of Electrical Engineers: Birmingham Local Section.

7:30 p.m. Meeting at the Birmingham University, when Dr. W. E. Sumpner, chairman, will deliver his Inaugural Address.

Society of Arts.

8 p.m. Ordinary General Meeting. Paper to be read: "The Systematic Promotion of British Trade," by Ben. H. Morgan.

Faraday Society.

8 p.m. Meeting at the Institution of Electrical Engineers, 92, Victoria-street, Westminster, S.W. Papers to be read: (1) "Recent Investigations bearing on the Theory of Electrolytic Dissociation," by Prof. L. Kahlenberg; (2) "The Potential of the Hydrogen-Oxygen Cell," by F. J. Brislee

THURSDAY, November 24th.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting. Paper to be read: "Hydrodynamical and Electromagnetic Investigations regarding the Magnetic Flux Distribution in Toothed-core Armatures," by Prof. H. S. Hele-Shaw, F.R.S., Alfred Hay and P. H. Powell.

FRIDAY, November 25th.

Manchester Students' Section: Institution of Electrical Engineers.

7:30 p.m. Meeting in the Municipal School of Technology. Paper to be read: "Electric Power in Machine Shops," by H. C. Jenkins.

SATURDAY, November 26th.

Glasgow Technical College Scientific Society.

7:30 p.m. Meeting at 38, Bath-street, Glasgow. Paper to be read: "The Electrical Drive of large Reversing Engines working Intermittently," by Maurice Georgi.

THE LIGHTING OF STREETS IN MANCHESTER.

On p. 88 of *The Electrician* for Nov. 4th, there appeared a copy of a report on the lighting of the streets in Manchester, drawn out by Mr. S. L. Pearce, electrical engineer to the city of Manchester. In our editorial notes of the same week we commented upon this report, and the *Journal of Gas Lighting* for Nov. 8th contained a lengthy criticism of these comments. A copy of the *Journal* was sent to Mr. Pearce, and he has been good enough to forward us a few observations which may be of interest.

The first important point which our contemporary disputes is the accuracy of the photometer employed. It is asserted that the writer of our editorial notes "evidently does not know the instrument; if he does, he has had no extended experience with it, or otherwise he would learn that 'accuracy' as one of its attributes has no existence." Presumably, therefore, our contemporary is fully conversant with the evil ways of the photometer in question, and ventures the opinion that if Parliament would only see fit to impose penalty tests on electricity suppliers in respect of the illuminating power of their lamps as tested by this instrument, we should at once launch forth poignant criticism. This may be perfectly true, as the function of the photometer would then be entirely different; instead of being employed for the purpose of making comparisons, in which case error cancels out, it would be used quite improperly for making an *absolute* measurement. Thus, although the portable photometer may be quite unsuitable for determining the actual candle power of any source of light, yet its suitability, and also its accuracy, are unquestionable for purely comparative purposes.

With regard to the respective illuminating figures for arc lamps and intensified gas lamps as given in Mr. Pearce's report, the *Journal* does not deny the lighting powers ascribed to the former, but characterises the latter as "absurd and inaccurate," if the gas lamps are kept in proper order. Now, Mr. Pearce informs us that he is quite prepared to stand by his figures, and calls attention to the fact that those for the intensified gas compare very closely with those obtained quite independently by Mr. Bradley, city engineer of Westminster. In Mr. Bradley's case the average candle-power was 573, and in Mr. Pearce's 525. The latter gentleman emphasises the fact that mantles do deteriorate with great rapidity resulting in tremendous diminution of illuminating power, although this diminution may only appear comparatively small to the naked eye. Naturally, no such charge can be preferred against arc lamps.

Our contemporary asserts that Mr. Pearce "has found the acme of perfection, as arc lamps go" in the Gilbert arc lamp, but Mr. Pearce disclaims any remarkable discovery of this kind and says that he has merely found this type of lamp most suitable for his purpose on account of the steady light with which it burns, and the immunity from trifling breakdowns. He considers the "single enclosure" type of lamp to be the best, but he has no doubt that many other lamps would give equally good results.

The main criticism, however, of the article in the *Journal* is directed against the basis on which the prices were calculated. It is stated that the figure of 1·08d. per 1,000 c.p. hours for gas lighting includes 10 per cent. for depreciation, and this is apparently correct, but Mr. Pearce informs us that the figure quoted for electricity (0·95d. per unit) also includes, not only depreciation, but also interest, sinking fund and management charges. The writer of our contemporary's article was under the delusion that the figure quoted included only works costs, and hence much of his subsequent criticism is fallacious. There is another fallacy in the argument that such a load as arc lighting should be charged for at the average rate per unit sold by the undertaking. Our contemporary says:

> The charge per unit, according to the last available returns, for public lighting in Manchester is 2d., for private supply 3·26d., and for traction purposes 1·49d., the average for the total supply being 2·21d The surplus profit last year, after providing for interest and sinking fund, worked out, on the number of units sold, to about 0·27d. per unit; so that electricity cannot be sold, except at a loss, in Manchester for less than a shade under 2d. per unit for any purpose without throwing the burden of the loss on to the private consumers.

Then, quoting figures from an electrical contemporary's table of costs it is shown that the total charges per unit sold in Manchester last year were equal to about 2d. per unit. "Now," asks the *Journal*, "by what means can Mr. Pearce justify his calculation of 0·95d. per unit for public lighting?" Below we give Mr. Pearce's "justification":

> The figures put forward by the *Journal* as being the real cost for street lighting, are altogether incorrect, and represent in the first place units sold and not units generated or produced, and are further nothing but *the average costs*, these of course being obtained by dividing the total expenditure by the total units sold. This method is simple, and that is all that can be said for it. This basis might, however, serve for gas costs, owing to gas being capable of storage to such a tremendous extent, but it will not serve for electricity costs, as the latter varies enormously with the rate at which it is produced. Further, as there are so many different classes of electricity consumers, the average cost affords no clue whatever to the actual cost of the energy supplied to each class, and unfortunately for the *Journal of Gas Lighting*, the figures it quotes are only average figures, and cannot be taken as the correct figures for the charge in this particular supply. If the costs as given by that Journal hold good, it would logically follow that all our charges for power and traction are on the wrong basis, similarly our sliding scale for lighting would be equally wrong in principle, and in fact all the towns which have adopted the maximum demand system would be on wrong lines. The standpoint of the *Journal of Gas Lighting*, and of all gas engineers, appears to be that a unit of electricity costs the same no matter at what rate it is produced, and that therefore a consumer using say 20 lights for 100 hours per annum is just as profitable as another with the same number of lights used for 1,000 hours per annum. This, of course is an absurd fallacy, and can only be put down to the ignorance of writers who know nothing about or have not cared to investigate the subject. The following table shows how the costs are made up. In Manchester the fixed costs are £7. 13s. 6d. per unit of demand, and the running costs 0·45d. per unit actually consumed. These were for last year, and there is no doubt that they will be considerably improved on for the present year. Applying these figures to the street lighting prospective supply, the figure of 0·95d. per unit is arrived at as follows:—

One unit of demand	£7	13	6
Demand used for 3,650 hours per annum (approximately 40 per cent. load factor)			
3,650 units at 0·45d. per unit	6	16	11
Total	£14	10	5

Divided by 3,650 = 0·95d. per unit.

Although the subjoined letter, which appeared in a recent issue of the *Finchley Press*, is not directly concerned with the question of street lighting in Manchester, it may prove of interest to our readers:—

> When we had the electricity installed at our works last year, Mr. Trewby, of the North Middlesex Gas Co., was good enough to say in a letter which appeared in the *Finchley Press*, "We were not the only enterprising firm who had adopted electricity and then been glad to revert to gas." We have waited our time before replying to this letter, for the simple reason that we had to test same by comparison. This we have pleasure in now doing, having used electricity for nine clear months for lighting, heating and power.

1903. *Gas Demand Notes.*			
Christmas to Ladyday	£8	3	11
Ladyday to Midsummer	9	3	4
Midsummer to Michaelmas	12	19	0
	£30	6	3

> The above includes a charge of 9s. 9d. for meter hire.

1904. *Electricity Demand Notes.*			
Christmas to Ladyday	£6	16	2
Ladyday to Midsummer	5	7	11
Midsummer to Michaelmas	5	12	7
	£17	16	8

> The above includes a charge of 28s. 6d. for meter hire.
>
> By deducting these items the actual cost of gas was £29. 16s. 6d., and electricity £16. 8s. 2d.
>
> Trusting these figures may prove useful to some of those folks who so kindly advised us our "light would cost us more."
>
> (Signed) BLOOMFIELD & SON.
>
> Steam Carriage Factory, North Finchley.

Proposed Berlin-Hamburg Electric Railway.—The Berlin correspondent of the *Standard* states that Herr von Budde, Minister of Railways, will preside shortly over a conference which has been called to discuss the practicability of an electric railway between the capital and Hamburg. The difficulties before the scheme are reported to be of a financial rather than a technical character.

THE NEW YORK RAPID TRANSIT SUBWAY.

(Continued from page 15.)

From alternators to alternator switches at the power house the 11,000-volt alternating currents are conveyed through single conductor cables, insulated by oil cambric, the thickness of the wall being $\frac{4}{32}$in. They are laid in vitrified clay ducts. From dynamo switches to 'bus bars and from 'bus bars to group and feeder switches, vulcanised rubber insulation, containing 30 per cent. pure Para rubber, is employed. The thickness of insulating wall is $\frac{9}{32}$in., and the conductors are supported upon porcelain insulators. The alternator switches at the central power station are provided with automatic overload and reverse-current relays, and the feeder switches are provided with automatic overload relays. These overload relays have a time attachment which can be set to open the switch at the expiration of a predetermined time ranging from 0·3 to 5 seconds. The type H oil switch is operated by an electric motor through the intervention of a mechanism comprising powerful springs, which open and close the switch with great speed. This switch when opened introduces in each of the three sides of the circuit two breaks which are in series with each other. Each side of the circuit is separated from the others by its location in an enclosed compartment with enclosing walls of brick and soapstone. From the power house on the Hudson River to the subway at Fifty-eighth-st. and Broadway two lines of conduit, each comprising 32 ducts, have been constructed. These conduits are located on opposite sides of the street, whence they extend to the sub-stations and track network. From City Hall to Ninety-sixth-street (except through the Park Avenue Tunnel) 64 ducts are provided on each side of the subway. North of Ninety-sixth-street 64 ducts are provided for the west side lines and an equal number for the east side lines. Between passenger stations these ducts help to form the side walls of the subway, as shown in Fig. 7, and are arranged 32 ducts high and two ducts wide. Beneath the platform of passenger stations the arrangement is indicated in Fig. 8. In order to minimise the risk of interruption of service, all cables, except at the joints, are covered with two layers of asbestos aggregating a full $\frac{1}{4}$in. in thickness. This asbestos is specially prepared, and is applied by wrapping the cable with two strips each 3in. in width, the outer strip covering the line of junction between adjacent spirals of the inner strip, the whole when in place being impregnated with a solution of silicate of soda. The joints themselves are covered with two layers of asbestos held in place by steel tape applied spirally. To distribute the strains upon the cables in manholes, radial supports of various curvatures, and made of malleable cast iron, are used.

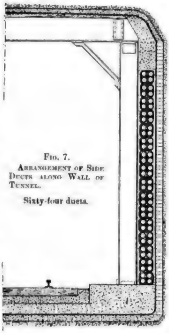


Fig. 7.
Arrangement of Side Ducts along Wall of Tunnel.

Sixty-four ducts.

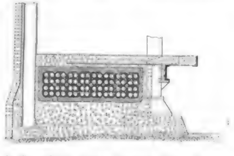


Fig 8.—Cable Ducts under a Passenger Station Platform.

Sixty-four ducts.

To diminish further the risk of interruption of the service due to failure of power supply, each sub-station south of Ninety-sixth-street receives its alternating current from the power house through cables carried on opposite sides of the subway. To protect the lead sheaths of the cables against damage by electrolysis, rubber insulating pieces $\frac{1}{8}$in. in thickness are placed between the sheaths and the iron bracket supports in the manholes.

The high-tension cable used for conveying current from the power house to the several sub-stations aggregates approximately 150 miles in length. It comprises three-stranded copper conductors, each of which contains 19 wires, and the diameter of the stranded conductor thus formed is $\frac{3}{8}$in. Paper insulation is employed, and the triple cable is enclosed in a lead sheath $\frac{9}{64}$in. thick. Each conductor is separated from its neighbours and from the lead sheath by insulation of treated paper $\frac{7}{64}$in. in thickness. The outside diameter of the cables is $2\frac{5}{8}$in., and the weight $8\frac{1}{2}$lb. per linear foot. The cable as manufactured was cut into lengths corresponding to the distance between manholes, and each length subjected to severe tests, including application to the insulation of an alternating current potential of 30,000 volts for a period of 30 min. After jointing, each complete cable from power house to sub-station was tested by applying an alternating potential of 30,000 volts for 30 min. between each conductor and its neighbours, and between each conductor and the lead sheath.

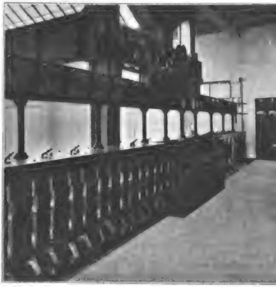


Fig. 9.—Sub-station Switchboard.

Each converter unit at the sub-stations has an output of 1,500kw., with ability to carry 50 per cent. overload for three hours. The average area of a New York city lot is 25ft. by 100ft., and a sub-station site comprises two adjacent lots of this approximate size, permitting the installation of a maximum of eight 1,500kw. converters with necessary transformers, switchboard and other auxiliary apparatus. In designing the sub-stations a type of building with a central air well was selected. The switchboard (see Fig. 9) is located at the rear of the station, and excellent light and ventilation for the operating room is secured by the central shaft. The steel work of the sub-stations is designed with a view to the addition of two storage battery floors, should it be decided at some future time that the addition of such an auxiliary is advisable. In each of the sub-stations, except one, foundations are provided for eight converters. The transformers, which are arranged in groups of three, receive the three-phase alternating current at a potential approximating 10,500 volts, and deliver equivalent energy (less the loss of about 2 per cent. in the transformation) to the converters at a potential of about 390 volts. The converters receiving this energy from their respective groups of transformers in turn deliver it (less a loss approximating 4 per cent. at full load) in the form of continuous current at 625 volts to the 'bus bars of the continuous-current switchboards.

In the sub-stations, as in the power house, the high-potential alternating-current circuits are opened and closed by oil switches, which are electrically operated by motors, these in turn being controlled by 110-volt continuous-current circuits. Diagrammatic bench boards are used, as at the power house.

As shown in Fig. 9, the instrument board is supported by iron columns, and is carried at a sufficient height above the bench board to enable the operator, while facing the bench board and the instruments, to look out over the floor of the sub-station without turning his head. The switches of the continuous-current circuits are hand-operated, and are located upon boards at the right and left of the control board.

A novel and important feature introduced is the location in separate brick compartments of the automatic circuit-breakers in the continuous-current feeder circuits. These circuit-breaker compartments are in a line facing the boards which carry the continuous current feeder switches, each circuit breaker being located in a compartment directly opposite the panel which carries the switch belonging to the corresponding circuit.

The three conductor cables which convey three-phase currents from the power house are carried through tile ducts from the manholes located in the street directly in front of each sub-station to the back of the station, where the end of the cable is connected directly beneath its oil switch. The three conductors, thus well separated, extend vertically to the fixed terminals of the switch. In each sub-station but one set of high-potential alternating-current 'bus bars is installed, and between each incoming cable and these bars is connected an oil switch. In like manner, between each converter unit and the 'bus bars an oil switch is connected into the high-potential circuit. The 'bus bars are so arranged that they may be divided into any number of sections not exceeding the number of converter units, by means of movable links, which, in their normal condition, constitute a part of the 'bus bars. Each of the oil switches between incoming circuits and 'bus bars is arranged for automatic operation and is equipped with a reverse-current relay, which, in the case of a short-circuit in its alternating-current feeder cable, opens the switch and so disconnects the cable from the sub-station without interference with the operation of the other cables or the converting machinery.

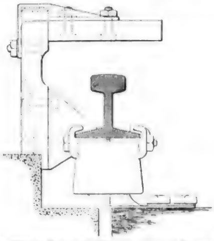


Fig. 10.—Type of Protecting Covering used over Contact Rail.

South of Ninety-sixth-street the average distance between sub-stations approximates 12,000ft., and north of Ninety-sixth-street the average distance is about 15,000ft. Each track is provided with a contact rail, of which Fig. 10 shows the design. There are four tracks and consequently four contact rails from City Hall to Ninety-sixth-street, three from Ninety-sixth-street to 145th-street on the west side, two from 145th-street to Dyckman-street, and three from Dyckman-street to the northern terminal of the west side extension of the system. From Ninety-sixth-street the east side has two tracks and two contact rails to Mott-avenue, and from that point to the terminal at 182nd-street three tracks and three contact rails.

Fig. 11 shows two section switches in the tunnel, which are employed for connecting or disconnecting the feeders to the track. It will be noticed that the switches are mounted in iron boxes with hinged doors. In the illustration the door of one switch has been opened to show the interior arrangement of the switch.

A most elaborate and carefully thought-out signalling and block system has been applied to the subway, a leading idea being the use of the "overlap" distance. It may be noted that the length of the overlap section was determined by the local conditions at each point. In order to provide for adverse conditions, the actual braking distance was increased by 50 per cent.; for example, the braking distance of a train moving at 35 miles an hour is 465ft.; this would be increased 50 per cent. and the overlap made not less than 697ft. With this length of overlap the home signals could be located 697ft. apart, and the block section length would be double this, or 1,394ft. The average length of overlaps, as laid out, is about 800ft. and the length of block sections double this, or 1,600ft.

This block signalling system, which is worked on the Westinghouse electro-pneumatic system with alternating currents, has been applied to the two express tracks between City Hall and Ninety-sixth-street, a distance of 6½ miles, or 18 miles of track; and to the third track between Ninety-sixth and 145th-streets on the West Side branch, a distance of 2½ miles. This third track is placed between the two local tracks, and will be used for expres traffic in both directions, trains moving toward the City Hall in the morning and in the opposite direction at night; also the two tracks from 145th-street to Dyckman-street, a distance of 2½ miles, or 5 miles of track. The total length of track protected by signals is 24½ miles.

The local tracks of the system will also be provided with block signals at important places, such as curves, stations, cross-overs, &c., and at the Harlem river tunnel. The apparatus used differs little in general principle from that employed in earlier automatic systems of block signalling, the substitution of alternating current in place of battery current for the track circuits, and the necessary alternating-current auxiliary apparatus, constituting the principal change. In detail of application to the peculiar requirements under subway conditions, however, the system embodies many radical features which are of unusual interest and importance. In accordance with the latest practice in block signalling for electric railway conditions, one of the running rails of each track is insulated from the propulsion-current return system and is devoted to the signal system. Thus, the other rail performs the novel function of serving simultaneously as conductor for the direct-current return for the propulsion system, as well as that of one of the conductors for the alternating current track circuit for controlling the signals. In accordance with the usual manner of arranging track circuits in block signalling, the current is fed into each block at the end from which the passing train leaves it, the connections to the signal-control apparatus being made from the opposite, or entering, end of the block. The track connections at the signal end of the block lead from the track circuit to the special alternating-current signal-control relay, which operates secondary connections in the various circuits of the signalling system. This relay apparatus, by means of its moving element, operates double contacts, so that when the block is clear and current is thus passing through it, two separate circuits are closed; one of these is the circuit leading to the automatic train stop at the entrance to the block in the rear. The special alternating-current relay is of an entirely new design and introduces an interesting departure from the preceding methods in signal work. Its principle of operation is based on the action of an alternating-current field upon a slotted metallic (non-magnetic)

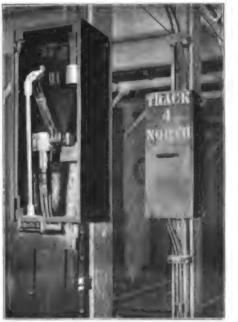


Fig. 11.—Feeder Switches in Tunnel.

vane, which is caused to move in such a way as to close the two circuit contacts. The vane, which is of aluminium, is pivoted in a vertical position on jewel bearings, being held in a down position by a hair spring. The effect of current passing through the field coils is that of causing the aluminium vane to rise to its upper position. This action of the alternating-current relay causes continuous current to flow through a magnet system which is operative only when the block is clear and actuates controlling air valves to the compressed-air cylinders operating the signals; the effect of the magnets becoming inoperative, due to the presence of a train in the block and consequent stoppage of the track-circuit current, is to set the signals to danger, which makes the system thus, in effect, the "normal clear" type.

The distant, or caution, signals are operated by an auxiliary circuit as the result of the setting of the home signal. When the home signal of a block is clear, current is passing through the control mechanism of the distant signal of the preceding block, thus holding it at clear also. When the home signal is thrown to danger, the current flowing in the auxiliary circuit is interrupted by a special circuit breaker in the block signal, which causes the distant signal to indicate caution.

The alternating current for the track circuits is supplied by special high-voltage alternating-current mains which run the entire length of the tunnel. These deliver current to the signal blocks at 500 volts potential, from which it is transformed down at each block by a special double-secondary oil transformer, one coil of which feeds the track circuit at 10 volts, and the other the signal-lamp circuit at 50 volts. In this way the most economical method of current supply is secured, while at the same time absolute independence of the various circuits is obtained by the use of the transformers. In order to safeguard the secondary of the transformer, a non-inductive resistance of 1 ohm is inserted into the 10 volt track circuit. A 8 ampere fuse affords protection to the primary of the transformer. The various magnet-control apparatus, which are used for operating the controlling air valves for the signal cylinders, receive current from a storage-battery main, which also runs the length of the subway. This main is fed by several sets of 16 volt storage batteries in duplicate, which batteries are located at the various interlocking towers and are charged by motor-generators. All these appliances—viz., the transformer, the transformer resistance, the alternating-current relay, as also the emergency stop relay (of which a description will follow later) are mounted on columns in the tunnel in close proximity to the block signals.

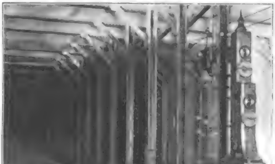


FIG. 12.—BLOCK SIGNAL AND AUTOMATIC TRAIN STOP.

The small amount of space available in the subway portion of the system made it necessary to design a special type of signal (see Fig. 12) involving radically new features. Clearances would not permit of a "position" signal indication, and, further, a position signal purely was not suitable for the lighting conditions of the subway. A colour signal was therefore adopted, conforming to the adopted rules of the American Railway Association. It consists of a vertical iron case fitted with two white lenses, the upper being the home signal and the lower the distant. Suitable coloured glasses are mounted in slides, which are operated by pneumatic cylinders placed in the base of the case. Home and dwarf signals show a red light for the danger or "stop" indication. Distant signals show a yellow light for the "caution" indication. All signals show a green light for the "proceed" or clear position. Although the limitations of space prohibited the use of semaphore arms or similar means of position indication, a position indication has, however, been provided for, as an auxiliary to the colour indications, in the form of the small arm immediately beneath the lenses. A small blade appears in a horizontal position when a danger or caution signal is displayed, and at an inclination of 60deg. when safety is displayed, this being provided in addition to the colour indications for use in case of failure of the lamps for the colour indications.

The signal consists of two sections, the upper and rear portion contains the lenses and position indicator for the home signal. Each signal is constantly lighted by two 4 c.p. incandescent lamps at the rear, the two lamps being connected in parallel for a safeguard in order that one may be always lighted even if the other burns out; in this way the lighting is made as nearly absolutely reliable as possible. These lamp circuits are, as above stated, operated from the local block transformers, the special double coils delivering 50 volts, alternating current, for this purpose. The pneumatic cylinders, which operate the heavy vertical sliding frames carrying the colour lenses for the signal indications, are located in the base portion of the case, and the controlling magnets for the air valves of both the home and the distant signal cylinder mechanism are located conveniently for access, as are also the various portions of the cylinders and slides. It should be here noted that the slides exhibit the green colour for the "clear" or proceed indication only when held in their upper position by the pneumatic cylinders; in this way any accident to the apparatus, cutting off the compressed air, will permit the heavy slides to drop and indicate the red colour for "danger."

The signals which are used on the exterior elevated portions of the system are of the position indication type, although operated similarly to those in the subway sections and by a similar construction of mechanism; the position indication of semaphore arms, which is depended upon in the main, is supplemented by the colour system for night work. The design of the signal of this type differs little from the subway type; the base portion of these signals is identical with that used for the tunnel signals, and the two pneumatic cylinders and their magnet controlling valves are similar, but in this case the cylinders operate semaphore arms instead of the heavy sliding frames. In these signals the colour indications for night purposes are provided by incandescent lamps, also in duplicate, which burn continuously. These lamps are located in a specially designed waterproof case with white lenses pointing toward the coloured glasses. The current supply is also taken from the local block transformers of the block system, and are thus independent of the power and general lighting circuits at the subway system.

An automatic train stop is used at all block signals, and at many interlocking signals. This device automatically applies the air-brakes to the train if it should pass a signal in the stop position, being an additional safeguard only to be brought into action when the danger indication has for any reason been disregarded; it insures the maintenance of the minimum distance between trains as provided by the overlaps established. This automatic train stop mechanism, which is the Kinsman form of track stop, consists of a trip located at the side of the running rail (see Fig. 12), which is normally raised to such a position that it will come in contact with a lever arrangement on the trucks of each subway car, thus throwing the air brakes to full emergency in case the train attempts to pass the stop. It is operated by a pneumatic cylinder located in a closed box. The operation of this automatic stop coincides with that of the home signal in the block next preceding it. When that home signal indicates danger, the trip is in its elevated position, so as to make an emergency application of the brakes. This trip is normally held in its elevated position by a heavy counter-weight located within the controlling box in the middle of the track. When the home signal is cleared, compressed air is admitted also to the pneumatic cylinder of this automatic stop, which acts to raise the counter-weight and thus lower the trip, holding it depressed until the home signal is again changed to danger indication.

The controlling mechanism for the automatic stop is located in a cast-iron box upon the pillar and below the track-instrument case alluded to above. The mechanism consists of a magnetically-operated air valve of the same type as used in the signals. Thus, when the home signal is set to "clear" the automatic stop valve is also operated to admit compressed air to the pneumatic cylinder, which depresses the trip. An additional feature of interest involved in this controlling box is the automatic stop release, by which, in case of failure of any portion of the signal control, the automatic stop can easily be depressed to "clear," so that a train may proceed without danger of an emergency application of the brakes. This is accomplished by a special key, which the guard or conductor may insert in the controlling box and turn to admit air to the pneumatic cylinder; as long as he holds the key turned the trip remains depressed, and as soon as the key is removed the trip will normally rise again. This ingenious mechanism adds an important factor of safety to train operation in the subway.

(To be continued.)

ELECTRIC HARDENING OF HIGH-SPEED TOOL STEELS.

BY J. M. GLEDHILL.

In a Paper on "The Development and Use of High-speed Tool Steel," read before the Iron and Steel Institute at New York, the author described some of the more usual methods of hardening tools, and then discussed electrical methods by which very regular and rapid heating is obtained. Where electric current is available, the system of electric heating is quick, reliable and economical.

One method of electrically heating the points of tools and the arrangement of apparatus is shown in Fig. 1. It consists of a cast-iron tank, of suitable dimensions, containing a strong solution of potassium carbonate together with a dynamo, the positive cable from which is connected to the metal clip holding the tool to be heated, whilst the negative cable is connected directly to the tank. The tool to be hardened is held in a suitable clip to ensure good contact. Proceeding to harden the tool the action is as follows: The current is first switched on, and then the tool is gently lowered into the solution to such a depth as is required to harden it. The act of dipping the tool into the alkaline solution completes the electric circuit and at once sets up intense heat on the immersed part. When it is seen that the tool is sufficiently heated the current is instantly switched off, and the solution then serves to chill and harden the point of the tool rapidly, so that no air blast is necessary.

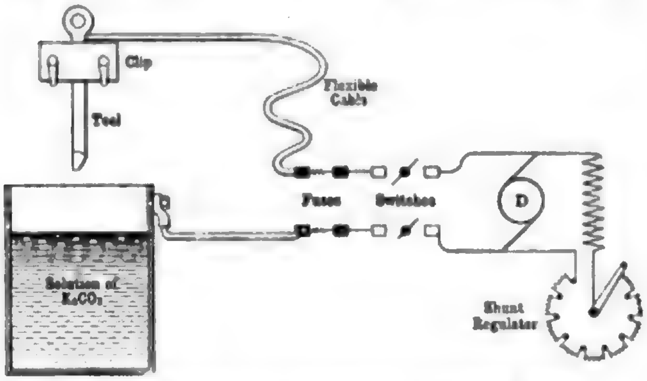


Fig. 1.—Apparatus for Electrically Hardening Tools.

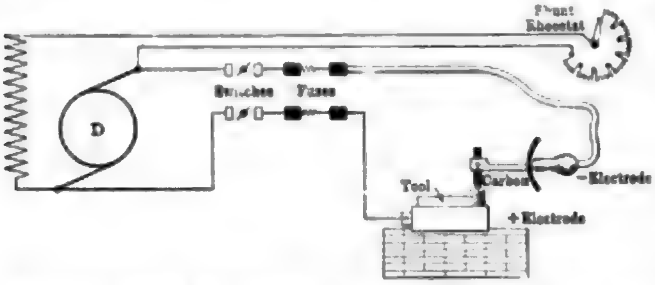
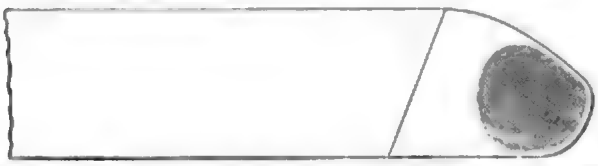


Fig. 2.—Apparatus for Hardening High-speed Tools by means of an Electric Arc.



The shaded portion shows the area of electrical contact. The negative electrode should be kept moving over the surface without approaching too near the cutting edge of the tool.

Another method of heating the point of tools is by means of the electric arc, the heating effect of which is also very rapid in its action. The general arrangement and form of the apparatus here employed being as illustrated in Fig. 2.

The tool under treatment and the positive electrode are placed on a bed of non-conducting and non-combustible material and the arc started gradually at a low voltage and steadily increased as required, by controlling the shunt rheostat, care being taken not to obtain too great a heat and so fuse the end of the tool. The source of power in this case is a motor generator consisting of a continuous-current shunt-wound motor at 220 volts, coupled to a continuous-current shunt-wound dynamo at from 50 to 150 volts. Arcs from 10 to 1,000 amperes are then easily produced and simply and safely controlled by means of the shunt rheostat.

Tempering.—Electricity is also a very efficient and accurate means of tempering such forms of tools as milling, gear, hobbing and other similar cutters, also large hollow taps, hollow reamers, and all other hollow tools made of high-speed steel, where it is required to have the outside or cutting portion hard, and the interior soft and tenacious, so as to be in the best condition to resist the great stresses put upon the tool by the resistance of the metal being cut, and which stresses tend to cause disruption of the cutter if the hardening extends too deep. By means of the apparatus illustrated in Fig. 3 this tempering or softening of the interior can be perfectly and quickly effected, thus bringing the cutter into the best possible condition to perform rapid and heavy work. Tempering of hollow cutters, &c., is sometimes carried out by the insertion of a heated rod within the cutter and so drawing the temper, but this is not entirely satisfactory, or scientific, and is liable to induce cracking by too sudden heat application, and further, because of the difficulty of maintaining the necessary heat and temperature required, and afterwards gradually lowering the heat until the proper degree of temper has been obtained.

In electrical tempering these difficulties are overcome, as the rod is placed inside the cutter quite cold, and the electric current gradually and steadily heats up the rod until the correct temperature is reached, when it can be held at such temperature as long as is necessary, and the current can be gradually reduced until the articles operated on are cold again, and consequently the risk of cracking by too sudden expansion and contraction is reduced very greatly. The apparatus used is very simple, as will be seen by reference to the sketch. It consists of a continuous-current shunt-wound motor directly coupled to a single-phase alternating-current dynamo of the revolving field type giving 100 amperes at 350 volts, 50 cycles per second, the exciting current being taken from the works supply main. The power from the alternator is by no means of a stepdown transformer, reduced to current at a pressure of 2 volts, the secondary coil of the transformer consisting of a single turn of copper of heavy cross section, the extremities of which are attached to heavy copper bars carrying the connecting vices holding the mandril upon which the cutter to be tempered is placed. The secondary induced current, therefore, passes through a single-turn coil, through the copper bars and vices and mandril. Although the resistance of the complete circuit is very low, still, owing to the comparatively high specific resistance of the iron mandril, the thermal effect of the current is used up in heating the mandril, which gradually attains the required temperature, slowly imparting its heat to the tool under treatment until the shade of the oxide on the tool satisfies the operator. The method adopted to regulate the heat of the mandril is by varying the excitation current of the alternator by means of the rheostat. An extremely fine variation and perfect heat control is easily possible by this arrangement.

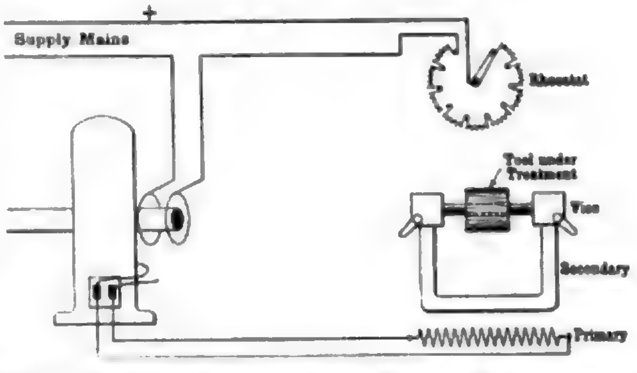


Fig. 3.—Apparatus for Tempering Milling Cutters, &c., Electrically.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Handbuch der Elektrotechnik." Vol. VI., part 1: Die Leitungen, Schalt- und Sicherheits-apparate für elektrische Starkstromanlagen. By H. Pohl and B. Soschinski. (Leipzig: S. Hirzel.) 1904. 20m.

"X-Rays: Their Employment in Cancer and Other Diseases." By Richard J. Cowen. (London: Henry J. Glaisher.) 2s. 6d. net.

"How to build a Petrol Motor." By J. F. Gill. (London: Dawbarn & Ward.) 6d.

METHODS OF CABLE LAYING.

The following is the substance of a communication received from Mr. Leonard Andrews :—

"If there is one subject, more than any other, upon which engineers hold widely different opinions it probably is the much discussed question of laying electric light mains. Some pin their faith to armoured cables laid directly in the ground; others prefer lead-covered cables laid in troughs filled with bitumen, whilst many others insist on some form of drawn-in system. Each system has its peculiar advantages, and it is impossible to obtain any system in which all the advantages of other systems are combined.

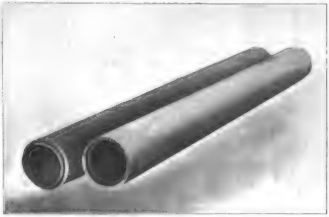


FIG. 1.—3IN. SOCKET CONDUIT.

The advantages and disadvantages of some of the systems that have been most largely used are summarised below :—

For open country work, where there are no gas and water pipes, armoured cable can be simply and cheaply laid directly in the trench by merely unwinding the cable drum over the trench, thus avoiding all risks of straining the cable. This advantage disappears if the cable has to be threaded under the many gas and water services that exist in most streets.

With this system there is a difficulty in localising faults and the steel armouring is liable to be attacked by salts or acids in the subsoil. The armouring is practically no protection against spikes and picks, and is highly susceptible to electrolytic troubles.

The method of laying cables solid in troughs filled with bitumen ensures high insulation between the lead sheath and earth, and freedom from electrolytic troubles. It is an excellent system for distributors, but there is a difficulty in localising faults, and there is no means of increasing the capacity of feeders, and consequently a very heavy, and to some extent unnecessary, expenditure on copper is entailed when the earning powers of the undertaking are small. Moreover, as the ultimate requirements are usually under-estimated, the streets have often to be reopened to lay another feeder.

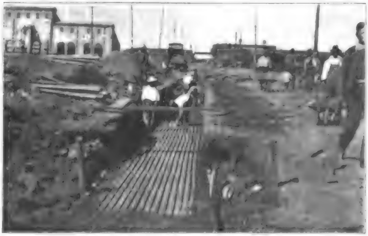


FIG. 2.—LAYING A 30-WAY FIBRE CONDUIT DUCT IN NEW JERSEY. Total length 260,000 feet.

A faulty length of cable drawn into an iron pipe is easily replaced by a sound length, and spare ways may be laid to provide for extensions. On the other hand, pipes rust very quickly, and if cable is protected with braiding a rust joint soon forms between the braid and the interior of the pipes, entirely preventing the withdrawal of the cable. Lead sheathing being uninsulated from earth, the strain on the insulation between conductors and earth is greatly increased. The pipes are also liable to electrolytic troubles unless they are efficiently bonded throughout.

About the only advantage of common earthenware pipes laid direct in the ground is that they are cheap. It is, however, impossible to keep them water-tight, and there is, therefore, an increased strain on the insulation, and electrolytic troubles are almost certain to cause the cable to break down in course of time. Further, there is no protection against picks, &c.

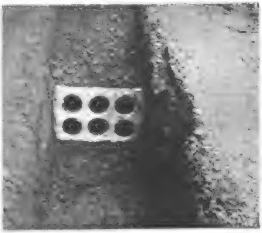


FIG. 3.—SIX-WAY SOCKET FIBRE CONDUIT LAID IN CONCRETE.

Moulded concrete affords good mechanical protection to cables, but on the other hand it is impossible to keep it watertight, and the ultimate damage to cables is therefore liable to be as great as in the case of common pot pipes.

High class earthenware ducts, if well laid on a solid bottom and carefully examined for cracks before laying, ensure a dry conduit. They do not, however, provide sufficient mechanical protection, and are liable to be rendered inefficient by any subsidence of the sub-soil.

High class earthenware laid solid in concrete undoubtedly constitutes, when well laid, an excellent conduit system, but its first cost is very high, and the percentage of breakages is great. Ducts can only be obtained in short lengths, entailing a large number of joints, and the cost of laying, cartage and handling is considerable.

Ordinary bitumen ducts provide efficient insulation between the lead sheath and earth. The disadvantage of this method, however, is that the heating of the conductors due to C^2R losses causes the cable to stick to the ducts with the result that it is frequently impossible to draw it out, and the great advantages of a draw-in system are consequently lost.

The cost of fibre conduit laid solid in concrete is considerably less than that of a high-class earthenware conduit, even when the latter is laid direct in the ground. Excellent mechanical protection is secured, and there is no risk of injury from subsequent disturbance of the ground. The conduit is an admirable insulator, and is absolutely watertight, the strain between conductors and earth being.

therefore, reduced to a minimum, and electrolytic troubles are entirely overcome. It is very simple to lay—one man has laid over 6,000ft. in 10 hours. The cost of cartage and handling is low owing to its small weight, and it is entirely unaffected by salts or acids. Being also tough and mechanically strong, the percentage of breakages is very small. It is supplied in 5ft. lengths, and does not become sticky with a rise of temperature. Experience has shown that cables that have been laid some years can be drawn out as easily at the end of that time as they can be drawn into a new earthenware conduit. Its principal disadvantage is that it is not quite so cheap as a common earthenware pipe.

The system last referred to is comparatively new in this country, though it has been used in the States for about 10 years. It was first brought to the writer's notice a few months ago, and he has since persuaded a number of engineers in this country to lay some trial lengths, and they all, without exception, report favourably upon it. The conduit is composed of a mixture of wood fibre, bitumen and paraffin wax, the method of construction being such that all ingredients are thoroughly mixed in the exact proportions which long experience has shown best to meet the conditions required.

Fig. 1 shows the general appearance of the conduit. It will be seen that each length has spigot and socket joints that fit perfectly into each other, making an excellent joint of the same external diameter as the rest of the pipe. Fig. 2 shows a 30-way duct in course of construction in New Jersey, U.S.A. Over 260,000ft. of conduit were used in this one installation. The method of construction was as follows: After the excavation was made a bed of concrete was placed on the bottom of the trench, then a line was drawn taut on one side, next to which was laid the first line of duct. The remaining lines of duct were laid parallel to the first and separated ¾in. from each other by means of wooden pegs. After the first layer was laid, it was covered with concrete and well grouted, sufficient concrete being used to cover the first layer to the depth of ¾in. The succeeding layers were laid in exactly the same way. The majority of the ducts were laid in five layers of six ducts per layer. Owing to an obstruction, a portion of the system was laid in two layers of 15 ducts per layer, as shown in the illustration.

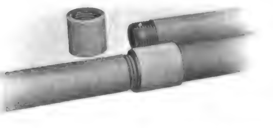


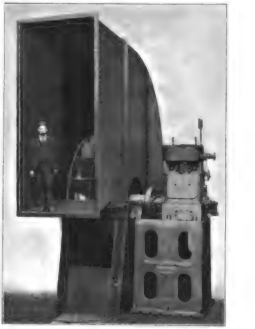
FIG. 4.—SCREWED FIBRE CONDUIT FOR LAYING DIRECT IN THE GROUND.

This was an exceptionally difficult installation, owing to the large quantity of water present, necessitating the frequent use of an electrically-driven hydraulic pump. Even though the conditions were unusually severe, the contractor made a record, one man in the trench and two helpers above laying over 15,000 duct ft. (nearly three miles) a day, exclusive of concrete. The end of a six-way duct laid in concrete is shown in Fig. 3. Fig. 4 shows a heavier build of conduit with screwed couplings. This conduit is largely used for laying single-way ducts directly in the ground, in positions where the cost of concrete would be prohibitive.

Powerful Electric Locomotives.—It is announced by the *Daily Telegraph* that as a result of successful trials of an electric locomotive on the New York Central tracks, near Schenectady, New York, last Saturday, 40 engines of the same type will be put into service on the suburban branches of the New York Central Railroad, north of New York. The normal capacity of these locomotives is to be 2,200 H.P., or 50 per cent. more than that of the locomotive which draws the Empire State express, and it has been demonstrated that the electric engines can haul a nine-car train at 60 miles or more per hour. The experimental track on which Saturday's trial was made is 4 miles long. At crossings the third rail is interrupted, power being supplied by an overhead conductor.

A STEAM-DRIVEN INDUCED DRAUGHT PLANT.

We illustrate herewith a large steam-driven induced draught plant recently constructed by Messrs. W. H. Allen, Son & Co. (Ltd.) This fan was constructed to Messrs. Preece & Cardew's specification for use in connection with an installation of Messrs. Babcock & Wilcox's boilers in Shanghai, the boilers being of the marine type, each having a grate surface of 100 sq. ft. The fan runner is constructed of steel plates, and is 10ft. in diameter, and the fan itself is capable of maintaining a vacuum, in the suction, of 1½in. water gauge when passing 122,000 cubic ft. of gases per minute at a temperature of 600deg. One of Messrs. W. H. Allen, Son & Co.'s two-crank two-cylinder enclosed compound engines is coupled directly to the fan, and is capable of developing 60 B.H.P. when running at a speed of 250 revs. per min. It is fitted with forced lubrication and is specially designed for continuous running with a minimum amount of attention.



STEAM-DRIVEN INDUCED DRAUGHT FAN.

The fan runner is supported by a large bearing fitted with automatic ring lubrication and provided with water circulation, and the fan bearing and engine are mounted on a massive cast-iron base, so that the whole is self-contained and only very simple foundations are required.

SOME DIFFICULTIES IN GETTING ON.*

BY J. SWINBURNE,

Past President.

The chief difficulty in connection with an Address is deciding what it is to be about. The obvious thing in an address to students is to give fatherly advice. But fatherly advice is apt to degenerate into platitudes. There is plenty of good advice of a general kind to be had already. There are lots of such books as Foster, Todd, and so on. Smiles has written showing people how to help themselves to the good things of the world; but I have not read any of them. Human nature is marvellously unchangeable, and though the ancients knew very little of the stuff we have to pack our craniums with, they understood much more about human nature; perhaps they had more time to study it than we have. Anyone wanting good advice can find lots of extracts of wisdom in the writings of the Ancient Orientals; much of it is in the form of proverbs and is accessible. Sometimes it degenerates into copybook heading. Ecclesiastes is quite interesting. Then there is lots of human nature in Shakespeare, but we do not read it now. We go and enjoy elaborate scenery, and pride ourselves we are appreciating Shakespeare. Rochefoucauld and Chesterfield contain much information, not the less true because it is in a form not flattering to humanity. There has been a large output of books about how to get on, during the last 10 years. I do not know that their authors have yet reached the top of the tree.

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* Address delivered to the Students of the Institution of Electrical Engineers on Wednesday.

None of the Eastern sages give advice that is specially applicable to the electrical engineer wishing to rise in his profession, so I think I may try to say something useful. I therefore propose to talk to you about a few of the difficulties in getting on. I do not propose to deal with my own experience, because that gives any enemy the chance of making the obvious remark, "There would have been no difficulty to anyone else in getting on as far as you have got." Besides one's own experience is of personal interest only; so I will never draw on it except where necessary for an argument or illustration.

The first difficulty is to know what equipment is necessary, and how to get it. That is to say, to know what ought to have been learnt, and how to make up any deficiencies. At once each of us is confronted with the question, "What is going to be my work?" I say "us," because the difficulty in many cases is permanent; one never knows what he will be called upon to tackle in the future. The difficulty is much greater, however, in the case of a young man, because he has probably the vaguest idea of what his life's work will be, and that idea time will show to be quite wrong. Ladies have at different times told me that so-and-so, the new Archbishop of Canterbury, said as a boy, he intended to be an archbishop, and this shows wonderful strength of character, and all that sort of thing. But probably every curate intended to be an archbishop, as there is only one career open, and one top. The lesser peak at York is of the same character. But in engineering it is quite impossible for any one to start out with a definite career before him. He is like a particular particle setting out across a containing vessel of gas. He cannot career straight across. He is buffeted about and frequently goes in quite the wrong direction If he is charged, and in a field he will zig-zag across in front of most of his fellows. A man who has made a specialty of electric waves, gets his first appointment as inspector of meters to an electric light company, and so on. A well-known engineer remarked to me the other day, that he found his knowledge of differential equations, and his experience in the correct analysis of the rare earths, was of little use in putting in sewage plant. Yet he had made lots of use both of his mathematical and chemical analysis in his time. Probably each man should have a general knowledge of applied physics and chemistry and mathematics, and a special knowledge of one or two subjects. The special knowledge may never come in useful; but the chances are that in the blind stumblings we call our careers, a specialty may be very valuable. If you glance round at the work of some of our big men you will be surprised to see how many have made their reputation by doing one small thing, but doing it well. If a man gets to the front in one narrow subject the world credits him with knowledge of all the rest. It is, however, even easier to acquire a large general knowledge than an advanced special knowledge of one narrow subject. The specialty must not be too narrow either. I remember a Scotchman applying for an opening. He had no knowledge of electrical work, but thought it was easy to become an electrician. I suggested he had better stick to his own line, in which he admitted he was really at the top of the tree. He said, unfortunately, eminent as he was in it, there was just then no opening. His specialty was "Turneep anawlysis." He could analyse a turnip better than anyone else in the country; but no one wanted any turnips analysed.

One of the great difficulties is to keep knowledge in a polished state ready for immediate use. In practice it may have to lie idle for long periods and then be wanted very much on short notice. This fact is overlooked by people who suffer from the modern craze for writing about technical education. For instance, we are told that all engineers ought to have the calculus at their finger ends, and so on; but it is forgotten that though an engineer ought to be well up in mathematics, he only makes a calculation requiring higher mathematics once in several years, perhaps; and it is impossible for him to keep his mathematics in working order down to minute details. All he can do is to keep general principles in his mind. Probably the only thing to do is to treat knowledge as a huge district into which one's life is long enough to make some very little roads. From each main road there are branch roads, and from each branch road little paths, and so on to an infinite extent. Many places can be reached by several paths. Each road or path gets obliterated by weeds if it is not constantly trodden. Life is too short to make many roads or paths, and very much too short to keep many of them in order by constant use. The best thing then is to keep one or two main roads clear, and remember where the branch roads and paths are, and go over them again when needed. To go back to plain speaking, the great thing is to master a certain number of broad fundamental principles which give a starting point for refreshing old knowledge or acquiring new. For instance, in physics, the law of conservation of energy and all that follows from it; the principles of the kinetic theory of gases; the ideas of lines or tubes of force; the principle of the interlinked circuits; the principle of the growth of entropy in all thermo-dynamic changes. Personally I have always found the backbone of organic chemistry troublesome to remember, chiefly because I very seldom have anything to do with it. I am now making a set of charts showing the derivation of the compounds, so as to get it clear in my mind and to have it as a reference. I do not mean that I am including all the substitution products that amuse the Chemical Society; all that is needed is a skeleton which can be developed in any direction when any particular matter has to be understood.

As to how a man ought to be technically educated; that is not a matter for me to discuss. It is a very large subject. I would only refer to one aspect of it. One of the greatest difficulties in getting on arises from the idea, which is carefully fostered among English science teachers, that there is something degrading in applying science, and that business ability is an inferior quality which is to be despised. No science teacher is so foolish as to tell his pupils in so many words that the object of science is not to be useful; but the whole attitude of science teachers in this country is that of contempt for practice and admiration for unapplied science. All teaching is hopelessly unpractical, and the teaching of science is wholly unpractical. This is not due to a curious perversity among schoolmasters in general or science teachers in particular; it is a perfectly natural and, I believe, quite unavoidable result.

If you imagine a school or college, which somehow came into existence and gave a good education, teaching the things that are useful in a useful way, and imagine that after a time new masters have to be chosen out of the old pupils, who will get the appointments? The old pupils will consist of clever men who absorbed the education in a practical way, and equally clever men who absorbed the information but gave it a less practical turn. It will also consist of less able men of each kind. The ablest practical men will have gone out into the world, doing its work, and so will many of the less able practically minded men. The able men with a slightly unpractical bent will thus become candidates for the new posts. The next generation of teachers is thus less practical, and the education becomes more and more unpractical as time goes on. There is thus an unavoidable tendency for education to become more and more unpractical. Ordinary school education is entirely and hopelessly useless. This is mainly due to its having come down through the Church and to the Church still having control of it, but very largely due to this tendency, which is really involved in clerical control indirectly, too. The only possible use of the present-day public school and university training is to make more schoolmasters. A man who does well at school and college is fit to be a schoolmaster or clergyman and nothing else. He may do other things in spite of it, especially as his competitors are equally badly off; but that is all that can be said. In science and technical training the same unavoidable evolution towards the unpractical is always going on. It is but human to glorify one's own office. The result is that the attitude of the science teacher in this country is that of a real though unavowed antagonism to the scientific development of the industry of the nation. Science, for which no use has been found, or which is not applied, is called "Pure Science," whereas it is really the raw material, and should be called "Raw" or "crude science." There is an assumption of superiority in the term "Pure Science," and generally the term "Science" is appropriated by workers in raw science in much the same way as the term "working man" is appropriated to the exclusion of brain workers. There is supposed to be something noble and superior about "Raw Science," and its study is treated as the unselfish devotion to the interests of man, which is obviously entirely the wrong way round. The so-called "scientific man" thinks that engineers and manufacturers are ignorant and unscientific, and that their practical knowledge is of no account; and that the cure for all industrial evils is more technical education, more universities and more power to the science masters. Though there are in existence a few practical science teachers they are rare. Perhaps no one would be more surprised than the average science master if you told him he was unpractical, and was, by his attitude and example, hindering science. He does not mean to. He is as keen as possible to do just the reverse, and is generally exceedingly anxious for the spread of science or technology: but, unfortunately, he has got a wholly wrong view of the relations of science and business. There is no more baneful influence on the technical advancement of this country than the Royal Society ideal in science.

It is often said that the pursuit of knowledge has a nobility of its own. But what knowledge? You may find out what all the numerals in "Bradshaw" add up to; or who was Napoleon's great aunt; or what Mary Shelley ate; or who really wrote the tune of "God Save the King," or the "Letters of Junius"; or who really started the kinetic theory of gases. In each case you gain knowledge. But you will say "What is the use of such knowledge?" Your question at once commands the answer. No knowledge is worth obtaining for its own or any other sake, unless it is or will probably be useful to man.

I would earnestly urge any of my hearers who has the idea that there is something noble and superior about "Raw Science," or who thinks little of business men, to get rid of all such notions if he hopes ever to get on. If you look round the electrical industry, or round the industries generally, who are at the top? Always the business men. The men at the head of large industries generally know very little science. A man may run a large electrical industry with the most vague ideas as to the true relation of the electrostatic and electromagnetic systems of units; in fact, he may think power, force and energy are very much the same kind of thing if looked at in a broad common-sense way without any scientific prejudice. If he wants good technologists he employs them. If he wants practical men who can take commercial responsibility he pays good salaries, if he wants men full of book knowledge he pays low salaries, but he does not generally want them. Raw scientists, to coin a horrible word for a most estimable class, tell him he knows nothing about science, and therefore does not know how to run a scientific business, and tells him to subscribe to universities, which are so inefficiently worked that they have to beg, like hospitals, and to employ young men from the technical colleges. He either takes no notice or he gets annoyed at their superior attitude, and discharges a couple of scientific men and puts their saved wages towards the salary of a new practical chauffeur, and enjoys himself. Yet the science teacher looks down with contempt on the engineer as an ignorant rule-of-thumb inferior person, and the engineer in his turn looks down on the business man as a money-grubbing person with no brains and no lofty ideals. But this is all topsy-turvy. The business man at the top, the practical engineer in the middle, and the unpractical engineer, or the raw scientist at the bottom. The business man may have no knowledge of the ways of nature, but he has a knowledge of the ways of man, a knowledge which is infinitely more difficult to acquire and infinitely more difficult to employ well. His brain may be different from that of the scientific man; but there is no reason to suppose that it is less. Its convolutions may be different, but the probability is that they are even more complex than those of the scientific man.

A man's value to the world at large may generally be roughly estimated by the income he earns. Where position is earned at the same time, the money income is in proportion less for a given usefulness; but taking such disturbing elements into account, the rule is broadly true. The business man comes out far away above the engineer. He employs the engineer; the scientific man is his servant. Just as the raw scientist looks down on the engineer, and the engineer looks down on the business man, so the business man has a contempt for the engineer; and the engineer in his turn looks on the raw scientist as an unpractical crank. So much is this the case that the business man will not trust the engineer more than he can help. He assumes that if you know anything about anything you cannot possibly be a business man. I remember a board of directors finding fault with a report of mine because I said that making a certain article would pay. They said such a statement was outside my province altogether, as I was a scientific man, and therefore could not possibly know whether a manufacture would pay, as that is a business question. As a matter of fact, I had at one time charge of a factory for making the article in question, but that did not matter: I was scientific, therefore it was not possible I could have any commercial sense. Now, how has such an idea come about? Is it not because scientific people profess such contempt for business that they do not trouble about it, and thus remain so useless that such ideas as those of my board are based on a foundation of truth.

If you examine the large industries you will, as I say, find the commercial or business man with little or no technical knowledge at the top of the tree. If you confine your attention to engineers, you will find the engineers who make the biggest incomes and occupy the most important and responsible positions are those who have most business or practical knowledge. Our leading consulting engineers do not spend a large portion of their lives plotting curves, counting electrons, or even making anything more than arithmetical calculations. They spend their time dealing with large questions on purely commercial lines; and as a rule the bigger the engineer the more he knows about practice and business, and the less he knows about text book science. I do not for a moment mean to say that text book science is not of priceless value; of course it is; and the more scientific knowledge you or I, or still more, the leading engineers have, the better; but most of us suffer from too little common sense in proportion to our scientific knowledge.

The engineers occupying smaller positions, assuming the same age in both cases, are not necessarily deficient in technical knowledge; but they are generally wanting in business attainment and less able to take responsible positions. It is often said that to be a good master you must have been a good servant; but a good servant does not necessarily make a good master, generally the reverse. There is a wide distinction between the man who can earn a few hundreds a year and the man who earns as many thousands. It is a very curious thing that there is hardly anything between. One type of man will either earn his few hundreds a year all his life, remaining permanently an assistant, or he will undertake responsible work and get into fair figures. The engineer who is worth £750 a year seems hardly to exist, except for a short time on his way from one class to another. This is what is meant by the saying that there is plenty of room at the top of the ladder. It is not that the men who remain as assistants permanently are ignorant of science, quite the reverse. The business man can rent a profound mathematician for a very few pounds a week if he wants him: but he probably does not. The real point is that the assistant is wanting in business knowledge or in push. If he is wanting in ambition, or lazy, nothing I can say is to the point; but he may be suffering from a false notion of the relative values of raw science, technology and business knowledge.

If you come down to the raw scientist you find that the industrial world has no use for him at all, and will not pay him anything, and will not employ him. The only opening he has is in teaching; and if he is not very unpractical there are a few Government appointments for him. You will find practically all our leaders in raw science are science teachers. It may be said that this shows they are useful. It does not. If young men's education consisted entirely of the study of Aztec Metempirics, some of the men that did best in Aztec Metempirics might get on in the world, and the brains that made them do well at school would make them do well in real work. But there would be a certain proportion of men who did well in their studies, but were of an unpractical turn of mind. They would become the teachers of the next generation, and they would teach Aztec Metempirics in a still more unpractical form, till the subject would eventually become as completely absurd as the present public school education. But the fact that teachers of Aztec Metempirics made a living in that way would not prove that they were really of use to the community.

Similarly the fact that a large army of teachers make a living by imparting the "education of a gentleman" does not prove they are of any real use. Our religions come from the nursery, and our worldly ideals from the school-room. Few men think of anything outside their particular business, so the ideals remain. Schoolmasters naturally have the idea that what they are good at is most important, so a huge convention is set up. The value of what is called "learning," "culture," "education," or more often "knowledge," is purely a convention with no foundation in fact. What is generally known as a "learned" man or "scholar" has only a memory full of interesting but useless items gathered from the scrap-heap of the past. The most unpractical science teaching is infinitely ahead of this, as it involves reasoning more than memory, and deals with the works of nature, not of man; but there is always the unavoidable tendency towards the unpractical and academical, however sincere and anxious the teachers are to be a real help to their students.

When I say that a man's earnings is a rough test of his value to the world, a great exception must be made in the case of genius. A genius does not work for a given employer; he works for the world at large; and the world at large does not pay him. It would be ludicrous nonsense to say that the value of Newton or Faraday could be reckoned in terms of their pecuniary earnings. They did grand work apparently because they were impelled to do it without any selfish motive. This is true of the great scientific men of to-day. We think now that we have no Newtons among us; the next generation will look back with envy to the present time as the day of great scientific men. The broad rule about measuring a man by his earnings breaks down, not only in the case of great geniuses, but to a proportionate extent in the case of many original workers in unapplied science. As soon as research becomes a means of advancing the individual by getting him better appointments as a teacher, or getting him kudos—taking genuine kudos as part of the earning, the rule holds good.

In the Charter of the Institution of Civil Engineers the engineer is defined as "Directing the Great Sources of Power in Nature for the use and convenience of Man." With all respect to this august body, and their often quoted definition, I would humbly suggest that it is bad. It is really the definition of a scientific man. It is incomplete as applied to an engineer, because it does not take into account the sordid element of Price. An American definition is much better:—"An engineer is a man who can do for one dollar what any fool can do for two." This is not poetical, and is useless for oratorical purposes; but it is right. It is no use being able to design most complicated alternating-current machinery, or being able to explain it with the help of a wilderness of clock faces and several issues of the technical journals, unless the machine, when made, is cheaper than its rivals. Every design, every engineering manufacture, and every piece of engineering is only a question of price. It is unpleasant, perhaps, but it is a hard fact, and we have got to face it. If one of us does £150 worth of work a year, and earns £100, he is efficient; if he only does £90 worth, he is an inefficient machine, and will come to grief. He is like a 90kw. alternator which takes 100kw. to excite; though the analogy is not close. If he does £15,000 worth of work and gets £10,000, he is an efficient machine of much larger size, and his efficiency is much more satisfactory to himself. I may mention, in passing, that an efficient man must do more work than he is paid for. This is not always realised. A man who only did what he was paid for would be of no use to the world at large. His efficiency is zero; his consumption being equal to his output. The man who does £15,000 worth of work and gets £10,000 consumes two-thirds of the work himself; so his efficiency is only 33 per cent.; which is very high, even for an engineer.

We see, then, that the business man is the master; the engineer is his good slave; and the raw scientist is not good enough even to be the slave of the engineer; he has no market value at all, except as a teacher of more Raw Science. The raw scientist will remain at the bottom of the tree until he gets rid of the professional cant which pretends that raw science is pure, or nobler and superior to science as a whole; and the engineer will remain in the middle position as long as he takes the middle view and considers engineering as something superior to money considerations, and as long as he looks down on business and commercial methods.

Views like these put forward in addresses do not alter the world at large, and they are not expected to do so. They are put strongly to warn you, who are young, and therefore inclined to be enthusiastic, against one of the greatest difficulties in getting on; that is to say, a poetic idea that there is something degrading or deteriorating in taking a money view of everything. You may say, "We take higher views of life than that; there is something better for us in our careers than money grubbing." So there is; I heartily agree with you; and when you have grubbed some money and are at liberty to attend to higher things, I would like to be allowed to join you.

It is cant to profess contempt for money. The poet professes to work for fame, and so do the musician, the artist, the philosopher, the scholar or the man of letters. They generally like money; but apart from that they are merely satisfying their proper vanity, or love of approbation, by getting ahead of their fellows. But that is all you want to get on for. Money is nothing in itself, it is only a means, and making it is merely a way of going ahead of your fellows. People who cannot make money do not like it being used as a criterion, so they run it down. Everyone thinks the world ought to be judged by what he can do best himself. If you want to be poets you have my sympathy, but I cannot deal with you in this address. I can only ask you to eschew cant.

You may, on the other hand, ask "How are we to get business and commercial knowledge?" You may say, "You are much older than we; you were practising engineering several years before any of us were born. How did you get all your practical knowledge and become an engineer?" I can only answer, "I am only a very little bit of an engineer." I know I will never be much of an engineer. This is mainly because this practical difficulty in getting on has always been in my way. I am entirely out of sympathy with the whole of this part of my Address to you. I so much dislike saying it all that I know it must be true.

I cannot tell you how to be engineers, because I do not know. All I can do is to make you realise some of your wants; and if you know what you want, you are more likely to get it. One of the greatest difficulties in getting on is to find a good opening. At present, especially, times are very bad, and many big incomes have fallen to negligeable quantities. The profession, or business or trade seems to me overstocked; but everybody is apt to think his own business overrun. Most of you have probably had, or are having, very thorough college trainings. Unfortunately, you will find that even good college educations are not of high market value. That is largely because technical colleges are subsidised, so that education costs the student little money. This tends to reduce its market value, however good it is in itself. You will find all about this in books on Political Economy. Mill deals with it, I am sure.

Then as to the different branches of the business—Business is really a higher title than Profession—in which are you to find openings? From the number of applications I receive from young fellows, it seems to be a common idea that consulting engineering is a good thing to begin upon. This is a curious notion. A consulting engineer is supposed to be a highly skilled engineer, with so much experience that he is an authority. I should have thought at least 20 or 30 years' experience, apart from school and college training, was necessary for a consulting engineer to be worth his salt. But there are various grades of consulting engineer; and I am entirely at a loss to know what the qualifications of the consulting electrical engineer really are. Then still less do I know what the consulting electrical engineer will be by the time you have had 20 or 30 years' experience. At present most of the large towns are electrically lighted, and have their tramways; railways will be electrified by that time, and it is probable the work will be done by their own men. Supervising contractors who are doing wiring will not be much of a profession in 20 years; and if that is consulting engineering, I do not think so much as 20 years' training is necessary.

In manufacturing work there is the designing of dynamos, motors, transformers, and so on. This was considered high grade work when I was a young man; and even very able men built some very queer machines in those days; and we were all pretty ignorant. But the works were smaller then, and salaries for dynamo designing were not princely. But now there is not much opening in electrical machine designing. There is some, of course, but it is not as it used to be. There are many openings to be had in central station work; and stations are growing bigger and more important every day. At present there are also many applicants for every opening. Central station work in a position of responsibility is very anxious. I do not think it is very well paid either. You will find exceedingly able engineers in most of the large town stations; and I am sorry to say their incomes are often very small for men of their technical and commercial ability. The assistants are often poorly paid, especially I think in municipal stations; though I do not know why this should be.

A large number of young men go in for installation work—which sounds as if they started bishops on their episcopal careers—but really means that they do what is in fact electrical plumbing, under an unnecessarily imposing name. There are a great many of them, and they seem to spend most of their time going into and out of partnership with one another, like ions, and sending notices round to that effect. At other times they go bankrupt and send no notices. The upper grades in teaching science are well paid, more especially as a position goes with an appointment, and there is time and facility for original research, which is a luxury and brings reputation. Moreover, a steady income with no expenses is a very blessed thing. But the lower grades are very poorly paid in proportion to their ability.

All this may sound rather discouraging, but I am dealing with the difficulties of getting on, and I am sure it will not discourage anyone who is worth his salt. At first it is very discouraging to make very little, and the good man has little chance of showing his superiority to the common run. But he should always remember that income as a young man is very little criterion of real value. There are many careers in which a young man can make something almost at once; but in all cases the income increases very slowly. In such a business as engineering a man of first-rate ability may be quite unable to make enough to marry on till he is 30, or enough to be comfortable on until he is 40. An eminent north country engineer, whose name you would all know, though he has been dead some years, said that he did all the hard work of his life for 30s. a week, and when he was well on in life money came rolling in of its own accord. I have reason to believe that one of our foremost engineers, now dead, never made £500 a year until he was over 40.

Though you may not like it, a hard struggle is very good for a young man who has anything in him. It gets him into the way of overcoming difficulties, so that when he gets above the small obstacles he goes on overcoming large ones from the mere force of habit. Nearly all great men rise from almost nothing with infinite trouble in their youth. There is nothing worse for a young man than to have about £200 a year of his own. He lives comfortably and does not worry; and when he is 30 he wants to marry and finds he cannot, and it is too late to begin life seriously then. If any of you have this sort of private income he had better go into partnership in installation work for a year or two, and then begin his business seriously.

I have only mentioned a few of the difficulties in getting on. I am sorry to say there are many more, which you will find out in good time.

TEST ON A 500kw. CURTIS TURBINE SET AT CORK.

The British Thomson-Houston Co. have sent us the following particulars of a series of tests carried out by Mr. C. H. Merz on a 500kw. continuous-current Curtis steam turbine set at the Cork Electric Tramway and Lighting Co.'s station:—

The object was to ascertain the steam consumption at varying loads, and for this purpose five tests were made at quarter-load, half-load, three-quarter load, full load and 25 per cent. overload respectively. Each run was of about 1½ hours duration, with the

Log Sheet.—Test of 500kw. Curtis Turbine.

Particulars of test.		Ammeter readings.	Voltmeter readings.	Average load in kilowatts.	Total units used throughout test.	Average units.	Total water pounds.	Water per kw. hour, pounds	Vacuum, inches.	Steam pressure, pounds.	Superheat, deg. Fahr.	Speed, revs. per min.
Load.	Duration.											
¼	1½ hours	234·0	549	128·5	191·75	196·0	4,879	24·9	28·8	155	51	1,845
½	1½ "	460·7	547	252·0	378·0	375·0	8,400	22·64	28·6	155	50	1,820
¾	1½ "	718·5	548	393·7	590·5	590·65	12,377	20·95	27·8	153	70	1,822
Full	1½ "	922·5	555	512·0	768·0	764·0	15,755	20·6	26·9	153	104	1,820
1¼	54 minutes	1,244·0	495	615·8	554·2	552·0	11,530	21·0	26·2	151	124	1,800

exception of the last test at 25 per cent. overload which occupied slightly under 1 hour. Great care was taken in each case that before the test was commenced all conditions of load, &c., should be absolutely steady.

The weight of condensed steam was measured by a tank and weighbridge, which was tested before and after the test and found to be accurate. Vacuum gauges were connected to the low-pressure chamber of the turbine and to the body of the condenser; these gauges were in agreement. Under conditions of full load, however, the vacuum registered in the turbine exhaust chamber was 2in. lower than that registered in the condenser, showing that the pipe connection from the turbine to the condenser was not sufficiently large. The barometric pressure throughout the test was 30·16in.

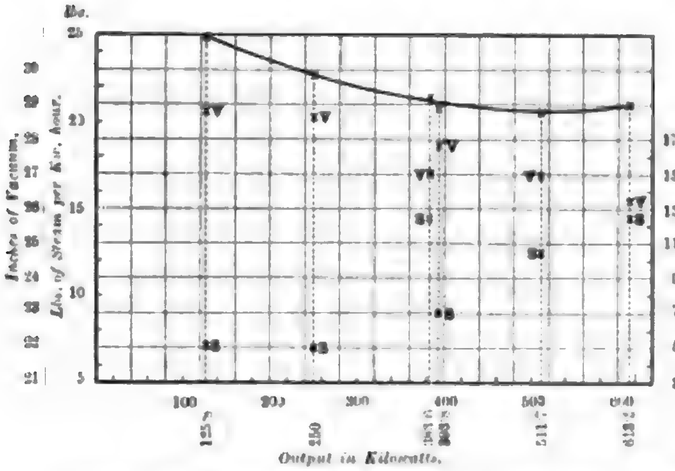

FIG. 1.—STEAM CONSUMPTION CURVE. PLOTTED FROM ACTUAL READINGS. Barometer, 30·16 ins.

Two ammeters, a standard voltmeter and a recording wattmeter were employed for measuring the output of the machine, and the figures entered on the log sheet below are the mean figures of all readings at each load. Those given are the corrected readings after each instrument had been carefully re-calibrated against a standard in the Newcastle-upon-Tyne Electric Supply Co.'s test house.

The tests were started by taking a reading of the wattmeter and by commencing to fill the water tank, and three minutes after the start ammeter and voltmeter readings were taken. Six minutes after the first wattmeter reading a second wattmeter reading was taken, and the condensed steam was weighed. Six minutes after the first ammeter and voltmeter readings second readings of these instruments were taken, and so on. Hence all readings were taken every six minutes, the ammeter and voltmeter readings being midway between the wattmeter and condensed steam records.

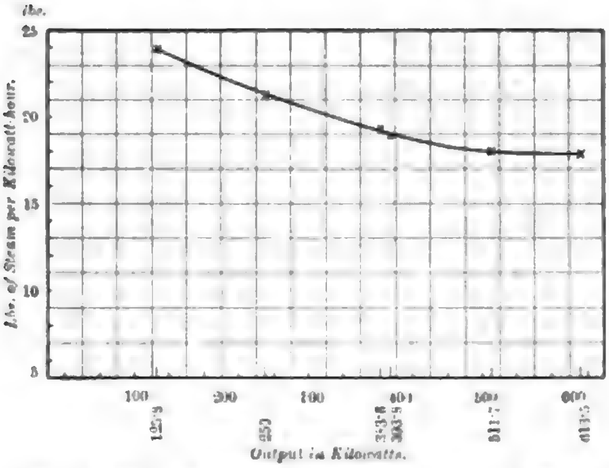

FIG. 2.—STEAM CONSUMPTION CURVE CORRECTED FOR VACUUM AND SUPERHEAT. Barometer, 30·16 inches. Standard vacuum, 28·66 inches. Standard superheat, 115°F.

In the steam consumption curves, Fig. 1 is the curve actually obtained, while Fig. 2 is calculated with correction to 28·66 vacuum and 115deg. superheat.

MR. MARK RUDDLE'S PRESIDENTIAL ADDRESS TO THE DUBLIN LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.*

As it is not usual for your chairman's address to be followed by a discussion, the omission of this feature entails upon him a great responsibility in the selection of the subject matter upon which he should address you. Unfortunately, in the present instance, owing to ill-health and pressure of work, I have been unable to prepare an address which, in itself, would prove sufficiently interesting to entitle me to take advantage of this custom. I hope, therefore, that in the remarks which follow you will find ample material for your criticism, as in view of the rapid increase in our membership I propose to deal briefly with the method of training necessary for entrance into the profession we represent.

The right of electrical engineering to be termed a profession has sometimes been questioned by men who considered that manufacturers were too freely admitted into the ranks of the Institution, and that it had thereby been reduced to the rank of a mere trade union, but I think it is now admitted that we hold a clear title to rank as a profession, since our development has been mainly due to the efforts of a long line of experimenters and philosophers Science, as Huxley says, is organised common-sense, and the groundwork of our claim to be a profession is the necessity for the exercise of all our past experience in the treatment of each problem as it arises—that is to say, for the application of those general principles unconsciously derived from all one has seen, or read, or thought about. The laboratory experiment of to-day is utilised in practical engineering to-morrow, and there is no other branch of engineering which so lends itself to exact mathematical treatment and demonstration. We have reason to be proud of the progress our profession—the youngest of the engineering sciences and arts has made during the 25 years of its existence upon any appreciable scale. A century ago electricity seemed but a scientific toy; it is now thought by many to constitute the reality of which matter is but the sensible expression. The latest evolution of scientific research places the atomic theory in the background of ancient history, and the atom is now regarded as only the relatively vast theatre in which minute monads perform their orderly evolutions, the monads themselves being considered to be units of electricity operating by their interaction with the ether in which they are bathed If this theory be true, it is small wonder that electrical science has of late years made such giant strides at a rate unparalleled in the history of the world.

A municipal engineer is often looked upon as an encyclopædia of information as well as a universal provider of employment, and parents frequently consult me as to the easiest way in which their sons can become trained electrical engineers, with, needless to say, a correspondingly satisfactory salary, and in the majority of instances, leave me with a feeling in their minds that I am unduly magnifying the amount of study and training necessary before the first step can be taken upon the ladder of remunerative practical work. One frequently hears the remark made, "Oh! So-and-so is a 'born engineer.'" To a certain extent this is, of course, true, but in the ordinary meaning of the term, as implying that the person in question had no difficulty in acquiring his engineering knowledge, I venture to think that these "born engineers" exist only in imagination. Man carries with him the physical texture of his ancestry as well as the inherited intellect bound up with it, but this extends no further in the making of an engineer than giving the possession of a quick comprehension, a retentive memory, and a power of grasping problems. All else in modern engineering has to be acquired by a more or less tedious process of strenuous education.

I shall not attempt to place before you to-night any cut-and-dried scheme or syllabus embracing the whole art of training an electrical engineer, for that at present seems to be a matter with regard to which the most diverse opinions are held by the leading experts in technical education All of you will, no doubt, have in your minds the very exhaustive Paper presented by Dr Walmsley to the meeting of the Institution in London on February 11th of this year,† and the prolonged discussion which ensued thereon, and it is a serious matter to find that even now no one settled plan seems to meet with general approbation. This is greatly to be regretted, for upon the system of technical education to be pursued in the near future rests largely the position which will continue to be held by the Empire in the commercial markets of the world. Notwithstanding our backwardness in this matter in comparison with many parts of the Continent, we have hitherto managed to hold our own, being largely assisted by the natural resources of the country, but competition is becoming more keenly felt every year, and we cannot afford to drift along in the same old careless way. The task of keeping the training of students for the profession of electrical engineering abreast of current practice seems almost hopeless in the face of the present rapidly increasing rate of development, and this leads to the important question whether it is advisable for the various colleges and technical schools to confine themselves to the teaching of the scientific principles which underlie engineering in general and the electrical branch in particular, or whether they should supplement that course by practical information upon the construction and operation of the various types of machines themselves, which would, of necessity, require that the equipment should be kept up to date by the newest and most efficient types of actual plant. In the British Isles we have not had the privilege of suffering from over-lavish equipment of our training institutes; on the contrary, for want of the necessary funds it has been cut down to the lowest point, and trained students do not appear to be thoroughly equipped for entrance to the profession.

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* Delivered Nov. 10. Abstract

† *The Electrician*, Vol. LII., p. 687,

One predominant fact appears certain—namely, that one course of general training is necessary for those men who have the ability and funds for qualification into the higher branches of the profession, and that an entirely different training is required for those who, under ordinary circumstances, will have to commence their routine work of the many applications of electrical engineering. By the higher branches I mean men who intend to devote themselves more particularly to original research and to the theoretical development of the scientific side of the profession, but this section is outside the scope of my present remarks. I feel more concern for what I may be excused for terming the rank and file of the profession, each one of whom, nevertheless, carries a marshal's baton in his knapsack, if he has been properly trained and qualified to seize the opportunity when it occurs. The question seems to hinge largely upon the syllabus of the primary and secondary education received up to the age of 16. Whatever the course of training to be pursued after this age, full advantage cannot be taken of it if the secondary education has not been directed with a definite idea of the engineering object in the future, for inadequate preparation means that much valuable time must be lost in preparatory work after leaving school.

Much, however, depends upon the student himself. If he has an innate love of the science and art of electrical engineering, and of learning for the sake of finding out hidden things; if he has the earnest desire to attain to as near the front rank as his capabilities will permit, and has the physical and mental constitution to stand the strain of burning the candle at both ends, so to speak, he will, with average good fortune, attain his end more surely than many others who start under more, apparently, favourable auspices, for, having the self-stimulus of an insatiable knowledge-hunger, he is in closer sympathy with his teachers, and does not wait to be spurred on in his work. And this is the true spirit which should animate those seeking to enter our profession. Its devotees must give more than lip-service—answering of examination questions and obtaining passes and certificates—for, as you know, these alone are no test of a man's fitness, and, in fact, are often the cause of much wasted time by giving a premium to those who best develop a parrot-like facility of answering set questions rather than probing the depth of the information they have assimilated. In saying this I must not be taken as considering these examinations entirely useless, for they undoubtedly do serve a useful purpose in separating the earnest student from the merely brilliant one. The failures in formal examinations often provide the most reliable raw material to be worked up afterwards, as only those who have grit in them continue to persevere as usual in spite of their failure to pass, and this determination to persevere stands to them in their after career, for it must never be forgotten by those who would be successful that they must be students all their lives. There is no such thing as finality in the knowledge of electrical engineering—a week now is more pregnant with discovery than 100 years was formerly, and those who desire to keep in the front ranks must keep pace with the times in their special spheres of work.

A serious danger is now developing owing to the great inrush of young men into anything electrical in name; many of them seem satisfied to acquire just enough technical knowledge to secure a post. Once secured, they settle down and perform their routine duties more or less thoroughly, and gradually drift out of keeping their training up to date. Football, cricket, cycling, and often matrimony, or the preliminary stages of it, claim their leisure hours entirely, and even when on duty occupy such idle moments as occur between the intervals of actual work in the perusal of sporting or sensational literature rather than in anything bearing on their professional work. Time goes on, and opportunities occur for promotion or for entering fresh fields of work, and they find they stand no chance against competitors of more modern training from not having kept their knowledge up to date. It is not enough to have sufficient knowledge for present needs: one must look ahead, and be prepared for developments.

I have hitherto dealt principally with the technical side of a student's training, but before a student can expect to secure a position of any importance he has yet to acquire the commercial or business side of his education. No technical training institute can teach a student how to handle workmen, or how to turn out finished plant from a workshop at commercially remunerative prices, nor would it be reasonable to expect it to do so, for such knowledge can only be gained in the hard school of practical experience, and learnt little by little as opportunity offers. And yet such is the ultimate object of all profession training in the majority of cases, for the most perfectly and scientifically designed scheme is quite valueless unless it can be made a commercially financial success. Students should therefore take every opportunity of seeing works in practical progress; they feel utterly at sea with regard to much that goes on, but to an observant mind there are many object lessons to be learnt and hints obtained which will be of much service in after life. I have often been struck with the apathy displayed by the majority of students when given the opportunity of visiting works in process of erection, or in actual everyday running; they ask no questions and apparently look upon the whole thing as a bore, or an opportunity of escaping a regular class lesson at best, instead of regarding it as a unique chance of seeing practical engineering works and life into which they may hope one day to enter. It is most depressing to those who have to show them round and desire to make the visit interesting and instructive to those who may be their colleagues or successors at some future time to find that so little interest is taken in what is going on, and they feel quite relieved and grateful when one of their visitors asks the most trivial question upon any point. Ask questions about everything is my advice to students: never mind whether they may appear foolish or trivial, give evidence in some way that you appreciate your opportunity, and you will gain many valuable hints for your future work, and render the task of your instructors a little easier.

I think I have detained you long enough upon this subject for to-night, and I would now say a few words upon the work of our local centre. The standard of Papers read before you has been well maintained during the past session, and, in fact, one or two have seemed almost too high class for a large number of the members, though not for the credit of our centre. I judge of this by the very limited amount of discussion which ensued thereon, and, with all due deference to my hearers, I cannot but feel it somewhat of a reproach that so few members can be got to join in the discussions, even upon subjects with which most of you are familiar in your everday business. This should not be. It is not quite fair to expect the same men to speak upon every occasion, and it does not tend to elicit the most profitable discussion upon the particular subject. This, I venture to say, is a great loss to all of us, and takes away largely from the main object of our meetings, which should be the advancement of our mutual knowledge, and, therefore, the interests of the profession at large. I would, therefore, appeal to our hitherto silent brethren to help us in the future; it is not necessary to make a long speech, a few words of practical experience straight to the point are worth infinitely more than a long dissertation couched in ornate phraseology but adding little or nothing to our information. Everyone should endeavour to contribute his mite to the discussion; it may not be easy at first to unpractised speakers, but it will improve with practice, and it is most valuable training for students. A more general discussion would enable us to invite shorter Papers from members, and this in turn would remove much of the present difficulty in getting members to contribute Papers. In most instances a Paper taking 15 to 20 minutes to read would furnish ample material for 1½ hours' discussion, and would not be such a tax upon the contributor as a more elaborate Paper lasting an hour or more.

Our honorary secretary informs me that there is such a scarcity of Papers in view that he may have to fall back upon a visit to the Corporation electricity works to fill up a gap in the meetings. I need hardly say that the Lighting committee will be ready to facilitate such a visit, as the chairman has always taken a keen interest in the work of our centre, but I hope it will not be necessary to take up one of our few regular meetings in this way, as, if the members desire, it can be arranged instead for some Saturday afternoon, when the generating station could be inspected under more favourable conditions.

In conclusion, gentlemen, I have to thank you for your attendance here to-night, and to express the hope that at the close of the present session our proceedings will show that we have made substantial progress in advancing the interests of the profession to which we have the honour to belong and of the Institution which officially represents it.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the first meeting of the Institution of Electrical Engineers of the 1904-5 session, held on Thursday last week, November 10th, Mr. R. K. Gray, the retiring president, who was in the chair, distributed the premiums awarded by the Council for the past session. The names of the successful authors of Papers, &c., were given in our issue for June 10th last. Mr. Gray then vacated the chair in favour of Mr. Alexander Siemens.

Sir **WILLIAM PREECE**, F.R.S., K.C.B., in proposing a vote of thanks to the retiring president, said that he did not know whether his accidental appearance that evening was due to the magnetic influence of the name Gray or not; but this he could say, that after an acquaintance of quite 30 years or more, he found Robert Gray the same Robert Gray whom he knew when a boy. He had known him perform many duties of the greatest responsibility, and he had always gone through them with the same genial expression on his face. He could not speak of Mr. Gray's duties in the chair, because an unfortunate illness had kept him away from the Institution for many months, but in the possession of tact in dealing with matters he knew of no one who could surpass him. One thing he could speak of in connection with his term of his office, and that was his munificence. Although a Scotsman, no one held money in such small regard as their past president. Also in connection with the little army that Mr. Gray had piloted to America this year, there was the most unanimous opinion from everybody who had returned from St. Louis that the dignity of the Institution could not have been better upheld than it had been. He therefore proposed "That the best thanks of the Institution of Electrical Engineers be given to Mr. Robert Kaye Gray for the very complete manner in which he has filled the office of President during the 20 months 1903-4, and for the indefatigable personal attention that he has given to the duties of the office."

Prof. **SILVANUS P. THOMPSON**, F.R.S., who seconded the vote of thanks, said he felt perfectly sure that every member of the Institution would agree with the words of Sir William Preece. Mr. Gray's had been an unusually long presidency, beginning a little before the ordinary time in order that he might preside during the visit to England of the International Meeting of Telegraph Engineers in June more than a year ago. Everyone would remember how splendidly the Institution, in the person of Mr. Gray, received the delegates, and gave them that concert in the Albert Hall, the expenses of which none of them would ever know, but which they knew could have fallen not very lightly upon the shoulders of their late president. Mr. Gray also served as their figurehead during the trip to Northern Italy and everyone who took part in that tour must have recognised how admirably fitted he was to represent, by his dignity, courtesy and amiability, all that was best in an English gentleman. Further, he did not know what they would have done, when death suddenly took away their late lamented secretary, Mr. McMillan, if it had not been for their president, who, busy man though he was, devoted himself almost night and day to the business of the Institution. His devotion in that emergency could never be exaggerated, and finally they had Mr. Gray piloting a party around the American States in the way Sir William Preece had described. Mr. Gray's presidency had been an unusually long one, marked by a number of unique events, and they would cherish for ever in their hearts the year of office when Robert Kaye Gray was president of the Institution.

Mr. ALEXANDER SIEMENS, in putting the vote of thanks to the meeting, which was carried most enthusiastically, said he regretted, as Mr Gray's immediate successor, the example he had set; for it would be hopeless to follow it.

Mr. R. K. GRAY, in returning thanks for the vote, said that all that had been accomplished could not have been done but for the help of a very willing council and of every one of the permanent officers of the Institution.

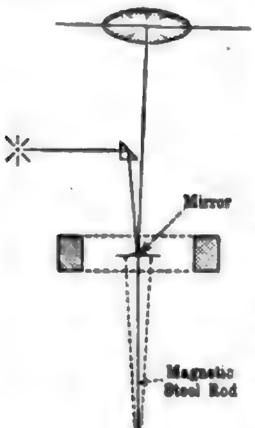
Mr ALEXANDER SIEMENS then delivered his Presidential Address, which was given in full in our last issue.

A vote of thanks proposed by Lieut.-Col. CROMPTON, and seconded by Mr. J. E. KINGSBURY, was carried unanimously.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

New Phase Meter.—H. T. Simon describes a new phase meter, and applies it to the transmission of the indications of the compass to a distance, a transmission which has an important application to the navigation of iron vessels. The phasemeter is based upon the well known optical principle that two circularly polarised vector fields of the same amplitude but opposite direction, when superimposed, combine to form a linearly-polarised vector field whose azimuth only depends upon the phase difference of the rotating fields. If two magnetic rotating fields are thus superimposed, a magnetic alternating field is obtained which is steady in direction for any given phase difference, but rotates through an angle equal to half the difference when the phase is altered. A Braun cathode tube may be used for demonstrating the principle, but the author prefers some arrangement like that shown in the diagram, where a small mirror is attached normally to the end of a thin steel rod whose period of vibration is in unison with the alternator. On board ship, the author proposes the following arrangement for the transmission of the direction of the earth's horizontal magnetic force: in other words, the compass reading. Two coupled polyphase generators have their axes normal to each other. The earth's field is used for exciting one of them—*i.e.*, the latter is a polyphase earth inductor. The other is excited independently. The field of one generator is, therefore, fixed with respect to the vessel, that of the other is fixed in space. If both armatures are coupled, the position of the vessel with regard to the magnetic meridian determines the phase difference of the two rotating fields, and that phase differences can be indicated on the bridge or in any part of the vessel where a compass cannot be placed. The main idea recalls the proposal of Weber to use the earth inductor for this purpose, but that proposal seems to have met with prohibitive practical difficulties.



[H. T. SIMON, *Physikalische Zeitschrift*, October 20, 1904.]

Electrical Effects of Explosion.—If an explosive mixture of oxygen and hydrogen is introduced between two cylinders, the inner one of which is a thick wire, and a difference of potential is established between the wire and the outer cylinder, a flow of electricity to the wire is observed. This effect, discovered by C. E. Haselfoot and Rev. P. J. Kirkby, has been further studied by them. The explosive mixture was passed through a drying bottle into an exploding tube provided with induction-coil terminals; this was connected to an aluminium tube through which a thick wire was drawn, one end of which was connected with a quadrant electrometer and a microfarad condenser. When no explosion occurred the heating of the wire alone produced no electrical effect. The pressure of the mixed gases before explosion ranged from 74mm. to 103mm. It was found that the sign of the potential of the outer cylinder was immaterial. On applying some 50 or 100 volts the amount of electricity deposited on the inner wire by an explosion was from one-fifth to 2 micro-coulombs. The wide variations in the amount are attributed by the authors to the amount of unexploded gases being from 5 to 10 per cent. of the gas originally present. The chief interest of the results lies in their bearing on the question whether the production of molecules of water vapour from atoms of hydrogen and oxygen is accompanied by the formation of ions to a comparable extent. The authors, therefore, calculate the ratio of ions formed to atoms combined, and find that there are some 10 million molecules of water vapour formed for every pair of ions produced, and that, too, when nearly 10 per cent. of the mixture is air. The authors think it highly probable that the electrical effect is not a direct result of chemical action, but that it is a secondary effect due to the enormous amount of heat set free by chemical union.

[HASELFOOT and KIRKBY, *Philosophical Magazine*, October, 1904.]

New Transformation Products of Radium.—E. Rutherford has discovered two further products of the transformation of radium, which he identifies with Hoffmann's radio-lead and Mme. Curie's polonium respectively. These products, called by the author radium-D and radium-E, are products of the slow decomposition of the active deposits left on metals exposed to radium emanation. The author gives the following table of the various products of the decomposition of radium, T being the time required by each body to be half transformed into the next.

Radium	about 1,000 years.
Emanation	4 days.
Radium-A	3 minutes.
Radium-B	21 minutes.
Radium-C	28 minutes.
Radium-D	about 40 years.
Radium-E	about 1 year.

Of all these bodies the first three and the last emit α-rays only. Radium B emits no rays, radium-C emits α, β and γ-rays, and radium-D emits β-rays only. Radium-D and radium-E must be present in pitchblende in amounts proportional to the quantity of radium present, and should be capable of separation from the mineral by suitable chemical methods. The author predicts their properties as follows: The β-rays activity of radium-D should decay to about half value in 40 years. In consequence of the change of D into E, the latter of which gives out α-rays, the α-ray activity will increase for a few years, pass through a maximum, and then decrease with the time and fall to half value in about 40 years. Since the rate of change of D is about 25 times as fast as radium itself, the activity on separation, measured by the number of electrons expelled per second, should be 25 times as great as from an equal weight of radium. The α-ray activity produced in it should at any time be capable of separation by adding a bismuth plate to a solution of the substance. Radium-E, on the other hand, should emit only α-rays, and its activity should fall to half value in about one year. The substance, when freshly prepared, weight for weight, should emit about 1,000 times as many α-particles as freshly prepared radium. The author shows that both Marckwald's radio-tellurium and Madame Curie's polonium resemble radium-E in all their chemical and radio-active properties. The author is engaged in an attempt to separate radium-D from pitchblende by a simple method.

[E. RUTHERFORD, *Philosophical Magazine*, November, 1904.]

Spark Potentials in Air.—B. Walter compares his formula for the discharge potential over a distance, d,

$$V = a + bd$$

with that given by Baur,

$$V = c\sqrt[3]{d^2},$$

much to the advantage of the former, as agreeing much better with observations. But the first formula only applies to distances greater than 5cm. The author draws the interesting conclusion from his formula that whatever the length of the spark-gap, the current at the moment the spark is formed is always the same. In other words, the genesis of a spark requires what the author terms a constant minimum ionisation current, the latter being a link between a conduction current and a displacement current.

B. WALTER, *Elektrotechnische Zeitschrift*, No. 40, 1904.]

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THE ELECTRICAL MANUFACTURE OF IRON AND STEEL.

Whether it is practicable to prepare iron from its ores by electrical methods has been debated for a good many years. There have been frequent and intelligent attempts to smelt oxide of iron in electrical furnaces, and to obtain from it ordinary pig iron. Sanguine inventors foresaw and predicted the abolition of the blast furnace, and dreamed of a time when a very black industry would be transferred to a region where the only coal used is "Houille blanche." Gradually a saner sense prevailed, and it began to be understood that electrical methods of heating afforded no royal road, but are controlled by the most commonplace considerations of physics, chemistry and commerce. Naturally, those countries which are relatively poor in coal, rich in water power, and possessed of a moderate abundance of iron ore, were the first to make a practical step towards the displacement of the blast furnace. It happens, however, that the blast furnace is a fairly efficient thermal contrivance, and has the great advantage of some two or three hundred years' experience at its back. The displacement looked for by the too eager did not occur, and its occurrence continues to be improbable.

But though the general substitution of electrical methods for the more usual process of smelting is remote and elusive, a particular direction of advance has been realised. The possibility of treating iron ores electrically in regions where the ore and the power alone are abundant, is generally recognised; if the country having these advantages, and the complementary drawback of dear fuel, happens to rejoice in a good stiff tariff, there is, at least, a case for inquiry. It seems that this aspect of the question presented itself to the Canadian Government, which, desiring to foster the iron and steel industry within its borders, appointed a Commission with power to rove. As Canada at present produces no iron worth mentioning, the Government did well in obtaining a European expert. The titular head of the Commission, Mr. HAANEL, was directed to engage the services of an iron and steel specialist, and he very properly obtained the co-operation of Mr. HARBORD. These two, with Mr. C. E. BROWN acting as electrician, constituted an excellent corpus, and in the pursuit of their duties visited the principal works in Europe where steel is manufactured electrically. The Commission conducted their inquiries at Gysinge and Kortfors in Sweden, at La Praz and Livet in France, and at Turin in Italy. They investigated the processes of Kjellin, Héroult, Stassano and Keller. In every case where such a proceeding was possible, they saw metal prepared, determined the output and expenditure of power, and ascertained the quality of the product. They succeeded in acquiring drawings and photographs illustrating the furnaces in use, and from the data, procured with no little labour, they have prepared a very notable report. This report has only within the last few days been permitted to become public. Its matter is of so solid an interest that we make no apology for presenting its pith to our readers and apprising them of such conclusions as may fairly be drawn from it.

Necessarily and rightly the report as a whole is descriptive. It is unique in presenting in one cover and without *parti pris* an account of processes which have been described hitherto chiefly by those interested or ignorant. Its statements are supported by experimental results original with the Commission. Thus, on this ground alone, it is a document of the highest value. But embedded in the description are crystals of opinion; these, as is natural, emanate in most part from the steel expert, Mr. Harbord. The Commission appears, with great sense and propriety, to have adopted his conclusions. Probably those of our readers who have followed this great question can predict with fair accuracy the nature of these conclusions. Put very briefly, the official opinion of the Commission is that pig iron can be produced from iron ore, and steel of all grades can be made from pig, scrap and ore in the electric furnace with as much ease and certainty as can be secured by the customary methods: that the production of pig iron is not to be thought of in a place where fuel is cheap, but may be practicable in a country like Canada, it being understood that this view is to be considered probable rather than established: that the manufacture of high-grade metal of the class of crucible steel can be conducted with economy in several forms of electric furnace; this product is excellent and the preparation far cheaper than in the old pot process. It is sagaciously suggested that special alloys, tungsten steel and the like, may well be made in furnaces which from their nature cannot adversely influence the quality of the metal they yield.

To the specialist all these propositions present that claim for consideration which is the right of old friends. He receives them, he believes in them; the absence of the unexpected appeals to his kindly conservative instincts. But the electrical and metallurgical world is not made up of specialists in this field and it is fitting that the truth concerning iron smelting and steel manufacture by electrical methods should be published with authority. The labours of the Commission have made this possible, and the work stands a monument of legitimate Government activity, directed with intelligence and achieving its goal.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Handbook in Cable Break Localisation. By Edward Raymond Barker, M.I.E.E. (Alabaster, Gatehouse & Co.) 2s.

It is intended that this handbook should be used with Mr. Raymond Barker's Calculator Board, the uses of which it explains, whilst a summary of break localisation tests reduced to a uniform nomenclature is appended. The condensation of the data required by the cable-ship electrician, in the form of curves, is the object fulfilled by the Calculator Board, on which are collected upwards of 20 curves, embodying break localisation formulæ and others relating to submarine cable work. The derivation of the desired value from any curve is rapidly and accurately obtained by the mechanical movement of a pair of cursors, conversely intended to serve for the graphical plotting of results on a celluloid working sheet. Both this conspectus of data and its explanation in the manual have been elaborated with great care, and form a valuable aid to the cable ship electrician, who, we think, will find that the trouble taken to familiarise himself with the working of the Calculator Board is amply repaid. The only drawback to the utility of such a system is the confusion which is liable to ensue when the number of co-ordinated curves exceeds a certain limit. On the other hand, if they are distributed over several sheets one loses the advantage of having all the curves in instant readiness for use, which the Calculator Board confers.

The late Walter J. Murphy, whose loss was so widely lamented by his confrères in the cable world, amongst his many contributions to the simplification of localisation work, showed that the two current break methods can be thrown into a general form which comprises both the Mance and reversals tests, which ought, accordingly, to be capable of inclusion in Mr. Barker's collection of curves.

It might almost be thought that the subject of cable-break tests had been over-elaborated by the numerous careful researches which have been made in it. When, however, heavy conductors are under test, in which an error of 2 or 3 ohms in the resistance allowed for the exposure is equivalent to a naut of the line, cable electricians value the reliability ensured by applying several methods to check one another; and in order to avail themselves of this they require the best obtainable combination of rapidity with accuracy. Mr. Raymond Barker's system appears to be decidedly a step in this direction, besides being equally applicable to a great variety of other engineering computations.

The Electric Tramcar Handbook. By W. A. Agnew. (London: H. Alabaster, Gatehouse & Co.) 1904. 2s. 6d. net.

We have tested this modest-looking volume by carrying it about as a pocket-book for several days and referring to it from time to time as questions have occurred to us to which it ought to have answers. The test has given good results, and we can recommend the book as a handy remembrancer on the electric equipment of tramcars. The descriptions and diagrams of controllers and their connections is especially full and up-to-date, but that on p. 47 would be more convenient if the block were turned the right way up to agree with the titling.

Whether the book will appeal to the average motorman is another question. The motorman would be greatly the better for reading and understanding it, but the majority would probably find it too condensed. That is hardly the author's fault, and whatever may be said about explanations, the instructions what to do are generally very correct, clearly expressed and to the point. The book might, in fact, be comfortably split into two parts—one of instructions to motormen for the working of their cars, and the other a remembrancer for motor inspectors and shed foremen.

We notice one exception to the usual clearness of expression. On p. 90 the motorman is told: "If the power has been off for some time, and a considerable number of cars have to start, do not pass the half-speed notch for a few minutes, so as to give the power station a chance to take up the load, and each car should be allowed to get into motion before the others put on power." Now we want to know which car is to start first.

Lois Fondamentales de L'Electrochimie. Par P Th. Muller, Professeur à l'Université de Nancy. (Paris: Gauthier-Villars.)

This is one of the volumes of the series of "Encyclopédie Scientifique des Aide Mémoire," and consists of 181 pages. The book commences with a description of first and second-class conductors, and at once plunges into a definition of Ohm's law. On the next few pages one is introduced to the theory of ions and their classification, and the reader is shown that dilute sulphuric contains three ions, while the strong acid is only dissociated into two ions. Then follows the mechanism of electrolysis with the usual experimental proofs of the velocities of the ions; this part of the book is clearly written and well up-to-date.

On p. 142 the theory of electrolysis is expanded, and the author discusses the importance of the E.M.F in the separation of metals from mixed solutions. Chapter V. is chiefly devoted to a discussion of the seat of energy in the electrolytic cell, the transformation of chemical into electrical energy being carefully explained.

From beginning to end this little book is devoted to the theoretical side of electro-chemistry, and almost entirely to the physico-mathematical part of the subject. In some respects it reminds one of the very useful book by Le Blanc, which was the first of its kind and, we may add, the best. As a matter of fact, one is becoming a little tired of the books on mathematico-physico-electrochemistry, which are now being turned out in such profusion. They are all of them based on Le Blanc's book, and, as has already been stated, they are none of them better and very few of them as good. We are rather afraid that so many books of this kind being published may rather obscure the extremely important bearings of the science of electrochemistry to industry. The average reader is apt to find them rather dull, and to say that electrochemistry "seems to be nothing more than symbols and mathematical formulæ woven round a superstructure of ions."

USE OF ELECTRICITY IN FACTORIES AND WORKSHOPS.

We have received from a correspondent the following suggested amendments to the draft regulations for the use of electricity in factories issued by the Home Office and published in *The Electrician* of Oct. 21, p. 18 :—

Clause 1.—The totally enclosing of wires in strong metal casings is objected to on the grounds of : Inaccessibility of conductors; difficulty in maintaining satisfactory insulation resistance between conductors and earth in totally enclosed metal tubing, owing to the condensation of moisture in such tubing; difficulty of inspecting the condition of conductors when in service; difficulty of localisation of faults and the remedying of same due to the inaccessibility of conductors; increased first cost.

Cables supported on insulators spaced a suitable distance apart are readily accessible, and enable the insulation resistance to be maintained at its maximum value. It is therefore suggested that Clause 1 be amended as follows :—

"All wires in connection with the supply shall be so arranged that there shall be a minimum danger from shock or fire. Where readily accessible the wires shall be completely enclosed in strong metal or other approved casing."

Clause 2.—Where suitably designed automatic circuit-breakers are used it is unnecessary to use switches in series with them, as an automatic circuit-breaker is equally reliable as a switch, and in general is better adapted to open a circuit under emergency conditions. The addition of a switch, in the circumstances, increases the first cost of the installation without increasing the safety of the arrangement. It is therefore suggested that this clause be amended as follows :—

"All mains and branch circuits should be protected by switches and fuses, or by automatic circuit-breakers. Where circuit-breakers are used on one pole only they shall be fitted either with a free handle device, or equivalent, to prevent the possibility of a circuit-breaker being held in on a short circuit."

Clause 3.—(From the word "provided" in the fifth line to the end) involves the provision of a separate switch for single arc lamps, even when connected in series, and prevents the control of such lamps in groups when the pressure exceeds 250 volts from earth. Now, various manufacturers are already supplied, and more will undoubtedly be supplied in the near future from systems of power supply, which also furnish power for traction purposes at 500 volts, and on which systems the negative pole will consequently be earthed. In the case of groups of arc lamps or other similar devices in series between the conductors there will be 500 volts pressure from earth. It is suggested that the extra cost and complication of a separate switch to each lamp, owing to the grouping of lamps connected across a 500 volt circuit, besides the extra cost involved in the wiring, is unnecessary. It is therefore recommended that this clause be amended from the word "provided" in the fifth line to the end, as follows :—

"That where arc lamps are connected in series across conductors on a circuit, the pressure of which cannot exceed 650 volts from earth, it shall be sufficient if one double-pole switch, conveniently placed, be provided for each such series of arc lamps."

Clause 5.—As regards the words "All metal holders for Incandescent Lamps," it is suggested that this clause would increase the cost of the installation of electric lighting in factories in many cases to a prohibitive extent, and would entirely prohibit the use of plain pendant fittings in positions for which they are eminently suited. The provision of earth wires for the metal parts of all such fittings, even if practicable, would be a very serious item. Further, in the event of the lighting being connected to a three-wire system with a grounded neutral and an earth occurring on to the metal work of the fitting, the full potential between the outers of the three-wire system would exist between the fitting and earth. The following amendment is therefore suggested :—

Omission of the words "All metal-holders for incandescent lamps," so that the amended clause will then read : "The frames of all motors and metal casings of all wires, switches, and fuses, and cut-outs, shall be efficiently connected to earth."

Clause 6.—While this apparently refers to apparatus under the control of public supply authorities, is it intended in Clause 6, paragraph (a) that the provision of a fuse in the neutral is prohibited only in so far as the service lines are concerned, and that fuses may be used on both poles of branch distribution circuits, one pole of which is connected to the neutral service lines? This applies particularly to lighting installations which are supplied from one outer and the neutral, of a three-wire system.

PERMANENT WAY FOR TRAMWAYS.*

BY CHAS. T. TAYLOR.

An essential feature of a well-equipped tramway or light railway is a good track. It is, therefore, advisable that every possible means should be adopted (consistent with reasonable expense) to ensure that the permanent way shall be perfect both in design and construction, for in addition to the first cost, which is about £6,000 per mile of single track of 4ft. 8½in. gauge (which is approximately one-third of the total outlay), its proportion of life is far lower than any other portion of the traction plant. This may be taken anywhere from 10 to 14 years (all depending on the service), which, "if we accept a generous average of 12 years," means that every year the sum of £500 per mile of single track must be earned over and above the fixed charges for maintenance and sinking fund. It will be seen, therefore, that every year added to the life of the track means a very considerable saving in capital outlay.

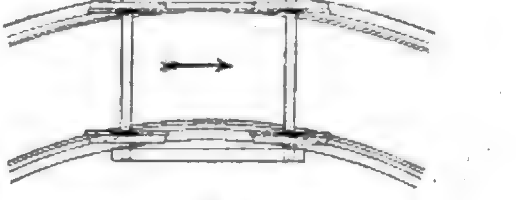

FIG. 1.

Experience of the last 14 or 15 years has shown that the rail section should be one that will provide maximum vertical and lateral stiffness, that the profile of the head should be one that will not interfere with the general traffic, and that its total width should be as narrow as possible. While a wide and deep groove allows a thicker and, therefore, stronger wheel flange, and is desirable at curves, as it allows free passage of the wheel flange without excessive friction, it has the disadvantage that it also allows more dirt, grit and larger stones to enter, as well as having a far greater reservoir capacity for surface water, which will be splashed by the passing car into the bearings and resistances. As the width and depth are practically controlled by the wheel flange, and as it is hardly safe to use a less than ¾in. flange, in the writer's opinion, the width of groove best suited to the climatic conditions of this country is 1¼in. This allows the use of a wheel flange ¾in. thick on straight work and curves with a greater radius than 75ft., and also reduces the capacity for grit, &c. On curves of less than 75ft. it is advisable to use rails having a wider groove, so as to reduce the friction and flange wear. The rail lip should be strong enough to support vehicular traffic, and should, on straight work, be lower than the tread, which naturally wears away much faster. It has become nearly general practice to increase both the height and strength of the lip on curves, as there is a greater tendency for the wheels to ride and, consequently, increased friction and wear from the wheel flanges. This is particularly noticeable where single truck cars are employed, and why it is so will be clearly seen by reference to Fig. 1. This shows the position a four-wheel rigid base truck assumes in traversing a curve. The portion of the flange in contact with the rail is shown in black, the arrow indicating the direction. It will be seen that the truck is guided almost entirely by the inner front wheel, which is all the time trying to climb the lip, and that the flange of its mate is in contact only where the gauge of track and truck permit. It has been definitely proved that were the rear wheels not retained by the flanges they would follow the forward pair in the manner shown in Fig. 2—viz., with the rear axle on a radial line. Thus with a

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* Abstract of a Paper read before the Rugby Engineering Society.

6ft. wheel base on a 85ft. curve the distance of the rear wheels from the gauge line would be about 7in., and on a 100ft. curve 2¼in. It is apparent, therefore, that the duty imposed on the rear wheel flanges is simply to keep that portion of the truck a few inches out of its normal position, thereby necessitating an increase in the height of lip to prevent derailment. Naturally this tendency of the wheels to climb produces greater friction and wear, thereby supplying the need of a heavier and stronger lip.

The web should be so placed that its centre is as near as is practicable below the tread so that the resultant of the forces from the rolling load of the car and the lateral pressure of the flange shall fall well within the base so as to reduce the tendency to tilt. The base should be sufficiently wide to resist this tilting, and to spread the weight over as large an area of concrete as possible without interfering with the paving. In the author's opinion, the design of existing rails is far from perfect and an important fact that has been generally overlooked is one that will be seen in practically all worn tramway rails; this is the decided inclination of the top surface of the head from the gauge line outwards. Figs. 3 and 4 attached show this. This, no doubt, comes from the coning of the wheels. It has up to quite recently been almost general practice to have the rail rolled flat on the tread so as to facilitate rolling, but that it is not impossible to make rails having an inward slope of the head will be seen by referring to some of the more recent sections; aside from all questions of better electrical contact, better traction, &c., to be obtained from a full bearing of the wheel tread, the rail head is bound to assume this shape early in its career, and if made so in the first instance, it is manifest that the life of the rail is increased thereby. Within the last few months, the British Standards Committee have recommended British rail makers to adopt five standard sections of various weights for both straight and curve work. They recommend that the groove shall be 1⅛in. wide and deep for straight rails, and 1¼in. wide and deep for curved rails; that the lip of the latter should be brought up level with the highest point of the rail head, and the weight of the same increased 6lb. per yard; also, that the head of all rails should have an upward slope of 1 in 21 from the gauge line outwards, and that car wheels be made of corresponding slope. The chemical composition of tramway rails is an interesting problem, as the specifications vary very much. During the last 10 to 15 years there have been as many changes in the chemical composition as there have been types of rail. Ten years ago rails contained only 0·35 per cent. of carbon: this gave a very soft rail, much too soft, in fact, as has been found out by those employing it. This has been gradually increased, until, at the present time rails contain from 0·5 to 0·65 per cent. of carbon: this gives a much harder and more durable rail. This steel will stand an ultimate tensile stress of 45 tons to the square inch, with an elongation of 15 per cent., and a contraction of over 40 per cent. in a 2in. test piece ¾in. diameter.

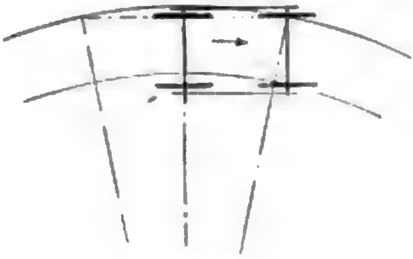


FIG. 2

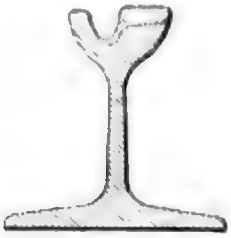


FIG. 3.

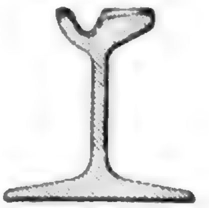


FIG. 4.

This, of course, varies considerably with the weight and percentages of the other elements employed. The effect of varying the proportions of these are:—

Manganese in excess causes increase in resistance, softening of metal, and flow of metal under traffic.

Silicon in excess causes increase in density, and smooth and close surface when rolled.

Sulphur gives a long fibrous and seamy metal.

Carbon and phosphorus in excess give brittleness and hardness, shortness of grain to the metal, and liability to fracture under severe temperature. The following is a fair average percentage of the elements in steel rails of from 90lb. to 110lb. weight per yard:—Carbon, 0·5 to 0·65 per cent., manganese, 0·8 to 1·0 per cent., phosphorus not more than 0·06 per cent., sulphur not more than 0·05 per cent., and silicon not more than 0·15 per cent.

The length of rails, until quite recently, seldom exceeded 36ft., but as it became recognised that the provision for expansion and contraction usually allowed was unnecessary owing to the small proportion of the total rail area exposed, the remainder being buried in practically a non-conductor of heat, and the variation of temperature in this country covering such a small range, the length has been increased until it is now quite common to employ rails of 45ft. and 60ft. Whether the latter or whether one of 45ft. is the best length to employ, is a matter of opinion, but from observation and experience the author prefers 45ft. rails, as the cost of handling and carriage is much less, and far less work has to be expended in straightening after shipment. The British Standards Committee recommend three lengths—viz., 36ft., 45ft., and 60ft., for straight work, and 36ft. for curves.

As there must be some good connection between the individual rails when laid to ensure a continuity of track surface, the question of joints comes forward as one of the greatest moment. What constitutes a good joint? Simply a fastening, which, when properly applied to the abutting rail ends, will hold them in as good line and surface as the body of the rail.

As no gap need be allowed for expansion, the problem of making a good joint is simplified, for any opening, however small, will cause the wheels to pound, the resulting jar eventually causing the nuts and other fastenings to loosen, consequently producing a weak or defective spot in the track. The most common form of joint is made with fish plates, placed one on either side of the rail, and taking a bearing on the inclined surfaces of the head and flange. From very early days until quite recently fish plates were rolled with a much too obtuse angle at the shoulder. This allowed the rail to act as a wedge, thus gradually bending the fish plates outwards, eventually causing a bad joint. This has now been greatly reduced and a more acute angle adopted, thus giving a much better and stiffer support for the rail head and eliminating the tendency of the rail to spread and bend the fish plates. Fig. 5 shows a type of seating and fish plate, a bad type being shown in Fig. 6. At the same time the weight and length have greatly increased, and it is now common practice to use six 1in. bolts to each pair of fish plates, instead of the four used a few years back. This, undoubtedly, adds considerably to the stiffness of the joint, but the author can see no advantage in putting in more, as is sometimes done.

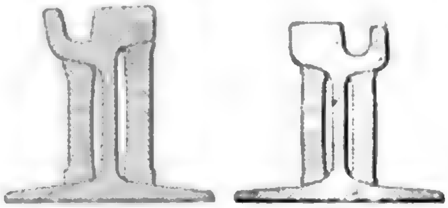


FIG. 5.

In order that the fish plates shall not bend under the strain of these bolts and reduce the amount of bearing with the rail head, they are made convex. This is a proper feature, but if not of sufficient thickness they buckle, and the bearing, instead of being distributed over a surface, is consequently concentrated along a line. The effect of this is rapidly to wear away the parts of the plate and rail in contact, and thus loosen the joint. Great care should therefore be exercised to see that the fish plates are of sufficient strength to prevent buckling. They have during the last few years been composed of tougher and softer steel than the rail, but the British Standards Committee now recommend that they be made of the same mixture as the rails. It is questionable whether fish plates should be relied on as the principle means of connecting tramway rails, or whether they should only be considered as an auxiliary to a more efficient form of joint piece. With fish plates only it has been found that the wear on the rail for a distance of 12in. from the rail ends is nearly double the remaining portion.

The employment of a flat joint or sole plate bolted to the rail flange is not recommended, as it does not give much increased vertical stiffness, and, being broad, does not allow of good, tight, solid packing with concrete, the bottom being broken with nut heads. In the author's opinion, the ideal thing to aim at is vertical stiffness with a good solid concrete bed. So far, the most satisfactory joint piece the author has seen is described below. This, in addition to providing a thoroughly rigid and efficient connection between the rail ends, makes reliable electrical contact between the abutting ends, and it has the additional advantage that no bolts are employed and it can be solidly packed. The joint piece mentioned above consists of three parts—a large curved bar, A, Fig. 7; a small curved bar, A, Fig. 7; a small curved bar, B, and a wedge, C. A and B are made of cast steel and C of martin steel. This joint is assembled in the following manner:—The small curved piece B is driven on to the rail flange, so that the point of the two rails lies in the centre of the curved bar. The large curve bar A is now inserted in a red hot state under the rail from the opposite side and pressed into position; the wedge C is then driven in between A and B. In consequence of the driving in of the wedge and the contraction on cooling of the bar A, the ends of the rails are gripped by the bars so strongly that there is secured a firm mechanical coupling and a nearly perfect electrical contact of the two rail ends. The shape of the wedge and the nose piece of bar A causes both bars A and B to press strongly against the under surface of the rail and at the same time prevent A slipping back. A few words on the way in which all joints should be assembled may be of interest.

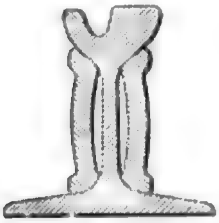


Fig. 6.

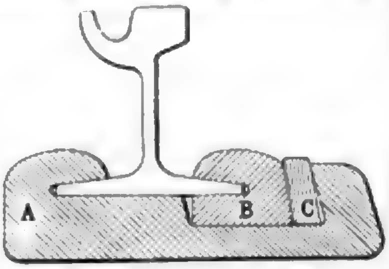


Fig. 7.

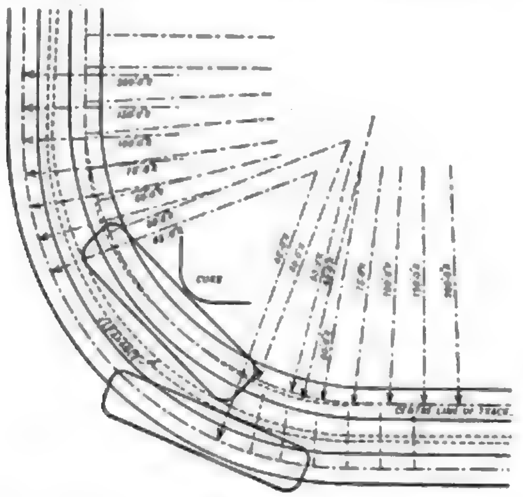


Fig. 8.

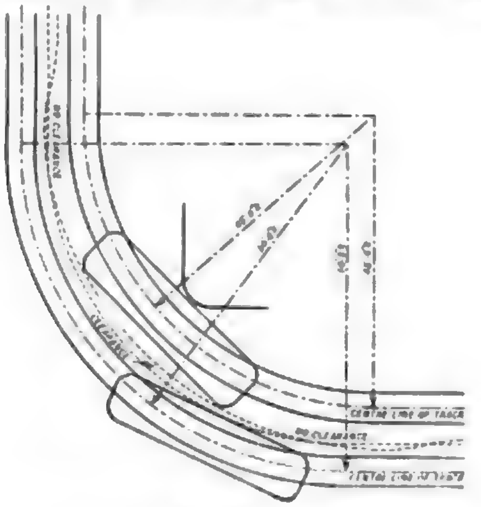
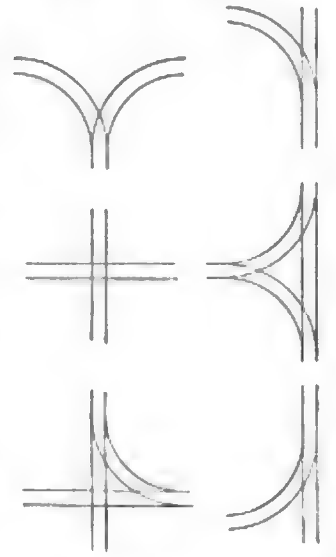
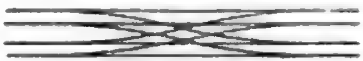


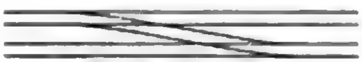
Fig. 9.

It will be seen that all rails fresh from the mill are covered more or less with a thin coat of black oxide of iron. Much of this undoubtedly falls off during the process of loading and unloading, but there is always some adhering to the rail when placed in position. This, in the author's opinion, is one of the greatest enemies of the joint, for after the latter is fixed and the track put into service this scale is reduced to a powder by the jar of passing car wheels. This powder works its way out from between the rail and joint plate, and leaves the latter loose or well started in this direction. This coating is also found on the joint plates. Therefore, the first thing to be done is to remove this scale from the bearing surfaces of both the rail and joint plates; this is a matter of considerable importance, and yet is often, if not generally, overlooked. The next step is to place the plates in their proper position with the bolts screwed up sufficiently tight to see that the plates bed evenly; the bolts should then be tightened up carefully. This can be accomplished by tapping the bolt head with a light hammer while putting on the wrench.

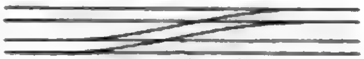




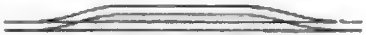
Double Cross-Over.



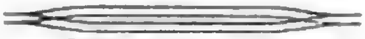
Right Hand Cross-Over.



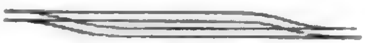
Left Hand Cross-Over.



Lateral or Side Loop.



Equilateral or Diamond Loop.



Straight Run in Loop.

Fig. 10.

Special Work.—It is usual on all curves over 500ft. radius to spring in the rails as the work proceeds, as they can be relied on to retain their position, but with curves of less radius it is advisable to employ a "jim crow." The author thinks it is better to employ the jim crow on all curves and not trust to the rails retaining their position. In the early days all curves were "simple" or curves built from one centre, but since the advent of "electric traction" and higher speeds it has become nearly general practice to compound the curves — *i.e.*, commence with a long radius and gradually reduce same until the desired curvature is reached for the centre portion of the curves This is done from each end so as to make a curve that is symmetrical about the radial line at the centre. Theoretically, the most satisfactory curve is the spiral, with gradually increasing curvature; but practically a compound curve as described above gives just as satisfactory results, while being much easier to figure out. It will be found quite impossible to detect any difference in the motion of a car when rounding such a curve if a sufficient number of centres has been employed and the arcs kept short. It will be found advisable to keep the arcs made from the different radii less than the car wheel base, otherwise a jerky motion will be given to the car when passing round such a curve. As it is desirable for all cars to clear and pass one another on curves, the advantage compounding gives will be clearly seen by reference to Figs. 8 and 9 which show the overhang and clearances on a simple and compound curve round a given corner. As special work covers such a vast amount of detail, and both space and time is limited, the author has prepared drawings illustrating the various simple layouts, giving the names most generally used (see Fig. 10). There are many other peculiar and complex arrangements of track work to which no specific name can be given other than "special work." Several examples are given (see Fig. 11) Outside the curves the pieces that go to make up a section of special work are:—Movable and spring points. Fixed points and crossings.

These have been greatly improved during the last few years by the introduction of manganese into the steel, thus giving a much harder and more durable steel. Points and crossings, owing to their short length, are especially liable to work loose, and great care is required in the design of the joints with the rails. Their bases should be wide and well supported, and the grooves reduced so as to help the wheel over that portion where it cannot ride on the tread. Their lead off from the straight should be as easy as possible so as to prevent undue racking of the cars and discomfort to the passengers. Many of the points and crossings now installed are fitted with renewal wearing pieces, but it is doubtful if they will last as long as a good sound steel casting. Considerable trouble is experienced in renewing these pieces on account of wear on the rest of the point; this does not allow the new piece to bed down sufficiently, and thus a jar is given to the car when passing these points. All movable points should be provided with side boxes, so as to permit of easy removal of the tongue without interference with the paving. The greatest care should be exercised in the laying of points and crossings, as if they are badly laid their life is shortened, cars are liable to jump the points and become derailed, and the force of impact is frequently such as to cause discomfort and possible injury to passengers. Care should always be taken not to lay points so as to turn out towards the inside of a curve, as this involves an increased angle of deflection with its consequent jerk. The angle of any crossing should not exceed 1 to 9, and the tops of all crossings outside the tread should be chequered. The usual length of point employed is 7ft. 6in. with a 1 in 3½ lead off, but longer points are sometimes employed, these, however, have to be specially manufactured. Crossings vary in length according to the angle, and in nearly every instance "except in the case of turn-outs and cross-over roads," have to be made to suit the requirements. Drain rails are not recommended, as their short lengths necessitate joints close together; a better arrangement is to drill several holes in the bottom of the groove, or cut away a short length of the rail lip and insert a drain box or special gulley.

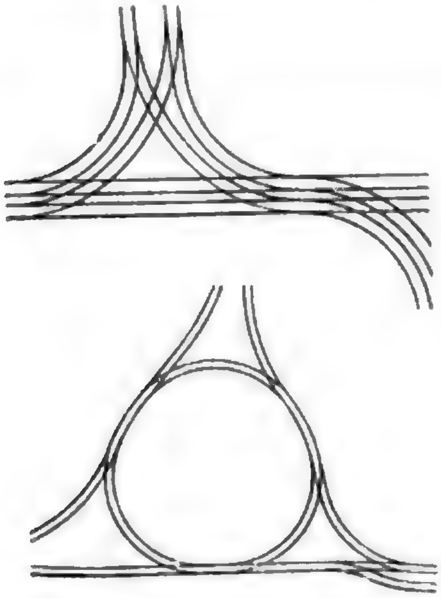


FIG. 11.

Rail Bed or Foundation.—In preparing the road bed for the concrete, care should be taken to see that sufficient super-elevation is allowed for the outer rail on curves, and that the camber of the roadway is maintained. All tramway permanent way should have a foundation of Portland cement concrete not less than 6in. deep. This should be composed of one part of cement to six of broken stone and sand. There are several methods of laying this foundation; probably the first method was to lay the 6in. layer as nearly as possible to the required level with a smooth top, and when the rails were laid to ram in cement grout in the spaces left between the hollows in the concrete and the rail flange. This is a bad method as it cannot be done tightly enough; another method is to pack the rail to the required level, and then pack in the 6in. layer of concrete in one mass and finish it off. This has the disadvantage that it is impossible to pack a mass of plastic concrete 6in. thick so as to take the weight of the rail, and consequently the rails are only bearing on the original support; and further, if it were possible, the slightest vibration would cause the still plastic concrete to sink away from the rail flanges. The method the author considers best is to put the 6in. layer of concrete in as truly to level as possible, but from ¾in. to 1in. lower than the finished level of the rail flange. After this has set, the rails should be put in position, and brought to a true level by cement packing at the joint and two or three intermediate places on a 30ft. rail. Two men should then be set to work, one on each side, to pack the space between the rail flange and concrete bed. This packing should be composed of one part granite chips or shivers that will pass a ⅜in. mesh, two parts sand and one part Portland cement. The whole to be slightly damped before packing and well watered afterwards through a rose or nozzle.

Paving.—It is essential that the paving used for tramways should be as imperishable as possible, and at the same time give a safe and firm foothold without the use of sand, under all atmospheric conditions. Granite or other stone blocks are usually employed, the type depending on the district. These usually are from 5in. to 6in. in depth, laid on a sand bed varying in depth from ¾in. to 1in., and finished from ¼in. to ⅜in. above the rail tread. It is now usual to make this bed of a mixture of dry cement and sand, as when this becomes damp and sets it gives a firm and rigid support, and undoubtedly adds to the life of the paving. Pitch grout is now generally used, and is undoubtedly the best of all groutings for tramway purposes. Its superiority over cement grout is due to the fact that it is more elastic, and instead of breaking, yields to the vibration of the rails and remains watertight. One of the chief drawbacks to the employment of pitch on electric tramways is the trouble it gives in very hot weather, when it bubbles up, fills the rail groove and insulates the car. This has been overcome in many instances by grouting the setts for three-quarters of the way up in pitch and filling in the remainder with cement grouting and fine chivers. All setts are now laid as closely as possible, as this reduces the amount of repairs and the cost of maintenance. For this reason it is necessary to see that they are well dressed, they should also be of various lengths from 5in. to 9in., as if setts of one length are employed the cutting of closers wastes from 10 to 15 per cent.

Where the margins of a tramway abut on a macadamised road, they should be finished straight, and not toothed, as this greatly facilitates the maintenance of the macadamised road and the marginal paving itself, as the macadam can be rolled right up to the paving; whereas with toothed margins there is always trouble as the macadam can only be rolled to the outside of the long tooth, and the space between the long and short tooth is left loose. This allows surface water to get in, and the result is loose setts and increased maintenance. Wood paving is on account of its noiseless character often called for in busy thoroughfares; but there are so many attendant disadvantages, especially with soft wood, that a tramway engineer seldom lays it from choice. It should not in any case be laid on grades exceeding 1 in 18. One of the chief troubles with wood paving is due to its expansion and contraction. It contracts with the cold as well as from excessive dryness. This allows surface water to penetrate to the underbed and wash the sand from the joints, thus causing the blocks to rock and tilt and the surface to wear unevenly, and in very wet and snowy weather it expands and either lifts bodily in the centre from the underbed or forces the rails out of gauge.

It is impossible with the time and space at disposal to go thoroughly into all the details of permanent way construction, but it has been the object of the author to draw attention to the importance that permanent way bears to the success of an electric-operated tramway, and to impress upon all interested how essential it is to have the best possible material and design, and in construction to pay the most careful individual attention to each and every part.

THE NEW BUILDINGS OF THE LIVERPOOL UNIVERSITY.

An important addition was made to the Liverpool University buildings on Saturday, when the Earl of Derby, Chancellor of the University, and Lord Kelvin opened, respectively, the new medical school and the physics laboratory. *The Times*, in a somewhat detailed description of the latter building, states that it covers an area of 9,600 sq. ft. and has an average height of 55ft. So as to secure absence of vibration, the foundations have been constructed on solid rock, and other precautions towards the same end have been observed. In the basement there is a large workshop, completely equipped with machine tools, store rooms, a liquid air plant, a furnace room, accumulator room, a room for the custody and comparison of standards, and a number of research rooms in which extra rigidity, or entire absence of light or constancy of temperature can be secured.

Near the entrance hall and cloak rooms on the ground floor are the large lecture theatre doors. On the same floor are also a smaller class room, a large laboratory for elementary students, preparation room, apparatus room, sitting room, office, and professor's private laboratory.

The first floor is reserved exclusively for senior students, and contains two large laboratories, four small rooms suitable for acoustical and optical work, students' workshop, library and two sitting rooms for demonstrators.

The second floor contains research rooms of various sizes, many designed for special purposes. Upon each floor is a photographic dark room, the making of lantern slides and enlargements being also carried on therein. On the roof is a small observatory, in which is a 4in. equatorial telescope. The buildings are also equipped with an electric lift.

Heating of the rooms is effected by means of low pressure hot water, and ventilation by an exhaust fan in the roof. The equipment of the rooms in other respects is also very complete. Gas is laid on, there are sinks with hot and cold water, electric power from the Liverpool Corporation mains is available, and a feature of the workshop is that the countershafting is so supported as to be entirely independent of the rest of the building, thus ensuring silence and freedom from vibration.

The total cost of the physics laboratory up to the present, including building, furniture and fittings, is £21,600. Thanks to the munificence of a body of donors, including the late Sir Henry Tate, Sir John Brunner, Mrs. George, Miss E. G. Holt, the executors of the late Rev. J. H. Thom, Mr. Alfred Booth, Mr. Holbrook Gaskell, Mr. John W. Hughes and Mr. John Rankin, a sum of £23,000 had already been subscribed, which, with interest, now amounts to nearly £26,000. In addition to the above sum of £21,600, the cost of the buildings, £12,000 has also been spent upon machinery and new apparatus, so that there still remain £3,000 for the completion and maintenance of the equipment. The laboratory is to bear the name of Mr. George Holt.

In opening the physics laboratory,

Lord KELVIN said that the laboratory was a realisation not only of the general results of 50 years of physics laboratories in our own country, in France, Germany, and the other countries of Europe, Australia, Cape Colony and the United States of America, but also of the large experience, profound scientific knowledge and all-vivifying enthusiasm of its director, Prof. Wilberforce.

In view of the opening of the extensions as set forth above, it may be interesting to give an outline of the prospectus of the department of engineering. The teaching staff comprises two professors, assisted by various lecturers and demonstrators, in addition to whom there are three associate professors, whose special subjects are railway engineering, municipal engineering and municipal electrical engineering, respectively. These gentlemen do not lecture regularly but only give occasional lectures. There are two new degrees—viz., Bachelor of Engineering and Master of Engineering, the former requiring attendance and study for the full three years' course, in addition to the satisfactory passing of the several examinations. Students who, for some reason or other, are unable to pursue the full three years' course, may work through a two years' course and obtain a recognised series of certificates.

INSULATION FOR HIGH PRESSURES.*

BY PROF. HARRIS J. RYAN.

(Cornell University.)

The difficulties in low-pressure insulation design that must be overcome are to be found in the mechanical requirements and the deteriorating influences of dust, temperature changes, moisture, &c. The judgment of the designer of low-pressure insulation is assisted only to a small extent by electrical science. Success depends mostly upon experience in regard to mechanical, factory and experimental knowledge of the various materials and expedients available for this class of insulation. On the contrary, in apparatus employing the higher electrical pressures in commercial use, great difficulty is encountered in the provision of insulation that has ample dielectric strength to withstand continuously the electric strains that are encountered. For these reasons the following methods and data are useful in the design of insulators to withstand high electric pressures:

(1) A convenient system for fixing quantitatively the flux of electric force produced by an E.M.F. in a dielectric, causing the electric strain therein. (2) The permeability of an insulation to a flux of electric force produced by E.M.F. (3) The density of flux of electric force which the ultimate electric strength of the insulation is called upon to withstand and at which rupture occurs. (4) Expedients that localise the application of the electric strain within those portions of an insulating system that are most powerful and capable of standing the total strain. (5) Experimental methods for testing the dielectric materials:—(*a*) For the construction of insulation so as to secure their breaking strains, that is, the densities of electric force flux at which their ultimate rupturing strengths are developed. (*b*) For testing completed insulations or insulators to determine: (1) The manner in which they satisfy the requirements. (2) To determine design factors. (6) Factors of safety. (Determined by trained judgment.)

1. *Flux due to E.M.F.*—When the terminal faces of a dielectric are in contact with conductors between which an E.M.F. is applied, an electric force is exerted throughout the dielectric in variable degree, according to position with reference to the conductors. This electric force produces a distortion of the atomic structure of the dielectric—*i.e.*, a displacement of the electrons forming the dielectric atoms. Such electron-displacement, while in progress, constitutes an electric current. The displacement encounters the reaction due to internal atomic forces which tend to maintain the original structural form. This reaction is the cause of the formation of the familiar counter E.M.F. of a condenser and is in proportion to the total amount of electricity or the time-integral of the current that was passed through the dielectric. When the process of atomic distortion proceeds beyond the point of structural rupture the ordinary conduction current ensues. Thus through a dielectric prior to the rupturing point the only current that can be passed is a *displacement current*.* The passage of such displacement current and the establishment of the corresponding field of electrostatic force are merely cause and effect in one and the same operation. In any portion of the dielectric the value of the strength of the electrostatic field of force therein established is proportional to the displacement of electricity—*i.e.*, to the time integral of the displacement current that accompanied the establishment of such electrostatic field.

For engineering purposes, therefore, the time integral of displacement current† *may be conveniently employed as a measure of the strength of the corresponding electrostatic field of force.*

For convenience, *strength of electrostatic field of force or density of flux of electric force* will be referred to as the *density of dielectric flux.*

2. *Insulation Permeability.*—A convenient designation of the permeability of an insulation for dielectric flux is based upon the above facts as follows:—

The specific inductive capacity of a dielectric is the ratio of the displacement current set up through such dielectric to that set up through air under the same conditions with respect to the electrodes and the E.M.F. Thus, when the displacement current for a unit volume of air subjected to a strain of unit E.M.F. is known, the corresponding displacement current becomes known for any dielectric for which the specific inductive capacity is known.

The energy that is taken up in the formation of an electrostatic field of force through a dielectric, and which has been applied, therefore, in the passage of the corresponding time-integral of displacement current, is

$$J = \tfrac{1}{2} C E^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where C is the capacity in farads—*i.e.*, the coulombs of displacement current per volt.

When an E.M.F. of *1 volt* is applied to the opposite faces of a centimetre cube of air at ordinary barometric pressure and temperature, the energy taken up by the electrostatic field formed thereby throughout the cube will be

$$441{\cdot}7 \times 10^{-16} \textit{ joules.}$$

No important change in this value occurs with variation of barometric pressure and temperature. When it is substituted in equation (1) the corresponding strength of electrostatic field thus produced per volt per centimetre of air expressed in coulombs of displacement current per square centimetre is found to be

$$C = 883{\cdot}4 \times 10^{-16}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

It may, therefore, be stated with reference to the dielectric permeability of air that *one volt applied through a distance of 1cm. in air will establish a dielectric flux density of* $883{\cdot}4 \times 10^{-16}$ coulombs per square centimetre.

Thus the product of this dielectric flux constant for air and the specific inductive capacity of an insulation will be the corresponding dielectric flux for that insulation.

Where the specific inductive capacity of an insulation is not known, it can be determined in the following manner:—The sample of insulation should be formed into a sheet of uniform thickness. Suitable disc electrodes are applied to either side of the test sheet. The charging current is measured which is made to pass between the electrodes through the test sample by an alternating E.M.F. of known wave form and value. To avoid the error due to the fringe of dielectric flux at the edge of the electrode, a guard ring should be employed similar to that used in an absolute electrometer. Care must be taken to connect such guard ring to the circuit in such a manner that it will not accept charging current through the current-measuring instrument. From the dimensions of the test sample and the guarded electrodes, the values of the current, E.M.F. and the time, *the coulombs of charging current per volt per unit cube are easily deduced.*

Since a certain amount of electric strain in a given insulation is due always to the passage through it of a certain quantity of electricity per unit cross-section, it follows that the permeability constant derived as above will enable one to predetermine the strains that are produced by the application of a given amount of electric pressure when the forms of insulation are simple. This is a means whereby the judgment may be greatly assisted or improved in designing insulations where the dimensions are too complex, as is generally the case, to admit of exact calculation of the electric strain.

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* Paper "Some Elements in the Design of High-pressure Insulation," read before Section B of the International Electrical Congress of St. Louis. Slightly abridged.

* An exception must be made in regard to the tiny current that will pass conductively through all dielectrics, gases, liquids or solids when subjected to E.M.F.s, generally understood to be carried by the free electrons that reside to a small extent in all dielectrics. These currents are so small for gases and the powerful solid and liquid dielectrics when homogeneous and free of all conducting matter, that for engineering purposes they may be entirely neglected.

† In engineering this is called the *charging current.*

It may be well to call attention to the relation between the electrostatic capacity that exists between any pair of electrodes and the dielectric flux that an E.M.F. applied between them will establish. The capacity is equal to the coulombs of charging current per volt applied between the electrodes, and is, therefore, numerically equal to the dielectric flux established per volt applied between such electrodes. Where the dimensions of the electrodes and dielectrics are simple enough to admit of handling them mathematically, dielectric flux densities—*i.e.*, electric strains may, therefore, be easily calculated from the value of the capacity; and vice versa, the capacity may be calculated from the dielectric-flux constants.

8. *Disruptive Flux.*—The dielectric flux density at which the resulting electric strain becomes sufficient to produce structural rupture for a given insulation under definite conditions as to temperature and mechanical pressure must be observed by experiment. In making break-down tests of this character some care must be taken in arranging the test sample so that the distribution of dielectric flux is uniform throughout the portion of the sample in which the rupture is made to take place. This is a condition in the present state of the technology that is rather difficult to obtain. It is highly desirable that the dielectric medium in which the test sample and electrodes are immersed should be dielectrically more powerful than the sample under test. It is difficult to make a reliable break-down test of a powerful solid dielectric in the ordinary atmosphere. This is due to the fact that the ultimate breaking strength of the normal atmosphere is small compared with the breaking strength of the test sample.

When the test is conducted in the normal atmosphere it is impossible to subject the sample to strain without at the same time straining the air about it or in contact with it. Unless great care is used in arranging the test sample the air will break, conduct and heat injuriously the sample when subjected to strains that are much lower than the strains at which such sample will be found to break if tested in a manner so as not to be injured by the intense heat of the conducting atmosphere.* This is quickly demonstrated by making a break-down test of sheet hard rubber mounted between the test electrodes first in the normal atmosphere and then in air, for example, at a mechanical pressure of 20 atmospheres. The dielectric strength of air in the latter case is quite on a par with that of the hard rubber, which will then rupture because of the electric strain and not because of injury by heat.

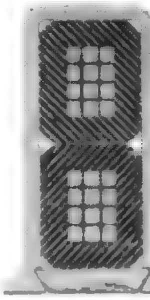

Fig. 1.

There is much to do in this branch of electrotechnics in the development of convenient and satisfactory methods for testing insulations to determine the actual dielectric flux densities or electric strains that produce rupture.

4. *Insulation Expedients.*—Every portion of a high-pressure circuit is covered with insulation that is permeated everywhere by dielectric flux causing corresponding strain. The quantitative nature and distribution of this flux is entirely similar to the corresponding features of magnetic flux, and should, therefore, be easily understood. Dielectric flux is established as tubes of electric force through the insulation between the conductor surfaces in proportion to their corresponding differences of electric pressure. Thus it is evident that the greatest dielectric flux densities must occur in those zones of insulation that are next to the conductors of the electric circuit. This must be so since the total flux through any outer zone surrounding the circuit must be the same as that through the zone next to the circuit. Since the sectional area determined by the latter zone must inevitably be smaller than the sections at corresponding outer zones, it follows that the density of the dielectric flux will be greatest in the zone-sections next to the high-pressure conductors. This fact would indicate that in rational design the insulation next to the conductor surfaces of high-pressure circuits should be formed of the most powerful dielectrics. Unfortunately, structural requirements generally make this impracticable.

For example, in Fig. 1, there is given a section of an armature slot containing two coils of a high-pressure alternator, 10,000 to 15,000-volt class. The conductor from which these coils are made is given an insulation covering that is fully capable of withstanding the electric strains due to E.M.F.s produced or consumed locally in that particular section of the armature circuit. This may be called the *minor insulation.* It is determined in the main, as are all low-potential insulations, so as to meet structural and mechanical requirements without undue expense. Over the coil as a whole there is applied a carefully constructed covering made of the most powerful available dielectric having an ample strength to withstand continuously in practice the strains due to the total E.M.F.s generated in, or applied to, the circuit of this armature. This outer covering may be called the *major insulation.* While this represents the best practice that has as yet been attained, it contains one element of serious weakness as follows:—The dielectric flux starts from the surface of the outer conductors and traverses the minor and major insulations in series and stops at the surfaces of the slot. Note the relative values of the densities of dielectric flux passing the two concentric zones in the insulation about the coil; the inner zone is located by the irregular outer surface of the conductors of the coil and the outer zone by the regular walls of the slot. The dielectric flux passes from the surfaces of the outer conductors of the coil to the walls of the slot, and in so doing traverses these zones. It passes the inner zone at considerable irregularity in density and the outer zone at a much more nearly uniform density. The sectional area determined by the inner zone is considerably less than that determined by the outer zone. From these two classes of facts it follows that the maximum dielectric-flux densities to which the insulations are subjected are considerably greater for the minor than for the major insulation. This is decidedly unfortunate; better results would be obtained with the conditions reversed.

Due to these facts it follows that in practice of this class the major insulation, without sacrificing break-down strength and structural character, should have the lowest attainable permeability to electric force—*i.e.*, the highest attainable specific reluctance to dielectric flux. This is needful in order that the total dielectric flux established from the surfaces of the outer conductors of the coil to those of the slot shall be limited so as to be well below the point at which the maximum flux dielectric density encountered in the minor insulation will not be sufficient to cause its rupture.

The minor insulation is invariably porous, containing air or other gases at normal atmospheric pressure. Comparatively low densities of dielectric flux are required, therefore, to rupture minute volumes of the minor insulations, which will then conduct the charging currents, causing rapid deterioration through heating and other physical and chemical effects. The thickness of powerful dielectrics having low specific inductive capacities that must be applied in order to maintain all dielectric-flux densities low enough so as not to injure the minor insulation becomes so great as to be impracticable in the present stage of the industry for machinery construction at higher pressures than 15,000 volts. In all high-pressure apparatus, whether of the machinery or transformer class, the inevitable dielectric flux is established in like amounts serially through the major and minor insulations. Owing to structural difficulties, the minor insulation is far inferior in strength to the strength of the best dielectric available for the major insulation. It is on this account that such an enormous amount of dielectric of high reluctance to dielectric flux must be used in the construction of the major insulations of dry or "air-insulated" transformers. The amounts of major insulation that must be used are excessive taken with respect to that which should be ample to withstand in practice the electric strains produced by the normal, or ordinarily abnormal, electric pressures.

It is the experience of reputable makers that the air-insulated transformer is impracticable for pressures higher than about 35,000 volts; space and materials cannot be afforded to limit the dielectric flux sufficiently at higher pressures.

Oil may be used successfully for the generation of the highest pressures desired in practice. By proper treatment in its preparation for use in submerging the high-pressure transformer, and by proper construction of the solid or supporting insulation of the transformer-conducting circuit, all air and other gases may be displaced. The oil and solid insulations thus form a combined or composite major and minor insulation having great dielectric strength at all points.

Even with the most approved use of oil, however, the conditions are not exactly ideal. The dielectric flux emanates with greatest density from the surfaces of the outer conductors of the terminal coils, owing to the fact that the zone-section at this point is the smallest and the density of dielectric-flux distribution the most variable. The result is that the chief electric function of the oil is to limit the dielectric flux to within the point at which the maximum flux density that will emanate from the surface of the conductors of the high-pressure circuit will be safely within that which the composition of oil and fabric next to the conductors will stand. Times will come in practice when the high-pressure circuit of the transformer must stand excessive pressures applied from without or developed within by complex impedance phenomena during short circuits or open circuits. Thus occasionally and momentarily the insulation next to the conductors will be subjected to strains due to dielectric-flux densities that exceed the breaking point, causing a corresponding momentary conduction, heating and injury. Such injuries initially are often very small, yet they are cumulative, for their cause is recurrent, and their location is the worst possible.

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* It is assumed that all test pressures are alternating

In this analysis, one is led, therefore, to the conclusion that a rational solution of these difficulties applicable alike for "air-insulated" and "oil-insulated" high-pressure apparatus consists in the employment of metallic guards or envelopes closely surrounding the coils or sections of the circuits of such high-pressure apparatus for the purpose of relieving the minor insulation of all electric strain due to normal operation. To relieve it further of those nighly localised strains that are due to complex impedance phenomena that accompany short circuits, opening circuits and similar punishing circumstances, an undue local rise of P.D. in the individual coils may be prevented by the attachment of properly chosen spark arresters to the terminals of such individual coils. The real function of the metallic guard is to form a conducting envelope about the individual coils of the high-pressure circuit to which to conduct the inevitable charging current and from which the corresponding dielectric flux starts through the major or powerful dielectric at an average lower and more uniform density. The guard must be connected to one terminal of the coil that it protects, and it must be constructed in such a manner as to avoid the circulation of current. Obviously these guards and spark arresters may be applied much more easily in transformers than in machinery. By their use it should be possible to make successful transformers for the use of the highest electric pressures that the transmission lines of the future can successfully carry.

5. Test of Insulating Material.—In all classes of tests to be made which are here referred to, measurements must be made that will determine the value and wave forms of the applied E.M.F. and charging current and their phase relation. The maximum value of the electrical pressure wave applied between a conducting cylinder and a wire mounted at its centre that produces luminous conductivity observed by the eye in the zone of air next to the wire is definite at definite barometric pressures and temperatures. This promises to be an acceptable method for determining the maximum value of the wave of high pressure applied in this class of testing. The wave-forms are most easily observed by means of the cathode ray wave indicator. When they are not too irregular the oscillograph may be used in lieu of the wave indicator.

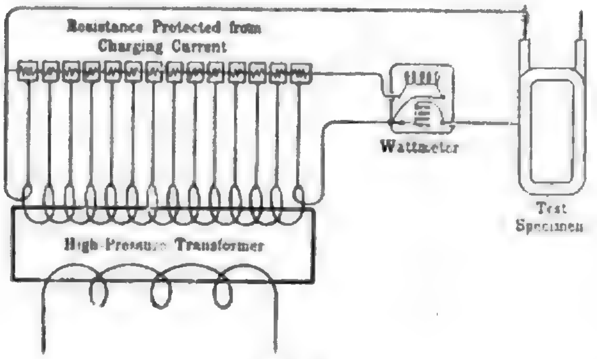
Resistance Protected from Charging Current
Wattmeter
Test Specimen
High-Pressure Transformer

Fig. 2.

A satisfactory indicating wattmeter is much needed for the ready detection of conduction due to rupture of gas bubbles or other weak foreign dielectrics in the sample under test. It is useful also for the purpose of measuring the total watts consumed by the charging current at any stage of the test. Any sensitive wattmeter of the dynamometer type and of excellent construction, having a suitably fine field winding, will give correct results, provided the non-inductive resistance used for the pressure circuit be properly protected from the delivery of the inevitable capacity-charging currents. Such charging currents, if allowed to pass to and from the surface of the pressure-circuit resistance, produce errors of an entirely uncertain character for which no satisfactory correction can be made. Since these capacity currents may not be avoided they must be made to pass from guards supplied independently with potentials correspondingly equal to the potentials of the respective sections of the pressure-circuit resistance about which they are mounted. Two obvious methods for accomplishing this are illustrated by the diagrams which explain themselves in Figs. 2 and 3.

The diagram of Fig. 2 illustrates the method for protecting the resistance of the pressure circuit from capacity-charging currents wherein the transformer furnishing the high-pressure test currents is near at hand. In this transformer the high-pressure circuit is divided into as many sections or coils as there should be guarded sections in the high-pressure resistance circuit of the wattmeter. When this sort of high-pressure transformer is not to hand, the method given by the diagram in Fig. 3 may be employed.

Across the terminals of the high-pressure source there are connected in series as many small auto-transformers as there are to be guarded sections in the pressure-resistance circuit. Each of these auto-transformers must have a normal E.M.F. rating as great as its share of the total pressure; it should be mounted upon a high-potential line insulator of a form suitable for the total pressure employed. These auto-transformers are connected to corresponding resistance guards as shown, bringing them to the potentials corresponding to those of the resistance sections over which they are mounted so as to protect them from the delivery of charging current. As the diagrams of Figs. 2 and 3 show, the wattmeter must be covered with a metallic guard net connected to the proper side of the circuit so as to relieve it also of the delivery of all charging current. A wattmeter mounted and used in this manner must give reliable results in the observation of *pressure-loss characteristics of insulations.*

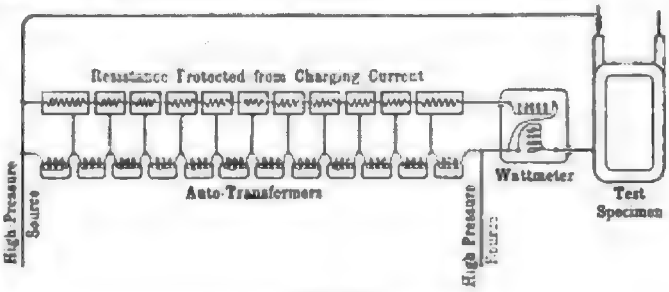

Fig. 3.

The nature of such characteristics is illustrated in Fig. 4.

Characteristic No. 1 is that an insulator which is homogeneous and continuous between the conductors and wherein the strain is distributed with some approach to uniformity.

No. 2 is the pressure-loss characteristic of an insulator wherein there are portions that are weak or the dielectric flux is distributed very irregularly, or both.

No. 3 is a characteristic taken from a composite insulation made up of strong and weak dielectrics, as found, for example, in a paper-insulated cable.

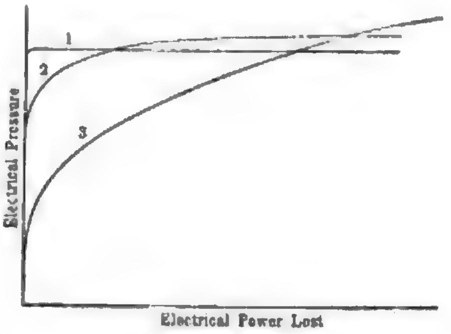

Fig. 4.

From the inherent nature of things the density distribution o dielectric flux through the insulation is definite only in a few form of electrical apparatus, as for example through the insulating sheet of condensers, except at the edges of their electrode coatings, o throughout the atmosphere about a transmission line. In the grea majority of cases the distribution of the dielectric flux is too complex to admit of the reduction of accurate results by the simpler mathematical processes. The judgment supplemented by the results of tests and measurements made upon test samples, specimens or models must, therefore, make up for lack of calculating methods.

TELEGRAPHY AND TELEPHONY IN JAPAN.*

BY SAITARO OI.

It is generally believed that Commodore Perry of the United States, when he came over to Japan in 1854, brought two sets of telegraph instruments with him and presented them to the Shogun (at that time the Lieutenant-General or Governor-General of the Empire). The first telegraph line, however, was constructed between Tokyo and Yokohama in 1869, the instruments used being Bréguet's instruments, which were employed for some time until all were superseded by Morse inkwriters. There was not very much progress until 1877, when the civil war broke out in the southern districts; this naturally necessitated an increased use of the telegraph, and the lines were extended to the important places of the empire.

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* Abstract of a Paper read before Section G of the St. Louis International Electrical Congress.

The first telegraph line in this country was constructed by some English engineers and linemen in the service of the Japanese Government. The chief engineer was Mr. E. Gilbert, who had been connected with a railway company in Scotland before he came to Japan, and, as may be imagined, the method of surveying, construction and maintenance of the land lines laid out by him was naturally after the English practice, and is continued, with more or less changes, down to the present day.

As to the telephone lines in towns, the method of construction may be said to follow American rather than English practice, and in some places where no cables are employed, as many as 100 to 150 wires are run upon a pole planted along the side of the streets.

Poles are generally of cedar, which grows in abundant quantity in different parts of the country. The number of main poles used varies, of course, with the number of wires put up, the nature of the route through which the lines pass, &c.; but in the open country there are, as a rule, from 38 to 28 per mile: and where there are too many wires for one pole to carry, trussed poles—often H poles—are employed. Ordinary main poles are of 22ft. to 24ft. Taking the average, 64 per cent. of the main poles are stayed, while 14 per cent. are strutted. Boucherezing is a common practice as a means of preservation of the poles, but lately creosoting is being tried, though on a small scale. Boucherized poles last about 18 years on an average, whilst untreated poles begin to decay within five or six years. 46 per cent. of the poles are boucherized, the remaining are untreated.

Arms with double-cup porcelain insulators are exclusively used, and are always fixed on that side of the pole facing the so called up-station. For telegraph lines, two-wire arms of 24in. and 34in. are generally used except where many wires are to be run. They are secured to the poles a foot apart, and alternately, in case more than two wires have to be put up. Telephone wires are run on four, six or eight-wire arms most commonly, and long-distance lines on braced six-wire arms. The distance between the centres of the arms is 1ft. 6in., the minimum distance allowed from the ground to the lowest arm being 16ft. The span of the long-distance lines is usually 48yds., the minimum transposition being done at every 20th pole.

No. 8 S.W.G. iron wire is the standard for the telegraph lines, though No. 11 iron wire is sometimes used for short lines. The long circuits for fast automatic or quadruplex working are of No. 12 S.W.G. copper wire. As a rule, an earth wire is attached to each pole. For telephone lines in towns where there is not much snow, we use No. 17 S.W.G. hard drawn copper wire, and silicon bronze wires, but in the northern districts where snowfall is abundant during the winter, No. 14 iron wire is run for subscriber's line. For the interurban telephone service three gauges of copper wires—No. 8 S.W.G., No. 12 S.W.G. and No. 14 S.G.W.—are employed.

For long spans such as river crossings, steel is almost always used in the case of telegraph lines, and bimetallic wire for telephone circuits of long distance. The longest air-span now in existence is 800yds. with steel wire, and 520yds. with bimetallic wires, each of 170lb. per mile.

Underground construction for the telegraph lines is rather limited at present, it being confined to a part of Tokyo only; but the increase of telegraph wires from year to year, in addition to those for telephony, electric light, and power, &c., shows the necessity of laying more wires underground in the large towns, and it is very likely that in the course of a few years the telegraph lines in the busy part of the large towns will be put underground. The greater part of the telephone lines, however, in large cities such as Tokyo, Osaka, Kyoto, Yokohama, &c., is already laid underground.

When the first underground construction was undertaken in Tokyo in 1896, we adopted 3in. cast iron pipes, and the same system was employed, to a considerable extent, in the other towns also; but my visit to the United States, in 1898, gave me a favourable impression as to vitrified clay conduit, and immediately after my return home I advised the authorities to adopt it where we have more than three ducts. Since then the single-duct vitrified clay conduit has become the standard of underground working, as our manufacturers can make it excellently and cheaply.

Underground cable used for telegraph purposes has prepared fibre insulation, and is covered with lead pipe. The telephone cable for underground work is of the dry core paper insulation, and in large towns apparatus for sending compressed dry air from three to four atmospheres into the cable are provided for. This proves very useful in Japan, as the cables are all imported, and in case cables should get low in insulation we can easily repair them. 100-pair cable was used when the underground work was commenced, but now 200 pair cable is very common, No. 20 S.W.G. being the size of the conductors. Smaller wire cable has been suggested for some uses, but it has not yet come into actual use. Most of the lines in towns being overhead, we have naturally a great many aerial cables, both of indiarubber and dry-core type, put up on poles to avoid too many telephone wires crowded together, or to cross electric light and power conductors, which are also carried along the streets like the telegraph and the telephone lines.

The laying of submarine cable was considered the most difficult work, and except in a narrow strait or in a river the work was almost always executed by the Great Northern Telegraph Co.'s steamer. The features of the country, however, called for a number of submarine cables in various parts, and in order to establish new communications and to maintain efficient working, it became necessary to do the work with our own staff. Sometimes we equipped a steamer with rough machinery to lay a new cable or to repair a broken one, and although not without inconveniences in most cases, still we accomplished our object and in this way our engineers and workmen have obtained some useful experience in this branch of telegraph engineering.

When Formosa was annexed to Japan in 1895, it became an urgent necessity to put the new possession in direct communication with Japan, and consequently measures were at once taken to lay cables connecting the Islands of Kiushu, Liuchu and Formosa. A cable steamer was built and fitted out at Glasgow for the purpose of laying and repairing cables and was brought out to Japan in June, 1896. The "Okinawa Maru," our cable ship, is a twin-screw steel steamer, having a double bottom. The gross tonnage is 2,212, the length between perpendiculars being 290ft., the extreme breadth 40ft., and the depth of hold 24ft. She is equipped with triple-expansion engines, double-ended boilers, and has three cable tanks of 15,952 cubic ft., 8,389 cubic ft., and 6,945 cubic ft. capacity, respectively. It remained still a question with us whether our engineers could manage to lay cables in very deep waters, as their experience had been previously limited to comparatively shallow waters, and it was strongly suggested to engage some experienced foreign engineers for the work. We wanted, however, to gain all possible experience and so we took up the work ourselves. The cables were successfully laid, though not without some difficulties; they have been working well during the past eight years, being worked duplex with direct siphon recorders. As mentioned elsewhere, Breguet instruments were the first instruments used for the transmission of public messages, while Wheatstone needle instruments were used for the railway service. The complication of the mechanism of the former and the consequent liability to get out of order made its extensive use unsuitable, and very soon the Morse inkwriter replaced it. Of about 1,100 telegraph circuits now working, 850 are fitted up with Morse instruments and the remaining 250 circuits are fitted with telephones. Out of 850 circuits, 90 are worked duplex, nine quadruplex, four automatic, and the remainder simplex. The sounders were first introduced in Japan in 1895, and have been working in comparatively large offices only. At present about 40 per cent. of the total instruments are sounders. Duplex telegraphy was tried in 1879, but its practical success dates from 1889; as to quadruplex working, it was only from 1893 that we could put it into actual use on important circuits. The Wheatstone automatic is limited to a few circuits in ordinary circumstances; but violent storms occur among the Islands, particularly in autumn, and often cause an extensive breakdown of the important lines; on such occasions the automatic working is found valuable to dispose of the accumulation of messages. Repeater boards are employed in important centres to the best advantage of working. Telegraph exchanges are confined to circuits in towns or to very short and less important lines only.

The Morse signals used in telegrams written in the Japanese characters are 50 in number in addition to those representing figures, and the signs of punctuation, &c. These signals are partly composed of those representing the Morse alphabet, and partly of additional combinations of dots and dashes. Telegraphically speaking, about 3·65 Japanese letters are equivalent to one word in English, which, on an average, consists of 4·67 Morse letters, and therefore one Japanese Morse signal corresponds to 1·28 international Morse signal. It may be, perhaps, interesting here to note how Japan is related telegraphically to foreign countries. Of the whole number of foreign messages forwarded or received, and which amount to some 800,000 a year at present, about 40 per cent. are credited to Korea, 28 per cent. to China, 9 per cent. to England, 7 per cent. to the United States, 4 per cent. to India, 3 per cent. to Germany, 2 per cent. to France, 2 per cent. to Russia, and 4 per cent. to all other countries.

Testing lines is carried out in 24 different offices located in the important centres of the country. Conductivity and insulation resistances of the lines are regularly measured once a month, while the condition of the lines is ascertained every day by observing the current strengths received from the distant stations. The lines are all worked open circuit with Daniell cells, except in Tokyo and Osaka, where storage batteries have been in use since the year before last. The change from primary batteries to secondary in these two large offices brought about a considerable reduction in the expense of maintaining batteries therein, and changes in the other large stations are now being planned.

The charge for inland telegrams in Japanese letters is 20 sen (1 sen = ½ U.S. cent) per message of 15 letters or less of text, the address of the receiver being free in this case; and for every five letters or less exceeding the first 15 the additional charge is 5 sen. Inland messages in Roman letters are charged 25 sen per message of five words or less, the additional charge being 5 sen per word. For telegrams within the limits of a town, 10 sen per message in Japanese and 15 sen per message in Roman letters are charged; for additional letters or words exceeding the numbers allowed for one message 8 sen are charged per five letters or one word.

The telephone was first brought to Japan in 1877 by a mechanic returning home from America, and was a magneto telephone encased in a box. Soon after its introduction the telephone was put into practical use as an auxiliary to the police service in Osaka and vicinity, a considerable length of lines being built for that purpose. Some of the circuits then constructed were more than 30 miles in length and as many as 10 such magneto instruments were connected in series on a single circuit of iron wire. As can be readily understood, conversation was no easy task unless by those who had experience in using the instrument. After the introduction of the carbon microphone, the application of the telephone for industrial and commercial purposes began to increase remarkably, and it was in 1888 that the idea of starting telephone exchanges first occurred to the authorities. A company was promoted for carrying on the business, and a petition was forwarded to the Government asking for a licence to start an exchange and carry on the telephone business in Tokyo. That was in 1884. The question whether it should be carried out as a Government undertaking or entrusted to private capital remained unsettled until 1889, when it was decided, after deliberation, to undertake the work as a State monopoly.

We got only about 70 contracts in Tokyo and 20 in Yokohama when we commenced the construction of the lines. The service was started in Tokyo and Yokohama in December of 1890, the number of subscribers at that time being about 200 in Tokyo and 40 in Yokohama. However, the actual opening of the exchanges and establishment of communication between the subscribers spoke far more eloquently to the public than any letters, newspapers or lectures, and before long our facilities were far behind the demand. On completion of certain lines now under construction Tokyo and Nagasaki, 800 miles apart, will probably be put in direct communication.

When the exchanges were started in Tokyo and Yokohama, single circuits of No. 18 S.W.G. hard drawn copper wire were arranged for subscribers' lines, the 100-wire standard switchboards of the Western Electric type and a modified form of the Gower-Bell telephone set with a battery for calling, were employed, the toll lines between the two towns being metallic circuits of No. 12 S.W.G. copper wires. No. 18 copper wires were afterwards changed to No. 17, which is now the standard size of wire for subscribers' lines, except in the northern snowy districts; and the modified Gower-Bell set with calling battery has been changed to the solid back or Delville set with a magneto. Small exchanges not having upwards of 600 subscribers are operated with the 100-wire standard switchboard, and for exchanges where more than 600 subscribers are to be connected, multiple switchboards are generally used. At present Tokyo has five exchanges, the largest of which contains 4,000 subscribers and the smallest 1,500, and each exchange is equipped with bridging multiple switchboards. In Osaka there are two exchanges, both of which are also fitted with bridging magneto multiples, having an ultimate capacity of 6,300. Reverse trunking is used between different exchanges in a town and also on short toll lines. Yokohama, Kobe and Nagasaki are also worked with bridging magneto multiples, these towns having only one exchange in each. Kyoto, our ancient capital, was worked with the old series-multiple switchboards, but an alteration to the relay switchboards, manufactured by the Western Electric Co., was effected in May last year, and since then the system is working satisfactorily. Kyoto has no branch exchanges; it has an ultimate capacity of 6,300 and the present equipment is [illegible]. The series-multiple switchboards are still in use at Nagoya. All other exchanges are being operated with the 100-wire standard switchboards, but some of them experience inconvenience at times in working, due to increase of subscribers, and we are now supplying them with multiple switchboards.

In order to give an idea of the present situation of our telephone exchanges, I give the following figures for the seven towns where the exchanges are worked with multiple switchboards:—

Name of town.	No. of subscribers.	No. of subscribers not yet connected.	Public call offices.		Population.
			Ordinary.	Automatic.	
Tokyo	[illegible]	[illegible]	[illegible]	[illegible]	1,640,000
Osaka	[illegible]	[illegible]	[illegible]	10	930,000
Kyoto	[illegible]	[illegible]	[illegible]	[illegible]	380,000
Yokohama	[illegible]	517	22	14	300,000
Kobe	[illegible]	[illegible]	14	9	290,000
Nagoya	[illegible]	[illegible]	7	6	270,000
Nagasaki	741	[illegible]	4	1	140,000

The wall set is furnished with either the solid back or the [illegible] transmitter and is also equipped with an arrester. A desk set of [illegible] pattern is used by some people and supplied, if required, upon an extra payment of 6 yen per annum. Where the C.B. system is employed, the same type as the post office wall set is in use, the transmitter being the solid back. Fuller's bichromate battery for the solid back, and the Leclanché for the Delville are generally used. The automatic telephone, which has come into use since 1899, is somewhat like the Grey instrument, and so constructed that the operator is enabled to distinguish the kinds of coin put into the slot by hearing different sounds made by the coin in its sliding down along each chute. No party lines are in existence at present, except a few telephone call-office circuits in small villages. The actual number of toll-line circuits amounts to about 100. In addition to that number 22 telephone circuits are formed by utilising the telegraph lines for simultaneous transmission, and 20 by duplex telephony or virtual circuit. Simultaneous transmission of telegraph and telephone was first experimented in 1884 after the Van Rysselberghe system between Tokyo and Yokohama, but the experiment was not made with sufficient care and it ended in failure. The second experiment in 1886 resulted in a success. When the telephone exchanges were started in Tokyo and Yokohama, in 1890, all the lines connecting the two towns were specially constructed with copper wire transposed at intervals as a precaution against disturbance from external causes, and there did not exist much necessity to have recourse to the telegraph lines. In 1894 duplex telephone circuits were tried between Osaka and Kobe, which are 23 miles apart, and were worked quite successfully. In order to actuate the indicators on the duplex circuit, the neutral points of the repeating coils were earthed, and by using the circuit so formed by earthing, direct signal current was sent so as not to cause disturbance to the conversation. The telephone lines between Tokyo and Osaka were opened to the public use in 1896. Combining these lines, which are 377 miles in length, duplex telephony was successfully applied.

In course of time telephone exchanges were gradually opened in various provincial towns, which has enhanced the popularity of the telephone to a great extent and petitions for telephone facilities came into the hands of the authorities from various quarters. This brought up the necessity of opening telephone call offices first in those places which did not possess telephones, and to save money, existing telegraph lines were used. At present some 1,000 miles of telegraph wires are worked simultaneously for the telephone.

The flat-rate system is adopted in all towns. The charges are as follows:—Tokyo and Osaka, 66 yen per annum; Yokohama, Kobe, Kyoto and Nagoya, 54 yen per annum; other smaller towns, 48 yen per annum.

These are for subscribers located within the town limits. Those living in the vicinity beyond the town limits, but within a certain telephone area specified by the Government, can be connected to the exchange by a payment of 10 yen per 120yds. or under, for construction of a line beyond the city limits, and a payment of 2 yen per annum per 120yds. or under beyond the city limits as additional subscription.

Interurban lines are charged for according to the distance and for a conversation not exceeding five minutes. The basis of the toll rate is approximately as follows:—Up to 5 ri (one ri is nearly 2·5 miles), 20 sen; up to 25 ri, 25 sen; for each ri beyond 25 ri, 1 sen.

THE BOROUGH POLYTECHNIC INSTITUTE.

Last Wednesday the new buildings of the Borough Polytechnic Institute, Southwark, were formally opened by Mr. J. W. Benn, M.P., chairman of the London County Council. The new buildings contain engineering laboratories, a new lecture theatre and various drawing offices, as well as a number of rooms devoted to domestic economy, &c. The total cost of the extensions is stated to have been more than £24,000, the greater part of which has been met by a grant from the London County Council.

Since 1892, when the Institute commenced its career with 60 rooms, adapted from premises which were formerly used as a training college, the progress has been continual. Extensions became unavoidable, and the opportunity of acquiring land in Kell-street was seized. Now the rooms in the building number some 100, and there is also a fine entrance hall. Day and evening classes are given in subjects of engineering, chemistry, art, bookbinding, boot and shoe manufacture, tailoring, cooking, laundry work and a number of other trades. The following is a brief description of the engineering features of the Polytechnic, with special reference to the electric part.

The institute is lighted by about 800 16 c.p. incandescent lamps and 20 arc lamps, whilst electric power is required to drive one 10 H.P., two 3 H.P. and one 1 H.P. electric motors, which are used in the workshops and the bakery for driving shafting and auxiliary machinery.

To supply the current required for this installation there is a 50kw. Bruce Peebles dynamo, driven by a 75 H.P. Reavell engine, and a 30kw. motor generator by Mather & Platt, both generators supplying continuous current to the 'bus bars of the main switchboard at a pressure of 100 volts, the motor generator taking current from the mains of the County of London Electric Supply Co. at a pressure of 410 volts. Also, as an alternative supply, the switchboard is connected up to the mains of the London Electric Supply Corpn., which delivers an alternating current at a pressure of 100 volts, the main switchboard being so designed that any section of the building may be put on one or other of the sources of supply, thus obviating the possibility of failure of the light in the event of the breakdown of any of the supply plants.

The accommodation in the physics department consists of a lecture theatre, two large laboratories, one for elementary and the other for advanced work, and a small laboratory for special work. The lecture theatre, which has seating accommodation for 100 students, is fully equipped with all the modern requirements for demonstration purposes. The lecture table is fitted with gas, water, and two independent sets of electric mains, and arrangements are made by which the room may be darkened for lantern demonstrations, the blinds being controlled from the lecture table.

The elementary laboratory which has quite recently been fitted up, and has only been opened during this present session, measures 28ft. by about 25ft., and provides for the requirements of 40 students. It is fitted round the sides with teak benches, and in the centre with four large movable tables. The artificial lighting in this room being supplied from both arc and incandescent lamps. The advanced laboratory, measuring 38ft. by 22ft., is fully equipped for all kinds of electrical and magnetic measurements. Slate slabs let into the walls are provided round the room on which to stand sensitive galvanometers and standard measuring instruments. A number of independent electric circuits capable of carrying large currents are led from a central switchboard of special design, to various parts of the laboratory, so that continuous, or alternating currents, or power from the laboratory storage battery may be obtained for various experimental purposes. This laboratory is also very fully supplied with all the latest forms of instruments for carrying out electrical and magnetic measurements of high accuracy, including a Kelvin balance and a Ewing hysteresis meter.

The new engineering laboratory in the basement is 80ft. long, 25ft. wide, and 20ft. high, and has a gallery 6ft. wide and 80ft. long. A glazed screen extending from the roof downwards to within 10ft. of the floor (to prevent the steam and other vapour passing from one part of the laboratory to the other) divides the laboratory into two portions, one of which, 35ft. by 25ft., is reserved for experimental work on boilers and prime movers, and the other part, 45ft. by 25ft., will be used for experimental work in connection with applied mechanics. In the smaller portion of the laboratory is fitted a 8½ H.P. petrol motor, a 4 H.P. "Crossley" gas engine, fitted for experimental work, and arranged to drive a line of shafting on the wall. There is a hot-air engine in the gallery above, and a feed tank for the 8 N.H.P. semi-portable loco. type of boiler, capable of working at 200lb. pressure, which it is hoped will be fixed in a short time. The boiler will have feed measurement tank, feed pump and injector connected with it. Later on it is proposed to add a compound steam engine, a centrifugal pump and a turbine, which, with the 1,000-gallon tank in the roof, and the 500 gallon tank below the boiler room floor, will provide a useful hydraulic installation.

The other part of the laboratory will be fitted with apparatus for experimental work on machines, some of which are already installed, and for simple testing of materials. The gallery above is provided with section models of steam engines to illustrate valve motions.

On the first floor is the engineering drawing office with seating accommodation for 76 students, and adjoining this room is the engineering lecture theatre, with a gallery, and having special lecture table fitted up for demonstrations requiring gas and water and a lantern screen are fixed for lecture purposes. On the second floor is the geometrical drawing office for about 40 students. The drawing offices are lighted by inverted arc lamps.

The workshop for engineering, fitting, and pattern making is top lighted and has floor space 55ft. by 22ft. in addition to a gallery. It contains bench and vice accommodation for 24 students, and is well equipped with tools and machinery, there being screw-cutting lathes, drilling, shaping and planing machines, and a "Universal" milling machine; the driving power is supplied by two 3 H.P. motors. For pattern making there are the necessary benches, tools and machinery. The course of work comprises the making of templets, tools, small parts of engines and machines, screw cutting, boring and turning, and all classes of milling and tooth wheel cutting, with special instruction in pattern making for each branch of their work.

With the increased accommodation obtained by the new gallery it is intended later on to develop other branches of metal work which require the use of tools of an engineering character.

The chemistry department contains two laboratories, a balance room and a lecture theatre; behind the lecture theatre there is a preparation room, which is also used for gas analysis and other experimental work. There is bench room for 50 students at one time, and the lecture theatre has seating accommodation for 80 persons. The larger or general laboratory is used for analytical and general preparative work, and is very completely fitted up with draught cupboards and a hooded lead-lined evaporating bench. Each bench is supplied with gas and water, and has a double set of lockers.

CORRESPONDENCE.

TRAMWAYS ASSOCIATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read your editorial note in your issue of November 4th, suggesting the amalgamation of the three tramway associations, with interest.

As I take it, the Municipal Tramways Association is really an association of general managers (who have been courteous enough to invite me to both past annual congresses), and as an engineer, and one who for some time acted as general manager also until I voluntarily relinquished the post, I feel that an Association of General Managers is one of great use. I do not think that it would be ever workable to amalgamate the companies' association and the municipal association, whose technical officers have a common ground, at least, in the engineering institutions.

I think the present Municipal Tramways Association may be considerably strengthened if the independent chief engineers of the tramway departments, who are not subordinates of the general managers, can be introduced, either as members or as honorary members. The resident engineers, who are subordinate to the general managers, might well be included as associate members, and other officials of the tramways departments, such as assistant managers, chief clerks or secretaries, included as associates. This would add materially to the strength of the Association, which might be organised to have sub-committees dealing with engineering or general management respectively, and on whose Council independent engineers might will be represented.

I may be thought self-seeking in making this suggestion, but, obviously, in making a suggestion, I should, necessarily, be precluded myself from carrying it into practice.

There would then be one united Municipal Tramways Association, representing both the general management and the engineering sections, and this would not in any way detract from the power or influence of the Municipal Electrical Association, to which I am a devoted adherent; and, secondly, there would remain the Tramways and Light Railways Association, which would include all those gentlemen interested in tramways owned by companies.

An occasional friendly conference between these two powerful Associations would aid the general tramway interests of the country.—Yours, &c., JOHN F. C. SNELL,

Chief Electrical and Tramways Engineer,

Nov. 14. Sunderland.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read the editorial note in your issue of November 4th *re* the formation of an association thoroughly representative of tramway and light railway matters, and in this matter I am entirely in agreement with Mr. H. England, the President of the Officials Association.

In my opinion there would be many advantages in having one single association, membership to include all classes interested in tramways, with sections devoted specially to the various departments. Such sections might be so divided that they would severally represent those departments which are now represented by the different associations already existing. For instance, there might be a section for officials and one for general tramway engineering, which might include consulting engineers, contractors, &c., and a third which would be chiefly concerned with matters of policy. In this way much duplicating might be saved, and information collected by the Association more easily circulated among those interested.—Yours, &c., ALAN N. BANISTER,

Engineer and Manager, Norwich Electric Tramways Co.

Norwich, Nov. 11.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: For a long time I have been an advocate of forming a single association or organisation thoroughly representative of tramway and light railway interests. In fact, in the forming of the Tramways Officials Association I did my best to induce the members to become affiliated with the Tramways and Light Railways Association, as I considered it was rather bad policy of tramways managers to hold their meetings apart from members of corporations, committees and tramway directors, as by doing this they had no chance of becoming acquainted with, probably, their future employers. At that time the Tramways and Light Railways Association were quite prepared to form a managers section to enable managers to discuss in private such questions as wages, and dealing with men, and kindred subjects.—Yours, &c. G. CONATY.

Birmingham, Nov. 10.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was very glad to see your editorial note in your issue of November 4th respecting the necessity of uniting the three associations at present in this country dealing with tramway business.

Most men engaged on tramway work admit that an association embracing the whole of the managers and engineers in the United Kingdom, irrespective of whether such tramway officials were attached to corporations or companies, would be a force calculated to improve the general status of its members, and would assist and influence the electrical tramway enterprise of this country.

I must confess I am surprised efforts have not been made long before this to bring such an association into existence. electrical engineers, civil engineers, mechanical engineers, and every similar profession have their representative associations, but the development and guidance of tramways and light railways is left to three more or less unsatisfactory associations which entirely fail to voice the requirements of tramway engineers and managers. They fail because they are not representative, and until the three associations are merged they will fail to exercise that influence and control that would naturally attach to a representative association.

It may be advanced as an argument against the establishment of an association for all tramway men that municipalities and companies have nothing in common, and, in fact, are often antagonistic, and therefore the officials must likewise be at cross purposes. This is an absurdity on the face of it. It matters nothing to engineers or managers whether the concern they are running is handled by a corporation or a company, and my experience is that tramway men leave directors of companies and members of corporation committees to fight out the question whether municipalities or companies are best fitted to run tramways. To debate such a point would not be one of the objects of the proposed association, and all such matters would be barred by the articles of association.

What we do want badly in this country is an organisation comprising all tramway men to discuss the construction, equipment and maintenance of all things appertaining to tramways, and the working of tramways, including the managerial and traffic side.

Can such an association be formed? I see no reason why it should not, and I shall welcome the day when this very desirable movement is initiated.—Yours, &c.

Nov. 17. UNITY.

NOTES ON PERMANENT WAY FOR TRAMWAYS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On page 141 of your issue of the 11th inst. I note that your definition of rail corrugation is "hog-backing of the rail between joints or anchors." The corrugation in question is in reality quite a different thing—viz., a slight wavy surface of the tread of the rail. The waves, or corrugations, have a pitch of about 2½in.—Yours, &c., A. N. CONNETT.

London, E.C., Nov. 15.

MR. SIEMENS' PRESIDENTIAL ADDRESS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: At the present moment, when the future of our industries hangs in the balance, it is appropriate that Mr. Siemens in his presidential address should have drawn our attention to the fundamental factor which must govern such future. This factor is "Cost of production"—nothing else matters. Yet there is a reservation from a purely philosophic point of view.

Mr. Siemens is correct in saying that "the progress of civilisation is in proportion to the cheapening of articles of consumption." From a practical point of view—not the general, but the relative—cheapening of production is of importance to us. A man or a nation is concerned to produce an article more cheaply than another man or another nation. This sounds a prosaic reason for happiness—yet poets have expressed the same truth. Emerson says: "If a man can write a better book, preach a better sermon, or make a better mousetrap than his neighbour, though he build his house in the wood, the world will make a beaten path to his door."

Mr. Siemens has not treated the subject from this comparative standpoint, and whilst we must thank our President for pointing out the important truth mentioned above, I regret that he has not brought it to its proper conclusion, and the result is that he does not set forth the true laws that govern cost of production, but leads us into by-paths that hide the truth. After introducing this subject, we, speaking as electrical producers, had the right to expect an answer to this question: Is the English electrical industry capable of producing as cheaply or cheaper than its Continental or American rivals?

If Mr. Siemens thinks the answer should be in the affirmative, then I would ask: "Why are the millions of pounds worth of electrical machinery imported from abroad?" If the answer should be in the negative, then we wish to hear from the Presidential Chair the reasons and the remedy. We cannot deduce from Mr. Siemens' address a decided opinion, but from its general pessimistic tone, we must surmise that English industries are not capable of producing that cheapness which he considers essential, and he makes this concluding remark: "It is hopeless to endeavour to re-establish our former monopoly."

Surely Mr. Siemens said nothing that should lead him to give such desponding advice, and I, being engaged in producing industries, wish to raise a protest against such a melancholy pronouncement which, if believed in, must inevitably have the effect of striking terror into the hearts of English manufacturers. Surely a country that not so long ago could make "mousetraps" better than other country can hope to do so again! England has a healthy climate, an unrivalled geographical position, a good soil, great mineral resources, and an industrious population—surely if we at present do not produce as well and cheaply as other countries, whose natural resources are worse than ours, there must be a reason for it of an exceptional character.

Mr. Siemens somehow endeavours to blame somebody—our workmen and trade unions are accused of restricting output and thus increasing cost of production; our patent laws and the "want of the metric system" are mentioned. I hold that these and similar reasons are secondary, and would disappear if the primary reason were removed. Cheapness of production nowadays depends upon the manufacture of large quantities, and to ensure a large output the first essential is demand—that is, customers and their orders.

We do not at present manufacture in England as cheaply as our rivals abroad, because our factories are not as large and our output not as continuous—in other words, our rivals have a larger market for their products. This larger market is given to foreign manufacturers by the help of their and our Governments. Their Governments give them security by means of custom duties of their home market—our Government gratuitously places at their disposal our own home markets—thus we in England are deprived of that reasonable security so necessary to procure large output and demand which our rivals possess.

It is evident that Mr. Siemens, whilst telling us in mournful language that we have lost the faculty of cheap production, does not give us the true reason, which is lesser demand than that enjoyed by our rivals. It is true that had he come to this very obvious conclusion, he would have had to touch upon the fiscal question—a contingency which he deprecates—but the question of cost of production is so intimately connected with the trading systems of the world, that it would have been better not to dwell on the subject at all, than to be diffident in attacking its logical conclusions.—Yours, &c.,

London, E.C., Nov. 16. G. BYNG.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your "Notes" dismiss the first part of Mr. Siemens' address as "a string of generalities . . . . . which it was hardly necessary to place before a well educated assembly of electrical engineers."

As the Presidential Address is not open for discussion, there is no convenient way of finding out how many of the "well-educated assembly" have ever studied economic questions sufficiently to take a "discussing" interest in them, but if there be any such they must have been struck by the President's declaration of "the identity of interest between the capitalist, the workman and the management." Previous to last Thursday it had, I think, been generally understood that that sort of declaration had been relegated to the limbo of the Water-lane Chapel Debating Society, for surely no reasonable person can discover any sort of identity of interest between the highly-skilled staff of a modern industrial concern and Miss Marion Murby, whose father, the late Rev. Joshua Murby, rector of Hayslope-on-the-Green, sold the family estate and bought industrial shares. It is the old error—mistaking the agent for the thing.

Capital, in its final definition, is "a stock, previously accumulated, of the products of former labour" (J. S. Mill), and has one attribute which is constantly forgotten it is being continually consumed and continually reproduced. "Of the present productive capital of the country scarcely any part was in existence 10 years ago, and even this would not have survived so long if fresh labour had not been employed in putting it in repair" (J. S. Mill).

It seems to me that the weak spot in our commercial system is the fact that Messrs. Siemens, Esson, Silvanus Thompson and the rest, together with no inconsiderable number of assistants and workmen, are compelled to pay, from now till doomsday, a most unjustifiable tax to Miss Marion Murby and other like persons who, through no fault of their own "render no equivalent service in return"; unless it be the inestimable one of graciously permitting us—the manufacturers—to reproduce their capital for them. Where the identity of interest comes in I fail to see: perhaps someone, at some future date, will explain it all in Great George-street, Westminster.—Yours, &c.

Weybridge, Nov. 13. BOYD DAWSON.

THE ELECTRO HARMONIC SOCIETY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The recent rapid growth of the Electro-Harmonic Society is undoubtedly due to the excellence of its concerts, and to the great improvement in the conditions under which they are held. Unfortunately the large increase in the attendance has resulted in the accommodation even of the King's Hall of the Holborn Restaurant being over-taxed, and on Friday last, the first Ladies' Night of the current season, many members and visitors were compelled to resort to the gallery.

The popularity of the concerts cannot but be regarded with satisfaction by the members, but it is to be regretted that it brings in its train certain drawbacks, to which I wish to draw attention with a view to their removal. Chief of these is the practice of "reserving" seats, a privilege which exists only by the courtesy of the members, and, like all such privileges, is liable to be abused. On the last occasion, several tables were wholly reserved long before the hour for the commencement of the concert, and even at 7:45, most of the best seats were thus appropriated, though the persons who had annexed them were for the most part absent from the room. No one can reasonably object to the custom of reserving one or two seats for friends who are known to be coming, provided that the person who reserves them remains on the spot; but to appropriate a row of seats or a whole table, by posting a scrap of paper or by tipping a waiter to drive away members and guests (as, to my knowledge, was done last Friday), is, I submit, absolutely improper. I trust that the Executive Committee may see their way, in the interests of harmony, to put an end to this objectionable practice.

The abuse above-mentioned has grown, perhaps, from a tendency to regard the Ladies' Nights as specially cheap entertainments to which a number of non-members may be invited, the cost of extra tickets on these occasions being only 1s. each, a merely nominal sum. It should not be forgotten, however, that the concerts of the Electro-Harmonic Society are not public, but private functions, and are not proper occasions for the giving of parties to non-members. The extra tickets, in fact, are much too cheap. I venture to suggest to the Executive Committee, therefore, that the price of the tickets might with advantage be made the same as on ordinary occasions—namely, 2s. 6d.—Yours, &c.,

London, S.E., Nov. 14. ARTHUR H. ALLEN.

LEGAL INTELLIGENCE.

Edey v. Smith.

In the City of London Court on Tuesday, before Judge Rentoul, K.C., Mr. F. G. Edey, electrical engineer, trading as F. G. Edey & Co., sued defendant for £76 for work done and material supplied. The case had been adjourned for the attendance of experts. Defendant was building flats in Chelsea, and entrusted to plaintiff the contract for electric light wiring and bell fitting.

Plaintiff's case was that he had done the work satisfactorily although he had been unable to complete it through the conduct of defendant.

Mr. W. R. WOODWARD said he had had 40 years' experience of electric lighting, and the work now sued for had been satisfactorily carried out by plaintiff.

DEFENDANT said plaintiff agreed to give three months' credit, which had not expired. Plaintiff had refused to complete his contract, and it was alleged that the work was so badly done that defendant could not ask the Chelsea Electricity Supply Co. to approve of it or to give supply. The electric bells which plaintiff put up would not ring.

The case having lasted two hours Judge RENTOUL, K.C., said that it was one of much difficulty, and he did not see how he could arrive at any conclusion which would be at all satisfactory, having regard to the contradictory evidence. He recommended the parties to compromise, and after consultation it was agreed that judgment should be entered for plaintiff for £20 and costs, in regard to one part of the contract, and as to the rest, plaintiff was to complete the work and then to be paid.

Walker v. Okonite Co. (Ltd.) and Stevens.

An action was brought in the High Court, before Mr. Justice Joyce, last week to recover five debentures of £100 each in the defendant company or value therefor. The plaintiff is the legal representative of the late Mr. Samuel Pope, K.C., who was chairman of the Okonite Co., and who, under a scheme of reconstruction, took five debentures in the company, which, it was claimed in the action, had not been issued to him, but to some other person illegally.

The Defendant Stevens, who appeared in person, gave an account of certain alleged transactions between himself and the late Mr. Pope, and at the conclusion of his evidence was severely cross-examined by Mr. Hughes, K.C., for the plaintiff, his Lordship remarking at the conclusion of the cross-examination that in the absence of corroboration he declined to believe Stevens's statement.

On this intimation counsel for the Okonite Co. declined to carry his case any further, and judgment was at once given for plaintiff, with costs.

Sheffield & Son v. Storey.

At the Rhyl County Court on Friday last Sir Horatio Lloyd delivered judgment in this case, which was heard in July last and was reported in our issue of July 15. Plaintiffs sought to recover £93. 5s. 6d., balance of £260. 13s. 6d., for work done in and materials supplied for electric lighting and bell-fitting work on defendant's premises. The work was done under contract, plaintiffs' original tender being £229. Plaintiffs alleged that defendant had informed him that a Mr. Lewis Evans had tendered to do the work for £200 and that he had been induced by that statement to enter into a contract for £200. The jury found that defendant did make this representation and returned a verdict for plaintiff for £76. 19s. 7d. Defendant then moved for judgment on the ground that it was not competent for plaintiffs to ignore the contract under which the work had been done, as the position of the parties had altered, and that any such misrepresentation was irrelevant to the issue.

In giving judgment, His Honour held that the action was not properly brought in its present form, and that if any action was maintainable it should have been one for deceit, and he must refuse plaintiffs' application to amend, as it had come after the case had been heard and the verdict of the jury given. Defendant also contended that no amendments would avail plaintiffs, inasmuch as the representation found to have been made by him was a gratuitous statement, and there was no legal obligation on plaintiffs to rely upon that statement. His Honour said that in matters of that kind the tradesman was the best judge of the terms upon which he was prepared to do work, and in that case plaintiffs, in a letter of Nov. 13, 1903, said they had gone into the matter thoroughly and cut the prices very fine. The fact truly, or untruly, stated to them that someone else had offered to do the work for less would be a gratuitous statement which he had no legal right to ascertain, and on which in the case referred to it was folly to rely. What a contractor had to consider, and as a man of business would consider, was the terms on which it would be to his advantage to do the work. What anyone else would do it for was beside the question. He entered judgment for defendant, but, having regard to the finding of the jury, without costs.

Corporation of Ontario v. Bell Telephone Co. of Canada.

Judgment in this appeal by Toronto Corporation from a decision of the Court of Appeal for Canada, reversing a decision of Mr. Justice Street, was given by the Judicial Committee of the Privy Council on Friday last.

In delivering judgment, Lord MACNAGHTEN said Toronto claimed an injunction against the company, and their claim was founded upon the contention that the company was not entitled to enter upon the streets of the city and to construct conduits or lay cables thereunder, &c., without the consent of the Corporation. The company had been incorporated by a Dominion statute in 1880 for carrying on the business of a telephone company, and the scope of its business was not confined within the limits of any one province. It was authorised to acquire any lines for the transmission of telephone messages in Canada or elsewhere, and to construct and maintain its lines along, across or under any public highways, streets, &c., or across or under any navigable waters, either wholly in Canada or dividing Canada from any other country. The British North America Act, 1867 (sec. 92, sub-sec. 10 (a)), in the distribution of legislative powers between the Dominion Parliament and provincial Legislatures, expressly excepted from the class of "local works and undertakings" assigned to provincial Legislatures "lines of steam or other ships, railways, canals, telegraphs and other works and undertakings connecting the province with any other or others of the provinces or extending beyond the limits of the province," and sec. 91 conferred on the Parliament of Canada exclusive legislative authority over all classes of subjects so expressly excepted. No doubt a telephone company, the objects of which, as defined by its act of incorporation, contemplated extension beyond the limits of one province, was just as much within the express exception as a telegraph company with like powers of extension. Therefore the Bell Co. acquired from the Legislature of Canada all that was necessary to enable it to carry on its business in every province of the Dominion, and that no provincial legislature was, or is, competent to interfere with its operations, as authorised by the Dominion Parliament. The question as to the company's rights to carry on local business was raised in the province of Quebec, and decided adversely to the company in 1881. In consequence of that decision, with which their lordships were unable to agree, the company applied for and obtained in 1882 from the Legislature of Ontario an act authorising it to exercise within that province the powers which the Dominion Act had purported to confer upon it. That act, however, according to the construction placed upon it by the Corporation, made the consent of the Council a condition precedent to the exercise of the company's powers in cities, towns and incorporated villages. The company was proceeding to construct its lines in Toronto city without the consent of the Corporation when the two actions, the subject of the present appeal, were brought. Mr. Justice Street decided in favour of the Corporation, but his decision was reversed by the Court of Appeal, Mr. Justice Maclennan dissenting. After referring to authorities, his Lordship said that they agreed that nothing had occurred to prevent the company from insisting on the powers which the Dominion Act purported to confer upon it, and their Lordships, therefore, were of opinion that this appeal must fail and ought to be dismissed, with costs.

Mansfield Engineering Co. v. Wyeld.

At Mansfield (Notts.) County Court last week, plaintiffs sought to recover £31. 15s. 6d. from defendant for wiring his premises and for fittings, &c., supplied. It appeared that in August, 1902, defendant had requested plaintiffs to estimate for an installation of 19 lights, and this estimate was verbally accepted. By October the wiring was completed, but the fittings and lamps had not then been placed in position. At that time defendant had completely altered his views and decided to have a number of extra lights and to alter the position of others. The whole of the wiring had to be done again, and other things altered. When the account was delivered in July, 1903, exception was taken to it, and 10s. was deducted. After proceedings had been taken defendant paid sums of £14 and £11. 18s. into court. A counter-claim for breach of contract for £12. 15s. was then filed.

After hearing the evidence his Honour said he considered the charges fair and reasonable. He awarded plaintiffs the amount claimed, less £3. 8s. for ornamental brackets, &c., and costs.

Re Northern Counties Electric Traction Co. (Ltd.)

In the Chancery of Lancashire, at Liverpool last week, the Vice-chancellor (Sir S. Hall, K.C.) heard an application by Messrs. A. Ward Thomas and J. W. Donaldson, electrical engineers, and A. M. Fowler, civil engineer, to reverse a decision of the liquidator rejecting applicants' proof for damages alleged to have been sustained by them by reason of a contract that applicants should be employed as engineers in connection with an electric railway scheme in North Wales. From the evidence of Mr. F. F. Roberts, it appeared that he was at the time of the alleged contract a partner with the applicants Ward Thomas and Donaldson, and that the partnership was afterwards dissolved.

The VICE-CHANCELLOR held that, assuming there was a contract as alleged, it was a contract for personal services, which applicants could not enforce after the dissolution of partnership.

The application was therefore dismissed with costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Leigh Corporation invite applications for the position of chief engineer and manager of their electricity undertaking. Salary £250, rising by annual increments of £20 to a maximum of £350 per annum. Further particulars are given in an advertisement. Applications to the town clerk (Mr. Peregrine Thomas), Town Hall, Leigh, Lancs., by noon, 29th inst.

A junior assistant is required for test room. Applications to British Electric Transformer Co., Basildon House, Moorgate-street, London, E.C. See advertisement.

An experienced engineer is wanted as first assistant to the cable engineer in charge to assist in laying submarine cables in the Far East and elsewhere. See advertisement.

An experienced assistant electrician is required for submarine cable work. See advertisement.

A first-class draughtsman on h.-t. and l.-t. switchboards and switchgear is required by the Brush Electrical Engineering Co., Loughborough. See advertisement.

Two draughtsmen used to switch gear and arrangement of switchboards are required by Messrs. Crompton & Co. Applications to the manager, lamp department. See advertisement.

Manchester Tramways committee require an assistant civil engineer (with experience in tramway work and building construction); also a junior draughtsman. Applications by 1 p.m. 28th inst.

A demonstrator in mechanical engineering is required for West Ham Municipal Technical Institute. Salary £150 per annum. Applications to the principal before noon Dec. 5. See advertisement.

A chief assistant is required for the mechanical engineering department of Northampton Institute, Clerkenwell, London. Applications to Principal by 30th inst.

A demonstrator in engineering is required at the Paddington Technical Institute. Salary £150. Applications to Clerk of L.C.C., Education Offices, Victoria Embankment, E.C., by Nov. 23.

An assistant secretary is required by the Council of the British Association for the Advancement of Science. Salary £300. Applications to Burlington House, Piccadilly, W., by Dec. 2.

Patent Office.—An open competitive examination for 20 situations as assistant examiner in the Patent Office, London, will be held by the Civil Service Commissioners, to commence Jan. 2. Dec. 15 is latest day for applying for admission forms from the Secretary, Civil Service Commission, Burlington-gardens, London, W.

Dr. Frederick Rose, H.B.M. Consul at Stuttgart, has been appointed assistant educational adviser to the Education Committee of the London County Council.

Mr. W. E. Curnock, of the Northampton Institute, Clerkenwell, has been appointed head of the engineering department at the Technical College, Huddersfield.

Mr. J. G. Doran, of Southampton, has been appointed chief assistant electrical engineer at Bermondsey (London) electricity works.

The staff of the electricity department of the Heston and Isleworth Urban District Council now consists of: Mr. F. A. Bond, A.M.I.E.E., chief electrical engineer; Mr. J. A. Sykes, chief assistant-engineer; and Mr. E. G. Hull, chief clerk.

EDUCATIONAL NOTICES.

At the annual meeting of the Governors of University College, Bristol, on Wednesday, the report of the Council was presented, and stated that steady progress had been made during the past year. The total number of students was 1,034, and (excluding medical students) the entries for the various lectures and classes numbered 2,354, an increase of 54 compared with the previous year. It was stated that the Treasury had decided to double the grant for the present year.

Prize Distributions.—The Right Hon. Lord Reay, G.C.S.I., G.C.I.E., will deliver the prizes at the Northampton Institute for the session 1903-4 on Dec. 9 at eight o'clock. The prize delivery will be followed by a conversazione, which will be continued on Dec. 10.

Lord Alverstone will distribute the prizes and certificates to the students of Birkbeck College, London, on Dec. 6, when an address will be given by Sir Oliver Lodge, D.Sc., F.R.S.

Accident.—At Dublin on Monday the city coroner (Dr. Byrne) held an inquest on the body of John Handley, who was killed at the Pigeon House electricity works on Saturday last, while engaged in working a crane.

Medical evidence showed that deceased died from shock due to a fractured skull and to severe internal injuries.

The RESIDENT ELECTRICAL ENGINEER (Mr. Mark Ruddle) said the crane was guaranteed to lift 25 tons with perfect safety. At the time of the accident it was being used in the erection of a set of generating plant at Pigeon House station. A clause in the contract provided that each contractor for plant to be erected in the engine house would be permitted to use, free of charge, but at his own risk and entirely under the direction of the engineer, the 25-ton overhead hand crane in the engine house. He was not present at the time of the accident. He examined the crane on Sunday morning. The handle on the side upon which the unfortunate man was working was bent slightly, and, so far as he could see, the bending was caused by contact with the man while revolving. He could not form an opinion as to the cause of the accident. There was no fault in the crane itself. Deceased was in the employ of the General Electric Co., the contractors. The crane at the time the accident occurred should have been in treble gear; it was in single gear on Sunday morning when he saw it.

JOHN MONESON, electrical engineer in the employ of the General Electric Co., stated that on the 12th inst. five men (including deceased) were working at a crane lifting a flywheel about 25 tons' weight from where it was lying on the floor from a horizontal into a vertical position. Two men were working the handle at one side and two men and deceased at the other side. When one side of the wheel was raised about 4½ft. from the floor, witness noticed the rope slipping slightly, and he called to the men at the crane to lower. They lowered about a yard, and witness then heard a noise in the crab. On looking up he saw the deceased falling and he also noticed that the men had lost control of the crane and it was running away. Along with Mr. Knowles, superintendent of works, he looked at it, and he discovered that the handle on the brake side was broken, and that the handle on the side at which deceased worked was bent. The whole of the machinery was in good order, with sufficient lever brake power by either hand or foot. For the convenience of the men there was a gangway erected at each side of the crane, and he could form no idea of how the accident occurred. There must have been treble gear on the crane at the time the accident occurred, as it would have been impossible to have lifted that weight with any other gear.

A labourer named Lowry, in the employment of the Corporation, stated that he left work for the Corporation on Saturday and was then employed by the company to help in working the crane for them. The crane was in treble gear. When the fly wheel was about 4½ft. from the ground it suddenly tilted, shaking the crane, some of the pins of which came out, and it fell into single gear. Mr. Gore, for the General Electric Co., said the company would do everything possible to relieve the widow and family of deceased. They would pay her his full salary, without admitting liability, pending investigation.

The Jury found that death was due to shock following fracture of the base of the skull, and that the accident occurred owing to defective slinging of the fly wheel which the men were about to raise.

Aden.—It is proposed to establish electricity works and to construct an electric tramway at Aden.

Annfield Plain.—The South Derwent Coal Co. are putting down electricity generating plant for lighting and power, and offer to supply current for lighting the district. A special meeting of the Council will consider the matter.

Argentina.—The Mayor of Buenos Ayres has entered into a provisional contract with Mr. T. B. Holway, on behalf of a foreign syndicate for the erection, equipment and working of electricity works. A capital of $18,000,000 will be required, and when this has been redeemed the undertaking is to revert to the Corporation.

The "Review of the River Plate" states that the tariff of prices for current is to be sufficiently high to pay 6½ per cent. interest on the capital. The contract provides that after paying interest on debentures ($9,000,000 gold at 4½ per cent.), the preferred dividend (minimum guaranteed by Municipality 4½ per cent., with maximum of 6 per cent.), the remaining profits are to be equally divided between the Municipality and the deferred shareholders, and when the latter receive 9 per cent. the balance will go the Municipality. The existing company (Compañia Alemana de Electricidad) are to be prohibited from extending their mains. According to the "Review" the mayor proposes that the Municipal Council should further handicap the Compañia Alemana by declaring as lapsed the concessions originally granted to the River Plate Electricity Co., the General Electric Co, (formerly Ruñno Varela) and the Primitiva Gas Co (formerly Edison Electric Light Co.), and that the Compañia Alemana be ordered to immediately stop making use of the installations of the above-mentioned companies. The mayor also, it is stated, urges the Corporation to exercise what he asserts to be its right to limit the Alemana Co.'s charges to $0.193 per kilowatt-hour for private lighting, $0.091 for public lighting, $0.068 for traction, and $0·102 for power. The company does not admit that the Corporation has any such rights of regulating its charges.

The shareholders of the gas company at Chivilcoy will shortly discuss the question of establishing electricity works.

Rosario Municipal Council have rejected Mr. Keenan's application for a concession for constructing and working electric tramways, and the mayor has decided to invite tenders for a municipal system.

Ashton-under-Lyne.—The Council have applied for a loan of £30,000 for extensions of the electricity undertaking.

Aston.—Another section of the electric tramways (Aston Cross to Gravelly Hill) was opened for traffic on Monday.

Audenshaw.—An extension of time of 12 months to complete the electric tramways has been applied for by the Council.

Bermondsey (London).—On Tuesday the Council borough electrical engineer (Mr. W. H. Vincent) reported on a short-circuit on the mains on the 25th ult., which involved certain sections of the network being temporarily disconnected. Little inconvenience was caused, however, only two consumers being seriously affected. It was the first case of the kind in Bermondsey. The faulty sections had been speedily located, and the whole of the public lighting affected was again promptly in operation. The localising revealed the fact that the network had broken down in three places. The damage to the feeders was slight. On close examination, he arrived at the conclusion that the pitting, which extended for 135yds., was due to electrolysis.

Bethnal Green (London).—A ratepayer of Hackney-road has obtained permission from the Borough Council to obtain a supply of electricity from Shoreditch Borough Council, provided he discontinues the supply when Bethnal Green is itself in a position to supply electric current.

Bournemouth.—During the six months ended September the municipal electricity works generated 869,227 units, an increase of 112,305 over the corresponding period last year. The works costs were 1·0461d. per unit generated against 1·1188d., and the total costs 1·6074d., against 1·8058d. in 1903-4.

Bradford.—The committee of the Bradford Drapers' Association have decided to again ask the Corporation for a reduction in the charges to consumers of current for lighting and to increase the price of energy to the tramways department to the actual cost of production. It was further decided to ask for an extra discount on electricity accounts in lieu of the free lamps now supplied.

Brandon.—The Council are considering an offer from the North Brancepeth Coal Co. for the supply of electricity to 72 25 c.p. incandescent electric lamps for public lighting at 42s. 6d. per lamp per annum, or 37s. 6d. per 16 c.p. lamp per annum.

Chelsea (London).—The Chelsea Electricity Supply Co. has offered to supply electric current for lighting the town hall and public baths, and a committee of the Council is to report as to whether the offer would be more economical than the erection of independent generating plant.

Colchester.—A special meeting of the Council was held on Tuesday to consider the promotion of a bill for the construction of additional tramway routes, but in the absence of a quorum discussion was postponed.

Dublin.—A special meeting of the Corporation in committee was held on Monday to consider the recent proposals of the consulting engineer (Mr. R. Hammond) for the working of the Corporation electricity works, and the report of the Lighting committee thereon. After discussion it was decided that the matter should be adjourned pending a report by the committee on the financial condition of the undertaking, and that no further work is to be undertaken until Mr. Hammond has reported that the works covered by his agreement of Sept. 22nd, 1899, have been completed.

Durham.—The County Council have been informed by the Local Government Board that no statutory authority exists enabling the Council to carry out the proposed county electric supply scheme.

A report was presented by the Electricity Supply committee to the County Council last week, in which it was stated that

The area at present covered by companies for electric lighting and traction was over 125,921 acres, out of 638,037 acres in the administrative county of Durham. In the area covered by these companies the population was 340,508, against a total population of 774,619 for the county. The report gives figures as to cost, &c., of electric current supplied by companies and local authorities in the county, and the report states that efforts have been made to obtain reliable data as to the working of public schemes of electric service. In one large group of public undertakings owned and managed by local authorities, the committee found that the authorities charged their customers 1·34d. per unit less than the companies. The saving in charges aggregated to nearly one million pounds, upon an invested capital of 17½ millions, or equal to a return of 5½ per cent. per annum, and in addition to this great saving in charges, they earned a commercial return of 6·14 per cent., or nearly ¾ per cent. more than the companies. This difference was due to two great causes; first, the authorities saved the huge sum of £472,344 in working expenses, as compared with the scale of working expenses prevailing with the companies. Second, in consequence of selling their electricity at so much less per unit the authorities sold an extra volume of current, which brought them an extra income of £585,222, as compared with the scale of sale by the companies for the same plant. These two large items of economy and extra sale made up (the report continues) the considerable total of £1,057,568. Out of 108 local authorities that replied to the question "Would the authority be willing to take part in a conference to consider the practicability of a county scheme of electric service?" 77 replied in the affirmative and 31 in the negative. The committee therefore asked the Council to give them authority to call in an expert to report upon the practicability of a county scheme of electricity supply, and, on receipt of the report, to invite the local authorities to attend a conference for ascertaining their views as to the working of such county scheme.

After discussion, the report was referred back.

Egypt.—A contract has been entered into between the Suez City Council and Messrs. G. Beyts & Co., Suez, for the establishment by the company of an electric lighting service for the city. The text of the contract is given in the "Journal Officiel" of Nov. 5.

Electric Lighting and Traction Notices.—The following further notices of intention to apply for provisional electric lighting orders have appeared:—

Corporations of Andover, Conway and Eastbourne (for Willingdon); District Councils of Kingsbury, Litherland, Penmaenmawr and Southall Norwood; Windsor Electrical Installation Co. (for Clewer Without and Old Windsor).

In the following instances procedure by Bill has been decided upon:—

The Urban Electric Supply Co. are promoting a bill to authorise the connecting up of the area of supply in their Walton-upon-Thames Electric Lighting Order, 1904, with the generating station of the company at Weybridge, in the area defined by the Weybridge Electric Lighting Order, 1900.

In the bill of the Andover Gas & Coke Co. power is sought to supply electrical energy in Andover, to accept transfers of authorised electrical undertakings, &c.

Aberdare District Council are promoting a bill to authorise the construction and working (or leasing) of electric tramways, to enter into agreements, &c., to erect and maintain electricity supply and refuse destructor works, to supply electricity within and beyond the district, to supply electric fittings, to purchase, sell and let on hire or deal in and fix motors, fittings, switches, lamps, &c., and to exempt same from liability to distress, to alter time for filing annual accounts, to make bye-laws with respect to electric fittings, to exempt Council from liability to supply in certain cases, &c.

Accrington Corporation are promoting a bill authorising the re-construction and conversion to electric traction of existing tramways within and beyond the borough, to enter into working and traffic agreements, to make further provision with regard to their electric lighting undertaking, to supply electricity in bulk to neighbouring authorities and others, to make special charges to consumers having stand-by supply, to authorise purchase, sale and letting-on-hire of motors, fittings, &c., to alter date of filing accounts, to exempt from distress motors, &c., let on hire, to authorise acceptance of transfer of electrical undertakings in districts adjoining or near the borough, to establish a municipal insurance fund, &c.

Electrical Contractors and Municipal Wiring.—The Teesside Association of Electrical Contractors recently complained to West Hartlepool Corporation that local contractors had been subjected to unfair competition by employés in the Corporation electrical department having, after working for the Corporation during the day, undertaken wiring work for consumers in the evenings. In reply the town clerk stated that the only work done in that manner had been connecting up short lengths of wire to meters. The contractors are not, however, satisfied with this explanation, and intend to consult the National Association of Electrical Contractors.

Electricity in Mining.—Electric plant has been put down by the Cathcart Proprietary Gold Mines, Victoria. Current is supplied by a Ganz three-phase generator, driven by a 170 B.H.P. Belliss engine. The boilers are of the Otis dry back type. Current is supplied not only for lighting but for winding, pumping, puddling, &c. The contractors for the whole of the plant, including the motors, were the Austral Otis Engineering Co. (agents for Ganz & Co.), the condenser plant being supplied by the Corrugated Surface Condenser Co., Melbourne.

Felixstowe.—The Felixstowe and Walton District Council formally took over on Friday the local works of the Suffolk Electricity Supply Co., but the company continues to manage the undertaking for 25 years, receiving the profits, and pays the Council 6 per cent. on the capital expended in order to provide interest and sinking fund on capital outlay. Of the purchase price (£8,000), £5,000 has been paid, the balance being retained as a guarantee.

Finchley.—An inquiry has been held into the application of the Council for sanction to borrow £17,000 for electric lighting extensions.

The Clerk (Mr E. H. Lister) said the capacity of the original plant was 10,000 8 c.p. lamps for private lighting and 150 public street lamps. They were at present supplying current to 16,000 8 c.p. lamps. Up to the end of September they had a balance unexpended on the original loan of £2,851. 13s. 11d. The district was a growing one, and electric lighting was becoming so popular that it was doubtful whether the loan now being applied for would enable them to more than tide over the present winter's load.

Gosport.—The Council have assented to the application of Gosport & Alverstoke Electric Lighting Co. for a provisional order.

Huddersfield.—The accounts of the electricity department for 1903 show a surplus of £5,915, and this has been carried to depreciation and contingencies account, which now stands at £11,853. The equivalent of 18,661 additional 8 c.p. lamps were connected during the year.

Hong Kong Tramways.—At the meeting of the United Exploration Co. (Ltd.) last week the chairman (Mr. E. Davis) said that the Hong Kong tramways, in which the company was interested, were open to traffic, and from all information to date they were led to expect satisfactory results. The question of additional rolling stock might possibly have to be gone into at an early date. The consulting engineer to the tramway company (Mr. A. Dickinson), upon whose advice and estimate as to ultimate receipts they went into the business, was leaving for the Far East on 3rd prox., and the principal question he would have to go into was that of dealing with the large traffic the company had to handle. The traffic at present carried by the tramways was larger per car-mile than that on any other tramway of which they knew; it was 45 per cent. higher than Dublin and very much larger than any line in the principal towns in England. The directors were already negotiating for the equipment of the line on a larger scale by the addition of a further number of cars, and when Mr. Dickinson arrived out that matter would be definitely settled.

Kirkcaldy.—Terms have been arranged between Mr. Wemyss, of Wemyss Castle, and Kirkcaldy Corporation for the construction of an electric tramway between Leven and Kirkcaldy.

Light Railways.—The Board of Trade have, after modification, confirmed the London United Tramways (Light Railway Extensions) Order authorising lines between Hounslow and Cranford and between Heston, Hounslow, Hanworth, Twickenham and Sunbury Cross.

At the Board of Trade offices on Tuesday, Sir Herbert Jekyll heard objections to the confirmation of the Snowdon to Bettws-y-Coed Light Railway Order authorising the construction of about 18 miles of railway in North Wales, to be constructed on a 2ft. gauge and worked electrically. The National Trust for Places of Historic Interest or Natural Beauty, the Co-operative Holiday Association, the Alpine Club and others opposed on the ground that the beauty of the Snowdon district was so exceptional, and its attraction for a large number of visitors so great, that it deserved protection from a railway. Mr. H. Lloyd, K.C., for the promoters, said they had done everything to avoid interfering with the natural beauties of the neighbourhood. Decision reserved.

London County Council.—At Tuesday's meeting the Council accepted the recommendation of the Highways committee that Parliamentary powers be sought to construct tramways over Blackfriars and Waterloo bridges and along Victoria Embankment.

Northern Tramways.—The Council postponed decision on a recommendation of the Highways committee that an agreement be entered into with the North Metropolitan Tramways Co., providing (i) that the tramways in Rosebery-avenue, when constructed on the conduit system, shall be worked by the company by horse traction pending reconstruction for electric traction of the tramways with which they will be connected; and (ii) that during the period of horse working the company shall pay the Council a rent equal to 8 per cent. per annum on the estimated cost (£10,285) for horse traction, with £600 added for Parliamentary, &c., expenses.

Long Eaton.—The Council have decided to discontinue the supply of electric current through slot meters owing to difficulty encountered in the collection of rents.

Loughborough.—The County Council have decided to introduce electric lighting at the police buildings, Loughborough. Current will be taken from Loughborough Corporation mains.

Macclesfield.—The Council have decided to allow their electric lighting order to lapse.

Mexico.—Mr. Jose Sitzenstalter, Mexico City, has secured a concession to provide telephonic facilities in the city. A Swedish syndicate are said to be interested.

Municipal Telephony.—Swansea Corporation have commenced proceedings against the National Telephone Co. to compel the company to grant intercommunication between subscribers of the municipal service and the company's system.

On Tuesday the Corporation received sanction to borrow £2,000 for extending their telephone system.

The elective auditors for Swansea have issued their report, in which reference is made to the municipal telephone service.

Portsmouth Telephone committee report that there are now nearly 2,000 subscribers connected to the municipal system.

Newport (Mon.).—An inquiry was held on Friday into the application of the Corporation for sanction to borrow £17,825 for extensions of their electricity undertaking.

Evidence was given by the town clerk (Mr. A. A. Newman) and the borough electrical engineer and tramways manager (Mr. H. Cullings Bishop). The works were started in 1895, and at present the equivalent of 82,000 8 c.p. lamps are connected. The revenue had risen from £1,400 in the first year to £18,166 for the year ended March, 1904, while the estimated receipts for the current year are £24,000, and a net profit of between £1,000 and £2,000 is anticipated.

The INSPECTOR (Major Stewart, R.E.) said the Corporation did not seem to have made much net profit.

Mr. Collison Bishop replied that a set-back occurred when the old works became so much overloaded that the Corporation had to erect new works for the tramways and other power purposes. The tramways department were customers for power at 1½d. per unit.

Norwich.—On Tuesday the Electricity committee will recommend the Corporation to authorise a revision of the charges for electric current.

Pemberton.—The electrical engineer (Mr. T. Partington) has been granted by the Council £287 for extra services rendered in connection with the electric tramways.

Personal.—Prof. Henry Adams, M.Inst.C.E., has recently retired from the City of London College, where for 35 years he has been head of the engineering department. He is, however, still continuing his practice as consulting engineer at 60, Queen Victoria-street, London, E.C., where he has had offices for the past 25 years.

Peterborough.—Werrington residents are petitioning the British Electric Traction Co. to extend the electric tramways to Werrington.

Pollokshaws.—An agreement has been entered into between the Council and Glasgow Corporation for the supply by the latter of electricity in the burgh. The agreement is conditional upon the Pollokshaws Council obtaining a provisional order with a clause authorising its transfer to the Corporation, whereupon the latter will pay the expenses of the Council up to £400; but if the Council obtain an order and no transfer clause, their expenses will be paid by the Corporation only to the extent of £200. If the Council obtain an order but carry out the work themselves or transfer their authority to a body other than the Corporation, no contribution will be made by Glasgow towards the expenses.

Portsmouth.—Sanction to a further loan of £23,883 for tramway extensions has been received by the Corporation.

Bonuses have been earned by 88 out of the 100 motormen who have for six months run their cars without accident. The men receive 10s. each.

Presentations.—Messrs. A. J. Eames and A. Evans, engineers in the postal telegraph service at Uxbridge, were last week presented by the staff of the local engineering branch with marble timepieces. Mr. Eames is being transferred to Shrewsbury and Mr. Evans to Bedford.

Huddersfield Corporation tramway officials have presented a smoking cabinet to Mr. C. Womersley, who is leaving for Kilmarnock.

Railway Servants' School.—The Canadian Pacific Railway Co. recently organised, in connection with its head offices in Montreal, a school of telegraphy and shorthand for its employés. There are at present about 150 in attendance, and this number is being increased daily. A fee of $2 a month is charged, but this is returnable at the end of six months if the student has attended 80 per cent. of the classes in telegraphy, or 70 per cent. in shorthand, or passes a satisfactory examination in these subjects.

Redditch.—In reply to a query by the District Council, the Board of Trade intimate that they have no power to relieve undertakers from the obligations imposed upon them by sec. 9 of the Electric Lighting Act, 1882, to make up the annual accounts to Dec. 31. In the circumstances referred to, however, the Board would not refuse to accept the current accounts made up to March 31, 1905, and the accounts for the succeeding years made up to March 31.

Sheffield.—It has been decided to remove the notices on tramcars and tickets limiting to £25 the Corporation's liability for compensation for accidents on the tramways.

Shildon.—The Northern Counties Electricity Supply Co.'s generating station will probably be completed by Jan. 1.

Shoreditch (London).—It was reported to the Council on Tuesday that during the 12 days of the recent electrical exhibition there were 23,460 visitors, and that, after paying all expenses, there was a small surplus. The success was due largely to the efforts of the borough electrical engineer (Mr. C. Newton Russell) and the staff of the electricity department. The Electricity committee had recognised the efforts of the staff by making suitable allowances for the extra services rendered.

Stoke Newington (London).—At a meeting of the Council on Tuesday the Electric Light committee submitted a report upon the electric lighting scheme.

The report stated that the re-opening of negotiations with the North Metropolitan Electric Power Supply Co. had resulted in a modification of the electricity scheme which the committee previously submitted. The main outlines remain, the chief modification being the introduction of a safeguard against any possible loss by the Council during the early years of the working of the undertaking. It has been arranged that during the first three years, and for such additional number of years as the Council shall think fit, the company supplying energy in bulk shall be paid for such energy the amount of net revenue the Council may derive from the undertaking, and that any loss which may occur shall be borne by the company. The Council may terminate this arrangement by six months' previous notice, on March 31, 1909, or on any subsequent 31st March. Upon such determination, the scheme outlined in the Committee's report of June 16, 1904 (see *The Electrician*, June 24), will come into operation with the following modifications: It is open to the Council to make an arrangement with Islington Borough Council for the supply of energy on similar terms and conditions to those previously made by Stoke Newington Council with Hackney Council. The minimum period of 12 years mentioned as the period before the expiration of which the agreement there detailed could not be determined will run from the determination of the arrangement above mentioned as applying to the early years of the undertaking. It is a part of the revised scheme that the Council's scale of charges shall be revised so that, instead of flat rate of 5d. per unit for light, consumers shall pay on the maximum demand system at 7d. per unit for first hour's daily use in each quarter, and 2d. after; and in lieu of 3d. per unit for power there shall be charged 5d. per unit for the first hour's daily use, and 1d. after when the demand does not exceed 20 H.P., with the substitution of 4d. for 5d. when the demand exceeds 20 H.P. Present consumers are to have the option of continuing at present rates. The charge for public lighting is to be 1·45d. per unit for lamps alight during all-night hours, and 1·85d. for those alight during half night hours. The scheme outlined in the committee's report of June 16, 1904, is to be proceeded with, and the agreement with the North Metropolitan Electric Power Supply Co. provides for such extension as the Council and the company may agree or as the Council may be lawfully called upon to undertake. The company bears, as part of the expenses of the undertaking, the interest and sinking fund or repayment of loan on the capital outlay, including the £3,000 already raised, and if London County Council should require a maintenance or reserve fund for repairs or renewals, that also is to be borne by the company; but if any part of the last-mentioned fund remains at the termination of the period during which the company is to take the profits and bear the losses, this amount is to be repaid to the company. When the yearly receipts for energy supplied for lighting exceed 4d. per unit for the total number of units supplied during the year, the excess is to belong to the Council, and similarly any surplus over 3d. per unit for the total number of units supplied during the year for power is to go to the Council.

In lieu of the recommendations in its report of June 16, 1904, the committee therefore recommended:—(1) The adoption and sealing of the agreement with the North Metropolitan Electric Power Supply Co. (2) The adoption and carrying into effect of the scheme outlined above, including the acquisition of sites, the erection and equipment of station, and the laying of cables in Church street, Lordship-road, Lordship Park, Manor-road, Woodberry Down and Seven Sisters-road. (3) Reference to the General Purposes committee of the acquisition of sites for the meter and transforming stations. (4) The immediate appointment of the Standing Electric Lighting committee, and reference to it of all the foregoing works other than the acquisition of the said sites.

At the suggestion of the chairman of the committee, consideration of the report was adjourned to a special meeting.

Swinton and Pendlebury.—The Council have entered into an agreement with the Lancashire Electric Power Co. for the supply of electricity in bulk.

Telephone Wires over the Thames.—At the meeting of the Thames Conservancy on Monday an application from the National Telephone Co. for permission to place six wires over the Thames at Wallingford was refused. The company stated that the expense of a cable under the river would be prohibitive, and unless the company were afforded facilities for carrying the wires over the river they would be unable to supply any of the residents on the Oxfordshire side with a telephone service.

The Telephone in Greece.—With an estimated population of 2,609,948 there were 365 telephone stations and 754 miles of telephone wire in Greece at December 31, 1902.

Transvaal Imports.—The imports of electric cables, wires and fittings into the Transvaal for the eight months ended Aug. 31, 1904, were valued at £49,000, compared with the same figure for the corresponding period of 1903.

Western Australia.—At Claremont the Municipal Council will commence electricity supply on Jan. 1, with an equivalent of about 500 8 c.p. Supply will be given at first in the evening only at 7d. per kilowatt hour.

Westhoughton (Lancs.)—Negotiations are proceeding between the Council and the Lancashire Electric Power Co. for the supply of electricity in bulk by the company in this district.

Westminster (London).—The Works committee of the Council have issued a report as to negotiations between the Council and the electric lighting companies on the subject of the hours during which the companies shall have access to their distributing boxes.

The report states that the amended proposals made to the companies were not more onerous than those accepted by the Postmaster-General. But the companies, through Prof. Kennedy, rejected the proposals, and closed the negotiations abruptly.

Whitefield (Lancs.).—The Council's reply to an inquiry from the Board of Trade as to the position of the Whitefield electric lighting provisional order is a request for terms from the Lancashire Electric Power Co. for a supply of electricity in bulk to the Council.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Visiting Committee of *Worcestershire County Council* invite tenders for supply and erection at their new lunatic asylum (in course of construction) near Bromsgrove, of engines, dynamos, booster and steam services; storage battery and accessories, main switchboard, ring main, feeders, distribution boards, wiring, lamps and accessories. Plans at the offices of the architects (Messrs. George T. Hine & Co.), 35, Parliament-street, Westminster, S.W. Specifications, &c., from the clerk (Mr. Robert J. Oliver), Shire Hall, Worcester. See also advertisement.

The *Dublin United Tramways* Co. invite tenders for the supply of general stores, including electrical supplies, car fittings, iron, steel, castings, oil, &c., for 1905. Forms of tender from the secretary (Mr. R. S. Tresilian), 9, Upper Sackville-street (where patterns may be seen), from 21st to 30th inst. Tenders (addressed to chairman) to Mr. Tresilian by Dec. 5. See also an advertisement.

Salford Corporation electricity department invite tenders for the supply, delivery and erection of a feeder booster at their Frederick-road works. Specifications, &c., from the borough electrical engineer, Mr. C. D. Taite. Tenders to the town clerk (Mr. L. C. Evans), by Dec. 8. See also advertisement.

The directors of the *Caledonian Railway Co.* invite tenders for stores for 12 months from Jan. 1, 1905, including electric lighting materials and fittings, telegraph appliances, telephones, &c., oils and grease, screws, tools, hardware, indiarubber, asbestos and gutta-percha goods, copper rivets, &c. Tenders to the secretary (Mr. J. Blackburn), 302, Buchanan-street, Glasgow, by Nov. 21.

Firms willing to tender for the electric lighting or the ventilating and heating of the new *Manchester* Stock Exchange buildings, Norfolk-street and Pall Mall, Manchester, are required to send in their names (with a list of three similar contracts which they have executed) to Messrs. Bradshaw & Gass, 19, Silverwell-street, Bolton, by 21st inst.

Whitby District Council invite tenders for one 200kw. direct-current dynamo, coupled to a high-speed engine (reciprocating or turbine type); and one water-tube boiler, fitted with chain grate mechanical stoker. Tenders to the electrical engineer (Mr. L. H. King) by 5 p.m. Nov. 21.

Oldham Corporation Electricity committee invite tenders for supply, delivery and erection of two negative return feeder boosters (with switch gear and boards for tramway system). Tenders to Mr. S. Wilmott Newington by Nov. 25.

Newport (Mon.) Electricity and Tramways committee invite tenders for various machine tools. Tenders to the town clerk by Nov. 21.

Messrs. Cadbury Bros., Bournville, *Birmingham*, invite tenders by Dec. 5 for 12 months' supply of electric lamps, cables, engineers' stores, &c.

Leith Corporation invite tenders by 26th inst. for 30 electric tramcars complete and a sprinkler car; also for rails, fish-plates, &c.

Swansea Corporation invite tenders by Dec. 1 for 12 months' supply of motors and starting switches.

Tenders are invited by Nov. 25 for the supply of 25 electric motors for the tramway service at *The Hague*. Tenders to the Director of Tramways, The Hague, Holland.

Salamanca (Spain) Municipality invites tenders for the electric lighting of the city for a period from July 25, 1905, to July 25, 1915. The adjudication of the contract will be made at the Municipal Offices, Salamanca, at noon, Dec. 12. The "Madrid Gazette" of Nov. 6 contains further particulars.

The municipal authorities of *Pola de Siero*, Spain, invite tenders for the electric lighting of the district for 10 years. Tenders will be adjudicated upon at the Municipal Offices, Pola de Siero, at 11 a.m. of Nov. 30. Further information is given in the "Madrid Gazette" of Nov. 8.

The Municipal Council of *La Paz*, Bolivia, invite tenders for the public and private electric lighting of the city for 12 years, which period may be extended. Further information from the Bolivian Consul-General, 12, Fenchurch-street, London, E.C. Tenders to the secretary of the Council, La Paz, by 2 p.m. Jan. 15.

TENDERS RECEIVED AND ACCEPTED.

Bermondsey Borough Council has accepted the tender of W. Dowell & Co. for 1,200 tons of small coal (Watson's washed nuts, specially prepared for chain grate stokers) at 13s. 6d. per ton, and that of Cockerell & Co. for 1,000 tons of Welsh coal (Bwllfa) at £1. 1s. per ton.

Hammersmith (London) Council have accepted the tender of Richardsons, Westgarth & Co., for a third surface condenser at £1,600; that of the Thermal Storage Co. for thermal-storage plant (four vessels) at £2,616; and that of Robey & Co. for feed-water heater at £430.

We are asked to state that through Messrs. Siemens Brothers & Co., the order for troughing required in connection with Messrs. Kennedy and Jenkins' specification for the Great Western Railway electrification has been placed with the Howard Conduit Co.

Acton Council have accepted tenders from the Key Engineering Co., Venner & Co. and the British Thomson-Houston Co. for the supply of electricity meters.

The Railway Commissioners, New South Wales, recently invited tenders for five years' supply of iron and steel (about 50,000 tons) for railways and tramways, the metal to be manufactured in the State. The only tenderer was W. Sandford, Lithgow, New South Wales, who will, if his offer be accepted, have to spend about £300,000 upon works.

Graham, Morton & Co. have supplied to Melbourne City Council a large complete coal and ash handling plant for the boiler house at the municipal electricity works. The plant is electrically driven by three separate motors. The motors for driving the crusher and coal conveyor are 12 B.H.P., running at 600 revs. per min., and are of the enclosed ventilated type and suitable for a three-wire direct current of 460 volts.

The Hart Accumulator Co. have secured from the War Office a contract for the supply of 67 standard lighting type cells of a capacity of 600 amp.-hours for Plymouth.

Belfast City Council have accepted the tender of J. W. Singer & Sons, Frome and London, for the supply of electroliers for the new city hall at £2,500.

Fulham (London) Council have accepted the tender of the British Thomson-Houston Co. for a 3,000-volt main generator switchboard for £492.

Hereford Corporation have placed an order with the India Rubber Co. for a rotary transformer at £50. 10s.

Portsmouth Telephone committee have placed an order with W. T. Henley's Telegraph Works Co. for cables.

BUSINESS NOTICES, &c.

We are informed that five leading British electrical and mechanical engineering firms have agreed to amalgamate their Egyptian interests. The firms in question are Messrs. Dick, Kerr & Co., Callender's Cable & Construction Co., Babcock & Wilcox, Gwynnes Limited and James Gibb & Co. A new company, the British Engineering Co. of Egypt (Ltd.) has been formed to acquire, develop and extend the business transacted in Egypt by the firms mentioned.

Mr. W. B. Esson, M.Inst.C.E., M.I.E.E., who recently retired from the position of chief engineer and manager to Messrs. Johnson & Phillips, has started in practice as a consulting engineer and electrical expert at 1, Victoria-street, Westminster, London, S.W.

Mr. Norman A. Thompson, until recently manager and resident engineer of the Clyde Valley Electrical Power Co., and Mr. J. G. Wilson, for several years chief electrical designer to Messrs. Siemens Brothers & Co., have commenced practice as consulting electrical engineers at 22, North Bridge-street, Edinburgh. Telegraphic address, "Inductive Edinburgh."

Messrs. B. Reid & A. Fishlock, electrical engineers, 2a, Maryland-street, Liverpool, have dissolved partnership. Debts by Mr. Fishlock, who continues as Reid & Fishlock.

BANKRUPTCIES, LIQUIDATIONS, &c.

A first and final dividend of 2s. 7d. will be payable on Nov. 21 at Messrs. Poppleton & Appleby, 8, Barbican, London, E.C., in the failure of Thos. Hyom, electric light fitter, &c., 139, Fawcett-road, Southsea.

A receiving order has been made against W. C. Bersey, Dacre House, Arundel-street, London, W.C. First meeting of creditors Nov. 22 at Bankruptcy-buildings, London, W.C.; public examination Dec. 14 at same place.

In the failure of A. J. Hollington, electrical engineer, Barclay Oval, Woodford Green, the first meeting of creditors will take place on 23rd inst. at Bankruptcy buildings, London, W.C., and the public examination on Dec. 15 at the same place.

Meetings of creditors and contributories of the Motor Mfg. Co. (Ltd.) will be held on 24th inst. at Bankruptcy-buildings, London, W.C.

Creditors of the Bath Electric Mfg. Co. (Ltd.) should send particulars of their claims to Mr. A. C. Comley, Albion-chamberrs, Bristol, by 30th inst.

Plant for Sale.—An eight-pole compound-wound dynamo of 150kw. (230 v., 612 amp., 145 revs.) for direct-coupling to engine is advertised for sale, owing to alteration of original scheme of driving. Applications to Messrs. Andrew Handyside & Co., Britannia Iron Works, Derby, or to Messrs. Greenwood & Batley, Leeds. See also advertisement.

Premises to Let.—There are three fine shops, with basements, to let in the Strand, London, on a 21 years' lease. Particulars from the secretary's office, Room 41, West Block, Hotel Cecil, Strand, London, W.C. See advertisement.

Warehouse premises, 222, Upper Thames-street, comprising four large well-lighted floors with total floor space of about 7,000ft., are to be let on lease. See advertisement.

Three rooms are to be let, separately or as a whole, in a third floor flat in 64, Victoria-street, Westminster, S.W. See advertisement.

Catalogues, &c.—Messrs. J. H. Holmes & Co., of Newcastle-on-Tyne, have ready two new lists describing and illustrating (1) Holmes-Page switches, and (2) recording instruments. In the former list a good range of quick-brake chopper-type switches are shown, and in the second recording voltmeters and ammeters which run for a fortnight without re-winding or re-inking. The difficulty of driving a continuous band of paper has also been overcome. The instruments are made up in two forms—the switchboard type and the portable type.

The Brush Co.'s bulletin No. 9 describes and illustrates induction motors.

The New Anglo-American Machine Brush Synd., 81, Wool Exchange, London, E.C., have ready a new illustrated catalogue of steel-wire brushes for the use of engineers, brass and iron founders, &c. A new catalogue of brushes for water-tube boilers will shortly be issued.

A sheet list of Atkinson's patent excess indicators is issued by Messrs. Monté Callow & Co., 6, Ludgate Broadway, London, E.C.

In a catalogue of electrical testing instruments issued by Messrs. Gambrell Bros., 23, North Side, Clapham Common, London, S.W., a portable testing set for fault location and insulation resistance (Calla's pattern) is fully described. This apparatus has been specially designed for accurately and quickly determining the position of a fault in a cable in a simple manner, and it is claimed that the accuracy obtainable is equal to that of testing room apparatus. A large variety of instruments and apparatus are described in this useful list.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Nov. 9 to Nov. 15, with the ports of destination:—

Africa—Alexandria, £547; Beira, £15; Cape Town, £490; Durban, £783; Mombasa, £770 (including £656 telegraph material); Port Elizabeth, £119; Suez, £12. *Argentina*—Buenos Ayres, £845 (including £800 telegraph apparatus). *Australasia*—Auckland, £303; Christchurch, £118; Melbourne, £274; Otago, £175; Perth, £565; Sydney, £3,297 (including £74 telegraph material); Wellington, £2,631 (including £602 telegraph material). *Brazil*—Rio Janeiro, £18; Santos, £127. *Ceylon*—Colombo, £336. *China*—Shanghai, £144. *France*—Paris, £3,237 (including £3,220 telegraph material). *Germany*—Hamburg, £520 (including £200 telegraph material). *Gibraltar*, £1,175. *Holland*—Amsterdam, £1,209 (including £371 telegraph cable); Rotterdam, £24 (telegraph material). *India*—Bombay, £552 (including £61 telegraph material); Calcutta, £724; Madras, £64. *Italy*—Genoa, £139. *Japan*—Kobe, 27 tons of cable strippings. *Malta*, £83. *New Caledonia*, £19. *North Atlantic*, £3,000 (telegraph wire). *Russia*—Helsingfors, £16; St. Petersburg, £1,430 (including £1,420 telegraph material). *Straits Settlements*—Penang, £319 (telegraph material); Singapore, £269. *Sweden*—Stockholm, £19. *U.S.A.*—New York, £73. Total, £24,231, against £15,741 in the corresponding week last year (Nov. 11 to 17).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

October 22, 1904.

22,820 B.T.-H. Co. (G.E. Co., U.S.). Variable speed windings for alternating-current motors.

22,821 B.T.-H. Co. (G.E. Co., U.S.). Windings for alternating current motors.

22,823 B.T.-H. Co. (G.E. Co., U.S.). Control of electric motors.

October 24, 1904.

22,832 Tangye Tool & Electric Co. and A. H. Bate. Birmingham. Automatically operating and controlling electric motor starters.

22,838 Jandus Arc Lamp & Electric Co. and A. W. Jones. Arc lamps.

22,839 J. W. Allen. Birmingham. Supporting trolley wires.*

22,903 B.T.-H. Co. (G.E. Co., U.S.). Controllers for electric circuits.

22,904 B.T.-H. Co. (G.E. Co., U.S.). Electrical measuring instruments.

22,905 F. de Mare. Electro-thermic fans.*

22,908 O. Arendt. Germany. Multiple connecting system for telegraphic and telephonic communication. (Date applied for, Oct. 24, 1903, date of application in France.)*

October 25, 1904.

22,914 H. Ashton. Manchester. Switch lampholders for electrical purposes.

22,915 C. B. F. Olai and Brown & Barlow (Ltd.) Birmingham. Switches.

22,930 J. Haydock and T. S. Jones. Halifax. Insulated bolts.

22,959 A. W. Pitt. Incandescent candle lamps.

22,962 J. Gresham, H. E. Gresham and G. Kiernan. Vacuum brake for electric trains.

22,964 J. R. Baker. Gas or vapour electric apparatus. (Date applied for, Nov. 6, 1903, date of application in U.S.)*

22,966 F. J. Chaplin and R. Chaplin. Birmingham. Construction of dynamo and like brushes.

23,001 W. M. Scott. Automatic switches.*

23,009 I. B. Birnbaum and H. G. White. Intercommunication telephone systems.*

23,015 R. F. Jones and C. J. Jones. Liverpool. Automatically switching electric cars from one line to another.

October 26, 1904.

23,027 J. A. Hirst and P. S. Brook. Chester. Terminal for resistance coils.

23,031 F. Render. Manchester. Fuse heads for electric blasting.*

23,032 L. T. Allen and R. E. Sharples. Manchester. Hangers for trolley wires.

23,050 O. S. Gill. Liverpool. Electric railways.

23,056 C. W. Hathaway and Triumph Cycle Co. Coventry. Switches for motor cycles.

23,084 G. H. Whittingham. Switches for reversing current in motors. (Date applied for, Oct. 29, 1903, date of application in U.S.)*

23,090 J. S. Stone. Liverpool. Increasing effective radiation of electromagnetic waves. (Date applied for, Oct. 30, 1903, date of application in U.S.)*

23,093 H. V. Mitchell. Contact breakers for overhead systems.

23,094 C. W. Maunsell and F. R. Butt. Shields and projectors for X-ray tubes.

23,095 F. W. Howarth (W. E. Haskell, U.S.). Thermo electric generators.*

23,097 G. C. Fricker. Electrical measuring instruments.

23,109 J. T. Armstrong and A. Orling. Electro-capillary apparatus.

October 27, 1904.

23,118 M. Cummins. Manchester. Automatic sanding apparatus.

23,128 S. R. Thompson. Manchester. Trolley pulleys.

23,150 A. F. Berry. Distribution of alternating current. (Date applied for, Oct. 29, 1903, date of application in France).*

23,165 G. Hill. Electric gas ignition and extinguishing apparatus.

23,182 W. B. Hopkinson. Electric fire alarms. (Date applied for, April 15, 1904, date of application in U.S.)*

23,201 E. J. Chambers. Third-rail insulators.

23,203 B.T.-H. Co. (G.E. Co., U.S.). Contacts for electric controllers, reversing switches, &c.

23,204 B.T.-H. Co. (G.E. Co., U.S.). Electric heating apparatus.

23,205 B.T.-H. Co. (A.E.G., Germany). Regulation of alternating distributing systems.

October 28, 1904.

23,219 H. Ashton. Manchester. Electric lamp fittings.

23,222 W. Muir, G. W. Sommerville and Howard & Bullough, Accrington. Electric stop motions for drawing and roving frames.

23,253 T. E. R. Phillips. Section insulator for trolley wires.

23,254 T. E. R. Phillips. Trolley head for collecting current.

23,260 R. Clayman. Telescopic tables.

23,271 La Société Bergès, Lord et Cie. Insulators. (Date applied for, Nov. 6, 1903, date of application in France.)*

23,276 B.T.-H. Co. (G.E. Co., U.S.) Electrical apparatus and manufacturing and operating same.

23,279 H. Aron. Resistances.*

October 29, 1904.

23,302 L. H. Walter. Magnetic or electromagnetic mechanisms.

23,352 O. Hellstern. Carbons for arc lamps and the like.

23,367 Lacey-Hulbert & Co. and N. Dickson. Hauling cables.

23,377 I. Deutsch. Dynamos.*

23,380 La Société Électro-Métallurgique Française. Process of smelting nickel ores in an electric furnace and crucible therefor. (Date applied for, Oct. 30, 1903, date of application in France.)*

23,392 V. A. Fynn. Alternating-current motors; also generators and direct-current machines.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

21,008 Hofstede-Crull. Mounting a number of electrical fittings or instruments on a common base.

21,173 Gasnier. Electro-mechanical arrangement for changing speed and for reversing.

21,280 Shone. Light and heat bath apparatus.

21,238 Davies. Switch holders or key switches.

21,504 Soc. Anon. des Ateliers de Mécanique de Précision de Ferrivet. Electricity meters. (Date applied for Oct. 15, 1902).

21,939 Lodge & Muirhead. Signalling through submarine and like cables.

21,939a Lodge & Muirhead. Signalling through submarine and like cables. (Date applied for, Oct. 12, 1903.)

22,216 Tanner and Clarkmont. Laying electric conductors.

22,443 Wilson. Apparatus for winding inductive and non-inductive coils.

22,551 Raworth. Electric motors and controlling devices for electric vehicles.

22,694 Allen. Apparatus for indicating stoppage of reduction of speed or utility of distant machines.
24,305 Lodge. Production of continuous high potential electrical discharges applicable for deposition of dust, fume, smoke, fog and mist, for the production of rain and for other purposes.
24,469 James Hinks & Son and Wright. Suspending chain for electric lamps and the like.
24,472 Ruhstrat and Grimmer. Electric furnaces.
24,796 B.T.-H. Co. (G.E. Co., U.S.). Motor controllers and emergency brakes.
25,006 Lewis and Daimler Motor Co. Electric ignition apparatus for internal combustion motors.
25,667 Lake (Theaton Electric Envelope Sealer Co.). Envelope sealing machines.
25,887 Scott. Controllers for regulating speed of electric motors.
26,267 Atkinson. Electric measuring and recording devices.
26,268 Atkinson. Electrolytic meters.
26,456 B.T.-H. Co. (G.E. Co., U.S.). Insulated conductors.
26,457 B.T.-H. Co. (G.E. Co., U.S.). Insulated coils for electrical apparatus and process of making same.
26,460 B.T.-H. Co. (G.E. Co., U.S.). Rheostats.
26,462 B.T.-H. Co. (G.E.C. Co., U.S.). Arc lamps.
26,577 Firzi. Field magnets for dynamo electric machines.
27,189 Deutsch. Controlling the voltage from an electric generator.
27,283 Biermann. Counters for electric current meters and the like.

1904.

1,374 Lang. Regulating electric motors.
6,110 Foster, Grote & Ely. Arc lamps.
6,411 Cooper. Brush-holders for electric motors or generators.
7,249 Lee. Electrical fuse boxes, junction boxes, and the like.
8,745 Binns. Trolley, pulleys for electric tram cars.
12,541 Moscicki. Production of chemical reactions in gases and vapours by electric discharges. (Date applied for, June 3, 1903.)
12,766 Sazérat. Gripping or holding and cutting submarine cables.
12,379 Irving. Adjustable support for electric light fittings.
13,170 Hulsmeyer. Hertzian-wave apparatus to indicate presence of metallic body in the line of projection of such waves.
13,216 Aitken. Telephone exchange systems.
13,433 Hocking. Cleaning out accumulators.
14,059 Potthoff. Electro-galvanising.
15,060 Botzano. Conductor and collector devices.
16,395 Hunter. Combined switch and lampholder.
16,578 Wolters. Morse telegraph-transmitters.
17,051 Stebbins and Wood. Tumbler switches.
17,181 Teston. Electrically lighting and extinguishing gas.
17,364 Bousfield and Ozonised Oxygen Co. Preventing the breaking of an electric circuit containing arc gaps or the like.
18,141 Robinson. Electric block systems for railways. (Date applied for, Aug. 22, 1903.)
18,654 Renk. Sparking plugs for internal combustion engines.

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension, Australasia & China Telegraph Co. (Ltd.)

The sixty-second half-yearly meeting of this Company was held on Wednesday. Sir John Wolfe Barry presiding.

The GENERAL MANAGER AND SECRETARY (Mr. F. E. Hesse) read the notice convening the meeting and the auditors' report, together with the minutes of the sixty-first half-yearly meeting, which were duly confirmed.

The CHAIRMAN said: Gentlemen, the report and accounts before the meeting to-day are, I am happy to say, more encouraging than those submitted six months ago, when we were suffering from considerably reduced revenue and increased expenditure. The gross revenue for the half year under review amounted in round figures to £300,000, against £265,000 for the corresponding period of 1903, showing an increase of £35,000. (Applause.) This comparison may be, however, somewhat misleading because the receipts for the past half-year include interest on investments amounting to £13,125, which, in the corresponding period of 1903 was credited to the reserve fund; consequently, to arrive at a proper comparison of other revenue between the two periods, the amount of interest should be deducted from the £35,000, thus reducing the increase for the half-year to, roundly, £22,000. This satisfactory increase is not entirely due to increased traffic, a portion of it having been obtained from contract work; but I am glad to be able to tell you that a distinct growth of telegraphic business is observable all over the Company's system, particularly in the local traffic, which is a very encouraging sign. (Hear, hear.) The working and other expenses amounted to, in round numbers, £141,000, against £138,000 for the corresponding period of 1903, showing an increase of £3,000, which is mainly accounted for by our having had to increase the staff in China and elsewhere to meet traffic requirements. The net profit for the half year is £143,378, and, after adding to it the credit balance of £41,890 brought forward from the previous half-year, there remains an available balance of £185,269. The usual quarterly interim dividend of 2s. 6d. per share has been paid for the past half year, and the balance of £110,269 carried forward to the current half-year. As will be seen from the accounts the general reserve fund has been debited with £6,273, the cost of a further partial renewal of the Hong Kong-Foochow cable, and credited with £2,679, representing the value of picked up cable from the partial renewal of the Singapore-Batavia section. When I last had the pleasure of addressing you I mentioned that your Directors were considering the advisability of re-arranging the Company's maintenance facilities, and that the s.s. "Restorer" might not be sent back to her former station at Adelaide. Circumstances have since arisen which have enabled us to sell the "Restorer" to the Commercial Pacific Cable Co. to replace the "Scotia" lost off Guam a few months ago. We have purchased and sent out to Singapore a small steamer named the "Magnet" for effecting repairs to the many cables which the Company possess in shallow waters of less than 400 fathoms. By these means it is expected that a considerable economy will be effected in the maintenance ships' expenses.

The subsidy arrangement made with the French Government many years ago for establishing and maintaining cable communication between Saigon and Tonquin having expired last February, negotiations were entered into for a new arrangement, with the result that an agreement was arrived at, subject to Parliamentary approval, by which the French Government will acquire the ownership of the Tonquin cable. The agreement is expected to come before the Chamber of Deputies for ratification very shortly.

The much talked-of conference that was expected to have been held long ere this to consider, among other questions, the effect upon the Pacific Cable Co. of the agreement entered into with us by the Government of New South Wales and others has again been postponed. Meantime the ratification of the agreement between the Federal Government and the Company is in abeyance, but the arrangement by which the Company is allowed to have direct dealings with the public in Melbourne remains undisturbed. The competition, however, between the two rival routes is being carried on as actively as ever, but so far we have succeeded in maintaining our position, notwithstanding the unfair treatment accorded to us by the Governments interested, and to which I have on former occasions fully alluded. Results of the traffic of Australia show each year more completely that no commercial necessity existed for the Pacific Cable, which involves a loss to the various Governments of between £90,000 and £100,000 a year and a serious loss to this Company by the abstraction of traffic under the influence of the various Governments.

Mr. R. L. O'BEIRNE asked if a good price had been obtained for the ship "Restorer," or had there been a loss on the sale?

The CHAIRMAN: No, we have lost nothing over the sale. A fair price was agreed to between the two companies, and that price was really ratified by Sir William White, the distinguished naval architect.

There being no further questions, the CHAIRMAN moved the adoption of the report and accounts, which was seconded by the Marquis of TWEEDDALE and carried unanimously.

Mr. JOHN NEWTON moved a vote of thanks to the Chairman and Directors, which was seconded by Mr. R. WOOD, and carried unanimously.

The CHAIRMAN, having replied, the proceedings terminated.

INDUSTRIAL STORAGE BATTERY SYND. (LTD.)—An extraordinary meeting was held on Monday, when the resolution recently passed altering the articles of association to enable the company to subdivide its shares into shares of a smaller amount was carried. The chairman (Mr. C. Temperley) stated that experiments made with the battery had been satisfactory, and several orders were on hand.

TYPEWRITING TELEGRAPH CORPN. (LTD.)—At the meeting on Monday the chairman (Mr. A. J. Parker) said there was a loss of £2,134 on the past year's working. The directors had not sold any of the foreign patents, nor had they been successful in securing any large orders. They had been successful in inducing the War Office authorities to see the instruments at work, and the War Office had bought two sets, which were now being tested at Chatham. Russia had some of the instruments in the Far East, and the directors believed they would secure a considerable order from St. Petersburg. The prospects of success with the military authorities were distinctly good, and the present machine was not likely to be endangered. In the field of the Post Office the position was not quite so promising with the old instrument, but with the new standard teletyper the directors believed they would have the best instrument. They wanted time to realise the assets, exploit the new instrument and carry on operations for a couple of years. If success did not come within that time there would be nothing left but to liquidate. The idea of a forced sale or reconstruction must be dismissed. He suggested raising £3,000 in 10 per cent. debentures issued at 85, or by preference shares, and this suggestion was adopted.

WESTERN UNION TELEGRAPH CO.—The report of the president for the year ended June 30 states that the amount of capital stock is unchanged—viz., $97,370,000, of which $29,394 is in the company's treasury. The bonded debt is $25,594,000, including $1,000,000 funding and real estate mortgage bonds issued during the year. The revenue was $29,249,390.41 ($81,703.64 increase over preceding 12 months) and the expenditure $21,361,915.46 (increase $198,700.39). Interest on bonds absorbed $1,157,708 (increase $90,004), leaving net profit $6,729,774.98 (decrease $106,926.75) of which $4,868,071.25 was appropriated for dividends, leaving $1,861,703.73 surplus (compared with $2,268,721.73 from previous year) making the total surplus $14,881,428.28. 199,350 miles of poles and cables were erected (compared with 196,517 in previous year) and 1,155,405 miles of wires (against 1,089,212) and messages transmitted, not including messages over leased wires or under railroad contracts, numbered 67,903,973 (against 69,790,866), the average toll per message was 31.7 cent (against 31.4 cent) and the average cost per message 26.1 cent (against 25.6 cent). The substitution of dynamo current for chemical cell main batteries has been continued, and, where power could not be obtained to operate dynamos, storage batteries have been employed. These changes were effected at 15 important battery centres during the year. The new method of generating current is found more efficient than the old, and so much cheaper as to save during the first year nearly the entire cost of making the changes.

NEW COMPANIES.

BRITISH ELECTRIC EQUIPMENT CO. (LTD.) (82,542.)—Reg. Nov 11, capital, £40,000 in £1 shares, to adopt an agreement with H. G. Nicholson, relating to the acquisition by the company of the business of the British Electric Equipment Co., to build, construct, purchase, lease or otherwise acquire railways, electrical and other tramways, telegraphs, telephones and other public works in England or elsewhere, and to carry on the business of engineers, electricians, suppliers of electricity, rolling stock manufacturers, makers of cables, wires, accumulators and lamps, &c. The subscribers are V. R. Nicholson, engineer, H. G. Nicholson, electrical engineer, T. Hawkins, engineer, L. H. Rosenheim, W. E. Sammes, J. R. C. Smith and T. H. Holt. First directors, H. G. Nicholson and V. R. Nicholson. Reg. office, 11, Queen Victoria-street, London, E.C.

ELECTRIC POWER DEVELOPMENT CO. (LTD.) (82,504).—Reg. Nov. 8, capital £25,000 in £100 shares, to carry on the business of suppliers of electrical power, proprietors of electric light, telephonic, telegraphic and other works, generators, storers and transmitters of electricity, electrical and mechanical engineers, manufacturers of rolling stock, &c. The subscribers are F. Priestman, J. H. Armstrong, B. Price, engineer, A. H. Finch, engineer, J. H. B. Noble, G. B. Richardson and Lord Armstrong. Reg. office, 57½, Old Broad-street, London, E.C.

HASTINGS & DISTRICT ELECTRIC TRAMWAYS CO. (LTD.) (82,521). Reg. Nov. 9, capital £500,000 in £5 shares (50,000 preference), to adopt agreements with M. S. Myers and C. Mendel, the Hastings Tramways Co., and with Dick, Kerr & Co., to construct, purchase, lease or otherwise acquire light or other railways and tramways in Hastings and Bexhill or elsewhere, to obtain orders or Acts of Parliament in connection with same, and to carry on the business of tramway and railway proprietors and workers, electricians, mechanical engineers, contractors for public and other works, &c. The subscribers are E. C. Morgan, C. Kitchin, J. Williamson, C. Mendel and M. S. Myers (100 shares each), F. Goetz and H. Strauss (20 shares each).

CITY NOTES.

MEMORANDA (Nov. 17).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 26⅝d. per oz. Consols 87⅞—88 for money, 87⅞—88⅛ for account; 2½ per cent. annuities 87½—87¾. Consols Pay Day, Dec. 1; Stocks and Shares Continuation Days, Nov. 28 and Dec. 13; Ticket Days, Nov. 29 and Dec. 14; Pay Days, Nov. 30 and Dec. 15; Mining Share Carry-over Days, Nov. 25 and Dec. 12.

ALLGEMEINE ELECTRICITATS GESELLSCHAFT (BERLIN).—At the general meeting on 8th prox. a dividend of 9 per cent. will be recommended for the past year, against 8 per cent. for 1903.

BURY, ROCHDALE & OLDHAM TRAMWAY CO.—At a special meeting last week the resolution recently passed to authorise the voluntary winding up of the company was confirmed, and Messrs. J. Coomer and S. Johnson were appointed liquidators.

CENTRAL ELECTRIC SUPPLY CO. (LTD.)—The 4 per cent. guaranteed debenture stock transfer books will be closed from 17th to 30th inst. inclusive, preparatory to payment of interest due Dec. 1.

HASTINGS & DISTRICT ELECTRIC TRAMWAYS CO. (LTD.)—Subscriptions are invited to an issue at par of £125,000 in 4½ per cent. debenture stock (part of a total authorised issue of £250,000) and 25,000 6 per cent. cumulative preference shares of £5 each. This company (which has an authorised capital of £500,000, equally divided into £250,000 6 per cent. cumulative preference and £250,000 in ordinary shares of £5 each) has been formed to carry into effect the construction and equipment of a service of electric tramways within the borough of Hastings, including St. Leonards-on-Sea, with a line from the latter place to Bexhill, a total route mileage of nearly 19¼ miles. An abridged prospectus of this issue will be found set out on another page, but it may be said here that the company has power to construct a line of tramways along the front at Hastings and St. Leonards for its whole length from Robertson-street to West Marina, and Messrs. Kincaid, Waller, Manville & Dawson have reported favourably upon the scheme. A contract has been entered into on favourable terms with Messrs. Dick, Kerr & Co. to construct and equip the lines. The list of subscriptions closes on or before 4 p.m. on Monday next, Nov. 21. Copies of the complete prospectus can be obtained at the offices of the company, 1, Queen Victoria-street, E.C., or from the brokers, Messrs. Mendel & Myers, 27B, Throgmorton-street, E.C., London, or at any of the branches of the Capital and Counties Bank.

NERNST ELECTRIC LIGHT (LTD. AND REDUCED).—A petition for confirming the resolution reducing the capital of this company from £320,000 to £90,000 will be heard by Mr. Justice Swinfen Eady on 29th inst.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to appoint a special settling day in and grant a quotation to £60,000 4½ per cent. debenture stock of the *Telephone Company of Egypt (Ltd.)* and to allow 7,500,000 4½ per cent. bonds of the *Montreal Light, Heat & Power Co.*

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The directors recommend a dividend of 7s. per share on account of arrears of dividend on first preference shares.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Nov. 12	1,150	+ 66	24	86,316	+ 5,718
Airdrie	„ 4	214	...	39	7,840	...
Ayr Corporation	„ 12	165	+ 4	26	9,015	+ 490
Barnsley	„ 4	159	− 13	44	7,491	− 234
Barrow	„ 4	196	...	38	7,754	...
Bath Electric Trams, Ltd.	„ 9	558	...	45	29,105	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	„ 13	977	− 28	...	...	...
Birmingham Corporation	„ 14	331	...	44	18,252	...
Birmingham Tramways Co.	„ 12	5,554	+ 303	19	103,717	+ 4,797
Blackburn Corporation	„ 11	926	+ 76	23	31,954	+ 3,178
Blackpool Corporation	„ 10	737	+ 89	32	41,467	+ 5,540
Blackpool and Fleetwood	„ 12	185	− 37	19	10,059	+ 372
Blackp'l, St. Anne's & Lytham	„ 10	155	− 15	†11	196	—
Bolton Corporation	...	...	...	...	...	...
Bournemouth Corporation	„ 9	827	+ 31	‡32	87,416	+ 2,012
Bradford Corporation	„ 12	8,864	+ 219	31	151,548	+ 25,939
Brighton Corporation	„ 13	857	+ 16	32	85,182	+ 3,276
Brisbane Tramways	...	...	...	...	...	...
Bristol Trams & Carriage	„ 11	4,084	[illegible] 86	14	181,486	+ 1,112
Buenos Ayres & Belgrano	...	...	...	...	...	...
Burnley Corporation	„ 13	955	+ 177	6	6,821	+ 1,221
Burton Corporation	„ 13	316	− 13	*3½	11,734	...
Calcutta Tramways Co.	„ 12	a37,8[illegible]3	+ a2,775	20	a7[illegible],154	+ a75,199
Camborne-Redruth	„ 14	127	+ 11	9	243	− 53
Cardiff Corporation	„ 13	1,802	+ 37	32	67,160	+ 1,664
Carlisle Tramways Co	„ 12	112	+ 8	45	9,013	+ 706
Central London Railway	„ 12	7,002	+ 6	19	117,861	− 279
Chatham & Dist. Lt. Rys.	„ 10	546	+ 19	45	26,727	+ 1,206
City & South London Rly.	„ 13	2,841	− 53	20	49,818	− 1,547
Colchester Corporation	„ 10	129	...	15	4,436	...
Cork Electric Trams Co.	„ 10	445	− 12	45	21,317	− 2,222
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	„ 4	496	− 44	44	29,751	+ 3,8[illegible]3
Dover Corporation	„ 13	151	+ 16	23	7,510	− 166
Dublin & Lucan Railway	„ 11	96	− 9	19	2,561	− 17
Dublin Southern District	„ 11	735	+ 19	19	100,871	− 3,023
Dublin United	„ 11	3,750	+ 24			
Dudley—Stourbridge	„ 4	751	+ 17	44	36,725	+ 1,426
Dundee Corporation	„ 9	816	+ 27	...	...	...
East Ham Council	„ 12	618	+ 5	31	24,163	+ 1,496
Gateshead & Dist. Trams	„ 4	595	− 55	44	4,190	+ 1,244
Glasgow Corporation	„ 12	14,[illegible]4	+ 290	*24	341,810	+ 19,191
Glossop	...	...	...	...	...	...
Gravesend – Northfleet	„ 4	209	− 33	44	11,3[illegible]	+ 612
Gt. Northern & City Rly.	„ 12	1,768	...	39	89,10[illegible]	...
Greenock & Port Glasgow	„ 4	5[illegible]3	+ 17	44	25,686	+ 1,298
*Halifax Corporation	...			...		...
Hartlepool Tramways	„ 4	261	...	44	13,149	+ 1,050
Huddersfield	„ 13	1,210	+ 67	32	45,114	+ 2,907
Hull Corporation	„ 12	2,151	+ 256	32	71,419	+ 9,411
Ilford District Council	„ 13	370	+ 27	*32	15,603	+ 657
Ilkeston Corporation	„ 9	121	+ 15	6	790	− 10
Ipswich Corporation	„ 14	573	...	31	16,739	...
Isle of Thanet Co.	„ 12	3[illegible]1	+ 29	6	2,248	− 113
Keighley Corporation	„ 6	[illegible]15		4	515	—
Kidderminster & District	„ 4	99	− 5	44	5,780	+ 18
Kirkcaldy Corporation	„ 16	204	− 81	45	10,906	...
Lanarkshire Trams Co.	„ 10	6[illegible]9	+ 100	45	29,588	+ 10,614
Leeds Corporation	„ 13	5,402	+ 256	32	194,676	+ 11,771
Leicester Corporation	...	...	...	...	...	...
Liverpool Corporation	„ 8	14,163	+ 248	45	467,418	+ 13,241
Liverpool Overhead Rly.	„ 13	1,409	− 227	†20	81,[illegible]2	− 1,612
London County Council	„ 5	12,902	+ 2,902	§31	404,744	+ 65,152
*Lowestoft	...	...			...	...
Maidstone Corporation	„ 10	118	...	17	2,814	...
Manchester Corporation	„ 12	11,788	+ 478	32	40[illegible],193	+ 17,215
Mersey Railway	„ 12	1,450	+ 138	19	27,772	+ 2,253
Merthyr	„ 4	126	− 16	44	5,913	+ 10
Metropolitan Elec. Trams	„ 11	1,751	+ 622	19	34,391	+ 9,441
Middleton	„ 4	276	+ [illegible]	44	14,696	+ 225
Nelson Corporation	„ 13	114	+ 37	38	3,965	+ 1,210
Newcastle-on-Tyne Corp.	„ 14	3,516	+ 2	19	60,757	+ 3,710
Newport (Mon.)	„ 12	545	+ 97	6	2,981	+ 303
Oldham, Ashton & Hyde	„ 4	5[illegible]4	− 13	44	24,159	− 1,017
Oldham Corporation	...		...		...	...
Perth (W. A.) Elec. Trams	„ 11	1,279	− 23	45	58,455	+ 6,198
Peterborough	„ 4	119	—	36	6,780	− 166
Poole and District	„ 4	359	− 6	44	13,729	− 42
Portsmouth Corporation	„ 14	1,594	+ 159	§32	67,719	+ 5,534
Potteries	„ 4	1,901	+ 109	4	75,516	+ 6,135
Reading Corporation	„ 10	631	+ 103	6	3,523	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	„ 4	58	− 12	44	6,718	+ 8
Salford Corporation	„ 14	3,900	+ 133	32	85,467	+ 8,148
Sheerness	„ 4	75	− 8	‡44	2,164	− 497
Sheffield Corporation	„ 13	4,574	− 123	31	126,153	+ 3,012
Southampton Corporation	„ 10	829	− 7	32	32,811	− 2,160
Southend Corporation	„ 9	235	+ 15	33	17,198	+ 1,353
Southport Tramways	„ 4	200	+ 10	44	14,654	+ 150
S. Staffordshire Trams.	„ 4	549	− 26	44	24,034	+ 6,154
Stockport Corporation	„ 11	456	+ 132	32	‡19,286	+ 7,[illegible]98
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	„ 4	494	− 7	44	26,164	+ 1,011
Taunton Trams	„ 4	[illegible]	− 21	44	2,409	+ 272
Tynemouth and District	„ 4	[illegible]	− 45	44	18,361	− 189
Tyneside Trams Co.	„ 9	[illegible]	+ 41	45	17,725	+ 2,940
Wallasey District Council	„ 12	[illegible]	+ 62	§32	15,[illegible]40	+ 1,490
Walsall	„ 13	471	...	43	21,844	...
Warrington Corporation	„ 10	521	+ 22	32	10,455	+ 249
West Ham Corporation	„ 10	1,047	...	37	35,819	...
Weston-super-Mare	„ 5	[illegible]	− 8	44	6,041	+ 506
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	„ 4	3[illegible]3	− 4	44	17,807	− 74
Worcester	„ 4	274	+ 150	30	12,100	+ 6,198
Wrexham	„ 4	88	− 24	44	4,[illegible]8	− 386
Yorkshire Woollen District	„ 4	412	− 55	44	25,0[illegible]	+ 9,674

(a) These comparisons are with the corresponding period last year.

Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

* Fortnight.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., Nov. 16.	Rate per Cent. Yield.	Dividend Due.	Business, Week to Nov. 16.	
				£ s. d.		Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	3/0	Anglo-Argentine Ordinary Shares	6¾—7¼	4 4 0	April, Oct	7⅛	6¾
5	2/6	Do. 5% Cum. Pref.	5¼—5¾	4 10 11	—	5¾	5⅝
St.	6%	Do. Permanent 6% Deb. Stock	141 —144	4 4 6	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	103½—106½	4 16 0	—	106½	106½
10	6%	Barcelona Tramways Ord.	9 —10	6 0 0	—	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 0	—	..	..
100	5%	Do. 5 per Cent. Debs.	98 —101	4 19 0	—	..	..
1	..	Bath Elec. Trams Pref. Ord.	½—¾	..	..	..	..
1	..	Do. 5% Cum. Pref.	1¼—1⅜	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1¾—2¼	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 8	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	98 —100	4 11 0	..	98½	98½
10	8%	Bristol Tramways and Carriage Ord.	19 —20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 16 3	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107 —109	3 13 4	Feb, Aug	..	..
St.	6%	†British Columbia Elec. Rlwy. Def. Ord.	100 —108	5 16 6	—	..	..
St.	5%	Do. Pref. Ord. Stock	103 —105	4 15 3	—	104½	101½
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10¾	4 13 0	..	..	..
46	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102%—104%	4 6 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	97 —100	4 10 0	..	99½	99½
10	6/0	British Electric Traction Ord.	9¾—10¼	5 17 2	..	10	9¾
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —11½	5 6 8	Feb, Aug	11⅞	11⅝
St.	5/0	Do. 5 per Cent. Perpetual Debs	117 —119	4 4 3	—	118½	118
St.	4½	Do. 4½ per Cent. 2nd Deb. Stock	95 —97	4 12 10	..	96½	96
5	1/6	Buenos Ayres and Belgrano Ord.	3¾—4	5 13 6	—	4⅛	3¾
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	6¼—6¾	5 4 4	—	..	..
5	3/0	Do. "B"	5¼—5¾	5 11 6	—	..	..
St.	5%	Do. 5 per Cent. Debs.	106 —108	4 12 8	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	102 —105	4 16 3	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. 5 Deb. Stk.	96 —99	5 2 6	..	..	..
5	3 0	Calcutta Tramways	7¾—7¾	3 15 6	—	7¾	7⅝
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —108	4 4 0	—	..	..
1	1/0	Cape Electric Tram Shares	1⅛—1¼	5 14 3	..	..	..
St.	4%	Central London Ordinary Stock	93 —96	4 4 2	June, Dec	94	93½
St.	4%	Do. 4 per Cent. Pref. Stock	101 —103	3 17 9	..	..	..
St.	4%	Do. Deferred Stock	84 —86	4 13 6	..	85	83½
100	4%	Do. 4 per Cent. Debs.	108 —110	3 13 4	..	..	..
5	2/6	City of Birmingham Trams 5% Cm. Prf.	4¾—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 3	..	..	..
St.	7½%	City and South London Rly. Con. Ord.	46 —47	4 15 3	Feb, Aug	47	46
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 3	Feb, Aug	..	..
St.	5%	Do. (1896)	117 —120	4 3 6	..	..	..
St.	5%	Do. (1901)	114 —117	4 5 0	..	116½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106 —107	3 14 9	May, Nov	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	101 —104	4 16 3	—	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13 —14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	—	..	..
10	3 0¾	Gt. Northern & City Rly. Prf. Ord. (4%)	5¾—6¾	..	—	6¼	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19 —20	5 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	110 —112	4 0 0	Jan, July	..	..
5	2/0	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4½	5 17 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 7 2	—	90½	..
10	1½%	Liverpool Overhead Railway Ord	7¾—8¼	3 15 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10¼—10¾	4 12 0	..	10½	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 —106	3 16 9	..	105	..
St.	..	Madras Elec. Trams 5% Deb. Stk.	103 —106	..	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10 —13	..	..	..	..
1	..	Metropolitan Electric Trams Def	½—¾	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	—	..	..
St.	13/7	Do. 4½ Deb. Stock	103 —106	..	—	104	103½
100	5%	Montreal St. Ry. St'g 5% Mrt. Dbs. (1908)	100 —103	4 17 3	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 —105	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	¾—1¼	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	103 —106	4 16 9	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock	99 —102	4 8 3	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	—
St.	5%	Waterloo and City Ord.	88 —90	5 7 0	June, Dec	89	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	½—¾	5 14 2	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	¼—⅜	..	..	½	..
5	4/0	British Insulated & Helsby Cables Ord.	5½—6	6 13 4	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5½—6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —104	4 6 7	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	100 —102	4 8 6	..	..	..
5	3/0	British Westinghouse 6% Pref.	3½—3¾	5 5 0	—	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	89 —91	4 8 0	..	..	..
1	..	Brush Electrical Engineering	½—¾	..	March	..	..
2	2/6	Do. 6 per Cent. Pref. Non-Cum.	1 —1½	9 12 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	93 —96	4 14 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	69 —75	6 0 8	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	9½—10	5 5 0	Jan, July	10	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5¼	4 10 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —106	4 6 7	Nov, May	105	104½
1	9¼d.	Castner-Kellner Alkali Co. (fully paid)	1½—1¾	4 18 9	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	95 —98	4 13 4	..	95½	94½
1	0/9½	Chadburn's (Ship) Telegraph Ord.	¾—1¼	5 17 6	..	..	..
2	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—1¾	4 5 3	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	90 —95	5 6 5	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	6¾—7½	6 18 0	Sept	7⅛	..
5	3/0	Do. 6% Cum. Pref.	5¼—5¾	5 9 1	Sept	5⅝	5½
St.	4½%	Do. 4½% Deb. Stock	104 —106	4 5 9	..	..	..
5	..	Edison & Swan United ("A" sh.) (£3 pd.)	½—¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	78 —83	4 17 9	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	78 —84	6 0 6	..	..	—
5	4/6	Edmundson's Elec. Corp. Ord.	6½—6¾	6 9 9	H'lf-yearly	6⅝	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5½—6¼	4 18 0	—	6⅛	6⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106 —108	4 4 3	..	..	..
2	1/7½	Electric Construction Co.	1½—1¾	6 8 0	July	..	..
2	2/9¾	Do. 7 per Cent. Cum. Pref.	2¼—2½	5 18 9	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98 —100	4 0 0	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —96	5 5 3	—	..	—
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10	5 0 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91 —96	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½—11¼	6 4 4	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5¼—5½	4 3 9	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	109 —111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	20 —22½	4 17 0	Feb, Aug	20⅛	..
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 6	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11½	4 5 10	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	37 —38	6 3 1	Mar, July	38½	38¼
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	102 —104	3 17 6	Jan, July	..	..
5	..	Willans and Robinson Ord.	1 —2	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2 —3	..	Apr, Oct	..	..
[illegible]	4%	Do. 4 per Cent. 1st Mort. Debs	74 —79	5 3 11	May Nov	..	..
		ELECTRICITY SUPPLY.					
..	..	Blackheath & Greenwich Dist. El. Lt. See South Metropolitan Elec. Lt. & Power Co. below	..	..	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11½—12½	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10	4 10 0	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104 —106	4 5 9	—	..	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	4¾—5¼	3 9 7	..	..	..
St.	4½%	Do. Do. 1st Debs	100 —103	4 7 5	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..	10⅞	..
5	3/6	Do. 7 per Cent. Pref.	10¼—10¾	3 5 1	Mar, Sept	..	..
5	3/0	†Calcutta Electric Supply Ord.	7½—8	4 7 6	..	7¾	7½
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 —109	3 14 6	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8½—9	4 8 9	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5¾—6¼	3 18 3	Feb, Aug	6½	6¼
St.	4%	Do. 4% Deb. Stock (red.)	103 —106	3 17 5	..	..	..
5	2/6	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	—	..	..
5	2/3	Do. Do. (1903)	4½—5	..	..	..	..
5	2/3	Chelsea Electric Supply Ord.	6¼—6¾	4 5 2	March	6¼	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109 —111	4 1 0	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	10½—11	4 10 11	Feb, Aug	10¾	10½
10	6/0	Do. 6 per Cent. Cum. Pref.	13½—14	4 5 9	Jan, July	13¾	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 —127	4 0 0	Jn, Dec	124	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	104 —106	4 5 9	..	104½	..
10	4/0	County of London Elec. Supply Ord.	9½—9¾	4 2 1	..	9⅝	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —12½	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106 —109	4 5 9	..	108½	107½
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 —103	4 7 5	..	..	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 —93	5 7 6	..	..	..
5	2 0	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 —104	4 7 0	—	..	—
10	..	Havana Electricity Co. Shares	9½—10½	..	—	..	—
5	2 6	Hove Electric Lighting Ord.	7½—8	3 6 3	..	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 —101	4 9 1	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅛—¼	..	—	..	—
5	5/0	Kensingtn & Knghtsbdge Ord.	12 —13	4 12 4	..	12¾	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —104	3 17 3	—	102½	..
2	..	London Electric Supply Ord.	2 —2½	..	..	2¼	..
5	3/0	Do. 6 per Cent. Pref.	5½—5¾	5 2 1	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	97 —99	4 2 0	Mr, Jn, S, D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	16 —16½	5 9 0	April, Oct	16⅜	16¼
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼—5½	4 1 10	Jan, July	5⅜	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	112 —117	3 18 0	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	87 —90	3 10 6	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	93 —96	4 13 9	..	..	—
10	6/0	Notting Hill Electric Ord.	14½—15	4 0 0	March	14½	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	101 —103	3 18 2	..	..	..
5	2/0	Oxford Electric Ord.	6 —6½	3 4 0	March	..	..
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 0	..	..	..
1	..	Rand Electric	1⅛—1¼	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mt. Deb	100 —102	4 8 9	April, Oct	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	14¼—14¾	4 13 4	Feb, Aug	14½	14⅜
5	3/6	Do. 7 per Cent. Pref.	8½—9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	99 —101	3 10 3	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2½—3½	6 3 1	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83 —87	4 12 0	..	..	..
5	3/0	South London Electric Supply Ord.	4½—4¾	3 6 3	—	4½	4⅜
1	..	South Metrop'n Elec. Lt. & Power Ord.	¾—1	..	—	..	..
1	0/8¾	Do. 7% Cum. Pref.	1⅛—1¼	4 16 9	—	1¼	..
St.	4½	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. Accm.)	107 —110	4 2 3	—	109½	108½
5	2/6	Urban Electric Supply Ord.	4½—5	5 0 0	..	5	4⅞
5	2/6	Do. 5% Cum. Pref.	4¾—5⅛	4 18 9	..	5⅛	4¾
St.	..	Do. 4½% 1st Mort. Deb.	103 —106	..	..	106	104
5	6/6	Westminster Electric Supply Ord.	12½—13½	5 2 0	Mar, Sept	13⅛	13
5	3/6	Do. 5 per Cent. Cum. Pref.	6½—7	5 11 6	—	..	—
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	99 —102	3 19 0	Jan, July	..	..
10	..	Amazon Telegraph	2½—3	..	Jn, Dec	..	..
St.	12/6	Anglo-American	53 —56	4 19 10	F, My, Ag, N	55	53½
St.	25/0	Do. Preferred	103 —105	5 4 9	F, My, Ag, N	104½	102½
St.	2/0	Do. Deferred	12½—12¾	0 16 2	F, My, Ag, N	[illegible]	[illegible]
100	$2	Commercial Cable Capital Stock	170 —190	4 4 2	Jn, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93 —96	4 3 6	Jn, Ap, Jy, O	95	..
10	5/0	Cuba Submarine Ord.	7½—7¾	7 15 0	Feb, Aug	7½	7⅜
10	10/0	Do. Preference 10 per Cent.	14½—15½	6 9 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	2½—2¾	5 16 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7¼—7¾	6 9 1	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	99%—101%	4 9 2	Jan, July	..	..
20	8/0	Direct United States Cable	10½—10¾	6 10 0	Ja, Ap, Jy, O	10¾	10½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 —102	4 9 6	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	133 —136	5 2 10	Ja, Ap, Jy, O	136	133½
St.	17/6	Do. 3½ per Cent. Pref. Stock	88 —90	3 18 0	Ja, Ap, Jy, O	89½	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —107	3 14 9	May, Nov	106½	105
10	2/6	Eastern Extension	12½—13½	5 6 8	Ja, Ap, Jy, O	13	12½
St.	4%	Do. 4 per Cent. Deb. Stock	106 —108	3 14 3	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1900	101 —103	3 18 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 5	May, Nov	..	..
10	5/0	Gt. Nrthn. (of Copenhagen)	22½—23½	5 4 4	Jan, July	..	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100 —103	4 9 6	June, Dec	..	..
25	12/6	Indo-European	44½—46½	5 7 6	May, Nov	44½	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	98 —100	4 0 0	June, Dec	..	—
10	6/0	West African Telegraph Shares	7 —7½	5 6 8	..	..	..
2½	..	West Coast of America	½—¾	..	..	..	..
100	4%	Do. 4 per Cent. Debs	98 —100	4 0 0	Jan, July	..	..
10	..	West India and Panama	¾—1	..	May, Nov	¾	..
10	6/0	Do. 6 per Cent 1st Pref.	7½—7¾	8 3 0	May, Nov	7½	..
10	..	Do. 6 per Cent. 2nd Pref.	6½—6¾	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	103 —104	4 17 6	Jan, July	103½	..
10	5/0	Western Telegraph xd & bonus	13½—13¾	5 4 8	Mr, Jn, O, D	13½	13
100	5%	* Do. 5% Debs. (2nd Series, 1903)	101½—104½	4 18 6	June, Dec	..	—
St.	4	Do. 4% Deb. Stock (red.)	101½—102½	3 18 6	—	..	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid)	5¾—6¼	6 19 3	August	5⅝	5½
1	0/7½	Monte Video Telephone Ord.	¾—1¼	..	..	..	..
St.	6%	National Co. Pref. Stock	106½—107½	5 11 7	..	107½	107
St.	5%	Do. Def. Stock	96½—97½	5 2 6	..	97½	96½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 8	Feb, Aug	14	14
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12 —13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5¼—5¾	4 13 0	Feb, Aug	5¾	5½
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97½—98½	3 12 3	June, Dec	98½	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104½—105½	3 17 2	..	105½	104½
..	5/9	Do. Do. Prov. Certs. 35% tobepd.	67½—68½	..	..	..	..
1	0/7½	Oriental	1⅛—1⅜	6 6 8	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼—1⅜	4 15 0	..	1¼	1¼
5	6/0	United River Plate	6¼—6¾	6 5 6	July	6½	6⅜
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—6¼	4 10 5	June, Dec	5⅜	5¼
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104 —106	4 14 4	June, Dec	..	—
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	—	..	..
10	2/0	Globe Telegraph and Trust	9½—10	5 10 0	Ja, Ap, Jy, O	10	9¾
10	3/0	Do. 6 per Cent. Pref.	13½—14	4 5 9	Ja, Ap, Jy, O	13¾	..
100	6%	Submarine Cables Trust (Cert.)	115 —120	5 0 9	April, Oct	..	—
..	36/7	Underground Elec. Rys. Co. of London 5% Profit Sharing Secured Notes	90 —92½	..	..	..	..

calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

IN spite of the warning issued a fortnight ago that no new tube railway schemes for London would be considered by Parliament until the Royal Commission on London Traffic had reported, we are pleased to see that a number of such schemes has been deposited. If the warning referred to above was intended to be taken seriously, then it would appear that the promoters have only put forward their schemes in the hope that the report of the Royal Commission will be made before the Committee stage in Parliament is reached next spring. Details of the schemes proposed will be found elsewhere in this issue, but it may be said here that they include most of those put forward in 1902, when Committees of the House of Lords presided over by Lord WINDSOR and Lord RIBBLESDALE spent nearly three months in considering some 16 Bills, the net result of which, eventually, was the authorisation of a few miles of extensions to existing lines. The primary cause of this unsatisfactory result was the marked success in Committee of the Bill for a line from Hammersmith to the North-East of London via the Strand and City, which, however, after causing the rejection of its numerous competitors, was abandoned by its promoters in consequence of internal disagreements. We once more express the hope that Parliament will allow these schemes to go forward independently of the report of the Royal Commission.

◆

THE Parliamentary Committees to which the Powers Bills are relegated will have an interesting batch of schemes to consider even if only one half of the proposals put forward in the Parliamentary notices are proceeded with. The most ambitious scheme of all is that which is brought forward by a company styling itself the Administrative County of London and District Electric Power Co. This company has scheduled an oblong area, embracing the whole of London and extending far beyond: from Hounslow in the west, to Gravesend in the east; and from Walthamstow in the north to Sutton, Carshalton and Croydon in the south. Powers to distribute as well as to supply "in bulk" are asked for by this Company. The Metropolitan Electric Supply Co., which has entered into an agreement with the Acton Urban District Council to supply "in bulk" to this suburb, seeks powers for this purpose and also powers to supply "in bulk" in the central and western parts of London, and to extend in a westerly direction, far beyond Acton, to Uxbridge and Staines. The North Metropolitan Electric Power Supply Co. wishes to extend its area to Islington, Stoke Newington and Hackney with permission to distribute in these districts as well as to supply wholesale. The Charing Cross & Strand Corporation is endeavouring to acquire a large district in the east and north-east of London in addition to its present area in the City and the so-called West-end, and the County of London Supply Co. and the City of London Electric Lighting Co., also desire to extend their boundaries, the former for "bulk" supply only. Finally, the East London and Lower Thames Electric Power Bill is again being introduced. This Bill, which it will be remembered was rejected last year, on account of unsatisfactory finance, now schedules a similar area.

◆

WE need not regard seriously the proposals for competition with local authorities in the retail business of electricity supply, for unless Parliament decides that it will reverse the policy of the Board of Trade in protecting local authority undertakers from company competition, there is little likelihood of anything but powers for wholesale or "bulk" supply being granted. But it is evident that a definite decision will have to be made on the question whether it is to the general interest that companies should be allowed to compete for the wholesale supply of electrical energy in the same districts.

Until two years ago no company had succeeded in obtaining permission to give supply for power purposes, or wholesale for lighting purposes, in a district where a municipal electricity works was already in operation, but this rule was broken through in 1903. In the present case, however, practically every inch of the ground scheduled by the companies above mentioned is already occupied by an electric supply company or a municipal electricity undertaking, and there is overlapping, sometimes by three companies, in the districts in which permission is sought to supply "in bulk." It is at present premature to examine the various schemes in detail, but when the Bills are deposited and information can be gathered with regard to the engineering and financial proposals we hope to return to the subject.

Mr. Hugh Campbell's Paper on "Gas Engines for Central Stations," which we publish in abstract this week, contains a considerable amount of valuable experimental data, his comparative figures for a steam-driven and gas-driven generating station of the same size, and with practically the same load-factors, being particularly interesting. It is instructive to compare the results of the six hours' test on one of the 280 H.P. gas engines at St. Sampson's, Guernsey, with the remarkably fine results obtained by M. Aimé Witz on a 250 H.P. double-acting gas engine using also producer gas. The particulars of the test by the well-known Continental authority named will be found on page 205 of this week's paper. It will be seen that the total amount of coal used in the boiler and producer per brake horse-power-hour was 1·12lb. in the case of the Guernsey engine against 0·744lb. for the Deutz engine. The coal appears to have been of good average quality in both cases, and the difference is probably chiefly attributable to the fact that the Deutz engine was double-acting.

The device for measuring the drop in magnetomotive force between any points of the magnet circuit of a dynamo, described by Mr. Rudolf Goldschmidt elsewhere in this issue, is not only ingenious but also of undoubted practical value, especially if the high degree of accuracy which Mr. Goldschmidt announces is confirmed by other workers. The greatest inaccuracy introduced into the readings is due to the leakage of the flux, but by properly shaping and dimensioning the magnetic shunt it appears possible to limit this adverse influence to a comparatively small value. Since the method is a zero method, the air-gaps, which of necessity have to be introduced in the magnetic shunt, do not, theoretically, occasion any inaccuracy in the result; but they have the effect of rendering the directional forces exerted by the flux in the magnetic shunt on the compass needle less vigorous than would be the case if they could be avoided altogether. It is, therefore, advisable to keep the air-gaps as short as possible. The iron shielding, used by the author in one of his patterns for excluding external fields, has of course the same effect, as it itself conveys the greater part of the flux in the shunt around the compass and allows only a small percentage of the flux to act on the compass needle. We presume, however, that Mr. Goldschmidt has found the force acting on the needle to be sufficient without the necessity of making the suspension too delicate. The method will be welcomed by the practical man who lacks some of the experience and ability of the scientific experimenter.

In a Paper contributed to the St. Louis Congress, of which we print an abstract, Prof. A. E. Kennelly has dealt with the application of alternating-current formulæ to the theory of the transmission of signals over submarine cables. His treatment, strictly academical as it is, certainly renders the subject somewhat more lucid than it has hitherto been, a striking feature which is brought out being the peculiar adaptability of hyperbolic trigonometry to the problem. The theory is that of the attenuation of reversals of various frequencies, applied to signalling through long cables on the assumption, firstly, that the fundamental sinusoidal component of a rectangularly impressed E.M.F. is the only one which requires consideration at the distant end of the line; and, secondly, that a definite ratio subsists between the fundamental frequency of a regular series of dots and that of the irregular combinations of telegraphy. The only alternative to this is the calculation of arrival curves from the first terms of infinite series, and the construction of a group of signals by the composition of all the ordinates. This has been done by others at considerable labour for cases where resistance and capacity alone are the controlling factors of the propagation, and for the case of a cable containing a fault, but when the investigation is extended to the effects of both leakage and inductance on the arrival curves, the labour of such methods rapidly becomes prohibitive.

Some years ago Crehore and Squier, in their experiments on an Atlantic cable with sine-wave transmitters, showed that the attenuation of reversals, as computed by the alternating-current formulæ, agreed fairly well with the observed amplitudes, with and without terminal condensers. The agreement between the observed and calculated phase-angles was, if we recollect rightly, less exact. A good instance of the discrepancy between alternate-current theory and commercial telegraphy is to be found in Heaviside's research "On the Theory of Faults in Submarine Cables." Here the conclusion is reached that a leak of one-thirty-second of the cable's resistance, placed at the centre of the line, would increase the speed of reversals by 40 per cent. or more. This greatly exaggerates the gain in signalling speed, which is, as a matter of fact, insignificant, owing to the dips between dots not being required in practice, and being, therefore, allowed no time to make themselves apparent. Another difference would, we imagine, be found if it were attempted to make the impedance of the receiving apparatus equal to the value assigned by the alternating-current formulæ. Again, on comparatively short lines, the magnification of reversals at a particular frequency by to-and-fro reflections is another cause capable of producing misleading results. Prof. Kennelly, however, clearly indicates that these are matters to be elucidated by experiment, guided, but not fettered, by the limitations of formal mathematical theory.

It is announced that a vessel conveying the third section of the cable between Brest and Dakar has just left Calais. The laying of this cable will involve the expenditure of about

£1,000,000, and the line is being put down almost solely for strategic reasons. The promoters of the scheme urge its necessity upon the French Government, pointing to the fact that, in the event of war, there would be a risk of Senegal being cut off from France. Opponents of the scheme have asserted that a system of wireless telegraphy could easily be established and maintained between Timbuctoo (whence there are land lines to Senegal, Dakar, Bathurst, &c.) and Algeria, a distance of about 900 miles. It is, in fact, just possible, in view of recent developments in wireless telegraphy, that this method of signalling could be carried on successfully over 900 miles of land, for Hertzian waves of great power traversing the Sahara desert would not interfere with anyone, and there is no necessity for high speeds.

◆

Through Running on Electric Railways.—We learn that a commencement has been made in the laying of the third rail between Seaforth (Lancashire and Yorkshire) Station and the northern terminus of the Liverpool Overhead Electric Railway. Early in the new year trains will be run from Dingle to Waterloo, Formby, Southport, Crossens and intermediate stations.

Wireless Telegraph Notes.—It is announced that the Admiralty have decided to erect a wireless telegraph station at Hagnish Tree on the island of Tiree (Scotland), which will be in communication with Malin Head in the north of Ireland and Duncansby Head on the north-east of Caithness. The mast is to be 160ft. high and the station will be operated by the coastguardsmen, for whom suitable houses are to be erected near the station.

The Engineers' Club.—This club, whose aim it is to promote the social intercourse of engineers engaged in different branches, commenced its second session on Saturday with a smoking concert held at the Café Monico. Mr. W. H. Lindley, President of the Junior Institution of Engineers, occupied the chair, and in reviewing the progress made during the last session, he expressed the hope that the Engineers' Club might at no distant date be in the possession of club rooms of its own. An entertaining programme, carried out to a large extent by members of the Club, was evidently appreciated by all present.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne—Pinheiros	**Aug. 13, 1903**	—
Reissi-Issa (Yemen)—Camaran	**Oct. 22, 1903**	—
Tarifa—Tangier	**Jan. 18, 1904**	—
Cayenne—Paramaribo	**July 13, 1904**	—
Trinidad—Demerara	**Oct. 11, 1904**	**Nov. 21, 1904**
Jupiter Julets (Florida)—Nassau (Bahamas)	**Oct. 20, 1904**	—
Rhodes—Sitia	**Nov. 1, 1904**	**Nov. 22, 1904**
Marseilles—Barcelona	**Nov. 11, 1904**	**Nov. 20, 1904**
Santa Cruz (Teneriffe)—Tejita (Teneriffe)	**Nov. 11, 1904**	—
Sitka—Valdez (Alaska)	**Nov. 11, 1904**	—
Mozambique—Majunga	**Nov. 15, 1904**	—
St. Kitts—St. Thomas	**Nov. 22, 1904**	—

Royal Society.—Amongst the Papers down for reading yesterday were the following:—"On the Refractive Indices of the Elements," by C. Cuthbertson, communicated by F. T. Trouton, F.R.S.; "On Galvanic Cells produced by the Action of Light," preliminary communication, by Dr. M. Wilderman, communicated by Dr. L. Mond, F.R.S. A donor, who desires to remain anonymous, has placed a sum of £1,000 in the hands of the treasurer of the Royal Society, to be devoted to the advancement of science. By his wish £500 of this gift is to be placed to the credit of the "Catalogue of Scientific Papers Account" of the Royal Society, and the remainder to the credit of the "National Physical Laboratory Account" of that body, with the request that the executive committee of the laboratory will accede to any personal wish of the director as to its expenditure.

Double acting Gas Engines.—M. Aimé Witz records in *L'Eclairage Electrique* the following tests, carried out by him last March on a double-acting gas engine working on the Otto cycle. The principal dimensions of this 250 H.P. engine, which was built by the Otto Company of Deutz, were:—Diameter of cylinder, 540mm. (21·2in.); stroke, 700mm. (27·6in.); speed, 150 revs. per min.; weight per brake-horse-power, 80kg. (178lb.) Gas was furnished by a Deutz gas producer, being cleansed solely by two coke scrubbers. The coal used had a calorific value of 14,600 B.Th.U. per lb. and contained 3·1 per cent. of ashes and 17·1 per cent. of volatile substances. With a mean load of 222·5 B.H.P., the following figures were obtained:—Coal consumed by the producer, 161·5lb. per hour; water consumed in the producer, 140lb. per hour; ditto in the scrubbers, 3,180lb. per hour. The temperature of the gas leaving the scrubbers was 170°C., and the calorific value of the gas ranged from 2,280 to 2,444 B.Th.U. per lb. As regards the consumption of coal, and of water for cooling the engines, the following figures are quoted: Coal, 0·744lb. per B.H.P.-hour; cooling water in the cylinder, 46·7lb. per B.H.P.-hour; cooling water in the piston, 17·6lb. per B.H.P.-hour.

A Storage Battery Railway Auto truck.—An interesting application of the storage battery to transportation may be seen in the Westinghouse exhibit, St. Louis. A standard-gauge truck is equipped with a storage battery and motors and designed for carrying materials or to be used as a locomotive. In its general construction the truck resembles an ordinary slow-speed electric delivery wagon, except that it is adapted for running on a railroad track. The truck with complete equipment weighs 9,500lb., and has a carrying capacity of 100,000lb. When used as a locomotive, its drawbar pull is 1,000lb., with a speed of from ¼ to 2½ miles per hour. It has a substantial steel frame carried on four iron wheels. Each axle is driven by a Westinghouse motor. The deck, 6ft. 9in. by 12ft. 10in., is constructed of heavy matched wood, easily removable to permit of access to the batteries. The wheel base is 8ft. 11in., the height over all 2ft 7in., the width 7ft. 4in. and the length 14ft. 4in. The truck is operated from one end by two hand levers—one reversing the direction of running and the other giving four different speeds in either direction. The operator has always under foot the lever of a mechanical brake and the push button of a signal bell. The truck is provided at both ends with drawbar heads and with receptacles for charging the storage battery.

Snowstorms.—Since the beginning of this week unusually severe snowstorms have been reported from many parts of the country, especially in the North, and some damage and a great deal of inconvenience and delay has been caused to railways, electric tramways and the telegraph and telephone service. A number of telephone wires and poles, belonging to the National Company, fell in Newcastle in consequence of the combined pressure of snow and wind, and, as the poles and wires fell across a street, the electric cars had to be stopped until the obstructions could be removed. The Post Office gives notice of probable telegraphic delay to Yorkshire and all offices north, including Scotland. The high wind and the heavy fall of snow caused a serious dislocation of electric tramway traffic in Bradford, and although several snow ploughs and quite an army of men were employed for clearing away the snow and sleet, yet anything like a regular service could only be kept up on a few routes within the city boundaries. Similar conditions existed in Halifax and other places in that district. In Aberdeen rotary brushes were employed for clearing the track, and they did their work so well that the regular tramway service within the town was not interrupted, but the service on the suburban routes suffered somewhat from delays. In Birmingham and district similar conditions existed, but with the help of snow ploughs a fair service was kept up. The electric car traffic in Wolverhampton (on the surface-contact system) had to be suspended on Tuesday owing to heavy snowstorms.

Comparative Tests of Gas and Electric Lighting.—Tests were commenced about a week ago at the Westminster Electrical Testing Laboratories, having for their object the determination of the relative photometrical efficiencies of gas burners and electric lamps. Besides these figures other experimental data will also be collected, such as the quantity, calorific value and density of the gas consumed. The electric lamps under test include flaming arcs, open arcs, enclosed arcs (the two latter will be tested with different kinds of carbons), miniature arc lamps, incandescent lamps, Nernst lamps, and mercury vapour lamps. All the tests are to be conducted with and without the lamp globes. Amongst the gas lamps are those of the intensified gas type and of the self-intensifying pattern. A number of incandescent mantles of various make are to be examined. Current for the electric lamps is derived from an accumulator battery, the voltage being finally adjusted by a rheostat. Determinations will be made of the maximum horizontal intensity, the minimum horizontal intensity, the mean horizontal intensity, the intensity at different angles and the mean hemispherical intensity. Lamps intended for street lighting will, in addition, be tested at various heights, and the curves of foot-candles will be ascertained by means of the street photometer belonging to the laboratory. All the experiments in the laboratory are carried out by means of a photometer of the Simmance Abady "Flicker" type (*The Electrician*, Vol. LII., p. 380), which was made by Messrs. Alex. Wright & Co. As the standard of light the Harcourt 10-candle pentane lamp is used, and the secondary standard, which is an incandescent electric lamp, is checked before and after each day's tests. These experiments and tests are being carried out by Messrs. L. W. Wild, Simmance and J. Abady, and it is their intention to collect and subsequently publish the data thus obtained.

Law between Air Gap and Disruptive Voltage.—In a communication to the *Elektrotechnische Zeitschrift* of November 3rd, Herr W. Weicker refers to some tests, undertaken at the porcelain factory at Hermsdorf, for establishing the relationship between the disruptive voltage across an adjustable air gap and the length of the latter. A 5kw. transformer (ratio of transformation 1:640) was used. It was fed with current at 100 ~ per second, and a maximum voltage of 100,000 volts was obtainable. The electrodes used consisted of two pointed brass rods, the angle at the apex being 11 degs., two brass plates with a diameter of 120mm., and several brass knobs with diameters of 34mm. and 48mm. respectively. In the case where both electrodes were pointed, it was observed that the voltage increased in accordance with a straight-line law from 48,000 volts to 100,000 volts for an increase in the air gap from 132mm. to 300mm. Below 48,000 volts, however, the law is represented by a curve, but the interval between the curve and the straight line is ill-defined. Similar is the case where the electrodes consist of two plates. Reference to the curves plotted by the experimenter shows that in this case the straight-line law is followed from 35,000 volts to 90,000 volts when the air gap is increased from 36mm. to 100mm. Below 35,000 volts there is apparently a jump from the straight line to a curve, but the jump, again, is ill-defined. When one electrode is a plate and the other a point, the jump is much more clearly defined. In the case of two knobs as electrodes, the character of the phenomenon depends on the way the knobs are disposed. If the two knobs are one above the other, there are two distinctive disruptive voltages for any air gap from about 65mm. to 160mm. For a gap of 150mm., for instance, the two voltages are approximately 57,000 volts and 82,500 volts. When the knobs are arranged horizontally, the law is represented by a single curve without irregularities.

Municipal Engineering on the Continent.—Mr. W. H Lindley delivered his Presidential address to the Junior Institution of Engineers last Friday. After touching upon water works and sewage works in Germany, the author proceeded to deal with the municipal supply of electrical energy. In 1887 a station was started at Elberfeld, and this was the first German municipal electric supply station. Both these were conducted on the continuous-current system. He then proceeded to describe the Frankfurt works, first designed by him in 1889, when Prof. Kittler and himself in their expert report proposed the adoption of alternating current. The great fight of continuous versus alternating current, which ensued, gave rise to the electrical exhibition in 1891 in Frankfurt. The question was then again treated by Mr. Oscar von Millar and himself in 1892, and resulted once more in the recommendation of alternating current, which, only after a controversy of 4½ years' duration, was adopted by the city authorities. Mr. Lindley then proceeded to describe the Elberfeld works, which were extended on the alternating-current system in 1898. The further developments were as follows: the raising of the pressure from 3,000 to 4,000 volts, limiting the drop in the primary to 2½ per cent. and in the secondary network to 1½ per cent., thus allowing large quantities of energy to be supplied at any point of the district without injuriously affecting the lighting. He then referred to the adoption of the Parsons steam turbine in large units of 1,250kw., and drew attention to the fact that for the Elberfeld station the working expenses (interest on capital and sinking fund excluded) per kilowatt-hour supplied had been brought down to 0·7d. and the coal consumption per kilowatt-hour reduced to 2·65lb.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, November 25th.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

3 p.m. Visit to the works in connection with the enlargement of Victoria station. Meet at the Main Line bookstall

PHYSICAL SOCIETY.

5 p.m. Meeting in the Physical Laboratory of the Technical College, Leonard-street, City-road, by invitation of Prof. Silvanus P. Thompson, F.R.S. Agenda :—(1) "The Measurement of Small Differences of Phase," by Dr. W. E. Sumpner; (2) "On the Curvature Method of Teaching Geometrical Optics," by Dr. C. V. Drysdale; (3) "Exhibition of Specimens of Crystals showing the Phenomenon of Luminous Rings," by Prof. Silvanus P. Thompson; (4) "On a Rapid Method of Approximate Harmonic Analysis," by Prof. Silvanus P. Thompson; (5) Exhibition of Apparatus by Prof. Dalby, Mr. Darling, Dr. Drysdale, and Prof. Thompson.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:30 p.m. General Meeting in the Lecture Theatre of the Literary and Philosophical Society, Westgate-road. Paper to be read:—"A Comparison of Vertical and Horizontal Tubes in Water Tube Boilers," by W. R. Cummins.

MANCHESTER STUDENTS' SECTION: INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Meeting in the Municipal School of Technology. Paper to be read: "Electric Power in Machine Shops," by H. C. Jenkins.

SATURDAY, November 26th.

GLASGOW TECHNICAL COLLEGE SCIENTIFIC SOCIETY.

7:30 p.m. Meeting at 38, Bath-street, Glasgow. Paper to be read: "The Electrical Drive of large Reversing Engines working Intermittently," by Maurice Georgi

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

10 a.m. Visit to the Tunnelling Works of the Great Northern, Piccadilly & Brompton Railway. Meet at corner of Cranbourne-street and Charing Cross-road.

TUESDAY, November 29th.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER LOCAL SECTION.

7:30 p.m. Meeting at Owens College. Paper to be read: "Compensated Alternating current Generators," by Miles Walker.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed: "Distribution of Electrical Energy," by J. F. C. Snell.

WEDNESDAY, November 30th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7:30 p.m. Meeting at 92, Victoria-street, Westminster, S.W. Paper to be read: "Motor-controlling Switch Gear," by L. J. Pumphrey.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "The British Canals Problem," by Arthur Lee. The Right Hon. Sir Michael Hicks-Beach, Bart., will preside.

THURSDAY, December 1st.

RUGBY ENGINEERING SOCIETY.

8 p.m. Meeting in the Benn Building, High-street, Rugby. Paper to be read: "Some Notes on High-speed Electric Railway Work," by F. W. Carter.

SATURDAY, December 3rd.

JUNIOR INSTITUTION OF ENGINEERS.

Afternoon visit to inspect the features of engineering interest at the London Coliseum, St. Martin's-lane, Trafalgar-square.

A METHOD OF MEASURING MAGNETOMOTIVE FORCES.

BY RUDOLF GOLDSCHMIDT.

Modern electrical machines are, as a rule, highly saturated in the iron of the magnets as well as in the teeth of the armature. The higher this saturation, the more the ampere-turns of the fields are dependent on the magnetic properties of the iron and on accidental faults in the magnets, such as blow-holes in the cast steel or bad joints. In any case it is very important, from the designing and manufacturing point of view, to find out from the actual machine how many ampere-turns are required for driving the flux through the magnet yokes and poles, the air-gap and the teeth of the armature.

The method of measuring the "magnetic potential drop" described in the following article was the outcome of special tests, which it was found necessary to make on actual steel field magnets which were suspected of being faulty in quality and casting, and the results proved that it was extremely suitable for the purpose, being easy to manipulate in the shops and requiring a minimum of special apparatus or fine adjustment, which would obviously lead to complications. To measure the "magnetic potential drop" between the points *a* and *b* in the yoke of a continuous-current machine, two laminated iron cores, AC and BD, as shown in Fig. 1, are placed on *a* and *b* respectively in the manner shown, the gap CD being from ⅜in. to ½in. By this arrangement we have formed a small "magnetic shunt" or "by-pass" to the yoke. This shunt will take up a small amount of the magnetic flux. Point C, for instance, will show north polarity, point D south polarity, and a small compass needle placed between C and D will assume the position indicated in Fig. 2, pointing with its south poles to C. The limbs AC and BD carry two coils, S_1 and S_2, which we excite with a current so that they counteract the magnetic potential between *a* and *b*. If we increase the ampere-turns of S_1 and S_2 sufficiently to overpower the magnetic force of *a-b*, then the flux in the "magnetic shunt" would reverse, the polarity of C would become north and the polarity of D south, and our compass needle would point as shown in Fig. 3. If we adjust the current in S_1 and S_2 so that the compass just begins to move from one position to the other the magnetomotive force of the coil is equal to the P.D. between *a* and *b*, and thus represents directly without any further calculation the amount of ampere-turns required to drive the flux through the yoke of the machine. From the above it will readily be seen that it is not necessary to have a very good fitting joint between the field magnet and the test cores, this being a zero method.

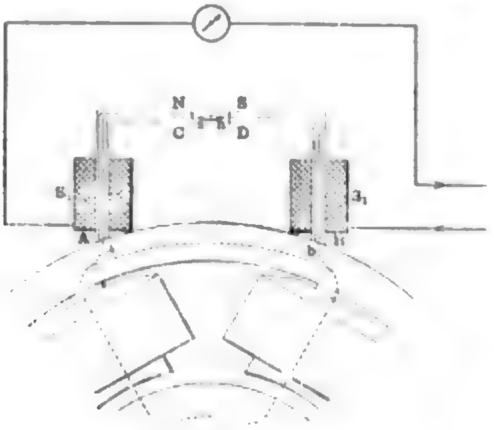

FIG. 1.

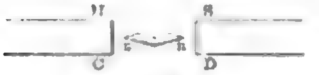

FIG. 2.

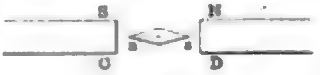

FIG. 3.

The method, as here applied to the yoke of a continuous-current machine, can, naturally, be used in any case where magnetomotive forces are to be measured. As to the exactness of the method, I may say that this was tested by measuring known values of known magnetomotive forces and by summing up the different potential drops in simple as well as in more complicated magnetic circuits, and it was found that the measurements agreed sufficiently well for all practical purposes. For instance, the measurement of a known value of ampere-turns was carried out with satisfactory results on a choking coil in which the drop of magnetic potential in the iron was insignificant, and practically the full amount of the ampere-turns in the choking coil could be measured by the apparatus.

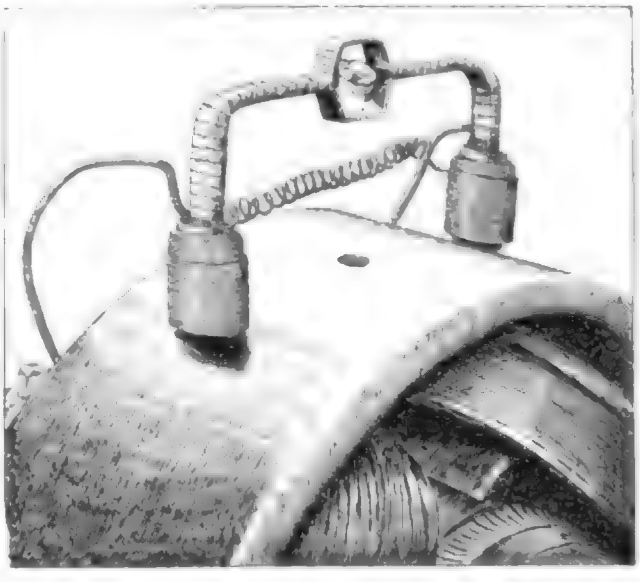

FIG. 4.

Among many other measurements the most interesting perhaps is that of the magnetic potential drop in the different parts of the magnetic circuit of a continuous-current machine. Fig. 4, drawn from a photograph, shows the apparatus applied to a continuous-current machine by Messrs. Crompton & Co. An actual measurement showed that the drop in the yoke was 300 ampere-turns; over the air gap and teeth, 6,400 ampere-turns; over the teeth alone, 600 ampere-turns. The actual ampere-turns on the field of the machine were 7,300. The difference between this amount and the sum of the single measurements—that is, 7,300 − (6,400 + 300) = 600—represents the drop in the two poles, or 300 ampere-turns for each pole. Fig. 5 shows a diagrammatic sketch of the magnetic circuit with the figures inserted as they were actually determined by the apparatus. To shield the compass needle from the influence of undesirable stray lines, the compass can be surrounded by a small iron box, as shown in Figs. 4 and 6.

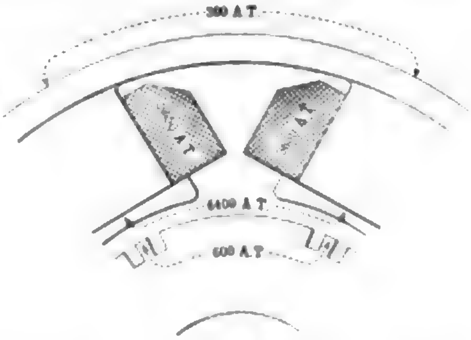

FIG. 5.

From a great number of applications where this apparatus may be used, we may mention the following:—

1. Measuring the "drop" for the different yokes and parts of a continuous-current machine so as to detect irregularities

and blow-holes in the iron. By special arrangements this can also be applied to the poles.

2. The apparatus can be used to obtain the full magnetising curves of the armature teeth of electrical machinery, which otherwise would be available only by calculation. With this test the flux can be determined in the ordinary way by running the machine and measuring the voltage on the armature.

3. It can be applied for detecting bad joints in any part of the yoke of continuous-current machines, which sometimes give rise to "out-of-balance" occurrences in machines with parallel coupled armatures.

Fig. 7 shows a peculiar application of the method for measuring the continuous current in a conductor—say a feeder cable—without inserting an amperemeter or cutting the cable in any way. An iron yoke carrying the magnetising coils on its limbs is put over the conductor, and the coils of the yoke excited so that the flux in the magnetic yoke is zero, which can be ascertained by means of the compass needle in the way described. Tests carried out show that an accuracy of within 1 or 2 per cent. can be obtained.

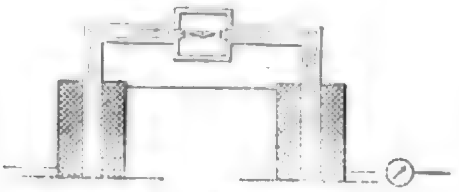

Fig. 6.

With regard to the sensitiveness of the method, I may say that with a good compass needle a discrepancy of 1 or 2 per cent. from the balancing amount would indicate itself by making the needle move to one or other position.

To ascertain balance, other ways have been tried besides the compass-needle method, but the latter has been found to be the best. I may mention one. Besides the exciting coils S_1 and S_2 an exploring coil was placed on the magnetic shunt circuit and connected to a milli-voltmeter. To ascertain if the balance was obtained—*i.e.*, if the shunt circuit did not carry any flux—the magnetic resistance of the shunt was altered by inserting an air-gap. The excitation in S_1 and S_2 was then adjusted until no deflection was indicated on the milli-voltmeter, when the magnetic resistance was thus varied, showing that balance had been obtained.

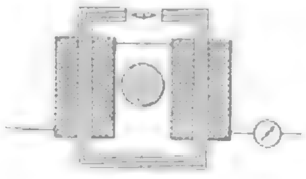

Fig. 7.

I have to thank Messrs. Denoon and Steinhaus, of the test-room staff of Messrs. Crompton & Co., for carrying out these experiments for me.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Proceedings of the Royal Society." No. 501. Vol. LXXIV. (London: Harrison & Sons.) 2s.

"Electricity: Its Place and Power in the Universe, or a Justification of the Single Theory of Electricity and Magnetism." (Glasgow: W. Hodge & Co.) 1s.

"Nature Intime de l'Electricité, du Magnetisme et des Radiations." By A. Breydel. (Paris: Vve. Charles Dunod.)

"Light Energy: its Physics, Physiological Action and Therapeutic Applications." By Margaret A. Cleaves. (London: Rebman, Ltd.) 21s.

"Model Steam Turbines." By H. H. Harrison. (London: Percival Marshall & Co.) 6d.

THE NEW YORK RAPID TRANSIT SUBWAY.

(*Continued from page 170.*)

Two novel safety devices closely allied with the signalling system may be here described. The first is an emergency train stop operated from the stations. It is designed to place in the hands of station attendants, or others, the emergency control of signals upon all adjacent approaching tracks. The protection afforded is similar in principle to the emergency brake handle found in all passenger cars, but operates to warn all trains of an extraneous danger condition. To provide as perfectly as practicable for such conditions, it has been arranged to loop the control of signals into an emergency box set in a conspicuous position on each station platform. The pushing of a button on this box, similar to that of the fire alarm signal, will set all signals immediately adjacent to stations in the face of trains approaching, so that all traffic may be stopped until the danger condition is removed.

The second safety appliance is the "section break" and cross-over protection. This consists of a special emergency signal placed in advance of each separate section of the third rail; that is, at points where trains move from a section fed by one sub-station to that fed by another. Under such conditions the contact shoes of the train temporarily span the break in the third rail. In case of a serious overload or ground on one section, the train wiring would momentarily act as a feeder for the section, and thus possibly blow the train fuses and cause serious delay until they could be replaced. In order, therefore, to prevent trains passing from a section charged with the full normal potential into a dangerously overloaded or grounded section, an overload relay has been installed at each section break to set a "stop" signal in the face of an approaching train, which holds the train until the abnormal condition is removed. The apparatus is applied at all section breaks in the third rail and at all cross-overs where the train might pass from a third-rail section in one track to a different one on another track.

On express-line tracks an effect of this signalling mechanism will be to throw the home signal to danger at the nearest block in advance of the third-rail section break. The method of operation of this signal control mechanism is interesting; it consists of a differential magnetic mechanism with rotating armature, one of the magnetic coils being connected between the third-rail and the ground on one side of the section break, and the other magnetic coil similarly between the third-rail and the ground on the other side of the break. When both sections of the third rail are fully charged, these magnets operate so as to annul each other, so that the armature is not attracted; if, however, the current supply is removed from either section of the third rail, one of these magnetic coils becomes inoperative, while the other is still magnetised, and the result is that the differential action is removed and the armature is strongly attracted, and, by lifting a counter-weight, breaks the contact in the control circuit of the nearest home signal in advance of this point. This sets the home signal to danger, and in turn the distant signal at the further block in advance, to prevent trains from approaching the section under these circumstances.

Upon the local tracks, where a block signal is not used, a special type of section-break signal will be used for a similar purpose and prevent trains from approaching a section break when voltages are unequal on either side. This type of signal is operated by a differential relay of special construction and gives a colour indication. In this case a warning of approaching trains is furnished by a special box plainly marked "S B.," which indicates by a red light for danger or stop.

At cross-overs and sidings, where it is similarly desired to prevent trains from crossing over from one third rail section to another in case of unequal voltages upon the third-rail sections, a different procedure is necessary. In these cases a special form of indication is to be used, which will show the tower man, or those in charge of the interlocking switches, whether it is safe for trains to be passed over from one section to another or not. This will be accomplished by means of vertical scale voltmeters arranged side by side and connected to the third rail sections on either side of the cross-over; by a mere glance at the voltmeters, the switchman can easily see whether the voltages on both sides are sufficiently near together to permit trains to cross over safely. There has also been installed a special emergency signal system, embodying provision for cutting off power from the contact rail in case of imminent danger. In the booth of each ticket seller and at every manhole along the west side of the subway and its branches is placed a glass-covered box of the kind generally used in large American cities for fire alarm purposes. In case of accident in the subway which may render it desirable to cut off power from the contact rails, this result can be accomplished by breaking the glass front of the emergency box and pulling the hook provided. Special emergency circuits are so arranged that pulling the hook will instantly open all the circuit-breakers at adjacent sub-stations through which the contact rails in the section affected receive their supply of power. It will also instantly report the location of the trouble, annunciator gongs being located in the sub-stations from which power is supplied to the section, in the train dispatchers' offices and in the office of the general superintendent, instantly intimating the number of the box which has been pulled. Automatic recording devices in train dispatchers' offices and in the office of the general superintendent also note the number of the box pulled.

An important feature of the signal and interlocking work is the provision of supply for the 500 volt alternating-current distribution mains throughout the subway system and for the low-voltage direct-current storage-battery supply mains, extending to all signals throughout the system for operating the valve-controlling magnets, and also for the compressed air supply system. The alternating-current main is fed by seven motor generators, arranged to operate in multiple, each of which is of 30kw. capacity, generating single-phase alternating current at 60 cycles and 500 volts. They are located separately in seven of the more important sub-stations of the line. Four of these machines could deliver the whole current required for operating the entire system.

Continuous current for the signal operating magnets is supplied by eight groups of storage-battery sets in duplicate, located at convenient points in the subway, usually in signal towers. Each battery has a capacity of 450 ampere-hours, and the two sets at each battery station are operated alternately, one being charged while the other is discharging. The batteries are charged by small motor-generators, driven by current from the 600-volt continuous current propulsion system, one being located at each storage battery point. They deliver to the storage batteries at 25 volts potential, the mean voltage of the battery itself being 16 volts.

The compressed-air supply for the various signal mechanisms and switches, the automatic car stop, &c., is supplied by a 2in. main extending the length of the system. This main is fed by six 35 H.P. electrically-driven compound air compressors, three being reserve units. They are driven by Westinghouse continuous-current motors, taking current from the continuous-current 'bus bars at the sub-stations at from 400 to 700 volts. Each of these compressors has a capacity of 230 cubic ft. of free air per minute, delivered into the supply system at a pressure of from 60lb. to 75lb. per square inch They are automatically controlled by the rise or fall of air pressure in the system. A pressure gauge, operating upon the Bourdon steam gauge principle, is arranged to make different contacts for certain maximum and minimum pressures. When the pressure falls so as to close the upper contact, current is delivered to an automatic switch, which operates a mechanism in such a way as to move the starting resistance switch for the air-compressor driving motor. This mechanism is so arranged that when the starting resistance is cut entirely out and the motor is up to speed, the starting switch is held magnetically in place, and the solenoid is actuated so as to throw the load on to the compressor to cause it to deliver air to the system. This same action starts the flow of cooling water through the cylinder jackets of the compressor cylinder, and automatically admits oil to the cylinders and bearings. When the air pressure in the system rises to the predetermined maximum the opposite contact is made, which causes the load to be removed from the compressor by closing the delivery of the system, and also shuts down the motor, the jacket-water supply for the compressor, the oiling system being also incidentally shut off. In this way the compressor is always started unloaded and stopped unloaded, the action being entirely automatic, so that no attention is required; it is designed to respond to variations of air pressure of 5lb. or less, and operates very satisfactorily.

The interlocking system employed in the subway portions of the line is of the Westinghouse electro-pneumatic type, while in the elevated portions of the line mechanical interlocking has been, in some cases, provided. The interlocking machines are housed in steel concrete "towers." An unusual type of switch movements and interlocking mechanism is required in the subway installation on account of the confined space and cramped conditions.

The engineers of the Interborough Company realised at the very outset the importance of maintaining lights in the subway independent of any temporary interruption of the power used for lighting the cars, and, in preparing their plans, they provided for lighting the subway throughout its length from a source independent of the main power supply. For this purpose the three 1,250-kw. alternators mentioned in the description of the power house convey current to the incandescent lamps used solely to light the subway. The 11,000-volt primary current is conveyed through paper-insulated, lead-sheathed cables to transformers, located in fire-proof compartments adjacent to the platforms of the passenger stations. These transformers deliver current to two separate systems of secondary wiring, one of which is supplied at a potential of 120 volts and the other at 600 volts. The general lighting of the passenger station platforms is effected by 14 c.p. and 32 c.p. incandescent lamps supplied from the 120-volt secondary wiring circuits, while the lighting of the subway sections between adjacent stations is accomplished by incandescent lamps connected in series of five across the 600-volt lighting circuits. As an additional precaution, a number of lamps fed by the contact rail circuit have been installed upon the stairways leading to passenger station platforms, at the ticket booths and over the tracks in front of the platforms. This will provide light sufficient to enable passengers to see stairways and the edges of the station platforms in case of temporary failure of the general lighting system. In lighting the subway between passenger stations it is desirable, on the one hand, to provide sufficient light for track inspection and to permit employés passing along the subway to see their way clearly and avoid obstructions; but, on the other hand, the lighting must not be so brilliant as to interfere with easy sight and recognition of the red, yellow and green signal lamps of the block signal system. It is necessary also that the lights for general illumination be so placed that their rays shall not fall directly upon the eyes of approaching motormen at the head of trains nor annoy passengers who may be reading their papers inside the cars. The conditions imposed by these considerations are met in the four-track sections of the subway by placing a row of incandescent lamps between the north-bound local and express tracks and a similar row between the south-bound local and express tracks. The lamps are carried upon brackets supported upon the iron columns of the subway structure, successive lamps in each row being 60ft. apart. They are located a few inches above the tops of the car windows and with reference to the direction of approaching trains the lamps in each row are carried upon the far side of the iron columns, by which expedient the eyes of the approaching motormen are sufficiently protected against their direct rays.

An interesting innovation is the use of electric heat in the passenger stations, for which purpose a number of the metallic "mica strip" heaters of a special model have been installed.

The average speed of express trains between City Hall and 145th-street on the west side approximates 25 miles an hour, including stops, and the maximum speed of trains is 45 miles per hour. An express train of eight cars, to conform to the schedule speed, requires 325 amperes at 570 volts when starting from a station. These high accelerating conditions necessitated a very substantial design of car body and truck (see Fig. 13) and motors of ample size, although, on the other hand, the weight of the car and its equipment had to be kept down as much as possible. A happy solution of the problem seemed to lay in the use of steel car construction, but the limitations of car building facilities prevented a sufficiently early production in steel at first.

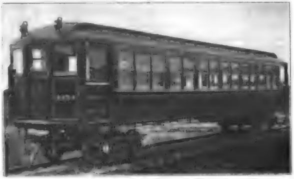

FIG. 13.—VIEW OF CAR.

On account of the special traffic conditions existing in New York City and the restricted siding and yard room available in the subway, it was decided that one standard type of car for all classes of service would introduce the most flexible operating conditions. In order further to provide cars, each of which would be as safe as the others, it was essential that there should be no difference in constructional strength between the motor cars and the trail cars. All cars were, therefore, made of one type, and can be used interchangeably for either motor or trail-car service. The motor cars carry both motors on the same truck—that is, they have a motor truck at one end carrying two motors, one geared to each axle. The truck at the other end is a trailer and carries no motive power. The length of the wooden cars, of which 500 were ordered in December, 1902, is 51ft., and there is seating capacity for 52 passengers. The platforms have sliding doors instead of the usual collapsible gates. The steel under framing provides a rigid and durable bed structure for transmitting the heavy motive-power stresses.

Some features of interest and of novelty in electric car construction were introduced in the form of wooden frame members, reinforced heavily by structural steel shapes. The side sills are of 6in. channels, which are enclosed on both sides by white oak timbers, and the centre sills are 5in I-beams, faced on both sides with southern pine. The car-body end sills are also of steel shapes, securely attached to the side sills by steel castings and forgings, the end-sill channel being faced with a white oak filler, mortised to receive the car-body end posts and braced at each end by gusset plates. The body bolster is made up of two rolled-steel plates bolted together at their ends and supported by a steel-draw casting, the ends of which form a support for the centre sills. The flooring inside the car is double and of maple, with asbestos fire felt between the layers, and is protected below by steel plates and "transite" (asbestos) board. The side framing of the car is of white ash, doubly braced and heavily trussed. There are seven composite wrought-iron carlines forged in shape for the roof, each sandwiched between two white ash carlines, and with white ash intermediate carlines. The platform posts are of compound construction, with anti-telescoping posts of steel bar sandwiched between white ash posts at corners and centres of vestibuled platforms. These posts are securely bolted to the steel longitudinal sills, the steel anti-telescoping plate below the floor and to the hood of the bow, which serves to reinforce it. This bow, it might be mentioned in this connection, is a heavy steel angle in one piece reaching from plate to plate and extending back into the car 6ft. on each side. By this construction it is believed that the car framing is practically indestructible. In case of accident, if one platform should ride over another, 8 sq. in. of metal would have to be sheared off the posts before the main body of the car would be reached, which would afford an effective means of protection.

For the lighting circuits in the car a flexible steel conduit is used, and a special junction box. On the side and upper roofs, over the lighting circuits, a strip of sheet iron is securely nailed to the roof boards before the canvas is applied. The wires under the floor are carried in ducts of asbestos compound moulded into suitable forms. Special precautions have been taken with the insulation of the wires, the specifications calling for, first, a layer of paper, next a layer of rubber and then a layer of cotton saturated with a weather-proof compound, and outside of this a layer of asbestos. The hangers supporting the rheostats under the car body are insulated with wooden blocks, treated by a special process, being dried out in an oven and then soaked in an insulating compound and covered with ¾in. "transite" board. The rheostat boxes themselves are also insulated from the angle-iron supporting them. Where the wires pass through the flooring they are hermetically sealed to prevent the admission of dust and dirt. At the forward end, or what is known as the No. 1 end of the car, all the wires are carried to a slate switchboard in the motorman's cab. This board is 44in. by 27in., and is mounted directly at the back of the motorman. The window space occupied by this board is ceiled up and the space back of the panels is boxed in and provided with a door of steel plate, forming a box, the cover, top, bottom and sides of which are lined with electrobestos ⅛in. thick. All the switches and fuses, except the main trolley fuse and 'bus line fuse, which are encased and placed under the car, are carried on this switchboard. Where the wires are carried through the floor or any partition, a steel chute, lined with electrobestos, is used to protect the wires against mechanical injury. It will be noted from the above that no power wiring, switches or fuses are placed in the car itself, all such devices being outside in a special steel insulated compartment.

The general dimensions of the all-steel car, of which 300 have been ordered, and some delivered, differ only slightly from those of the wooden cars. Some of the principal dimensions of both types of car are:—

—	Wooden Cars.		All-Steel Cars.	
	ft.	ins.	ft.	ins.
Length over body corner posts	42	7	41	0¼
Length over buffers	51	2	51	2
Length over draw-bars	51	5	51	5
Width over side sills	8	8¾	8	6⅞
Width over sheathing	8	10	8	7
Width over window sills	8	11¼	9	0¼
Width over battens	8	10¼	8	7¼
Width over eaves	8	8	8	8
Height from under side of sill to top of plate	7	3¼	7	1
Height of body from under side of centre sill to top of roof	8	9¼	8	9¼
Height of truck from rail to top of truck centre plate (car light)	2	8	2	8
Height from top of rail to under side of side sill at truck centre (car light)	3	1¼	3	2¼
Height from top of rail to top of roof not to exceed (car light)	12	0¾	12	0

The desire of eliminating the element of wood as far as possible, in order to secure absolutely incombustible construction, led to the incorporation of many novel ideas, such as, in addition to the metal framework, the use of plastic flooring, metal door and window framing, metal interior trim throughout, &c. It became evident very soon, especially from the experience gained in the construction of the experimental car, that a radical departure from usual methods of supporting the car body, namely, by the centre and side sills with the usual under-trussing, would be necessary. Any attempt at carrying the weight of the car by the sill members would have required very heavy construction of under framing. Eventually the idea of carrying the weight of the car by the side framing, which is being very largely introduced into modern heavy steel-car construction, was made use of, with the result that in the sub-way steel car the side-framing sections of each car are made to serve as plate girders, from which the floor load of the car is carried. The centre sills consist of two 6in. I-beams, while the side sills are 5in. by 3in. steel angles; each of these sill members extends in one piece from platform end sill to platform end sill. This under-frame construction is in reality very light, and would in itself be far from sufficient to carry even the weight of a car of this size; in fact, the framework of the car alone is not self-supporting.

The actual load-carrying member of the car is beneath the special belt rail. This member, as built up, serves to form a plate girder 36in. in height, the lower member of which is the 3in. by 5in. angle side sill, and the upper member of which is the special 8¾in. by 4in. bulb angle, which serves as the belt rail. The web is of ⅛in. steel plate, having been applied in lengths corresponding to the distances between the single side posts of the car; here the plates are joined with butt-strap joints, heavily riveted to the single posts. This forms a girder of such unusual strength that no truss rods beneath the car are required for keeping the car in alignment, and it is used to carry the entire floor load of the car, transferring the same to the trucks through the special body bolsters. The novel idea of placing the upper truss member outside and making it serve also as the window belt rail enables the upper frame posts to be made continuous from the lower side sills to the top plate.

The under-framing construction of the car was, of course, greatly simplified by the absence of steps, the station platforms in the subway having been arranged, in conformity to elevated railway practice, on levels with the car floors. This permitted the side sills to extend to the end sills, which are located adjacent to the buffer beams. Thus, in reality, no special construction was necessary in the under framing for the platform, which extends as a solid member throughout the length of the car. The car-body end sill is formed of a 6-in. by 3½in. steel angle, bent to radius of 5¼ft., to conform to the shape of the buffer. It is secured to the side and centre sills of the under frame by special cast-steel brackets, and, in addition, by a heavy steel anti-telescoping plate, which is strongly riveted to the under sides of the sill members, producing an immensely strong frame-end construction. A construction corresponding to that of a body-end sill is applied in the form of two 4in. channels, fitted in between the longitudinal sills, and heavily riveted by means of corner brackets of 3in. by 3in. angles. These members carry the end bulkheads of the car between the platform and interior. They are faced on top with a fire-proof ash member, to which the malleable iron threshold plate is fastened. Cross members of steel angles are also riveted between the longitudinal sills at various spacings to correspond with the usual needle-beam construction of wooden cars; these, besides stiffening the underframe, assist in carrying the floor. The buffer beam is of white oak bolted to the platform-end sill and faced with a ⅜in. steel plate. The vestibule posts are set in and riveted to the special cast-steel pocket castings which serve to join the side and end sills of the under frame, as above referred to. The body-end posts are similarly secured in place by pressed-steel brackets, which, when rivetted up, furnish enormously strong construction. The tying of these posts to the roof framing is similarly provided for.

The body bolster is made up of two rolled-steel plates, each ¾in. by 9in., and the top and bottom members are machined on their outer ends, so as to fit perfectly, and are bolted together at their ends and to the side steel of the car; a filler casting is used in joining the ends to the side sill of the car. The filler casting between the top and bottom members of the bolsters is of malleable iron which is planed on top, bottom and end surfaces so as to perfectly fit the bolster. This casting is bolted to the bolster, the four vertical bolts used being also made use of to secure the centre-bearing plate to the lower side of the bolster frame. The body bolster, filler casting and centre plate are drilled for a 2⅛in. king bolt. The side and centre bearings provided are of types which are in general use, the side bearings being spaced with centres 28¾in. from the king bolt.

The window posts, which form a part of the side-plate girder construction, previously referred to, extend up and are riveted to the steel angle side plates, which extend from end bow to end bow. The body-corner posts and the vestibule posts are also rigidly connected to the side plates by special steel castings, thus forming a rigid base for the roof frame. The roof is built up in a unit of a series of malleable iron carlines, each attached to the side plate above a window post, and all tied together by the longitudinal purlins to which they are riveted by special angle brackets. All carlines and purlins are faced with furrings of fire-proof ash, and similar blocks are also bolted to the side plates, upon which the roof covering of fire-proof composite board and the head-linings are fastened. Special forged brackets are also provided on each carline to carry the clerestory eaves moulding, while the deck plate and sills are of fire-proof ash pieces.

A new automatic coupler, built by the W. T. Van Dorn Company, is fitted to the cars. The coupler head is attached to the draw bar through the Van Dorn standard type of spring buffer casting, to the top of which is riveted the main draw bar, 8in. by 1½in. in section. Limitations of construction prevented this main draw bar being carried through to the king bolt, so that a special form of auxiliary bolster construction was necessary to permit the desired radial movement or swing for the coupler. An auxiliary draw bar, 8in. by 2in. in section, is carried from the opening in the main body bolster filler casting forward a distance of 19in., where it ends in a special type of auxiliary bolster, bolted in between the centre sills. The auxiliary draw bar is forged in clevis shape, into which the end of the main draw bar is secured by an auxiliary king bolt 2⅜in. in diameter. This provides a main draw-bar radius of 6ft. 1in., while a transverse swing movement of the coupler of 36in. is thereby secured. The weight of the main draw bar is carried by a special sector plate above the spring buffer casting, which assists in taking care of the buffing strains from the draft rigging. The main sector plate upon which the draw head itself slides, is built up of a 4in. angle, curved to correspond with the movement of the draw head. The safety chains are built up of 2⅝in. links of ⅞in. round iron.

(To be concluded.)

GAS ENGINES FOR CENTRAL STATIONS.*

BY HUGH CAMPBELL.

The particular branch of gas engine development I wish to speak about is that which concerns central station work. The first central station of any size adopting gas engine power was built by the city of Belfast, who erected, in 1895, a station consisting of four horizontal double-acting engines, each of 120 I.H.P., and two double-acting engines, each of 60 I.H.P. The cost per unit of current sold from January 23rd to December 31, 1895, as given by Mr. V. A. H. McCowen, electrical engineer to the Belfast Corporation, in a Paper read before the Institution of Mechanical Engineers in July, 1896, is as follows :—

Number of units sold, 82,771.

	Pence.
Gas used as fuel (2s. 3d. per 1,000ft.)	1·450
Oil, waste, water and stores, including ignition tubes	0·233
Salaries and wages at generating station	1·290
Repairs and maintenance of buildings, engines, dynamos and accumulators	0·272
Repairs and maintenance of mains..	0·221
Rents, rates and taxes	0·684
Management expenses, &c.	1·200
Insurance........................	0·067
Total......	5·417

The later history of the Belfast station shows that the gas engine plant was a failure and has since been replaced by steam engines, the cause of this being no doubt the extraordinarily heavy cost of production, as well as trouble with the plant. In consequence of the enormous development in gas engine design and operation since that time, however, several other stations have during the last few years been set to work with gas engines. The working cost of a few of them is given below :—

—	Units per annum.	Load factor.	Fuel cost per unit.	Oil waste and water	Wages.	Repairs.	Total works costs.	Fuel used.	Cost of fuel.
			d.	d.	d.	d.	d.		
Walthamstow	814,187	15·45	·46	·19	·36	·6	1·07	Anthracite coal	26s per ton in bunkers
Redditch	265,717	14.11	·88	·19	·53	·24	1·84	..	..
Northwich ..	157,198	9·20	·51	·15	·50	·35	1·51	Mond gas	2d. per 1,000ft.
Averages ..	..	14·28	·555	·184	·413	·135	1·29	..	..

On looking through Mr. Henry McLaren's Paper, read before the Institution of Mechanical Engineers, July, 1903, on "Fuel Economy in Generating Stations," I find the average cost of coal per unit sold in seven Metropolitan non-condensing stations to be 1·0290d.; in four Metropolitan partly condensing stations the average cost of coal per unit sold to be 1·120d.; in nine Metropolitan condensing stations the average cost of coal per unit sold to be 1·060d.

I now come to some more recent installations of gas engines for central station work, those in which my firm has been responsible for the engines. In one of these—viz., that of the Guernsey Electricity Co., there existed prior to the installation of the gas engines a steam-driven plant of practically the same output as the gas engine plant which was installed later. The comparison of the working costs of the steam and gas engine stations at Guernsey afford, in my opinion, a good guide and a fair comparison of the relative merits of the two powers—steam and gas, since the stations are equally favourably situated with regard to the coalfield, and the cost of carriage on the coal is the same. The plant at the St. Peterport steam-driven station consisted of one battery (capacity 32kw. for 10 hours), two 75kw. combined steam engine sets, two 180kw. triple-expansion steam engine sets, one condenser 360kw. capacity, two water tube boilers and superheater for 75kw. each, two water tube boilers and superheater for 180kw. each, one Green's economiser and two Weir pumps. The St. Sampsons gas-driven station consists of one battery (capacity 50kw. for 10 hours), two 180kw. "Campbell" gas engine sets, two Daniels gas producers, one 20ft. diameter gas holder, two circulating water pumps and water storage tank. I am very much indebted to the kindness of Mr. Arthur G. Bird, A.M.I.E.E., the engineer to the Guernsey Electricity Co., and to Messrs. Edmundson's Electricity Corpn. (Ltd.) for the figures relating to the operation of both stations which I am able to give you (p. 212).

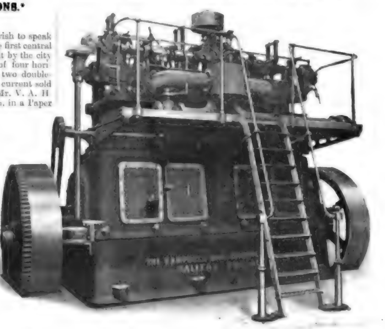

FIG. 1.—300 B.H.P. FOUR-CYLINDER VERTICAL PRODUCER GAS ENGINE INSTALLED AT GUERNSEY AND HEBDEN BRIDGE.

Originally the St. Peterport steam station was designed for lighting only, since then the demand for power sprang up at the local quarries some two or three miles away, and to transmit the current there transforming had to be introduced. The steam station for a period took both the lighting and power loads. Since then the St. Sampson gas-driven station has been erected to deal with the power load only, the current for which is delivered direct to the mains.

With reference to the capital cost of the two plants at Guernsey, I am able, by the kind permission of Messrs. Edmundson's Electricity Corporation (Ltd.), to tell you that the total cost of steam plant was £3,642, against a total cost of the gas plant of £8,200. In these figures no allowance has been made for foundations, buildings, rough labour for erection or cartage in either case, nor is there included the cooling tower, or any water storage, in connection with condenser plant. This is balanced by water storage tank for the gas plant.

Description of St. Sampson's Plant.—The gas engines at St. Sampson's Station consist of two four-cylinder vertical engines of the enclosed type (see Fig. 1), working on the "Otto" cycle, each developing 300 B.H.P. on producer gas, the normal speed of each being 250 revs. per min. The engine cylinders are 17in. diameter by 17in. stroke, the pistons being direct-coupled to a four-throw crankshaft running in three bearings. The sequence of the explosions in the cylinders, commencing with the cylinder on the left hand, is Nos. 1, 2, 4 and 3. Splash lubrication is adopted for oiling the crankshaft, connecting rods, pistons and cylinders, and this has been found to be very effective and satisfactory. The whole of the

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* Abstract of a Paper read before the Leeds Local Section of the Institution of Electrical Engineers, on November 17th.

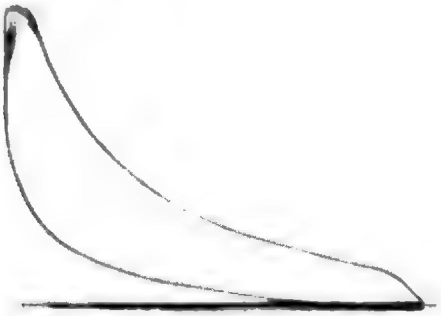
Generating Costs of Guernsey Steam-driven Station, in Pence, per Unit, Sold and Generated Respectively. No Condenser. No Power Load.

	May.		June.		July.		August.		September.		October.	
	Sold.	Gen.	Sold.	Gen	Sold.	Gen.	Sold.	Gen.	Sold.	Gen.	Sold.	Gen.
	d.	d	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.
Coal	0·71	0·502	0·69	0·503	0·71	0·452	0·66	0·458	0·71	0·525	0·83	0·589
Stores and water	0·06	0·042	0·06	0·044	0·07	0·042	0·06	0·042	0·11	0·078	0·11	0·078
Wages	0·26	0·184	0·25	0·182	0·29	0·177	0·23	0·160	0·22	0·156	0·20	0·142
Repairs, all plant, mains and buildings	0·17	0·122	0·20	0·146	0·15	0·092	0·11	0·076	0·23	0·163	0·36	0·256
Total works cost	1·20	0·850	1·20	0·875	1·25	0·763	1·06	0·736	1·30	0·922	1·50	1·065
Efficiency of distribution	70·6 per cent.		73 per cent.		61 per cent.		69·5 per cent.		71 per cent.		71 per cent.	
Units sold	37,776		32,354		32,130		41,906		39,078		38,911	
Units generated	53,506		44,241		52,574		60,306		55,133		55,108	
Possible units, full load	80,700		67,570		68,640		77,460		78,585		85,335	
Plant load factor	66·3 per cent.		65·6 per cent.		76·6 per cent.		78 per cent.		70 per cent.		45·6 per cent	
Coal, units generated	5·9lb.		5·8lb.		5·23lb.		4·83lb.		5·56lb.		6·13lb.	
Price of coal in bunkers	15/10		16/-		16/-		17/10		17/6		17/6	

Ditto for Gas Driven Station (Power only).

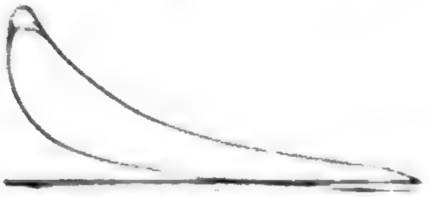
	May.		June.		July.		August.		September.		October.	
	Sold.	Gen.	Sold.	Gen	Sold.	Gen.	Sold.	Gen.	Sold.	Gen.	Sold.	Gen.
Coal	0·32	0·255	0·30	0·240	0·30	0·240	0·28	0·224	0·31	0·248	0·31	0·248
Stores and Water	0·09	0·072	0·13	0·104	0·13	0·104	0·07	0·056	0·06	0·048	0·06	0·048
Wages	0·26	0·206	0·19	0·152	0·23	0·184	0·24	0·192	0·20	0·160	0·19	0·152
Repairs, all plant, mains and buildings	0·22	0·175	0·15	0·120	0·17	0·136	0·17	0·136	0·15	0·120	0·13	0·104
Total works cost	0·89	0·708	0·77	0·616	0·83	0·664	0·76	0·608	0·72	0·576	0·69	0·552
Efficiency of distribution	80 per cent.		80 per cent.		80 per cent.		80 per cent.		80 per cent.		80 per cent.	
Units sold	18,566		26,132		29,153		31,130		35,597		40,289	
Units generated	23,208		32,665		36,441		38,913		44,496		50,361	
Possible units, full load	37,020		42,840		47,700		52,200		55,080		61,380	
Plant load factor	62 per cent.		76 per cent		76·5 per cent.		74·5 per cent.		81 per cent.		65·8 per cent.	
Coal units generated	2·6lb.		2·44lb		2·33lb.		2·19lb.		2·32lb.		2·44lb.	
Price of coal in bunkers	18/6		18/6		18/6		18/6		19/6		18/6	
Diff. in favour of gas plant per unit generated	0·142d.		0·259d.		0·099d.		0·128d.		0·346d.		0·513d.	

valve gearing is mounted on the top of the cylinders, the cam shaft being driven by screw gearing and bevel wheels from the crank shaft. The exhaust valves and exhaust valve box are of special construction, in that they are both independently water cooled. The method of governing adopted is that known as the throttle system,



No. 1. Load on Engine 140 kw. Scale [illegible]th.

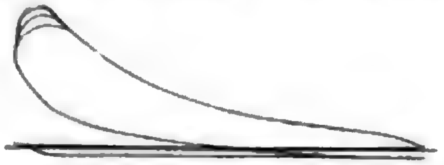
which is carried out exactly on the lines of the steam throttle. The gas and air arrive at the [illegible] valve by separate pipes, and are mixed as they pass through the throttle valve. The type of valve for the throttle depends upon the nature of the gas employed. For producer gas an ordinary double-beat valve is used. The



No. 2. [illegible]

[illegible]

to me, is one weak spot in all the gas plants hitherto used in this country. My own opinion is that in the near future suction gas plants of larger power will be adopted, thus abolishing the boiler and its fuel consumption and simplifying the gas plant generally, as this type of plant does not require a steam boiler or gas holder.



No. 3. Load on Engine 44·1kw. Scale [illegible]th.

Some large plants of this character are already at work, the most recent examples being the central station for lighting and tramways at Scheveningen, Holland, where six gas engines of 500 B.H.P. each, and a suction gas plant of 3,000 H.P. are at work. The actual figures as to the cost of working are not yet available, owing to the

No. 4. Engine Running Without Load. Scale [illegible]th.

station having been at work but for a few months, but I can speak from knowledge gained by a visit to the station that everything is satisfactory, and the results will be economical.

Summary of Results on [illegible] Trial Run, St. Sampson's, Guernsey. Sept. 27, 1904. Engine No. 2.

Units generated wattmeter	1,120
Average load by wattmeter	[illegible]
Maximum load	[illegible] kw.
Average B.H.P.	[illegible]
Mechanical efficiency	[illegible] per cent.

[illegible]

Total coal used in producer	[illegible]
Total coal used in boiler	[illegible]
Coal used in producer per kw. hour	[illegible]
Coal used in producer and boiler per kw. hour	[illegible]
Gas used per kw. hour	125 cubic ft.
[illegible]	
Average of two tests	[illegible] gross [illegible] net.
[illegible] of gas produced by 1 lb. of coal used in producer	[illegible] cubic ft.
[illegible] pressure [illegible]	[illegible] per sq. in.
Temperature of exhaust gases	say [illegible] F.

Water evaporated by boiler	1,470lb.
Water evaporated by boiler per lb. of coal (at 80lb. pressure)	6·05lb.
Equivalent evaporation from and at 212°F.	7·2lb.
Steam used per kw.-hour	1·3lb.
Maximum amount of CO_2 observed	5·8 per cent.
Minimum amount of CO_2 observed	4·8 per cent.
Depth of fire in producer	22in.
Average blowing pressure (column of water)	8½in.
Gas pressure near engine (when engine was running with load)	⅞in.
Momentary variation in speed, maximum load thrown off by pulling out main switch	9 per cent.
Permanent difference in speed between maximum load and no load	4 per cent.

I may add that in the governing of the engine between its rated load—viz., 180 kw. and no load, the permanent difference in speed is 2½ per cent., and that there is practically no cyclical variation on a steady load.

Another installation, for which my firm has been responsible, is at the electric lighting station of Hebden Bridge.

The engines consist of a four-cylinder vertical gas engine of similar size to those made for Guernsey, but as the Hebden Bridge engine uses lighting gas of 600 B.Th.U. value, the maximum brake horse-power developed will be 350 B.H.P. Another engine of the horizontal ordinary type is also installed, but it is proposed to remove this and replace it by a four-cylinder vertical engine of larger power. The results of a test run made by Mr. Emmott and his assistants will be of interest, and will afford a comparison between the Belfast results of 1895, where the engines used lighting gas of equal heat value.

Results of Four Hours' Test on the 300 B.H.P. *Engine at Hebden Bridge Station.*

Capacity of dynamo	140kw.
Maximum kw. generated	146·4
Gas consumed per kw.-hour at 146·4 kw. load	21·96 cubic ft.
Gas consumed per kw.-hour at 75kw. load	26·7 cubic ft.
Cost of gas	1s. 9d. per 1,000 cubic ft.
Full cost per unit generated	0·462d.
Efficiency of dynamo	93 per cent.
Mechanical efficiency of combined engine and dynamo	77 per cent.
Thermal efficiency of engine	33·7 per cent.

Better results and efficiencies could no doubt have been secured if it had been possible to put more load on the engine.

HYDRODYNAMICAL AND ELECTROMAGNETIC INVESTIGATIONS REGARDING THE MAGNETIC-FLUX DISTRIBUTION IN TOOTHED-CORE ARMATURES.[*]

BY PROF. H. S. HELE-SHAW, F.R.S., LL.D., ALFRED HAY, D.SC., AND P. H. POWELL, M.SC., M.ENG.

INTRODUCTION.

Some four years ago two of the authors of the present Paper described a hydrodynamical method of attacking two-dimensional magnetic problems. A full account of this method, including a detailed description of the apparatus used and examples of the results obtained, will be found in a Royal Society Paper for 1900.[†] Here it will be convenient, for the sake of those members who do not happen to have seen an account of the method, to give a brief outline of it.

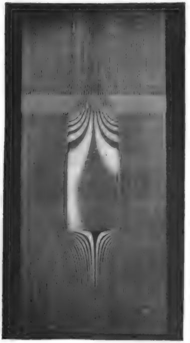


FIG. 1.

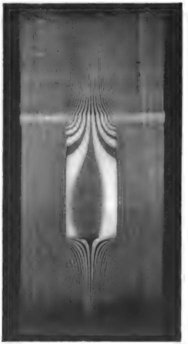


FIG. 2.

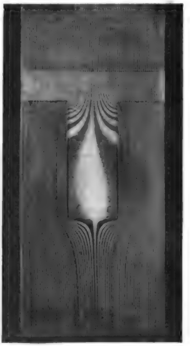


FIG. 3.

The laws which govern the distribution of magnetic flux in space of two dimensions are identical with those which apply to the stream-line motion of a perfect incompressible fluid in two-dimensional space. If, therefore, we had such a fluid at our disposal, and by causing it to flow between parallel bounding walls determined the distribution of the stream-lines, this distribution would also represent that of the magnetic lines or tubes in a corresponding two-dimensional magnetic problem. This is the underlying principle of the hydrodynamical method as applied to magnetic problems. In trying to put the principle of this method into practice, we encounter the following difficulties:

(1) The difficulty of mapping out the invisible stream-lines of the fluid. (2) The fact that there is no such thing as a "perfect" fluid at our disposal, every actual fluid being more or less viscous. (3) The difficulty of finding an analogue for magnetic permeability, in order to enable us to study the flux distribution in cases where the field consists of regions having different permeabilities.

The first difficulty is surmounted by using a colourless liquid into which are injected thin colour-bands, consisting of the same liquid mixed with a suitable dye.

The second difficulty at first sight appears insurmountable. But a closer mathematical investigation by the late Sir G. G. Stokes[*]

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[*] Paper read last night before the Institution of Electrical Engineers

[†] *Phil. Trans.*, Vol. 195 (Series A) pp. 303-327.

[*] B. A. Report, 1898.

has revealed the somewhat astonishing fact that when any viscous liquid is made to flow in a very thin layer between parallel bounding walls, *the stream-lines obtained are identical with those of a perfect liquid*. This theoretical deduction was subsequently fully confirmed by us in the Paper already referred to. The liquid used by us was glycerine, and the dye for mapping out the stream-lines was a mixture of aniline dye with permanganate of potash. The colour-bands were injected through a series of very minute apertures at one end of the slide between whose parallel plate-glass walls the liquid was allowed to flow.

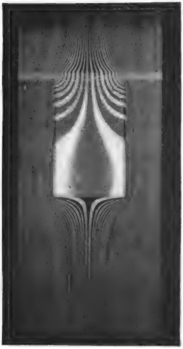

FIG. 4.

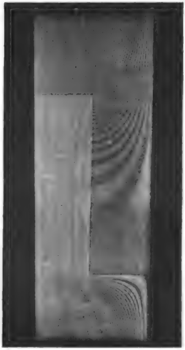

FIG. 5.

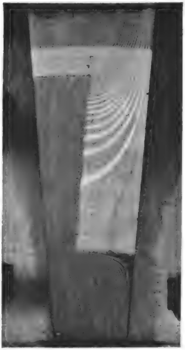

FIG. 6.

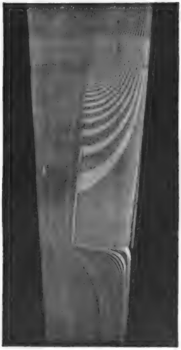

FIG. 7.

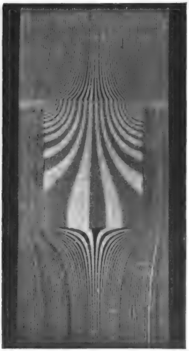

FIG. 8

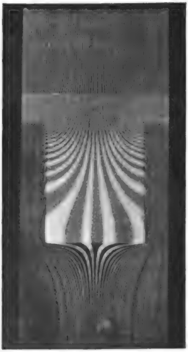

FIG. 9.

The third difficulty consists in devising a method by means of which the effects of varying magnetic permeability may be imitated.

Now it may be shown, both theoretically and experimentally, that when a viscous liquid flows in a thin parallel layer, the quantity of liquid passing per second across a plane of unit length drawn normally to the stream-line is, for a given pressure gradient, inversely proportional to the cube of the thickness of the liquid layer. Hence, if the liquid is made to flow through several regions of different thickness, the ratio of the cubes of the thicknesses gives the ratio of the permeabilities in the corresponding magnetic problem.

The practical method employed by us consisted in coating one of the thick glass plates forming the slide with a thin layer of paraffin wax, and then forming a cavity or cavities of the required shape by carefully scraping away the wax over certain areas. These areas, over which the liquid layer had a greater thickness, represented the regions of high permeability. The permeability varying in proportion to the *cube* of the thickness of the liquid layer, no difficulty was experienced in constructing slides in which the permeability over certain regions had as high a value as 1,000. The slide through which the liquid flowed being suitably illuminated, a photograph of it was taken, and thus a permanent record obtained of the particular stream-line distribution. The stream-line diagrams which accompany the present Paper are reproductions of the photographs so obtained. The validity of the hydrodynamical method having been established, we proceeded to apply it to some problems in dynamo design whose solution has always been a matter of considerable difficulty. In order to render the investigation more complete, however, we decided to supplement the results obtained by the hydrodynamical method by experiments carried out on an actual dynamo fitted with several armature cores having different sizes of teeth and slots, and different air-gaps. In the calculation of the magnetomotive force required to produce a given magnetic flux in a dynamo having a toothed-core armature, the designer encounters two important difficulties. The first of these is the determination of the reluctance of the air-gap, including the allowance to be made for the distortion due to the armature teeth and for the fringing effect around the edges of the pole-pieces; and the second is the determination of the reluctance of the teeth themselves. It is in connection with the first problem—that of air-gap reluctance—that the hydrodynamical method is of particular value. Although attempts were made to apply it to the second problem—that of tooth reluctance—by *continuously* varying the thickness of the liquid layer representing the tooth, yet the difficulties of doing this satisfactorily proved so great that the attempt had to be abandoned, and we preferred to carry out this part of the investigation electromagnetically, using the ballistic method.

HYDRODYNAMICAL INVESTIGATION OF AIR-GAP RELUCTANCE

For the sake of completeness, and with a view to rendering the present Paper as useful as possible to the dynamo designer, we propose, in what follows, not to restrict our attention to our own investigations, but to supplement these by an account of the more important researches carried out in this direction by other workers, and to state the results obtained in a form which will render them available for immediate practical use.

A. *Fringing Problem.*—If we except various more or less arbitrary and imperfect empirical rules, the first attempt to deal with this problem in a scientific manner is due to Messrs. C. C. Hawkins and R. Wightman, who, in a Paper entitled "The Air-Gap Induction in Continuous Current Dynamos,"* obtained a correction for the fringing effect on the basis of certain very simple (though incorrect) assumptions regarding the form of the magnetic lines in the vicinity of the polar edges. Shortly afterwards Mr. F. W. Carter† succeeded in obtaining an exact mathematical solution of an ideal case, which, however, so closely corresponds to the actual problem that, from a practical point of view, the solution may be regarded as furnishing a perfect correction. The most convenient way of taking the fringing effect into account is to add to the length of the polar arc (in estimating the effective cross-sectional area of the gap) a term consisting of the product of the single air-gap length into a certain coefficient, c, whose value depends on the ratio r = distance between pole-pieces length of single air-gap, the "distance between the pole-pieces" being measured along the armature circumference, and hence representing the length of the interpolar arc. The following table contains the values of c corresponding to various values of r:—

r =	4	5	6	7	8	9	10	12	14	16	18
c =	1·32	1·59	1·79	1·80	2·15	2·30	2·43	2·65	2·84	3·00	3·15

r =	20	22	24	26	28	30	35	40	45	50	60
c =	3·28	3·40	3·51	3·61	3·70	3·78	3·93	4·14	4·28	4·40	4·66

By means of this table, the necessary correction in any given case may be at once applied.

B. *Problem of the Flux Distortion brought about by Armature Teeth.*—It is at once obvious, without the necessity of going into any elaborate investigation, that the presence of teeth in the armature core is equivalent to an increase in the gap length (or a reduction in the gap area); for the teeth disturb the uniformity of the flux distribution, causing a crowding of the lines into the regions of the polar surface which are opposite the teeth, and thereby increasing the fall of magnetic potential, from the polar surface to the crown of any tooth, above the value which it would have if the distribution were uniform (*i.e.*, if the core were smooth) and the total flux unaltered. Assuming that the exact effect produced by the teeth is known, a convenient method of applying the necessary correction consists in multiplying the gap length by a certain "correction coefficient," and then, using this corrected value, in proceeding with the calculation as if the armature core were smooth—*i.e.*, as if the flux distribution were uniform. The "correction coefficient" clearly represents the ratio of the maximum to the mean induction. It is not difficult to see that the value of the correction coefficient depends on the two ratios s/t and s/g, where s = width of slot, t = width of tooth (at top), and g = length of gap. In Figs. 1-9 are given a series of stream-line diagrams for various values of the two ratios s/t and s/g, and a careful examination of these enables one to form a very good idea of the effect produced by the teeth. The chief value of the diagrams, however, lies in the fact that they enable us to determine the numerical values of the correction coefficient in the various cases. All that is necessary for this purpose is to determine the number of stream-lines per unit of length in the space well under cover of a tooth, and to divide this by the mean number of stream-lines per unit of length for tooth and slot. The values of the correction coefficient so obtained are given in Table I. Attention may be drawn to one or two features clearly exhibited by the diagrams. Two well-known effects are shown very plainly: the *refraction* of the lines as they pass from a medium of low into one of high permeability, and the crowding of the lines along the sharp edge of the tooth. It will be further noticed that between the straight lines in the region immediately above the tooth and the curved lines entering the slot and passing into the flank of the tooth, and exhibiting a concavity towards the tooth, there are certain intermediate or transition lines which are characterised by a point of inflection, the upper part of the line being concave and its lower part convex towards the tooth; the convexity gradually decreases as we take lines further and further away from the tooth, and is ultimately replaced by a concavity along the entire length of the line.

Table I.—*Air-gap Correction Coefficients.*

Fig.	s/t.	s/g.	Stream-line method.	Carter's method.	Method I.	Method II.	Method III.	Method IV. (Hawkins & Wightman.)
..	0·500	3·42	1·18	1·16	1·50	1·20	1·22	1·21
1	0·510	2·80	1·13	1·14	1·51	1·20	1·22	1·19
2	0·515	6·65	1·26	1·24	1·515	1·21	1·22	1·28
..	0·524	2·35	1·11	1·12	1·524	1·21	1·23	1·18
3	0·580	1·68	1·10	1·09	1·53	1·21	1·23	1·14
..	0·670	4·57	1·21	1·24	1·67	1·20	1·28	1·30
..	0·770	2·27	1·22	1·16	1·77	1·28	1·32	1·23
..	0·810	4·00	1·23	1·25	1·81	1·29	1·33	1·32
4	0·940	9·60	1·52	1·48	1·94	1·32	1·37	1·53
..	0·945	4·30	1·31	1·30	1·945	1·32	1·38	1·38
5	1·00	4·00	1·25	1·29	2·00	1·33	1·39	1·38
6	1·00	4·40	1·37	1·32	2·00	1·33	1·39	1·40
..	1·00	4·50	1·32	1·32	2·00	1·33	1·39	1·40
7	1·02	4·45	1·35	1·32	2·02	1·34	1·40	1·41
..	1·28	3·90	1·33	1·34	2·28	1·39	1·52	1·44
8	1·88	13·2	1·96	1·95	2·88	1·46	1·62	1·95
..	1·94	3·86	1·37	1·40	2·94	1·49	1·63	1·55
9	1·98	3·34	1·39	1·36	2·98	1·50	1·64	1·51

While our experiments were in progress, a very important contribution to this subject appeared by Mr. F. W. Carter,* who followed up his previous success in attacking the fringing problem by working out a solution for the air-gap flux distribution in the case of a toothed-core armature, on the assumptions of negligible pole-face curvature and infinite permeability in the teeth. According to Mr. Carter, the correction coefficient is given by

$$\frac{1+\frac{s}{t}}{1+(1-\sigma)\frac{s}{t}}, \text{ where } \sigma=\frac{2}{\pi}\left\{\tan^{-1}\frac{s}{2g}-\frac{g}{s}\log\left(1+\frac{1}{4}\frac{s^2}{g^2}\right)\right\}.$$

Mr. Carter's solution furnishes a correction coefficient which may be regarded as quite accurate enough for all practical purposes, and a reference to Table I shows very satisfactory agreement between the values determined by our stream-line method and those calculated by means of Mr. Carter's formula. Such divergencies as exist in some cases are to be attributed to want of accuracy in working out the values from the stream-line diagrams, due to their comparatively small scale.

(To be concluded.)

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* *Journal* of the Institution of Electrical Engineers, Vol. XXIX., p. 436.

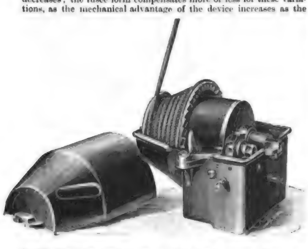
† *Ibid.*, p. 925; also *Electrical World and Engineer* of New York, Vol. XXXVIII., p. 884.

* *Electrical World and Engineer* of New York, Vol. xxxviii., p. 884.

A NEW TROLLEY ARRESTER.

This device has been designed specially to control the trolley pole when, by any accident, it leaves the overhead wire and, by a sudden upward movement, fouls the spans or becomes entangled in other portions of the overhead equipment. The method of working the apparatus is as follows:—The attendant winds up the drum (which is shown in the illustration) by pulling the trolley rope until the motion is stopped by the Geneva stop, and he then replaces the trolley wheel on the wire, thus depressing the stalk of the head, breaking the circuit, de-energising the magnet, locking the drum in its fully-wound position and disengaging the drum from the barrel. In these circumstances the spring of the barrel causes the latter to take up the slack of the rope while permitting the trolley head a large range of motion to accommodate itself to both vertical and horizontal deviations of the trolley wire. If now the trolley wheel should leave the wire the immediate effect is in the upward sliding of the stalk in its socket; the electric circuit is then closed, the electromagnet energised, the barrel and the drum engaged together and the latter released. As a result the trolley pole is immediately drawn down sufficiently to clear the span wires or other overhead construction, whatever may be the length of the rope extended.

Attention is drawn to the fact that the barrel is made of taper-cone formation as shown in the illustration, and that the trolley rope is attached to the larger end of the barrel. This is a very important feature, and considerable advantage results from it. As the rope is drawn in the resistance of the trolley pole spring increases, while the effect of the partially unwound drum spring decreases; the fusee form compensates more or less for these variations, as the mechanical advantage of the device increases as the drawing-in of the rope proceeds. A further important advantage lies in the fact that, when the trolley head is drawn low immediately over the car, the apparatus does not wind in enough of the trolley rope to bring the pole down dangerously near the top of the car. On the other hand, when the pole is considerably deflected laterally, a much greater length of rope must be drawn in in order that the invention may effect its object. The drum having a fixed play of, say, four turns, the fusee form of the barrel gives the necessary variation in the amount of rope drawn in, for when the trolley head is low the rope is coiled on the smaller diameters of the barrel, and the length drawn in is relatively small. On the other hand, when the trolley head is much displaced laterally, the rope is coiled on the larger diameter, and the length drawn in is, therefore, relatively large.



The electrical energy required for working the device is supplied from the bell battery on the car, and we are informed that so long as there is sufficient energy to operate the bells the arrester will work satisfactorily. Messrs. James Hawley (Ltd.) are the makers of the apparatus, and we are indebted to them for the above information.

Electro-therapeutic Papers at St. Louis.—No less than 12 Papers were read in Section H (Electro-therapeutics) at the International Electrical Congress of St. Louis. Dr. Clarence Skinner reported a case in which X-rays had been employed successfully for a large abdominal tumour. Dr. G. Betton Massey discussed the treatment of cancerous growths by the electrolytic introduction of metallic (zinc and copper) ions. Prof. Maurice Benedikt reported three cases in which an X-ray photograph had been successfully employed to localise the situation of intra-cranial disease. The remaining Papers call for no comment.

MR. C. D. TAITE'S PRESIDENTIAL ADDRESS TO THE MANCHESTER LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.[*]

Permit me to tender you my most sincere thanks for the honour you have done me in selecting me as chairman, for the present session, of the Manchester Local Section. This section is now, and has been for some time, by far the most important branch of the parent Institution, embracing, as it does, over 700 members of the various grades. A students' section was successfully inaugurated last session, and this immediately led to a large increase in the number of students belonging to the section; in fact, at one meeting of the Institution in London, no fewer than 120 new Manchester students were elected. The students start the session with about 250 members, and an excellent syllabus has been arranged, upon which the students' committee are to be heartily congratulated.

I will now pass on to the subject with which I propose to deal principally to-night, as it is the branch of electrical work with which I am best acquainted—namely, electricity supply undertakings, and having had the privilege recently of a tour in America, under the auspices of our own Institution, and also the American Institute of Electrical Engineers, I propose to discuss a few points in which American practice differs from our own. Both in this country and in America, the electricity supply business started in a very modest way with small stations equipped with what would now be considered quite diminutive machines, the main point of difference in the practice of the two countries being that in America all wires and cables were run above ground, while almost from the earliest days, both feeders and distributors in this country were laid underground with few exceptions. If we follow the development over here we find that it has been slow but steady, the small stations being gradually enlarged, until in the big cities they became so unwieldy and so uneconomical, that a new generating station on a comprehensive scale with big units became a necessity, the small stations being used as sub-stations for distribution purposes. A fundamental difference, due to legislative enactments in the methods of dealing with the problem of supplying electricity from central stations, was observed in the two countries from the commencement. In Britain, with the sole exceptions of London and Newcastle, competition in the supply business was prohibited, one provisional order being granted for each city, town or district. In America, on the contrary, a town of the size of Chicago or Philadelphia, would be divided up amongst quite a number of companies, totalling sometimes as many as 20, each operating on a comparatively small scale and frequently adopting entirely different systems as regards voltage and type of current. The development was more rapid over there, on account largely of the absence of those vested interests which here one always finds opposed to any great change, and also because the overhead system of supply enabled cables to be run more easily and much more cheaply than in this country. To the early success of supply undertaking in America is perhaps traceable a great divergence of practice in distributing electricity. I refer to the almost universal system of supplying current in the States at a pressure of 110 to 120 volts direct current for lighting and 230 volts for motors, as compared with our pressures of from 220 to 250 for lighting and 440 to 500 for power.

It seems not improbable that when the higher-pressure lamp came along it was found it would be so expensive to change the arc lamps and motors that the psychological moment was allowed to pass without any alteration being made. Probably another reason was that no company operating in competition with other companies cared to make a change which, at that time, would certainly have caused an increase in consumers' accounts, due to the low efficiency of the high-pressure incandescent lamps. Be that as it may, the Americans, with very few exceptions, did not make the change and probably will never do so now. The result is that their distributing systems—so far as they are laid underground—are, at the present time, very much more expensive than ours, and where the supply necessitates sub-stations and transformation from high tension three-phase to low tension direct current, sub-stations have to be much more frequent than over here. When the American engineers found their original sites becoming too small to meet the increasing demand, they recognised the fact that centralisation of large units under one roof would tend to economy, and there began in the various cities and towns the process of consolidation, with the result that at the present time one generally finds in each city one company only operating, this company being a consolidation of the many pioneer companies.

By a series of developments, therefore, America has arrived at a point which our authorities foresaw from the first, and provided for by refusing to sanction more than one provisional order for a given area, and the evolution which has taken place over there seems to emphasize the fact that the competition which immediately arises between electricity and gas where light is concerned, and electricity and private plants where power supply is concerned, is, in the nature of things, so keen, that to create competition between rival electricity undertakings in the same area is totally unnecessary, and not to the best interests of the community.

In England we are rapidly becoming converted to the advantages of the steam turbine for driving our large units, particularly for alternating-current work. The manufacture of direct-current dynamos suitable for the high speeds at which turbines have to be run has not yet become general practice, although there are a fair number of successful turbo-driven direct-current generators in operation, but, generally speaking, they are of comparatively small size. It is now clear, however, that turbo-alternators can be satisfactorily designed and built for almost any power, and we shall shortly have running the power station of the Underground Railways in London, equipped with 10 5,500kw. turbo-alternators, these machines being capable of carrying a load of 50 per cent. above that at which they are rated. The advantages of turbines have been enumerated so frequently that there is no need to tabulate them here. I would only call attention to two of them—namely, the great capacity they have for overloads, and, secondly, the saving in capital expenditure which their adoption renders possible. A 50 per cent. overload can be maintained permanently on a turbine with little loss of efficiency, the principal loss being generally in the reduced vacuum. It is, therefore, important when ordering turbo-driven plants to specify for ample margin in the generator, in order to take advantage of the overload capacity of the turbine a feature likely to be of the utmost utility in central station work. With regard to the reduced capital expenditure required with turbo-driven plants, it is obvious that the plant itself costs much less than a slow-speed set of similar output, and owing to the reduced weight, the even turning moment and the absence of all downward thrust, the foundation can be made much lighter. Again, a turbine plant—even of the vertical type—can be housed in a comparatively low building, and the floor space occupied is a minimum. On the other hand, in order to get the best results from a turbine an ample water supply for condensing purposes is essential, and this to some extent restricts the choice of a suitable site. As regards coal consumption the advocates of turbines and of reciprocating engines both claim the best results for the type which they favour, but I think that one will not be far wrong in stating that with regard to this feature there is little to choose between the two types when both are working under suitable conditions.

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[*] Delivered November 18th. Abstract.

In America it did not appear that the turbine was making such rapid headway as in this country. One could not help being struck, for instance, by the very large number of slow-speed machines in course of construction going through the shops of the General Electric Co. and the Westinghouse Company of America. On the other hand, at Boston and Chicago turbine stations are in course of construction, the machines being of the vertical type and of 5,000kw. capacity. In both these stations, but more especially in the case of the Chicago station, the division of the plant into units complete in themselves has been very thoroughly developed; thus not only was each set supplied with its individual condensing plant and hydraulic pump for the step bearing of the turbine, which is worked at 1,200lb. pressure per square inch, but there was by the side of each machine a boiler feed pump; the firemen had, therefore, nothing to look after but their boilers and stokers. Each turbine, again, had its own range of boilers, which normally was kept quite distinct from the rest of the boilers, there being only a—comparatively speaking—small connecting pipe between two adjacent ranges for use in case of great emergency; there was also a common chimney for two ranges of boilers. The arrangement, in fact, was practically the same as in the Carville power station in Newcastle, the boiler house being at right angles to the engine room.

With regard to the control of these large units, the Americans have adopted everywhere—in some cases in a most elaborate manner—a complete system of oil-break motor-driven switches with electrical remote control; in some cases duplicate control boards have been provided, so arranged that while one remains in use the other cannot be operated. Duplicate 'bus bars appear to be universal, and they are so designed as to render it possible to sub-divide the feeders and sub-stations which they supply into distinct groups, each of which can be fed by a separate machine. The safety of the employés—as far as the handling of these large units is concerned—has been dealt with most thoroughly, and at the same time elaborate precautions have been taken to prevent breakdowns and also to minimise their effect should a failure of any portion of the plant occur. The oil-break switches themselves are usually arranged in lock-up rooms provided for the purpose. The amount of capital expended on switchgear is very great, but figures giving the percentage of the capital expenditure under this heading were not forthcoming.

With regard to the boiler houses, Babcock & Wilcox boilers, sometimes with mechanical stokers and sometimes without, appeared to be a universal feature of American power houses. It seemed strange to find that in a country where labour-saving devices are specially favoured, owing in some degree to the high rate of wages prevalent, the question of mechanical stokers versus hand firing has not yet been definitely settled. The Americans appear to be in the same state of doubt as to which system is the most economical in the long run as we are in this country. When one hears of widely divergent results being obtained from mechanical stokers of the same make and using similar fuel, one is driven to the conclusion that the personal factor of the fireman has a good deal to do with the results obtained, and in cases where inexperienced men have been employed, owing to the belief that a mechanical stoker only requires watching and oiling, good results can hardly be looked for. Experience seems to show that the quality of the labour required for the mechanical stoker is quite as high as for hand-firing, but the quantity required is less. The fact is the burning of coal—if the best results are to be obtained—requires close attention and strict supervision, whatever be the means adopted for feeding the furnace, and steam users who neglect to take any account of the products of combustion can hardly look for the best results. In these days of automatic recorders there is plenty of choice as regards the necessary instruments for taking records of the flue gases, and when the apparatus is first connected to the flues, the small percentage of CO_2 gas indicated is frequently astonishing.

With regard to the staff employed in a generating station, all those who have visited the States must have been struck by the attention which is given to the personal comfort of the staff, and also to the opportunity which is given to them to improve their technical knowledge, by providing them with club rooms where they may meet and discuss matters of interest; these rooms are open—not only to the technical and office staff, but to every man employed by the company, however humble his position. Encouragement of this kind undoubtedly tends to make a man work more intelligently, and the statement that the men avail themselves largely of the facilities offered them to improve their knowledge, seems to point to the fact that education in America has reached a higher standard than has yet been obtained in this country; this system of encouraging all grades of workmen to learn is a good one, and one which station engineers over here may with advantage take into consideration.

Turning now from central station practice to the question of transmission and distribution of electricity, we find in America conditions which do not exist in this country. The longest transmission scheme which was visited by the Institution of Electrical Engineers on the occasion of the recent tour was that from Shawinigan on the St. Maurice River in the province of Quebec to Montreal, a distance of about 90 miles. Power is transmitted on this system at a pressure of 50,000 volts, the current being three-phase at 30 periods, and the conductors being of aluminium. The line runs the whole distance alongside the railway, which is convenient, as the country is quite new and transport difficulties would otherwise arise. This transmission scheme is typical of many other cases, with the result that three-phase working from the transmission point of view was developed much earlier than was the case in this country, where the necessity for high-tension transmission did not arise so soon. At the same time it is noteworthy that while the three-phase transmission schemes have been perfected, the distribution schemes are almost invariably on the original system of three wire direct current at 110 to 120 volts between the neutral and each of the outers, with a certain amount of alternating current for the scattered suburbs. The question of speed regulation of motors has undoubtedly had a great deal to do with the general adoption of direct current, while with regard to the low supply pressure referred to previously, it was stated that not only did expense stand in the way of any change to a higher pressure, but in the interests of consumers themselves, the lower pressure was preferable owing to the higher efficiency claimed for the lamps. The latter argument was undoubtedly one of considerable force in this country years ago, when the first changes to the higher pressure were being made, but at the present day there is little to choose in efficiency between lamps of 110 and 220 volts, and the saving in capital expenditure, not only on the cable system, but also in the houses of consumers, makes the higher pressure undoubtedly the most economical for both supplier and consumer. With regard to lamp pressure, the Edison Companies control a large number of stations and arrange matters so that the standard pressure in the various towns varies only very little; this is done in order to utilise to the fullest extent the lamps turned out by the lamp makers, the specification and standardisation of these lamps for the various pressures being very rigid.

Electricity is in much more general use in America for all purposes than is the case in this country, in spite of the fact that in the large cities, at any rate, the price charged is considerably higher than in England; thus in Boston, where they have a lamp connection of 500,000 16 c.p. lamps and 24,000 H.P. in arcs and motors, the normal flat rate for lighting is 10d. per unit, subject to discounts according to current consumption; a small power consumer pays 3d. per unit, and the lowest figure quoted to any party is 1d.; on these prices we were informed that private plants were rapidly being given up. At Chicago the price was on the maximum demand system, with Wright indicators, the tariff being for lighting 10d. for 30 hours' use per month of the maximum demand, and 5d. for all current used in excess; similarly for power the price charged was 5d. and 2½d. Similar prices were charged in most of the other large cities visited. Watt meters are universally used for registering the current, as compared with our system of ampere-hour meters.

With regard to output, the New York Edison Co., with a population in its area of about 2,000,000, has a maximum load of 50,600kw. for lighting and power, with an annual output of 131,000,000 kw.-hours, which is a greater output than all our London companies and municipalities combined can muster. Montreal is an exceptional case, but it is so interesting that its position is worth recording; it has a population of 350,000 and 10,500 consumers, compared with the 5,171 consumers of Manchester, with a population nearly twice as large. The annual consumption, which includes power for the tramway service, is no less than 85,000,000 kw.-hours, and the company which supplies the current is the fortunate possessor of a 75 per cent. load-factor. Amongst the consumers at Montreal is a 3,000 H.P. cotton mill, which is driven throughout by electricity, paid for at the rate of ½d. per kilowatt-hour; the mill has arranged its hours of work, so that in certain winter months no current is taken between the hours of 4 p.m. and 7 p.m., hence the low rate of charge. This alteration has only necessitated a reduction of the average weekly working hours from 56 to 54. We were informed that the output from this mill had increased 40 per cent. since the conversion to electric driving, owing to the greater flexibility of the system and improved machinery, as compared with steam driving. That 40 per cent. represented greatly increased profits, the costs, exclusive of the raw material, being practically constant. There is no doubt but that it would pay many of our north country stations handsomely to supply current between certain hours at ½d. per unit, and it would not require much modification of mill hours to accommodate themselves to a power supply which would only be shut off in the months of November, December, January and February, from 4 p.m. to 7 p.m. Such a striking example of what can be done in the way of obtaining a good load factor is well worth the consideration of all those who have to deal with the supply of electricity in this country, it being remembered that improvement in the load factor, even if it be obtained at a low margin of profit must eventually be the means of a reduction in price to the general body of consumers.

Municipalities in America, at any rate in the larger cities, and to a considerable extent in the smaller ones have not cared to take up the position of public suppliers of electricity, as has been done in this country; they have instead given franchises, usually for 50 years or thereabouts to companies, who appear to be organising their business on a very sound basis. The companies frequently have a wiring department, and in some of the cities this department nearly monopolises the wiring business of the city. The lamp question has been solved in America by giving the consumer free lamps; the Edison Companies—of which there are a great number—have large local organisations for dealing with this part of their business. Every consumer starts his installation with lamps furnished by the supply company, nominally on loan; he may have these lamps changed as often as he thinks fit, and in case of the theatres, where coloured lamps are frequently required, they are often changed weekly without any charge outside the cost of carriage. All lamps prior to being sent out are tested for candle-power and consumption, the limit for a 16 c p. lamp being in the region of 14·5 c.p. and the consumption 3·2 watts per candle-power; all lamps are marked with their voltage, candle-power, and with the name of the supply company. When lamps are brought in, should they give less than 14·5 c.p. at normal voltage, they are, if sufficiently good, put aside for colouring for shop signs and theatrical purposes; otherwise, if too much blackened, they are destroyed. The life of the lamp is only reckoned as about 500 hours; their price is 7½d. We were told that the system of giving lamps free added about ¼d. per unit to the price of current, but that figure seems to be rather under the mark, the total cost of the system being about ⅓d. and ½d. Be that as it may, the effect of the system on the incandescent lighting is very marked; lamps in the shop windows always look bright, and give a good light, and blackened lamps are as rare in America as they are common in this country. It is difficult, however, for engineers in this country to recommend their directors or committees to adopt exactly the same system here; the companies in America, by doing the bulk of the wiring themselves, have not to consider the effect of giving free lamps on the position of the wiring contractor; in England, on the other hand, it is very rare to find a company or a corporation doing the wiring of the district; this is in the hands of the contractors, who calculate to make a steady income out of the sale of lamps, and there would naturally be a great outcry on the part of these gentlemen if the free lamp system, as adopted in America, were introduced on a large scale into this country. On the other hand, some such system seems to be the only way of insuring that the consumers get a thoroughly satisfactory light with a minimum expenditure of current, and if the manufacturers were aware that all their lamps would be tested by an independent authority, and would be returned if below a certain standard of efficiency, it would make them more careful as regards the class of lamp they send out. The American system, however, has its drawbacks; thus, the consumer being assured of a free supply of incandescent lamps, has very little encouragement to try any new type of lamp, such as the Nernst, and it is a fact that in America so small is the demand for Nernst lamps, where direct current is supplied, that a design suitable for direct current has not yet been put upon the market; the lamp is in the hands of the Westinghouse Company, and is used on alternating-current circuits only.

Generally speaking, the average American seems to have a much better appreciation of electricity for all purposes than the average Briton; he has appreciated its virtues and has adopted it accordingly. He also appears to have made up his mind that it is more profitable to him to buy his supply from the public mains at a price giving a reasonable margin of profit to the company than it is to worry about a private installation. His money can be invested to better account in plant suitable for his own processes of manufacture, and he prefers to put his whole energies into his own business rather than be troubled with the details of a private plant. It is a remarkable fact, and one much commented on in America, that while the American generating costs are as a whole no greater than similar costs in England, being, in fact, considerably lower than are obtained, generally speaking, by London stations, yet the selling price of current in America has to be considerably higher than the price in England in order to obtain the same return on the capital invested. It was a matter of great difficulty to obtain detail costs—including management charges—of American supply undertakings, but it seems pretty clear that the cost of the various consolidations that have taken place has been very appreciable. To begin with, the original companies which formed the consolidated company had frequently adopted different systems of generation and supply; thus some would be alternating with different periodicities, while there would also be considerable variation in the supply pressures. To bring these various systems on to a common basis has been an expensive matter, and it is well known also that consolidations of this description rarely take place without the creation of a large amount of paper capital. In America the coal bill is low, due to the use of large and economical units, but the capital expenditure per kilowatt installed is high, owing to the charges which have had to be made in assimilating the systems of the various companies and in effecting the consolidation. From the companies' point of view the position is a satisfactory one, as a monopoly has been established, but from the point of view of the consumer it will be some years before he feels any financial benefit from the process of evolution which has taken place. This experience emphasises in a marked degree the necessity for careful finance with regard to capital expenditure.

The supply of electricity business is different to most others with which we are familiar owing to the preponderating effect of capital expenditure as compared with running costs upon the selling price, and it behoves us, therefore, to do our utmost to prevent the capital of the undertakings with which we are concerned being unnecessarily inflated; as plant becomes obsolete the capital it represents should be written down out of revenue, and although this may mean a temporary loss of apparent profit, the undertaking will soon reap the benefit by the increased business which the reduced charges will bring in. It cannot be driven home too strongly that a heavy capital expenditure per kilowatt installed is bound under ordinary conditions to necessitate a high tariff with a correspondingly restricted business. To undertakings, whether worked by companies or municipalities which intend to cultivate a power load, this is a matter of great importance, and I am of opinion, therefore, that where current has to be transmitted to scattered areas, overhead wires should be as far as possible adopted; where it is necessary, as in the case of the power companies, to convey electricity in many directions over huge areas, it would seem that overhead conductors are essential, if the companies are to attain financial success. That it is important to all of us, in whatever branch of the profession we are employed, that these power companies should be successful, is, I think, self-evident; any development in the use of power in their areas cannot but stimulate the demand for electricity throughout the country generally. We shall all watch, therefore, with the greatest interest—not unmixed with anxiety—the progress made by the pioneer stations which these companies are equipping; apart from the supply of power to mines and factories, they should have a large sphere of usefulness in supplying current, not only to those towns which have not generating stations of their own, but also to those which have. In many cases I think it will be found to be to the best interests of those concerned to purchase current from outside, in preference to carrying out expensive extensions to existing works, provided that the prices quoted are as reasonable as one has been led to suppose they will be; in any case municipalities and others will do well before embarking on extensive schemes of expansion to inquire what the power companies are prepared to do, and to compare the terms quoted with their own costs, not forgetting the effect of the proposed capital expenditure on the selling price.

The chairman's address was followed by a smoking concert, Mr. Giles, of Blackburn, having arranged the programme, which included two songs by himself. In "Off to Philadelphia" the words "Off to Capetown" were used by some of the company; "Blackburn" was substituted for "Old Ireland." This was occasioned by the fact that Mr. Giles will shortly take up an important appointment in South Africa. In reply to the toast of his health, he made a farewell speech to the section in a few well-chosen words. Mr. P. C. Pope's humorous songs, "A Dynamo Legend" and "The Institution Pilgrimage," were hailed with great delight. Mr. E. H. Liebert's violin solo, Messrs. Liebert, Wood and Ainsworth's overture and trio, Mr. J. M. Gibson's and Mr. Welbourn's songs were much appreciated. Mr. F. P. Wood's rendering of "Die Beiden Grenadiere" (Schumann) was exceptionally good. A smoking concert is distinctly new in connection with the Manchester Section, and Mr. A. A. Day, in seconding the vote of thanks proposed by the secretary, Mr. Ramage, to those members who had contributed the musical progamme, said that the chairman, Mr. Taite, was to be complimented on the innovation.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Radio-activity of Salts.—R. J. Strutt has examined a hard deposit, left in the lead pipes of some old Roman baths, for their radio-activity. As might have been expected, their radio-activity is considerably less than that of similar fresh deposits. He adds that it would be rash to draw any positive conclusion from this fact, for we are ignorant of the precise conditions under which the Roman deposits were formed. But the idea suggests itself that the radium has been here separated from its parent (uranium ?), and is consequently much diminished in activity after a lapse of 2,000 years. The author continued the researches begun by Blythswood and Allen on the radio-activity of well waters, and found that the activity of the dissolved gas extracted by boiling from the freshly-collected water is very great compared with that due to the dissolved radium. The gas bubbling up with the water is not so active as that extracted by boiling. If the radio-activity of the Bath waters has any connection with their reputed medicinal value, the dissolved emanation, and not the traces of dissolved radium salt, must be the agent principally concerned. Samples taken at Brighton, Bath, Kelso and other places exhibit slight differences between the activity of the gases collected by boiling or otherwise at the various springs. These, however, may well be due to differences of temperature and to differences in the conditions under which the bubbling gases are exposed to the dissolving action of the water near the place of collection. The quantities of emanation in the water show clearly that it must have had access to large quantities of radium; indeed, the radio-activity so frequently associated with thermal springs is suggestive of the conclusion that radium is a far more abundant constituent of the internal portions of the earth than of the external ones. In any case, distinct radio-activity appears to be much commoner in the saline residues of waters than in rocks.

[Hon. R. J. STRUTT, *Philosophical Magazine*, November, 1904.]

Radium Rays and Penetrating Röntgen Rays.—A. S. Eve adduces some evidence to show that the γ-rays of radium are identical with "hard" or penetrating Röntgen rays. The chief objection to this view has hitherto consisted in the wide divergence of the effects produced by the respective rays when ionising various gases and vapours. The three types of rays from radium all produce ionisation currents proportional to the densities of the gases through which the rays pass. The Röntgen rays have been found to diverge widely from this law. Thus, in methyl iodide, which has a density five times that of air, the γ-rays produce an ionisation 4·8 times as great as in air, but the Röntgen rays produce an ionisation 72 times as great. Rutherford suggested that the more penetrating rays from a hard bulb might give figures approximating to those obtained from γ-rays, and the author has found this to be the case. Thus, in chloroform, with a density of 4·3, the previous value for the relative ionisation, amounting to 32, was reduced to 4·6. Similarly good results were found in the case of sulphuretted hydrogen, sulphurous acid and tetrachloride of carbon. The value for methyl iodide was reduced from 72 to 13·5. The author also deals with Paschen's claim of having proved that the γ-rays are projected particles with a negative charge. He says that an endeavour to deflect these rays in a very powerful magnetic field has failed to show any curvature of the rays. Moreover, if radium is enclosed in a mass of lead several centimetres thick, negatively-charged particles are projected from the outer layers of the lead. These can be readily deviated in a magnetic field and are absorbed by 1mm. or 2mm. of lead, whereas the γ-rays will penetrate several centimetres. Thus the γ-rays give rise to a secondary radiation of the cathode type, and it is this radiation which Paschen has detected and which he incorrectly concluded to be γ-rays. That the γ-rays are produced from the β-rays at the time of the projection of the electrons is made very probable by the fact that in all changes of radium the β-rays and γ-rays always appear together and in the same proportion.

[A. S. EVE, *Philosophical Magazine*, November, 1904.]

Absorption of Radium Emanation by the Human Body.—J. Elster and H. Geitel have tested Ashworth's contention that air breathed out of human lungs has a conductivity due to ionisation. Ashworth attributes the bad insulation of electroscopes in the lecture room to such ionisation due to the breath of the audience. The author found on measuring the ionisation of the human breath that it contains no proportion of ions above the normal proportion in the atmosphere. They conclude that there was an unknown source of error in Ashworth's experiments. They then proceeded to test the breath of a man who spends several hours daily in a room where radium preparations are made. This was F. Giesel, the well known radium physicist. He was asked to blow air into the apparatus, some 18 hours after he had left his laboratory. The result was a degree of ionisation distinctly above the normal. The breath had to pass through a cotton-wool filter and a tube cooled with water at 8deg. The normal loss of potential was 10·6 volts per hour. Immediately after the entrance of the breath it rose to 25·4. In seven hours it rose to 29 without further breathing meanwhile, and then it gradually fell, being 15·1 after 72 hours. The rise within the first few hours shows that we have to do with emanation, which decomposes and forms the three deposits, Radium—A, B and C. That there is some induced radio-activity is evident from the fact that after 72 hours, on replacing the breath by fresh air, the loss of potential was 16·2 volts per hour, which decreased to 9·1 volts in about four hours. The rate of decay also agrees with that of radium emanation. The authors found that Herr Giesel was himself a radio-active body, the substance having permeated all his tissues. They now propose to test whether a similar radio-activity is imparted to the human body by the consumption of water holding radium in solution.

[ELSTER and GEITEL, *Physikalische Zeitschrift*, November 1, 1904.]

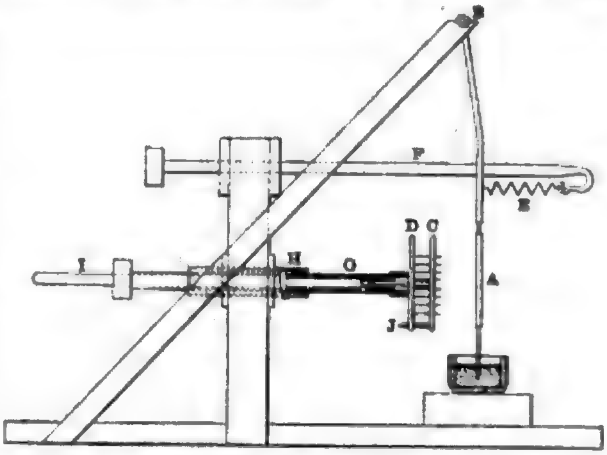
Actinium.—A. Debierne protests against the independent name "emanium" given by Giesel to the active lanthanum prepared by the latter. He shows that this emanium resembles actinium in all its chemical and physical properties, the only difference lying in its mode of preparation, which yields it in association with lanthanum instead of thorium. It is distinguished from radium by the fact that its emanation easily issues from solid compounds, and its ionisation is much greater than that produced by the rays of the original body. The actinium emanation decays to half value in four seconds. The rate of decay of "emanium" is not yet quoted, but it will probably be found to be about the same.

[A. DEBIERNE, *Physikalische Zeitschrift*, November 1, 1904.]

Acetylene Standard of Light.—C. Fery maintains that acetylene will burn satisfactorily for photometric purposes when issuing from a capillary tube of glass or steatite. He uses a thermometer tube about half a millimetre in internal diameter. A flame 24mm. high gives about 12 c.p. Its maximum of luminosity is at one-third of its height. If, therefore, the jet changes in height, the point of maximum luminosity only shifts by one-third of the amount, and the risk of variation is lessened to that extent. It is essential that the tube should be a bad conductor of heat. Otherwise the aperture, remaining cool, is clogged with distillation products. The height of the flame should be from 22mm. to 28mm. The consumption of gas is 7 litres per hour.

[C. FERY, *Journal de Physique*, November, 1904.]

Automatic Potential Regulator.—Having occasion to maintain potentials from about 5,000 volts on, which were kept up by a Toepler-Holtz machine driven by an electric motor, more constant than is possible with an ordinary point overflow to earth, A. W. Gray designed a simple arrangement which ensures a greater constancy. A light disc A of polished metal is suspended by means of an insulating rod from a suitable support, so that it can rotate with the least possible friction about a horizontal axis B. Opposite A is mounted another disc C, through small holes in which project a great number of needles fastened into a third disc D. Extending downward from A is a rod carrying at its lower end a light metallic plate, which serves at the same time to damp the motion of A and to make electrical connection between it and some slightly-diluted glycerine contained in a glass trough resting on a block of paraffin, and having some calcium chloride dissolved in it to render it conducting. A wire dipping into the glycerine connects A with the positive terminal of the machine, while another connects C and D with the negative. The needle points opposite A form a number of point overflows which are all in operation at the same time, so that the P.D. between A and the needles is maintained at a fairly definite value, depending on the distance between them, as long as the source of electricity furnishes a sufficient supply. Besides the advantage of the multiple points, there is a gain effected by the movement of the plate A. The attraction due to the electrostatic field between A and C is counterbalanced by the delicate spiral spring E, whose tension is adjusted by pushing the glass rod F through the cork that supports it. Any increase in the potential now causes the disc A to move towards the points, thus hastening the overflow, while a decrease causes the spring E to draw A away and lessen the action of the points. The original adjustment is made by sliding the tube G through the tube E. The author has maintained a potential of 12,000 volts for hours within 1 per cent. without further attention.



[A. W GRAY, *Physical Review*, November, 1904.]

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THE LOCAL SECTIONS.

The Local Sections of the Institution of Electrical Engineers have now commenced work for the session 1904-1905 in real earnest. Each chairman has given a starting signal in the shape of an admirable presidential address, and the various committees have laid before the members programmes which possess many features of interest. It appears, however, that there is a certain amount of difficulty in persuading members to read Papers, and last year in at least one instance it was necessary to substitute a visit to works for an ordinary meeting. On other occasions Papers read before the Institution in London were discussed, a plan which has much to commend it, as it is unquestionably valuable to have the opinions of engineers other than those who attend the London meetings upon the more important Papers presented there; but there is cause for regret that such a mode of procedure should have been adopted, not from choice, but from necessity. The reason for a falling off in the number of good Local Section Papers cannot be want of talent, since many of the large manufacturing firms have their works in provincial centres, and many of our most prominent engineers have made their homes there. The only two alternative explanations are, therefore, lack of time and disinclination. Engineers are notoriously busy men, and we would not have them otherwise, but they must not forget the objects for which the Institution was formed. It is not sufficient that members should occasionally attend the meetings, less occasionally join in the discussions and never contribute a Paper. They are not studying the interests of the Institution, to say nothing of the profession at large, by so doing. This sort of thing is the indirect cause of the younger members remaining silent while a few veterans are expected to provide not only material for discussion, but, frequently enough, the discussions themselves. The formation of students' branches in connection with all the Local Sections would do much to check this tendency; such a branch has been formed at Manchester with almost phenomenal success. In his Presidential address to the Manchester Local Section, Mr. C. D. TAITE called attention to the fact that at a single meeting of the Institution in London no fewer than 120 new Manchester students were elected, and that the students start the present session with about 250 members.

The remainder of Mr. TAITE's address dealt principally with his visit to America with the Institution party. He contrasted the growth of electricity supply undertakings in America with those in this country, and expressed the opinion that in view of the existing keen competition between gas and electricity it is not in the best interests of the community to create competition between electricity supply undertakings. He drew a moral from the conditions prevailing in the United States, which emphasises the necessity of keeping down capital expenditure It seems that in spite of American generating costs being, as a rule, no greater than the corresponding English costs, yet the selling price of energy has to be considerably higher in order to obtain the same return on the capital invested. The reason for this is not far to seek: In the early days of electric lighting licences were granted to several companies to supply in the same area, but as time went on these companies became amalgamated, and as their systems of generation and distribution varied greatly, enormous sums of money had to be expended in order to bring them into line. In England only one Provisional Order, with certain exceptions, was granted for each area, and this expenditure was avoided. But Mr. TAITE goes further than this, and advances the proposition—a bold one to be made by a municipal electrical engineer—that local authorities already possessing their own undertakings should take supply in bulk from the power companies instead of extending their own works. A few weeks ago a press representative obtained from Lord Welby, Chairman of the Finance Committee of the London County Council, the expression of opinion that the Local Government Board should fix a limit beyond which municipal indebtedness should not be extended except for necessary sanitary improvements, the limit to be fixed in proportion to the rateable value in the municipal area in question. The difficulty in applying this to expenditure on electricity supply undertakings is that those local authorities who are undertakers under the Electric Lighting Acts are bound by statute to meet the demands of new consumers within reasonable reach of their mains. Mr. TAITE's suggestion, it will be seen, affords a means of overcoming this difficulty by enabling the local authority to add new connections to its mains without considerable increase in its capital commitments. The same course may commend itself to some companies who are desirous of curtailing their capital expenditure.

Turning to Mr. MARK RUDDLE's address to the Dublin Local Section, we are once more confronted with the well-worn theme of technical education. It is a difficult matter to say anything fresh on most engineering subjects, and technical education is, perhaps, the most difficult of all in this respect, but Mr. RUDDLE has contrived to bring some interesting aspects before his hearers, and his address is by no means the wearisome compilation of statistics and data relating to foreign technical education with which we are all too familiar. He rightly expresses his disbelief in the "born engineer" theory; no matter what natural ability a man may possess, he can never become a great engineer without a long course of laborious training, whether that training be obtained in the technical college or in the great college of experience. Mr. RUDDLE utters a timely word of warning against the "great inrush of young men into anything electrical in name." There are young men who are "satisfied to acquire just enough technical knowledge to secure a post. . . . Football, cricket, cycling, and often matrimony, or the preliminary stages of it, claim their leisure hours entirely. . . ." We have more compassion for the young men who are not idle, but who secure a more or less hurried and imperfect technical training at some obscure institute, simply because they cannot, through no fault of their own, afford anything better. There are hundreds of these turned loose in the electrical industry every year, and their prospects of ever becoming eminent or even very useful are poor indeed. Added to them are some other misguided individuals who pay premiums "to learn electrical engineering" in some small municipal electricity works, and their prospects are, if anything, somewhat worse than those of their technical college brethren.

Dr. W. E. SUMPNER's address to the Birmingham Local Section dealt with measuring instruments for alternating currents. As the author pointed out, continuous-current instruments are much more accurate and sensitive than alternating-current instruments, and moving-coil instruments of former type possess the further advantage that their indications are proportional to the current passing instead of to the square of the current, as is the case in alternating-current instruments. Dr. SUMPNER did not enter into great detail regarding alternating-current ammeters and voltmeters, but devoted the larger part of his address to a detailed description of a phase-meter and an alternating-current wattmeter of improved pattern, which had been built to his design and tested by him. The phase meter or power-factor indicator consists, as do all such instruments, of two windings, one fixed, the other free to rotate about a diameter, but the instrument appears to have been rendered exceptionally powerful and economical in operation by distributing the fixed winding on circular ring stampings, after the manner of the stator winding of a three-phase induction motor. A useful hint is also given in this part of the Paper concerning a method of connecting a reversing switch between the power-factor indicator and the mains, so as to render possible accurate phase readings with very low power-factors. Dr. SUMPNER then drew attention to alternating-current wattmeters, and, *en passant*, he mentioned a wattmeter method for measuring the iron losses in transformer iron, which he had occasionally used with good results. It is a remarkable coincidence that this method is identical in principle with the method suggested by Mr. L. W. WILD in *The Electrician* of November 11th, p. 128. Much interest and value attaches to Dr. SUMPNER's technical description and experimental data regarding the electromagnetic type of alternating-current wattmeter. It is true, of course, that the readings of this wattmeter are not independent of frequency and power-factor, but the inaccuracy introduced into the readings by a varying power-factor does not appear to be very serious. It certainly is comforting to learn that a common water resistance, although not strictly non-inductive, yet had a power-factor equal to 0·999978; but it is a pity the audience was not taken into the author's confidence as to how these very accurate and imposing figures were obtained. Dr. SUMPNER, it would appear, has accomplished the feat of measuring power-factors with greater accuracy than is usually attainable in ordinary resistance measurements!

THE USE OF IRON IN ALTERNATE-CURRENT INSTRUMENTS.*

BY DR. W. E. SUMPNER.

It is probably no exaggeration to state that the amount of time, ingenuity and skill devoted during the last 10 years to the improvement of alternate-current instruments has exceeded that spent in perfecting those for direct-current measurements during a period more than twice as long. Yet no one will maintain that the result is anything like so satisfactory in the former case as in the latter. It will, I hope, be interesting to spend some time this evening in considering the reasons for this, and what prospect there may be of a better result in the future.

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* Chairman's inaugural address to the Birmingham Local Section of the Institution of Electrical Engineers, delivered on Wednesday. Slightly abridged.

The first idea that will no doubt occur is that alternate-current measurements are more complicated than those with steady currents, and that in consequence, the tests are not likely to be so accurate. Now, I believe this view to be entirely wrong. Direct-current measurements, as the result of a development spreading over many years, are really much more numerous and varied, and are certainly quite as intricate in character as those practised in alternate-current working. It is not so much in the nature of the measurements to be made, as in the character of the instruments available for the tests, that the difference really lies. The result, I believe, is almost entirely due to the fact that for alternate currents there is no instrument at all comparable in sensitiveness with the galvanometers and voltmeters available for steady current work.

Now perhaps this idea, though familiar to some, will take others by surprise. But if we proceed to consider how much all good direct-current tests depend upon sensitive galvanometers or voltmeters, we shall, I think, most of us be surprised. Take the three fundamental cases of the Wheatstone bridge, the potentiometer, and the voltameter. In each of these instances the accuracy of the test is directly dependent on the use of a delicate voltmeter to adjust to equality two voltages. In the first case, the adjustment is made in order to measure a resistance in terms of a standard. In the second, by means of known resistances, a current, or voltage, is measured in terms of these resistances and the E.M.F. of a standard cell. In the third case, in which, say, a current balance is being standardised, although the voltameter measurement does not need a voltmeter, the adjustment of the current to a constant value is directly dependent on the use of such an instrument, and this adjustment is just as essential to accuracy as the correct measurement of the amount of chemical action. Measurements of insulation, magnetic induction and capacity would hardly be possible without delicate galvanometers. Indeed the sensitive voltmeter seems the one common essential to all accurate electrical testing.

It is, of course, to the use of permanently magnetised steel that direct-current instruments owe their great sensitiveness. Whether of the fixed-coil or moving-coil types, galvanometers may be described as single-current instruments in which the deflecting force is proportional directly to the current or voltage applied. Unfortunately all alternate-current instruments have the characteristics of the double-current type, in which the deflecting force is proportional to the square of the current or voltage. This is obviously true of dynamometers, current balances, wattmeters, phasemeters and electrostatic instruments. It is also true of induction instruments, whether the current induces magnetism, as in moving-iron instruments, or eddy currents, as in the more recent induction meters. Hot-wire instruments have the same characteristic, since the heating effect varies as the product of volts and amperes. Instruments in which the deflecting force varies as the square of the applied voltage cannot be made sensitive for minute voltages, owing to the rapid diminution of the force as the voltage decreases, and this constitutes the main reason why alternate-current instruments cannot be made to indicate low voltages.

Hot-wire instruments are as yet the most suitable for measuring small alternating voltages. Commercial instruments can be obtained reading from 1 volt down to about $\frac{1}{10}$th of a volt. Prof. Threlfall has described an instrument before this Institution capable of measuring $\frac{1}{15}$th of a volt, and Prof. Fleming has shown a somewhat similar instrument to the Physical Society of London. Mr. Duddell has recently made an instrument which may be described as a combination of a hot wire voltmeter with the radio-micrometer of Prof. Boys, the heat from the wire causing a thermo-electric current in a delicately suspended electric circuit placed in the field of a strong permanent magnet. With such an instrument, using as pointer a reflected ray of light, with the scale at 1 metre distance, it is possible to get a deflection of more than 1cm. per *microwatt* spent in the hot wire. But such instruments, and especially the last, are more fitted for laboratory and research purposes than for ordinary testing.

An instrument may be made sensitive either by weakening the control, or by increasing the forces causing the deflection. The strength of the control is a fair measure of the suitability of the meter for ordinary commercial work, since the weaker the control the more tenderly must the instrument be used, and the more liable are its indications to be affected by extraneous influences. The true measure of the sensitiveness (except for research purposes) is therefore the turning moment exerted per unit of current or voltage applied. Now it is generally stated that a galvanometer of the fixed-coil, or Thomson, type is more sensitive than the moving-coil form of instrument; but this is merely due to the fact that the control used can be made, and is made, much weaker in the former than in the latter case. With equally strong control the permanent magnet form of instrument is much the more sensitive of the two, owing to the strength of the field applied to the coil conveying the current to be measured. In order to make alternate-current instruments as sensitive as the corresponding direct-current ones, strong magnetic field must be produced. The permanent magnet is useless for alternate-current work unless satisfactory instruments of the vibration type can be devised; but the electro-magnet, the most powerful form of magnet, still remains a possibility. Electro magnets are not used in galvanometers because existing instruments are sufficiently responsive, and thus only when extreme sensitiveness is needed—as, for instance, in the oscillograph—is any one willing to put up with the inconvenience of supplying a subsidiary magnetising current, and maintaining it of constant strength. The problem of producing sensitive alternate-current instruments resolves itself therefore into an inquiry into the conditions under which iron-cored electro-magnets may be introduced into such instruments, without involving errors due to differences of phase, frequency, wave-form, and other disturbing factors.

Now, before discussing how to use iron in alternating current instruments, it must first be stated that this is already done in many cases, as in moving-iron indicators, and in instruments of the eddy-current type. The latter now form an important class, and are either of the shielded pole type, the outcome of some pioneer experiments of Elihu Thomson, or of the rotary field type due originally to Ferraris. The rotating field instruments are particularly useful. They have the great advantage that the geometrical relations of the fixed and moving parts are not changed as the disc or cylinder turns, so that the indicating instruments possess regularly dividing scales and a range of deflection extending to nearly 360deg. Such instruments have many undoubted merits, but their calibration varies with frequency, and to a slight extent with wave-form. The wattmeters of this class are indeed not much more than good indicators. They fulfil all the requirements of central station use, but for accurate measurement something more is needed.

The first instrument to which I wish to direct your attention is the phasemeter or power-factor indicator. These instruments may be made for either single or multiphase circuits. In the former case the calibration depends somewhat on the frequency, but only very slightly so in the latter. All such instruments consist of a fixed and moving set of coils having a common diameter about which the moving system turns. The moving system is quite free to revolve. There is no control except that due to the interaction of the currents. Each system may comprise more than one coil, but as a rule the fixed system consists of a single coil through which the current passes, while the movable system consists of two coils inclined at some fixed angle to each other, and traversed by currents in different phases, obtained usually by tapping the multiphase mains, but, in the case of single-phase circuits, by providing two paths of different inductive properties for the pressure currents needed for the coils.

Now, in the theory of these instruments as hitherto given, the action of the current in the fixed coil on that of each of the moving coils is separately considered. Two moments are exerted, one on each moving coil, and the position of balance indicated by the pointer is such that these moments are equal and opposite. This position is independent of the amperes, or volts, since alteration in either of these equally affects the two moments, so that if these moments are balanced for, say, 20 amperes, they are equally balanced for 80 amperes. The position of balance can, therefore, only depend upon the phase differences between volts and amperes, and hence the deflection of the pointer can be calibrated to indicate phase. But there is another way of looking at the action which is useful to consider, and which, I think, has not been previously noticed. The two-coil system traversed by currents in different phase produces a rotating field, and the interaction between this and the alternating (or rotating) field due to the current (or currents) in the other system of coils must be such that there is only one stable position of the moving system of coils for which the torque vanishes, and this position can only depend upon the phase differences involved in the two systems of currents. This is illustrated in rotary synchronisers, such as that of Everett-Edgcumbe, the rotor and stator of which are each wound so as to produce a rotating field by splitting a single-phase current into an inductive and a non-inductive branch. If two generators are joined up, one to the rotor and the other to the stator, the rotor revolves rapidly if the frequencies are different, but as these approach equality the rotation is slow, clockwise if one machine leads, counter clockwise if it lags; the position of the pointer indicates at each moment the phase difference of the two currents. If the two machines are coupled together so as to generate voltages in fixed phase relation, the pointer attached to the synchroniser takes up a fixed position in correspondence with this phase. The instrument thus becomes a phasemeter and can be calibrated as such, but in its present form it is not suitable as a power factor indicator.

Now imagine a coil traversed by an alternating current placed in a rotating magnetic field of the same frequency, and free to turn about the axis of rotation of this field. The position taken up by the coil depends merely upon the phase of the current through the coil. If we assume uniformly revolving fields, and currents varying according to the sine law, the position will be such that at the instant the rotating field is parallel to the coil, the current in the latter is passing through its zero value. The angular deflection of the pointer from some fixed point on the scale measured in degrees will be an exact measure of the phase of the current. If the currents are of irregular wave-form, and the rotating field is not uniform, this will not be precisely the case (see Appendix), but there will in all cases be a fixed position of the coil for each phase, independent of the magnitudes of the currents in the different coils, and quite independent of the frequency, since this will affect currents and fields alike. The most efficient way of producing strong rotating fields is, of course, well known. It is exemplified in every induction motor. But it does not appear to have been noticed hitherto that phasemeters really act by means of rotating fields, and hence the means adopted in practice for producing such fields in commercial instruments are anything but the best available.

To illustrate this and other points I have had some instruments constructed in the Technical School workshops, all designed for strong alternating magnetic fields. In one of the phasemeters made the fixed coils are wound through circular ring stampings just as in the stator of a three-phase motor. There are three coils, each of eight turns, wound with wire suitable for 5 or 6 amperes, with each coil brought to a separate pair of terminals. The portion corresponding with the rotor consists of a cylindrical block of circular stampings held in a fixed central position, and unwound. In the air-gap between the two is placed a pivoted coil similar to those used on moving coil galvanometers or voltmeters, but without control. It is capable of free motion about the axis of the instrument, and its position is indicated on the scale by an attached pointer. The position taken up by the pointer is quite definite under any given circumstances, and if the coil is moved out of its equilibrium position the forces tending to make it return are considerable, in spite of the fact that a very large non-inductive resistance is used in series with the pressure coil. This is only what is to be expected, since the strength of the field due to the fixed coils is about equal to that usual in permanent magnet direct-current instruments. Here at all events is one alternating-current instrument in which strong fields are employed without any of the disadvantages and errors supposed to be associated with the use of iron under such circumstances. Of course, it would be possible to wind the fixed coils for pressure instead of current, either for direct connection to the mains or, if necessary, for the secondary of a step-down transformer. In many cases the moving coil would be put in series with the secondary of a current transformer. It is usual now with high-tension mains to have two current transformers, each primary being placed in one of the mains, and each secondary circuit, after passing through an ammeter, returning through a path common to both secondary circuits, and in which an ammeter and power-factor indicator are placed. The connections are shown diagrammatically in Fig. 1, in which A_1, A_2, A_3, represent the ammeters, (1), (2) and (3) indicate the mains, in the first two of which the primaries of the current transformers CT_1 and CT_2 are placed, and the power-factor indicator is represented by P.F.I. Owing to the vector properties of alternating currents, if the current transformers are alike, the current measured by the ammeter A_3 will indicate the current in the third main, as shown by the vector diagram in Fig. 2. With such an arrangement it would be advantageous to use a reversing switch (short-circuiting during reversal) on the secondary of one of the transformers, say CT_1, as indicated in Fig. 1. By reversing this switch A_2 is unaltered, A_1 becomes A^1, equal but opposite in phase to A_1, and A_3 A'_3, about 70 per cent. greater than A_3 in magnitude, and strictly in quadrature with it, whatever the wave-form may be, provided only A_1 and A_2 are equal in magnitude. Owing to the properties of a right-angled triangle, A'_3 is perpendicular to A_3 if A_1, A'_1 and A_2 are equal to each other, whatever may be the phase difference between A_1 and A_2. The advantage of this device arises from the fact that the power-factor indicator can be made to read on circuits of low power-factor as well as on those of high power-factor. As a rule these instruments are calibrated between power-factors 0·5 and 1·0, and are not available for low power-factor circuits. By using the reversing switch the phase of the current passing through the instrument can be altered by 90 electrical degrees, so that the position corresponding with unity power-factor is made to denote zero power-factor, and by means of an additional calibration of the scale low power-factors can be measured. If satisfactory power-factor indicators can be constructed, they will prove more serviceable than wattmeters on highly inductive circuits, since the latter instruments under such conditions are liable to large percentage errors, and their indications are low down on the scale.

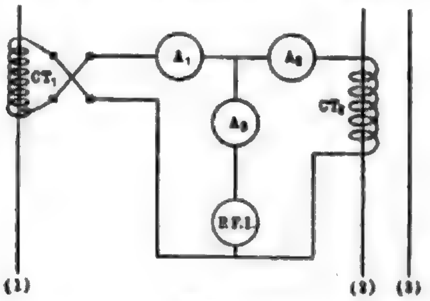

FIG. 1.

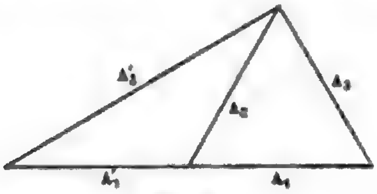

FIG. 2.

I now pass to the consideration of wattmeters. The introduction of electro-magnets into these instruments is naturally a more difficult problem. With the exception of electrostatic instruments, all accurate wattmeters are of the dynamometer type. Iron, and indeed all metal parts, are severely excluded, with the result that these instruments are insensitive, lacking in range, and subject to disturbances caused by external fields. It has nevertheless become necessary to use transformers in conjunction with them, owing to the high potentials and heavy currents now common. These accessories of course contain iron, and introduce errors, due to small differences in phase, which are as serious, I believe, as those which would arise from the use of well-designed electro-magnets in the wattmeter itself. The error in wattmeters due to the lag of current in the pressure coil has frequently been theorised about, but I think a somewhat exaggerated idea exists as to its nature and extent. I have calculated in the accompanying table the wattmeter error caused by 1deg. lag in the pressure coil, for a fixed load current corresponding, say, with 1,000 volt amperes, and for loads of different power factor.

Table I.—*Wattmeter Error for a Load of 1,000 Volt-amperes (for a Lag of 1deg. in the Pressure Coil).*

Power factor.	True watts.	Error.	Error per cent.
1·0	1,000	0·3	0·03
0·9	900	7·6	0·85
0·8	800	10·5	1·31
0·7	700	12·5	1·78
0·6	600	13·9	2·32
0·5	500	15·1	3·02
0·4	400	15·9	3·98
0·3	300	16·6	5·54
0·2	200	17·1	8·55
0·1	100	17·3	17·3
0·02	20	17·4	87·2

The error increases the reading if the load current lags and diminishes it if it leads. If the power-factor of the load is cos ϕ, the error in the reading is proportional to sin ϕ, while tan ϕ represents the error per cent. of the true reading. It will be seen that the error in the reading, instead of indefinitely increasing as the power-factor diminishes, rapidly attains a maximum value, which is less than 2 per cent. of the reading corresponding with the same current if non-inductive. The error per cent. may be enormous for low power-factors, but the error as a deflection may all the same be unreadable unless the instrument has a wide scale. (The theory of this error, and the application to wattmeters used on three-phase circuits, are given in the Appendix.) The lag in the pressure coil can be easily reduced to one-tenth of a degree, and the error caused by it is proportionately diminished. It is not so well known that the phase differences introduced by current and voltage transformers can, if these are properly designed, be reduced to similar small values. Of course the errors due to such phase differences are of the same nature and importance as if they were all due to lag in the pressure coil. Electro-magnets may be introduced into wattmeters either by putting the magnetising coil in series with the current, or by connecting it in shunt across the mains. In the former case, owing to hysteresis, eddy currents, and varying permeability, the induced magnetism will not properly follow the variations of the current, even when the magnetic circuit contains an air-gap, and only low magnetic densities are needed. On the other hand, if a shunt coil is used to produce the magnetism, not only is there an error due to the resistance of the coil, but the flux of magnetism is practically in quadrature with the voltage producing it. The resulting errors can perhaps be made negligible in either case, but it is the latter method I have tried experimentally lately, in order to bring the question before you.

If N is the magnetic flux in the core of a transformer or electro-magnet produced by a current, C, through a winding of n_1 turns of resistance R, the voltage V_1 necessary to produce this current is given by $V_1 = RC + (n_1 dN/dt)$. We also have $V_2 = n_2 dN/dt$, where V_2 is the voltage on open circuit of a secondary winding of n_2 turns (assuming no magnetic leakage). For large transformers on open circuit the term RC may be less that one ten-thousandth part of V_1. For magnetic circuits of small dimensions, suitable for instruments, especially if an air-gap is introduced to allow a moving coil to cut the flux, the term RC is much larger compared with V_1, but may still be a small proportion of it. As a rule the copper drop CR is by no means negligible compared with V_1. This is only too noticeable when testing small masses of iron for hysteresis losses by the wattmeter method, since the losses in the magnetising coil are often an appreciable fraction of the whole. In such cases I have often found it convenient to use two windings (as shown in Fig. 3), one of a few turns n_1, suitable for a considerable magnetising current, C, passed through the current coil of the wattmeter W; the other of a large number of turns n_2, connected with the pressure coil of the instrument. The reading of the wattmeter must then be divided by the ratio n_2/n_1 in order to get the watts wasted in the iron circuit. This method has several advantages. Only the core losses are measured, the losses in the magnetising coil becoming a matter of indifference. A wattmeter suitable for heavy currents, and the measurement of large amounts of power, may be utilised for the estimation of only a few watts; and the flux can be calculated independent of the copper drop in the primary coil by attaching a voltmeter V to the secondary coil, the resistance of this being allowed for, if need be, by the ordinary fall of potential method. Unfortunately there does not appear to be any similar method of eliminating the copper drop when the electromagnet is to be used as part of the wattmeter itself. The effect of hysteresis, eddy currents and variable permeability is to alter the RC term; but if we assume that by suitable design this term RC can be made negligible compared with V_1, we have $V_1 = n_1 dN/dt$, and hence, whatever the nature of the iron, the strength of the flux N, and therefore the magnetic density in each part of the air-gap, is strictly proportional to V_1, and in perfect quadrature with it. If now the load current A be passed through the primary of an air-core transformer (shielded if necessary from external fields by a shell of suitably laminated iron), the voltage induced in the secondary coil will be proportional to A in magnitude, and in quadrature with it as regards phase. It may thus be used to produce a minute current a through a large non-inductive resistance and the moving coil of the instrument. Theory then shows (see Appendix) that if a is in quadrature with A, and if N is in quadrature with V_1, the torque on the moving coil is proportional to the average value of the product $V_1 A$, and therefore measures watts, independently of frequency and wave-form, and of the nature of the iron used in the electromagnet.

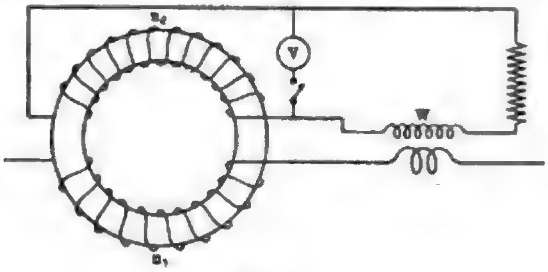

FIG. 3.

(To be concluded.)

THE ALTERNATING-CURRENT THEORY OF TRANSMISSION SPEED OVER SUBMARINE TELEGRAPH CABLES.*

BY PROF. A. E. KENNELLY.

In 1855, or nearly half a century ago, Sir William Thomson (Lord Kelvin) published a theory of transmission over submarine cables which has ever since been the standard of reference on this subject. The theory was developed and supplemented in parts by Stokes, Fleeming-Jenkin, Hockin, A. Gray, and Heaviside. The basis of the theory given by Kelvin is quite general, but the application of the theory has been made almost entirely through considering what happens at the receiving end of a cable after a steady E.M.F. is applied to the sending end. This has made the subject hard to understand. When alternating currents over the cable have been considered the treatment has been complicated. The result is that there is only a very meagre working theory of cable transmission in the hands of engineers. With the exception of a few empirical formulæ, the technical knowledge of the speed of transmission of a cable is limited to the formula $n = 10/\tau$ letters per second where 10 is an empirical constant and τ is the time constant of the cable in farad-ohms or seconds. This is one form of the "C.R. law." The C.R. law of cables, enunciated by Kelvin, has been found inapplicable to overhead landline telegraphy or telephony, and the working theory of telephony has, therefore, grown up independently of that of submarine cables, an unnecessary and unnatural division. If, however, the theory of alternating-current transmission can safely be extended to include the case of signalling over submarine cables, then the same theory can readily cover every case of signalling over wires. Such a theory can be made not only very comprehensive, but also very easy. It is the object of this Paper to outline the application of this general alternating-current theory to submarine telegraphy.

Hyperbolic trigonometry is the natural and simple key to the solution of problems of waves and currents over wires. In telephony and telegraphy hyperbolic trigonometry leads to formulæ of great simplicity and power. There is, however, no need for hyperbolic formulæ in dealing with power-transmission circuits operated at ordinary commercial frequencies below 100 cycles per second. For such circuits and frequencies a simpler solution is reached by placing all the capacity in a lump or imaginary condenser at the centre of the circuit. The results so derived are usually sufficiently accurate for practical purposes. For higher frequencies, however, such as are presented in telegraphy and telephony over long circuits, the method of lumped capacity is usually unreliable, and hyperbolic formulæ must be resorted to if simple expressions and arithmetic are desired. If the impressed periodic E.M.F. at the sending end is not simply harmonic it may be resolved into a fundamental sinusoid with harmonic superposed ripples. Each component frequency may then be computed, as though it alone existed, and all the components summed, at any instant, to obtain the total instantaneous current. With any assigned magnitude of impressed E.M.F. the strength of the received current depends wholly upon the "receiving-end impedance." For a limiting working value of the received current, below which receiving becomes impracticable, the range of alternating-current transmission necessarily depends upon the receiving-end impedance. This impedance becomes a criterion of transmission. When this impedance, $Z_r = z_0 \sinh La + z_r \cosh La$, exceeds a certain limiting value the maximum available impressed E.M.F. will fail to deliver a current strength at the receiving end sufficient for requirements.

Turning now to long submarine cables in good working order, these circuits are characterised by the property that their leakance and inductance are insignificant by comparison with their resistance and capacity, so that $l = g = 0$. Consequently, for such cables

$$a = \sqrt{r \times jc\omega} = \sqrt{rc\omega}\ \angle 45^\circ \text{ per naut.} \quad . \quad . \quad . \quad (1)$$

and

$$z_0 = \sqrt{r/jc\omega} = \sqrt{r/c\omega}\ \diagdown 45^\circ \text{ ohms per naut.} \quad . \quad . \quad (2)$$

Thus the "attenuation constant" a, the "attenuated length" La and the "sending-end impedance" z_0 are all affected by the angle $\pi/4$ or 45deg. This simplifies the computation of the hyperbolic trigonometrical ratios. Under the conditions employed in cable telegraphy the waves of impressed E.M.F. are rectangular (except for drop of pressure in the battery) and the waves are separated by intervals or spaces that are approximately of the same duration as the individual waves or E.M.F. impulses. Successive rectangular E.M.F. waves are sometimes of the same sign and sometimes of opposite signs, according to the signals being transmitted. Between letters there are extra long spaces. Between words there are yet longer spaces. These conditions depart considerably from simple alternating-current transmission. Nevertheless, it is generally admitted that the speed of signalling depends upon the speed of transmission attainable with currents due to impressed alternating rectangular E.M.F. impulses, so that, if the latter theoretical problem can be solved, the former and more practical problem is immediately capable of approximate solution. The problem is, therefore, to determine the system of alternating currents on a cable subjected to an alternating impressed E.M.F. of the rectangular wave type.

If $\sqcap\!\sqcup$ be the cyclic magnitude ab of a rectangular E.M.F. then it is well known that this E.M.F. is equivalent to the following harmonic series of sinusoidal E.M.Fs.

$$\sqcap\!\sqcup = E \sin \omega t + \frac{E}{3} \sin 3\omega t + \frac{E}{5} \sin 5\omega t + \ldots \text{ volts} \quad . \quad . \quad (3)$$

where

$$E = \sqcap\!\sqcup\, 4/\pi \text{ maximum cyclic volts} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and the fundamental sinusoid $E \sin \omega t$ has the same period as the rectangular E.M.F. That is, the fundamental sinusoidal E.M.F. has the frequency of the rectangular E.M.F., but has a maximum 27·3 per cent. greater. The effective or R.M.S. E.M.F. of this sinusoid is 9·004 volts, or nearly 10 per cent. less than the rectangular. The successive harmonics increase directly in frequency, and inversely in amplitude, as the successive odd numbers. If we superpose a rectangular E.M.F. of ± 10 volts upon a continuous E.M.F. of +10 volts, we obtain a rectangular E.M.F. entirely above the zero line. This corresponds to "dot" impulses from + 20 volts, successively followed by pauses of equal duration with the cable to ground. A succession of 20-volt dots and pauses, say four to the second, is, therefore, the equivalent of a steady application of + 10 volts combined with a rectangular alternating E.M.F. of ± 10 volts. This rectangular E.M.F. would be the equivalent of the following sinusoidal E.M.Fs.:—

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* Abstract of a Paper read before Section A of the St. Louis International Electrical Congress.

12·73	volts maximum with the frequency	4	cycles per second.
4·244	" " " "	12	" "
2·546	" " " "	20	" "
1·818	" " " "	28	" "
1·415	" " " "	36	" "

&c. The current at any point in the circuit of the cable after the steady regime had been set up, with dots and pauses sent into the cable, would be the sum of a steady current from + 10 volts, and of the alternating currents from these various sinusoidal E.M.Fs., each acting independently.

In determining the current strength of the cable at or near the sending end, a number of these frequencies must be taken into account. At the receiving end, however, when the frequency of dot-signalling is such as to approach the maximum practicable rate of signalling, it is only necessary to compute the first term in the series, or the fundamental frequency, because the succeeding terms all vanish. In other words, nothing is received at the distant end of a cable, when the frequency approaches the maximum, except the sinusoidal current of fundamental frequency. The problem of determining the maximum speed of dot-signalling over a cable-conductor thus consists in finding the receiving-end impedance Zl of the circuit, including the receiving apparatus, and the maximum available impressed E.M.F. at the sending end. When the minimum readable amplitude of sinusoidal received signals is known, and the corresponding current strength which will produce this amplitude, the receiving-end impedance is immediately determined. The maximum frequency of the impressed rectangular E.M.F.—*i.e.*, the number of dot-signals per second—is that which leads to the development of the critical receiving-end impedance for the particular cable considered. Knowing in this way the highest available dot-frequency of the cable, the frequency of the mixed dots and dashes of practical signalling should be empirically determinable. The receiving-end impedance is

$$Zl = z_0 \sinh L\alpha + z_r \cosh L\alpha \text{ ohms } \angle \quad . \quad . \quad . \quad . \quad (5)$$

So that the maximum cyclic amplitude of the received current is

$$I_r = \frac{\dfrac{4\,\boxminus}{\pi}}{z_0 \sinh L\alpha + z_r \cosh L\alpha} \text{ amperes} \quad . \quad . \quad . \quad (6)$$

When the impedance z_r of the receiving instrument may be neglected, the receiving-end impedance becomes

$$Zl = z_0 \sinh L\alpha \text{ ohms} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

In most practical cases, however, the impedance of the receiving instrument has a marked influence upon the amplitude of the received signals, and cannot be neglected. At the values of $L\alpha$, which are presented in the neighbourhood of the highest practicable frequency, it will be found that $\sinh L\alpha = \cosh L\alpha$ very nearly, so that

$$Zl = (z_0 + z_r) \sinh L\alpha \text{ ohms} \quad . \quad . \quad . \quad . \quad (8)$$

That is, the receiving-end impedance is the hyperbolic sine of the attenuated length of the cable, times the sum of the sending-end and receiving-instrument impedances.

For example, let a cable circuit be considered for which some data have been published. The 1888 Penzance-Canso Atlantic cable is stated to have a length L of 2,518 nauts, a conductor resistance r of 3·041 ohms per naut, a capacity c of $0{\cdot}3729 \times 10^{-6}$ farad per naut. This corresponds to a total resistance of 7,657 ohms, a total capacity of 939×10^{-6} farad, and a time-constant of 7·19 seconds. It is stated to carry 19 five-letter code words per minute. The average five-letter word contains 36·50 dot elements, so that the cable would carry 693·6 dot-elements per minute, or 11·56 per second, corresponding to a frequency of 5·78 dots and pauses per second ($n = 5{\cdot}78$), for which $\omega = 6{\cdot}283 \times 5{\cdot}78 = 33{\cdot}62$ radians per second. We may suppose the cable to be connected in the following different ways:—(1) To ground directly at B, the receiving end. (2) To ground through a syphon recorder of 500 ohms and 0·25 henry at B. (3) The said syphon recorder and a 50mfd. condenser in series at B. (4) The syphon recorder at B and the condenser at A. (5) Condensers at each end, and the cable duplexed.

1. *Cable to Ground at the Receiving End through Receiver of Negligible Resistance.*—The receiving-end impedance, by formula (7), is $Zl = z_0 \sinh L\alpha$.

$$z_0 = \sqrt{r/jc\omega} = \sqrt{3{\cdot}041 \times 10^6 / j0{\cdot}3729 \times 33{\cdot}62}$$

$$= \sqrt{0{\cdot}2425 \times 10^6 / j} = 492{\cdot}4 \diagdown 45^\circ \text{ ohms.}$$

$$\alpha = \sqrt{r \times jc\omega} = \sqrt{j3{\cdot}041 \times 0{\cdot}3729 \times 33{\cdot}62 \times 10^{-6}} = \sqrt{j38{\cdot}12 \times 10^{-6}}$$

$$= 0{\cdot}006174 \underline{/45^\circ}.$$

$$L\alpha = 2{,}518 \times 0{\cdot}006174 \underline{/45^\circ} = 15{\cdot}55 \underline{/45^\circ}.$$

It is to be observed that $L\alpha = \sqrt{\tau\omega}$ . . . . (9)
where τ is the time-constant (CR) of the cable in seconds.

$$\sinh (L\alpha) = 29{\cdot}849 \underline{/680^\circ}$$

$$\therefore \; Zl = 492{\cdot}4 \diagdown 45^\circ \times 29{\cdot}849 \underline{/680^\circ} = 14{,}697{,}000 \underline{/585^\circ} \text{ ohms.}$$

If the minimum amplitude (from zero) of sinusoidal current discernible at B is, say, ¾ microampere (corresponding to a double amplitude of 1½ microamperes), then the sinusoidal E.M.F. at A of 5·78 ∼ which will produce that current at B is

$$\tfrac{3}{4} \times 10^{-6} \times 14{\cdot}697 \times 10^{6} \underline{/585^\circ} \text{ max. cyclic volts}$$

or $E_s = I_r\, Zl = 11{\cdot}02 \pm$. The rectangular E.M.F. of the same frequency which develops this sinusoid is

$$\boxminus = 11{\cdot}02 \times \pi/4 = 8{\cdot}657 \text{ volts } \pm.$$

If, then, 8·657 volts be steadily applied to the cable at A, and a rectangular alternating E.M.F. of 8·657 ± volts superposed, dot-signals of ± 17·314 volts with equal intermediate pauses to ground are produced. The steady voltage will give rise to a steady current at B of $I_r = 8{\cdot}657/7{,}657 = 0{\cdot}00113$ amperes, or 1,130 microamperes.

At the sending end, when the frequency of dot-signals approaches the maximum working limit, the steady current is a relatively petty current by comparison with the first members of the series of harmonic currents. At the receiving end, however, the same steady current is enormous relatively to the strongest sinusoid, and only the fundamental sinusoid appears, as a faint ripple on the edge of the current which it swamped at starting. Since in changing from dot-signals to dash-signals the steady current of 1,130 microamperes at B will change from + to −, while the ripples will retain their double amplitude of 1·5 microamperes, the unsuitability of signalling without condensers over a long cable is manifest. Whereas series of dots or of dashes will only have a double amplitude of 1½ microamperes, the zero of such ripples will shift through 2,260 microamperes. The insertion of a condenser into the cable circuit stops the steady current and gives passage only to the sinusoidal ripples. The zero line of these ripples will be the same whether dots or dashes are being sent in succession.

2. *Syphon Recorder Inserted at* B. *Same Frequency.*—In this case the receiving-end impedance $Zl = (z_0 + z_r) \sinh L\alpha$.

$$z_r = (\text{resistance} + j \text{ reaction}) \text{ of the syphon recorder coil}$$

$$= 500 + j33{\cdot}62 \times 0{\cdot}25 = 500 + j8{\cdot}4 = 500{\cdot}1 \underline{/0^\circ 58'} \text{ ohms.}$$

$$z_0 = 492{\cdot}4 \diagdown 45^\circ = 348{\cdot}2 - j348{\cdot}2 \text{ ohms.}$$

$$z_0 + z_r = 848{\cdot}2 - j339{\cdot}8 = 913{\cdot}7 \diagdown 21^\circ 50' \text{ ohms.}$$

$$\sinh L\alpha = 29{\cdot}849 \underline{/680^\circ}$$

$$Zl = 918{\cdot}7 \times 29{,}849 \underline{/608^\circ 10'} = 27{,}270{,}000 \underline{/608^\circ 10'} \text{ ohms.}$$

$$= 27{\cdot}27 \underline{/608^\circ 10'} \text{ megohms.}$$

The sinusoidal E.M.F. at A required to produce ± ¾ microampere max.: cyclic amplitude at B will be, at $n = 5{\cdot}78 \sim$, $E_s = 27{\cdot}27 \times \tfrac{3}{4} = 20{\cdot}45 \pm$ volts, or $\boxminus = 20{\cdot}45 \times \pi/4 = 16{\cdot}07 \pm$ volts rectangular alternating E.M.F. $= + 32{\cdot}14$ volts in dot-and-pause sending. The required sinusoidal current would be superposed upon a steady current of $I_s = I_r = + 16{\cdot}07/(7{,}657 + 500) = + 0{\cdot}00197$ ampere; or + 1,970 microamperes. No change in the impedance at B exercises any appreciable influence upon the sending-end impedance z_0. This remains at 492·4 \ 45° ohms; whether the cable at B be freed or grounded or put to ground through impedances. It is clear that the insertion of the syphon recorder at B has required the rectangular E.M.F. $\boxminus$ at A to be increased from + 17·314 to + 32·14 volts in dot-impulses, or nearly doubled, the receiving-end impedance having been increased by the recorder-coil from 14·7 to 27·27 megohms. Conversely, if the + 17·314 volts had remained unaltered, the insertion of the syphon recorder would have reduced the amplitude of the sinusoidal ripple at B nearly 50 per cent. If this had originally been just sufficient to discern, it would have been rendered undiscernible by the change, so that the receiving-end impedance would have had to be reduced, by reducing the frequency and $\sinh L\alpha$.

Syphon Recorder at B. Frequency Variable.—If the maximum cyclic strength of the received current required to give readable dot-signals is changed from ± ¾ milliampere to say + 1 microampere as by some reduction in the sensibility, and sensibility-constant, of the instrument, the frequency of dot-signalling must be reduced, if the sending battery is already at its maximum available voltage, in order to reduce the receiving-end impedance. Thus, in the preceding case, ± 1 microampere at B with + 32·14 volts at the sending battery and negligible drop in the battery

$$\left(\overline{\boxminus} = + 32{\cdot}14, \quad \boxminus = \pm 16{\cdot}07, \quad E_s = \pm 20{\cdot}45\right)$$

will require a receiving-end impedance of 20·45 megohms, instead of 27 megohms, a reduction of 25 per cent. That is, the quantity $(z_0 + z_r) \sinh L\alpha$ must be reduced 25 per cent. Nearly all of the reduction will have to be made in the hyperbolic factor, since the sending end impedance varies much more slowly with the frequency. This means that $\sinh L\alpha$ must be reduced from 29,849 to about 22,380. The corresponding value of $L\alpha$ is 15·145, and

$$\alpha = 15{\cdot}145/2{,}518 = 0{\cdot}006015 \underline{/45^\circ}.$$

From this ω is found to be $n = 5{\cdot}077$, instead $5{\cdot}78$ cycles per second; so that the speed of dot-signalling has to be reduced 12·2 per cent. in order to secure the greater sinusoidal current strength desired. If the sending-end impedance z_0 be recomputed for this frequency, by formula (2), it will be found to be $505{\cdot}6 \diagdown 45^\circ$ ohms, an increase of 2·7 per cent. over the previous value. The receiving-end impedance at $5{\cdot}077\sim$ would be

$$Zl = (505{\cdot}6 \diagdown 45^\circ + 500)\ 22{,}380 \underline{/618^\circ{\cdot}20'}$$
$$= 929 \diagdown 22^\circ{\cdot}38' \times 22{,}380 \underline{/618^\circ{\cdot}20'}$$
$$= 20{\cdot}79 \text{ megohms } \underline{/590^\circ{\cdot}42'}.$$

The sinusoidal current of $+1$ microampere would lag $590^\circ{\cdot}42'$, or about $1\frac{2}{3}$ cycles behind the impressed E.M.F.

3. *Syphon Recorder and 50-microfarad Condenser at Receiving End.*—The effect of inserting a condenser at the receiving end B has no effect at the sending end near the limiting frequency of transmission, except to stop the steady current $I_s' = I_r'$ of dot signalling. The effect at the receiving end is to stop the wandering of the syphon due to the current I_r' when changing from dots to dashes, and also to increase the impedance of the receiving apparatus z_r. The impedance of a 50-microfarad condenser to sinusoidal currents of frequency $5{\cdot}78\sim$ or $\omega = 33{\cdot}62$ is $1/j50 \times 10^{-6} \times 33{\cdot}62 = 1/j1{,}681 \times 10^{-6} = 594{\cdot}9 \diagdown 90^\circ$ ohms. Consequently $Z_r = (500 + j8{\cdot}405) - j594{\cdot}9 = 500 - j586{\cdot}5 = 770{\cdot}7 \diagdown 49^\circ{\cdot}33'$ ohms. And the receiving-end impedance by formula (8) is

$$Zl = (492{\cdot}4 \overline{\diagdown 45^\circ} + 770{\cdot}7 \diagdown 49^\circ{\cdot}33') \times 29{,}849 \underline{/630^\circ}$$
$$= 1{,}339 \diagdown 47^\circ{\cdot}47 \times 29{,}849 \underline{/630^\circ} = 39{,}970{,}000 \underline{/582^\circ{\cdot}18'} \text{ ohms,}$$
$$= 39{\cdot}97 \underline{/582^\circ{\cdot}18'} \text{ megohms.}$$

If the maximum cyclic amplitude of received current at B is $\pm\frac{3}{4}$ microampere, the maximum cyclic amplitude of sinusoidal E.M.F. at A will be $E_s = \frac{3}{4} \times 39{\cdot}97 = 29{\cdot}97$ volts, from which the cyclic value of the corresponding rectangular E.M.F. is $\overline{\underline{E}} = 29{\cdot}97 \times \pi/4 = \pm 23{\cdot}54$ volts. Or in dot signalling to battery and ground alternately, the battery E.M.F. is $2\overline{\underline{E}} = +47{\cdot}08$ volts. If dot-signals are sent at A with 47·08 volts of battery, having no appreciable drop by internal resistance, at the rate of 5·78 dots and pauses per second, or at the rate of 19 five-letter words per minute, the cable and receiving apparatus will behave like a resistance box of 40 megohms on short-circuit with an alternator of $\pm 29{\cdot}97$ volts, permitting an alternating current of $\pm\frac{3}{4}$ microampere to flow through the recorder R, at the frequency for which Zl is developed. At the sending end the conditions are different. Not only is the fundamental sinusoidal more than sinh L_a times stronger at A than at B, but there are also a number of upper harmonics of very appreciable strength. These upper harmonics absorb power uselessly from the battery at A, but otherwise they are quite independent of the signalling, neither aiding nor obstructing the working sinusoidal current of fundamental frequency. Judging from these results it would seem that the limiting speed of signalling on a cable of any assigned length and electrical constants may be that which makes the receiving-end impedance about 40 megohms.

4. *Condenser Inserted at the Sending End.*—If the condenser is inserted at the sending end the case reverts to (2) above considered, except that the steady current I_r' is cut off and that the impressed E.M.F. on the cable at A is reduced by the drop in the condenser. For the conditions above considered the receiving-end impedance is 27·27 megohms, and $\frac{3}{4}$ microampere maximum cyclic current at B, with $n = 5{\cdot}78\sim$, will call for an impressed sinusoidal E.M.F. at A of $E_s = \pm 20{\cdot}45$ volts maximum cyclic amplitude. The sending-end impedance is $Z = 492{\cdot}4 \overline{\diagdown 45^\circ}$ ohms, and the impedance of the condenser to the frequency of $5{\cdot}78\sim$ is $Z_s = -j594{\cdot}9 = 594{\cdot}9 \diagdown 90^\circ$. Consequently, the maximum cyclic E.M.F. behind the condenser will be

$$20{\cdot}45\left(\frac{z_s + z_0}{z_0}\right) = 20{\cdot}45\,\frac{(594{\cdot}9 \overline{\diagdown 90^\circ} - 492{\cdot}4 \diagdown 45^\circ)}{492{\cdot}4 \diagdown 45^\circ}$$
$$= 20{\cdot}45\left(\frac{1{,}005 \diagdown 69^\circ{\cdot}44'}{492{\cdot}4 \diagdown 45^\circ}\right) = 20{\cdot}45 \times 2{\cdot}041 \diagdown 24^\circ{\cdot}44'$$
$$= 41{\cdot}73 \diagdown 24^\circ{\cdot}44' \text{ volts} \pm.$$

The corresponding rectangular E.M.F. is $\overline{\underline{E}} = \pm 32{\cdot}78$ volts, or, in dot-space-dot signalling $2\overline{\underline{E}} = +65{\cdot}56$ volts.

The effect of inserting the condenser at the sending end instead of at the receiving end of the cable is to leave the receiving-end impedance the same as with no condensers, but to reduce the impressed E.M.F. from $\pm 41{\cdot}73$ maximum sinusoidal to $\pm 20{\cdot}45$. For the same condenser capacity and amplitude of received signals the sending battery is $+47{\cdot}08$ volts when the condenser is inserted at B, and $+65{\cdot}56$ volts when the condenser is inserted at A. The battery would thus be 39·2 per cent. greater in the latter case. This means that if the battery were limited to 47·08 volts, the speed of transmission would be lowered by changing the condenser from the receiving end B to the sending end A. This proposition seems to be quite general. If, however, the maximum impressed voltage on the end of the cable at A and not the battery voltage is to be the criterion, then the maximum cyclic amplitude E is $\pm 29{\cdot}97$ volts when the condenser is inserted at B, and E is $\pm 20{\cdot}45$ volts when the condenser is inserted at A. So that if we consider only the maximum electric stress on the cable, that stress is less in the case considered by 31·8 per cent. when the condenser is used at the sending end, while the same magnitude and frequency of received dots are produced, the receiving-end impedance being 31·8 per cent. less in the latter case for the same 500-ohm recorder coil. The maximum speed of dot signalling is, therefore, greater for a given impressed E.M.F. at A, when the condenser is at the sending end. The best resistance for the receiving instrument (assumed reactanceless), when the condenser is at A, is equal to the sending-end impedance z_0. In the case considered, it would be nearly 500 ohms.

With the condenser at A, the cyclic maximum current received at B is

$$I_r = \frac{\frac{2}{\pi}\overline{\underline{E}}}{z_s + z_0} \times \frac{z_0}{(z_0 + z_r)\sinh L_a} \pm \text{ amperes } \angle . \quad . \quad (10)$$

This current increases as z_s is reduced—*i.e.*, as the condenser at A is increased in capacity, the speed of signalling being kept constant.

According, therefore, to the alternating-current theory of cable signalling, the highest speed is attainable from a given laid cable by placing a large condenser at the sending end, impressing the assigned maximum E.M.F. on the sending end, and making the impedance of the receiving instrument (assumed of maximum sensitiveness in construction) equal to the sending-end impedance, but with the opposite angle.

Condenser at Each End of the Cable. Duplex System.—Here z_0 at B is the sending-end impedance of the artificial line. If this artificial line is a level imitation of the actual cable, then $z_0 = 492{\cdot}4 \overline{\diagdown 45^\circ}$ the same as the actual cable offers at A. Similarly,

$$z_c = 594{\cdot}9 \diagdown 90^\circ = z_s.$$

The impedance of the receiving instrument at B is increased by z_0 and z_c to $z'_r = z_r + \dfrac{z_0 z_c}{z_0 + z_c}$.

$$= 500 \underline{/0^\circ{\cdot}58'} + \frac{492{\cdot}4 \diagdown 45^\circ \times 594{\cdot}9 \diagdown 90^\circ}{492{\cdot}4 \diagdown 45^\circ + 594{\cdot}9 \diagdown 90^\circ} \text{ ohms}$$
$$= 672{\cdot}7 \diagdown 22^\circ{\cdot}24' \text{ ohms.}$$

The receiving connections are, therefore, equivalent to an instrument impedance z_r' of $672{\cdot}7 \diagdown 22^\circ{\cdot}24'$ ohms, shunted by a condenser of impedance z_c of $594{\cdot}9 /90^\circ$. This in turn will be found equal to a single receiving instrument impedance of

$$z''_r = \frac{z_r' z_c}{z_r' + z_c} = \frac{672{\cdot}7 \diagdown 22^\circ{\cdot}24' \times 594{\cdot}9 \diagdown 90^\circ}{672{\cdot}7 \diagdown 22^\circ{\cdot}24' + 594{\cdot}9 \diagdown 90^\circ} = 379{\cdot}6 \diagdown 58^\circ{\cdot}34' \text{ ohms.}$$

The recorder is, however, shunted with a multiplying power of

$$N = \frac{z_r' + z_c}{z_c} = \frac{672{\cdot}7 \diagdown 22^\circ{\cdot}24' + 594{\cdot}9 \diagdown 90^\circ}{594{\cdot}9 \diagdown 90^\circ} = 1{\cdot}772 \underline{/36^\circ{\cdot}10'}.$$

The receiving-end impedance of the system is, therefore,

$$Z_l = N(z_0 + z''_r)\sinh L_a$$
$$= 1{\cdot}772 \underline{/36^\circ{\cdot}10'}(492{\cdot}4 \diagdown 45^\circ + 379{\cdot}6 \diagdown 58^\circ{\cdot}34')29{,}849 \underline{/630^\circ}$$
$$= 45{\cdot}79 \underline{/615^\circ{\cdot}17'} \text{ megohms.}$$

The impressed maximum sinusoidal E.M.F. at the sending end for $\pm\frac{3}{4}$ microampere maximum sinusoidal current in the recorder is $E = \pm\frac{3}{4} \times 45{\cdot}79 \underline{/615^\circ{\cdot}17'} = \pm 34{\cdot}34 \underline{/615^\circ{\cdot}17'}$ volts. At the key behind the condenser at A, this requires a maximum sinusoidal E.M.F. $E = \pm 34{\cdot}34 \underline{/615^\circ{\cdot}17'} \times 2{\cdot}041 \diagdown 24^\circ{\cdot}44' = \pm 70{\cdot}08 \underline{/590^\circ{\cdot}33'}$ volts and in rectangular E.M.F. $\overline{\underline{E}} = \pm\frac{\pi}{4} \times 70{\cdot}08 = \pm 55{\cdot}04$ volts. Or for dot and ground signals $2\overline{\underline{E}} = +110{\cdot}08$ volts.

If the E.M.F. of the battery is limited to, say, 65·56 volts, the speed of signalling in duplex connections must be reduced sufficiently to reduce the receiving-end impedance about 40 per cent. The figures seem to show the maximum speed of transmission that can be reached with the best simplex connections is always greater than that attainable in the same direction with the corresponding duplex connections.

CONCLUSIONS.

According to the alternating-current theory of cable signalling, as above outlined, the receiving-end impedance is the true criterion of any signalling circuit for given limits of impressed E.M.F. at the sending end and sensibility of apparatus at the receiving end. The proposition applies, however, not merely to long submarine cables, but also to long-distance telegraph and telephone aerial circuits. The CR time-constant of a cable (farad-ohms = seconds) is a first approximation to this receiving-end impedance, because for an assigned value of the impedance multiplier sinh L_a the frequency limit is inversely proportional to the time-constant. Whereas, however, the time-constant of a circuit ceases to be a criterion of long-distance transmission when the circuit possesses considerable inductance or leakage, or both, the receiving-end impedance of the same symbolic expression (5), but very different magnitude, is still the true criterion. Moreover, even in long cable circuits, the time-constant CR is only a first approximation to the speed criterion, because of the influence of the $(z_0 + z_r)$ impedance in the phenomena of signalling, which impedance does not enter into the time-constant. The real speed criterion, therefore, of any long-signalling circuit is $Zl = z_0 \sinh La + z_r \cosh La$ ohms.

Experimental Data required for the further Development of the Theory.—In order to develop the application of the above-outlined theory experimental observations should be secured upon the following matters:—

1. To determine experimentally the limits of receiving end impedance in dot-signalling over long cables, under measured frequency, impressed E.M.F. terminal condenser, and sensibility of receiving apparatus. It seems important to determine how far this limiting value of receiving-end impedance departs, in practice, from the estimate above given of 40 megohms.

2. To ascertain what is the relative frequency of mixed signalling in industrial practice to dot signalling as determined by alternating-current theory. The practical frequency of mixed signalling may be either greater than, or less than, that of dot signalling, but, perhaps, bears a definite empirical ratio thereto.

3. To ascertain the effect of curb signalling upon this ratio.

4. To ascertain the practical value of reactance at the receiving end, and how far this value agrees with that assigned by the alternating-current theory.

Some of these observations are probably capable of best being made over artificial cables.

MR. WALTER EMMOTT'S PRESIDENTIAL ADDRESS TO THE LEEDS LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.[*]

It is occasionally interesting and instructive to take a retrospective view of the various stages through which we and the profession to which we belong have passed. To go back a little beyond one's own experience has also a value in enabling us to appreciate the labours of those who have done their share before us in laying the foundation of this great industry. I happen to have a copy of the "Transactions and the Proceedings of the London Electrical Society from 1837 to 1840." One extract from the Presidential address in 1837 will give an idea of the views then held. Said the President: "The last 40 years have been more productive of electrical discovery than all the previous centuries embraced in the history of the science," and yet, gentlemen, the year 1837, in which the foregoing Presidential statement was made, was practically the first year of the application of electricity to the serious needs of man, in the introduction of the electric telegraph by Cooke and Wheatstone

Practically all branches of engineering have been at a somewhat low part of the commercial curve during the year 1903. As to the cause of this, I think you will all agree that it is not due to any want of energy on the part of those responsible for the industries concerned, nor do I think it due to any strained relations between capital and labour during that period. We must, I think, take it that this depression, which has extended not only to this country, but to nearly all the civilised world so far as engineering is concerned, has arisen through circumstances practically beyond human control. Had the depression been confined to Great Britain alone, we might have concluded that foreign competition was turning us out of our own markets as well as securing our trade at home, which we are so anxious to guard. I have carefully studied the various returns, and am thereby confirmed in my opinion that our safety lies largely in maintaining a firm grip on the various departments over which we have control, with a view to at least holding our own. Let us not forget that times of depression and activity alternate, and as we are now at the bottom of the curve we may, I believe, fairly look for an upward tendency in the immediate future.

The effect of a complete system of standardisation on the various engineering industries cannot be over estimated. Not only will the manufacturer be able to turn out better work, but the prime costs will be reduced, and delivery expedited. All the leading manufacturers have for some time been making the various parts of their engines and machines to template, and interchangeable, to the benefit of both the manufacturer and the user. What we now require is some sort of uniformity as to sizes and output, and some reasonable range of E.M.F. and periodicity in central station working. This, if taken in time, is not such a serious matter as might at first sight appear, as the exceedingly low voltage stations have by this time been mostly changed over to the higher voltages common to-day. Another effect of standardisation will be to rid the manufacturer of the nuisance of specifications of the "one man type" where the individual does not know what he wants, and tries to put his ideas into a specification full of detail of no value beyond making a bulky and imposing looking document, from which the manufacturer has to extract some sort of idea as to what is required, and has practically to find the brains which the gentleman who has prepared the specification is paid for and supposed to possess.

Steps have been taken during the past year to amend our patent laws, which up to the present have been of comparatively little value in enabling an inventor to feel when he had obtained an English patent that he had something to deposit in his safe to which he could attach a value. So-called amendments have been made from time to time in the past, one being by the distribution of the fees over a number of years, and thus assisting the inventor of small means. It is a moot point, however, whether this has not in a measure increased the evil by rendering a patent of less intrinsic value than previously existed under the old system, since it has afforded an opportunity for piratical patentees to take out large numbers of "fishing" patents, simply on the chance of what might turn up, or to use them as a block to some worthy invention. To this, I believe, may be traced the statement so often heard, that the validity of a patent is only known after it has been fought. The new patent laws may remedy this to a certain extent by "amendment," which, after all, is but a re-trial of a system of examination and search on the part of the patent officials before granting a patent, and which was introduced in 1884, but for all practical purposes allowed to lapse. The new regulations, which come into force on January 1st next, will place us somewhat on the same lines as the American and German paten laws in regard to examination, and much will depend on the examiners, and the value of the arrangement will be mainly to indicate to the honest inventor whether, in view of prior publication, it is worth his while to proceed with his patent. It is a question whether litigation in regard to patents will be reduced under the new regulations, but in any case it is interesting to note that, taking the capital invested, the litigation connected with patents is relatively small; indeed, fewer patent cases come before the courts than any other actions of approaching monetary value. It is also worthy of note that when such cases do come before the courts, the patentee receives every consideration and fair treatment from the judges, who have a tendency to place a wide interpretation on a specification where the invention is one of public utility.

By slow degrees and at long intervals, though not quite in keeping with the rapid advance the industry has warranted, the B.O.T. regulations have from time to time been amended, and again we have further proposed extensions and amendments in the Electric Lighting Acts, which go part of the way towards bringing them up-to-date. It is satisfactory to know that the Institution of Electric Engineers (by its provision of half a dozen committees) has from time to time brought under its consideration all the various questions arising out of any alterations proposed by the Board of Trade which may affect the engineering profession, as well as any new regulations issued by the Home Office, besides making it their business to watch and safeguard the interests of the profession generally.

The past year has been chiefly interesting by reason of a few municipal telephone undertakings getting under way, and whether such undertakings, and others likely to follow, will prove the great success which has been foreshadowed remains to be seen. Personally, I see no reason why they should not ultimately prove a success; of one thing there is evidence already—viz., that the competition has had the effect of obtaining some valuable concessions, and a better service for the public than might otherwise have been enforced for some time to come, from the company holding what may be termed the monopoly. I venture to think that the telephone department of the Post Office is the proper authority to control the whole of public telephone work in the country, and until this has been done I fail to see how we can ever attain to that high state of efficiency in telephonic matters which is so desirable. Of course the Government do not wish to, nor would they be justified in, paying a fancy price for the purchase of the National Telephone Co. As the State was not wise enough to take over the working and full control of the telephone exchanges of this country in 1880, and having in view the fact that this work has been carried out by private capital, and admitting that such capital has been fairly remunerative, it is still fair to remember that the National Telephone Co. has borne the heat and burden of the day, and is entitled to a fair and reasonable recompense for having inaugurated and developed such a vast undertaking. An argument very common to certain sections of the daily press against the absolute State control of the telephone is the alleged danger of the Post Office being compelled to pay a price far beyond the actual value of the undertaking, and fears have been expressed that an "exhorbitant price," as it is assumed was paid by the State in 1869, may be repeated. Anyone conversant with the telegraphs prior to the transfer in 1869, when at least four telegraph companies were at work, will deny that an "exhorbitant price" was paid for the various undertakings then existing; on the contrary, my opinion is, and always has been, that the price was a fair one, and as we judge of the value of an undertaking by the ultimate results obtained from it, we need only take into account that the result of the so-called "bad bargain" in connection with the purchase of the telegraphs, has been a national benefit of such magnitude that the mere pounds, shillings and pence part of the undertaking becomes insignificant, especially when we remember that we possess the finest system of telegraphy in the world.

This branch of the profession when I joined the Institution was practically *the* profession, and was divided into two departments—that of the telegraph engineer and that of the electrician. The former was understood to embrace the erection of telegraph lines and general outside construction, including—in a measure—submarine work, while the electrician was responsible for the instruments, the testing of lines and localisation of faults, the latter more often than otherwise being accomplished by "walking the line." The most notable commercial feature in this department during the past year may be taken to be the underground connection of London with the North, which has been on the carpet and under discussion for the last 15 years, and which may now be considered an accomplished fact. In the early days we considered we were doing well, if with a well-adjusted Varley

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[*] Delivered November 17th. Abstract.

"pecker" (relay), we were able to get through 30 words per minute. now, the pace of signalling attained is only limited by the amount of work to be got through, and by the means at hand, outside the purely electrical, of dealing with that work. In submarine telegraphy the commercial value of a cable, and the rates charged for the transmission of messages, both depend upon the speed of working, or the number of words per minute which can be transmitted. By duplexing and automatic working the speed has been increased ten-fold. Yet the materials used and the general construction of the deep-sea cables of to-day are practically the same as those in vogue nearly 60 years ago, and the "Minutes of Evidence taken before the Submarine Telegraph Committee, at the office of the Board of Trade," in 1859, is a striking illustration of this fact. It is worthy of note that two of the founders of the Institution of Electrical Engineers, both of whom are still with us, notably Lord Kelvin and Sir W. H. Preece, gave evidence on that occasion.

Although each of the branches mentioned above has a large army of engineering experts engaged in construction, working and maintenance, we do not hear so much of them in the *Proceedings* of the Institution and the technical press, they are there, however, all the same, and their work is carried on with so much energy and zeal, that, comparatively, each is advancing at an equally rapid rate as the branch of electric light and power which I now wish to consider. Why this more recent birth somewhat overshadows the older ones, is due to the fact that electric light and power apply more to the everyday life of the individual, and on the face of it appears to play a more important part in our domestic economy. This, to my mind, is more apparent than real, and the older departments of the profession, although moving less noisily, are assuredly performing an equal share in the nation's welfare. Another reason is probably due to the fact that the various branches of the profession have expanded to such an extent, that each one may be considered to have become specialised, and so contains its own army of workers. While it is naturally an advantage to know something of each branch of the profession, it is an absolute necessity that a man must, if he intends getting into the first rank, take up and make himself master of the details, both theoretically and practically, of one special branch, and this point I cannot too strongly urge upon our junior members. Although the general trade has been, as already stated, bad, the onward march of the electric light and power branch has continued, and the amount of capital expended or borrowed on municipal undertakings has not appreciably decreased, neither has the public investment in various companies diminished abnormally. Over 1,000 miles (single track) of electric tramway have already been opened, and two of the leading railway companies have electrified part of their system, and have already made the fact generally known by reason of a few deaths, due to contact with the live rail of their respective systems. These accidents, although unfortunate and deplored by all, will not curtail this branch of engineering; but will undoubtedly be the means of the evolution of a method of collecting the current which will be more in conformity with the usages of this country in protecting the individual against himself, even though such individual may be an unfortunate trespasser on forbidden ground. In the central station there is no margin for any very extended increase in the efficiency of our dynamos, and we are therefore left with the two items, fuel and its utilisation, as the only two directions in which reduction in generating costs can be effected, and even in these there is not a very great margin to work upon in an up-to-date station, with the best steam raising, superheating and condensing arrangements. From a close practical acquaintace with the various power gas generators and the modern gas engine for large powers as we have it to-day, I am led to believe that at no distant date a combination of power gas generator and gas engine will perform a very important function in our generating stations. Mr. Humphrey deserves credit for having so ably brought under notice the capabilities of the modern gas engine when thus combined. As we all know, to our regret, the steam engine and steam-raising plant, as now in use, in even the most modern stations, is not by any means so efficient as one would like, or in other words, the amount of heat units obtained at the crank shaft of the steam engine as useful work is but a small proportion of the total heat units contained in the fuel used for steam raising; even with the best combination of steam plant we do not get more than one-eighth of the original heat represented by the fuel. The various losses from flues, radiation, condensation, &c., are familiar to the youngest member of our Institution. The fact is also well known that the internal combustion engine, either as an oil or gas engine, is far less wasteful in this respect. But it is only during the past few years that gas engines of nearly the power of the steam engines at our command have been introduced with any degree of confidence. This has not been by reason of inability on the part of the gas engine manufacturers to make large engines, but more from the fact that the power gas plants had not reached the necessary requirements of a large supply with a capital outlay in first cost and efficiency to compete with a large steam-raising plant. Mr. J. Emerson Dowson, whose name is a household word in connection with power gas, has done much to advance this department of the industry, both for electric driving, and also for other purposes, in replacing the steam boilers in many branches of manufacture. Dr. Ludwig Mond has carried the matter to a further degree in enabling the gas engine to take a most leading position as a prime mover, by the introduction of Mond gas.

A further type of power gas plant, and one which has come to stay, and which will play a most important part in the future of gas driving in this country, is that known as the "suction" gas producer. From tests I have made with such a producer of 250 B.H.P., I have no hesitation in concluding that an average over all thermal efficiency of 25 per cent., or twice that of a good steam plant, can be obtained. Unlike the pressure plant heretofore in use, the suction plant, as its name implies, depends upon the suction of the engine for the supply of gas, which supply is strictly in unison with the load on the engine. A number of such plants, up to 250 B.H.P., are in use in this country, and special plants are being installed by the leading gas engine makers and others for supplying large powers. On the Continent this system is quite common, and installations are already at work of 2,000 H.P. The question of economical power gas production being to my mind settled, the next factor is that of the engine, and from my own experience and observation I consider that we need have no fear in installing large power gas engines for central station work. Engines of 1,000 H.P. and 1,500 H.P. are now quite common, especially on the Continent and in America, and in this country a confidence is being gradually produced which will result in a wider application of these larger powers. I have had the installing of two four-cylinder 800 B.H.P. 250 revs. per min. engines, and I find that running under varying loads, and with varying thermal efficiencies of gas, they are equal to the best steam engines as to steadiness. I grant that my experience so far has been that, if anything, a little more attention is required with the gas engine than with the same sized steam engine, the latter often being left to take care of itself, but I believe that a large amount of this extra attention is due to natural nervousness and fear that something may happen, and this will wear off all too soon. In the engine just named we have had an igniter fail on one or two occasions, through no fault of the engine, which at the time not being fully loaded up continued to run without any variation of speed or alteration whatever. Indeed, the difference in the sound of the exhaust was the first indication that a couple of cylinders were not working. I grant that the relative sizes of the steam and gas engine is in favour of the former so far as floor space is concerned. The question of speed is also in favour of steam so far as the size and cost in the dynamo concerned. The relative first cost of the two classes of engine is also in favour of steam; at the same time, the cost of the power gas plant is less than boilers, &c., and the cost of banked-up fires for steam to meet any emergency (which is no inconsiderable item in the generating costs of a large station) does not exist. With a supply of gas at hand we have no difficulty in starting up and getting current on to the switchboard in slightly under a minute. For small stations, say to meet there quirements up to 15,000 inhabitants, a gas-driven plant will, to my mind, prove to be a most successful combination in the very near future. I even venture to think that we may see our competitor, the municipal gas engineer, supply us with the necessary power gas as our fuel in some instances at no very distant date. We have rendered inestimable value to the public at large, and to the gas engineer in particular, by our healthy competition in lighting, by stirring up the gas industry to increased efficiency in gas mantles, and in a multitude of other directions, and I see no reason why, where circumstances are favourable, we should not, with that brotherly love which is supposed to exist among various branches of the engineering fraternity, let one department of a municipal undertaking help the other, in the manner indicated.

There has been a marked increase in the number of combined destructor and electricity works which have been put down of late, and all indications go to prove that the number of such works will increase even more rapidly in the near future; this even in view of the fact that some of the power companies are canvassing most of the small towns. This increase in combined stations may arise from the fact that those towns which have obtained provisional orders and have not yet put them into force, are being pressed by the Board of Trade to do so, or they run the risk of losing their powers, which they are loth to do, and further the establishment of a refuse destructor in many places has become an absolute necessity on sanitary grounds alone, as it is practically the only means of disposing of the ever increasing refuse of our towns. Some use must be made of the steam generated, and the production of electricity seems to be the most natural available. As there is now no difficulty in getting an output of 15kw. per ton of refuse of even only a fair average quality, it is evident that the return is worthy of consideration as representing a certain monetary value which would otherwise be expended in coal, and by this means helps a municipality along with its electricity undertaking, and also enables it to get rid of the refuse. As a rule, the destructor comes under the control of the sanitary committee, and is installed to meet its requirements, while the electrical department is controlled by the electricity committee. Although these two committees are often quite distinct, as to their personnel, the joint result financially affects the whole body of ratepayers as if the whole were under one committee. This, no doubt, is the reason why there is no recognised system of dealing with the accounts of the two departments when thus combined, as it is regarded as being "all the same in the long run." One thing is certain, that by combining the two departments the municipality obtains the best possible arrangement for efficiently disposing of its refuse, and any electricity obtained is an asset which would otherwise be lost unless some means were found for utilising the steam, as, for instance, in sewage pumping, stone breaking, clinker crushing, &c.

Attempts have been made from time to time, even as far back as what may be called the telegraph days of the Institution's history, to form a Yorkshire Provincial Centre, working in harmony with the parent Institution in London. I was associated with one of these early attempts, but it was reserved for our honorary secretary, Mr. G. R. Blackburn, to secure the honour which must be attached to his name of having, by his energy and zeal, succeeded in bringing about a consummation so devoutly to be wished: I desire to place on record my appreciation of the successful labours of Mr. Blackburn, and in doing so I am sure that I am but voicing the feelings of at least every Yorkshire member of the Institution. As to our location in Leeds, it goes without saying that there is no other city in the county so well adapted for our purpose, nor do I know of an Institution so well adapted to our needs as the Leeds University, under the shelter of whose roof by the courtesy of its governors and through the assistance of Mr. Parr, one of our local council, we are able to hold our meetings.

PHYSICAL SOCIETY.

At a meeting of the Physical Society held November 11, 1904, Dr. R. T. Glazebrook, F.R.S., President, in the chair, a Paper on the

"Investigations of the Variations of Magnetic Hysteresis with Frequency."

by Prof. T. R. LYLE, was read by Prof. Trouton.

The experiments were made on two rings of laminated annealed iron, in one of which the radial breadth of the iron was considerable relative to its mean radius. These rings were magnetised by alternating currents of different strengths and periods: both the magnetising-current wave and the magnetic-flux wave were quantitatively determined by a wave-tracer (described by the author in the *Phil. Mag.*, November, 1903), and the wave-forms so obtained subjected to harmonic analysis. The experiments were divided into series, in which the period and wave-form of the magnetising current were kept as nearly constant as possible throughout any one series, while its strength was varied. The analytic expressions for the associated current and flux waves for a few series are given in tabular form. From the analytic expressions for each pair of associated waves it was found that when the magnetising current was approximately sinusoidal the total iron loss (I) was, within certain limits of the induction, given by a formula, $I = (a + bn)\mathfrak{B}^{1\cdot 57}$, where n is the number of periods per second, $\mathfrak{B}$ the "effective induction," and a and b are constants. When from the total iron loss per c.c. per cycle the sum of the statical hysteresis and the value that theory assigns to eddy-current loss was subtracted, a considerable quantity remained, which increased both when the frequency and the flux-density increased. This quantity, called by Fleming the kinetic hysteresis, has been obtained for each experiment. An interesting case of transformation and what is called reflection of energy is drawn attention to and discussed. If the E.M.F. impressed on the magnetising circuit on the iron ring be sinusoidal, the flux-wave produced contains third, fifth, &c., harmonics. These higher flux harmonics induce currents in the magnetising circuit which are dissipated as heat in it. Thus we have a transformation of electrical energy due to alternating currents of frequency, n, to energy of currents whose frequencies are $3n$, $5n$, &c., which is reflected back into the magnetising circuit. This the author believes is a hitherto unnoticed source of transformer loss.

Dr. J. A. FLEMING said the Paper appeared to contain many points of interest. The result given by the author that the total iron losses varied as the 1·57 power of the induction density agreed with practice. There was, however, no hard and fast law for the calculation of the iron losses, but the number 1·6 was useful as a guide. In many cases the loss varied according to an exponent considerably less than 1·6. He pointed out that this exponent was practically the same for all magnetic metals, and said it would be interesting to know if the law would be true in the case of a Ewing model of a magnet. The Paper clearly showed that transformer losses should be determined by measuring the watts. The experimental determination of the statical hysteresis was not of practical importance; what was wanted was the real loss which varied with the frequency. What is required is an expression to allow us to calculate the loss at any induction and frequency from the known loss at any particular induction and frequency.

Mr. A. CAMPBELL drew attention to the work of an earlier investigator on the same subject. Max Wien, in a Paper on "Magnetisation by Alternating Currents" (Wied. *Ann.* 13), August, 1898), gives results of an investigation on the change in flux-density and hysteresis loss due to variation in frequency of the magnetising alternating current. His chief method of measurement was based on Maxwell's method of comparing two self-inductances. One of the inductive coils so compared was the winding of the iron ring under test, the source of voltage being alternating (128 to 520 ∼ per second), and the indicating instrument a tuned optical telephone or vibration galvanometer. The bridge measurements (starting with direct current) gave the "effective" resistance and self-inductance of the ring winding, and from these (with the dimensions, &c.) were deduced the values of B and the hysteresis loss due to the fundamental component of the alternating flux, allowance for eddy-currents having been made. A number of conclusions are drawn from the results; amongst others that increase of frequency decreases B for a given value of H, and increases the hysteresis loss for a given value of B. This appears to indicate that with quickly alternating fields B lags behind H. It is interesting to notice that for one of the rings tested the "kinetic hysteresis" found for $n = 128$ is of somewhat the same order of magnitude as that given by the rings of Prof. Lyle at lower frequencies.

Dr. D. K. MORRIS, in a communication which was read by the Secretary, said that much experimental work on this subject had been lately carried out (chiefly by Mr. R. P. Hulse, B.Sc., now with the British Westinghouse Co.) in his (Dr. Morris') laboratory, and it had always appeared that with good transformer iron the increase of hysteresis with frequency was less than that found by Prof. Lyle. These experiments were made with ring magnets built up of stampings properly insulated from one another and having a small difference only between internal and external radius. But another method of experimenting was the following: If the no-load loss of a transformer were measured at different frequencies, the voltage being so adjusted as to give constant flux density, then by dividing each measurement by the frequency and plotting the quotients against the frequency, a straight line was obtained from whose inclination the eddy-current constant could be obtained on the assumption that hysteresis did not vary with the frequency. Prof. Lyle quoted $\pi^2/6 = 1\cdot645$ this constant.* Different methods of arriving at it as variously given showed that it certainly came between 1·2 and 2·0. Measurements on transformers by the above method gave figures between 4 to 5 as far as his experience went. This meant that that portion of the loss which did not simply increase proportionately with the frequency was rather more than double that which was ordinarily explained by eddy currents. Such measurements had been made for a maximum flux density ranging between $B = 2{,}500$ and 5,000 lines per square centimeter, and Prof. Lyle's results were very closely in agreement with this. Excess eddy-current loss had, however, usually been attributed to current flowing across from plate to plate. Such currents certainly did not occur in Prof. Lyle's experiments. Sometimes the discrepancy between observed and calculated eddy currents was due in part to the existence of higher harmonics in the flux-wave for which the relatively large allowance had not been made. But if it was not due to either of these causes it certainly would seem to indicate "kinetic hysteresis." Prof. Lyle asserted that "if the E.M.F. wave impressed on the magnetising winding is sinusoidal, the flux-wave will contain third harmonics, &c." It was quite true that the magnetising *current* contained such harmonics, but unless the resistance of the magnetising winding were exceptionally high, these harmonics would surely not appear appreciably either in the back voltage or the corresponding flux. The practical significance of the "reflected energy" was therefore very slight.

Mr. T. H. BLAKESLEY said that 10 or 12 years ago he read a paper before the Society describing experiments which pointed to the existance of kinetic hysteresis. The present Paper substantiated what he said then.

A Paper

"On the Practical Determination of the Mean Spherical Candle-Power of Incandescent and Arc Lamps,"

by Mr. G. B. DYKE was read by the author.

Mr. Dyke points out the need of an improved method of expressing the efficiency of glow-lamps, and adopts the suggestion of Dr. Fleming of expressing the whole flux of light in lumens per watt. The expression of the efficiency in this manner involves the determination of the mean spherical candle-power (M.S.C.P.), and the Paper describes a method of doing this. The objects of the Paper are (1) to obtain curves showing the variations of candle-power of glow-lamps in a horizontal plane, (2) to obtain reduction factors by which the mean horizontal candle-power (M.H.C.P.) may be calculated from the maximum horizontal candle-power (C.P.), and (3) to obtain reduction factors for deducing the M.S.C.P. from the M.H.C.P. and from the C.P.

A self contained motor-driven lamp-holder is described which rotates the lamp about a vertical axis at from 200 to 300 revs. per min. The M.H.C.P. was determined by spinning the lamps, and by taking C.P.S. in different azimuths by a step-to-step method. The results agreed within the limits of experimental error, thus showing that the filaments were not sensibly distorted during rotation.

An integrating photometer was used to determine the ratio (M.S.C.P.)/(M.H.C.P.). The instrument is of the type suggested by Mr. C. P. Matthews, and consists of several pairs of mirrors placed around the circumference of a semi-circle, and so arranged that light emitted from a source placed at the centre of the system is incident upon the photometer screen, also situate at the centre, at the same angle with the vertical as it made on emission from the source. It is shown how the ratio (M.S.C.P.)/(M.H.C.P.) can be determined by observing one distance after obtaining a photometric balance. The effects of any departure from Lambert's cosine law, and of varying reflection coefficients of the mirrors were investigated and allowed for. It was also found impossible to reduce the size of the apparatus by interposing ground-glass screens because of the varying absorption of ground glass for light of different colours. Nine types of glow lamp were experimented upon, and the high peaks and depressions on the curves of horizontal intensity were ascribed respectively to a mirror action of the bulb and to portions of the filaments obstructing the light from other portions. Values of the ratios (M.H.C.P.)/(C.P.), (M.S.C.P.)/(C.P.), and (M.S.C.P.)/(M.H.C.P.), have been obtained, and for lamps of the same type of filament it is found that the ratio (M.S.C.P.)/(M.H.C.P.) is remarkably constant. The author therefore suggests the determination of the M.H.C.P. by means of a rotator, and then, with the aid of a reduction factor, determined once and for all for a particular type of filament by an integrating photometer, the deduction of the M.S.C.P. Preliminary experiments upon arc lamps seem to show that a similar method may be adopted for the determination of their M.S.C.P.

Dr. J. A. FLEMING congratulated the author and referred to the peculiar difficulties under which the research had been conducted at University College. Two features of the integrating photometer used were the possibility of compensating departures from the cosine law by the setting of the mirrors and the determination of the M.S.C.P. from one reading. It was now as easy to obtain a value for the M.S.C.P. as to obtain a useless measure of the horizontal intensity in any particular direction. The variation in the reflecting powers of the mirrors due to dust and dirt could also be eliminated.

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* That figure—namely, which when multiplied by the (thickness of stamping)^2 × (induction density)^2 × (frequency)^2 and divided by the specific resistance of the stampings will give the eddy-current loss.

Mr. **PATTERSON** gave an account of similar experiments which were being carried out at the National Physical Laboratory. Referring to the fact that the author had taken for his zero position in determining the ordinary C.P. of a lamp, that in which the mean plane of the filament was at right angles to the axis of the photometric bench, he pointed out that this position was unsatisfactory because of the prevalence of streaks and shadows on the screen. The M.H.C.P., and not the C.P. in any particular direction, was the only unit now in use. The results of the author were in close agreement with those obtained at the National Physical Laboratory.

Mr. W. **DUDDELL** pointed out that if the peaks in the curves of horizontal intensity were due to reflection from the bulb, one would expect that their position would vary with the distance between the lamp and screen. He asked the author if he had noticed any such variation. The integrating photometer described in the Paper was very cumbersome, and he would like to know in what respects it was superior to Blondel's lumenmeter.

Dr. C. **CHREE** remarked that it would be interesting mathematically to express the illumination in a series of spherical harmonics.

The **CHAIRMAN** expressed his interest in the fact that some of the results of the author had been confirmed by Mr. Patterson at the National Physical Laboratory. He had recently been in America, and found that the integrating photometer was in use for measurements upon arc lamps but that incandescent lamps were measured with a rotator, no particular regard being paid to the M.S.C.P. With regard to the observations of Dr. Chree, he said that Mr. Patterson could give him sufficient data to carry out the calculations.

The **AUTHOR**, in reply to Mr. Duddell, said that although he had not varied the distance between the lamp and the screen, he had taken photographs of the "blaze" of the lamp at different distances, and found that it was always the same.

Exhibition of apparatus by Mr. R. W. PAUL.

The construction of highly sensitive pivoted electrical instruments has been rendered difficult by the fact that delicate pivots will not admit of transporting without injury. A number of galvanometers were shown in which the design was based upon the use of a moving coil, supported on one pivot in a powerful and uniform magnetic field, and controlled by a spring. The adoption of one, in place of the usual two pivots, renders it feasible to raise the coil when the instrument is out of use, and thus secure the pivot from risk of injury. By taking advantage of this, and the incidental reduction of pivot friction, a practical instrument has been made approaching in sensibility to that of a reflecting galvanometer. Some of the instruments exhibited gave a full scale-reading of 100 divisions for 2 millivolts or for 60 micro amperes. Combined with shunts and resistances, other forms gave direct reading insulation measurements to 2,500 megohms, pressures to 500 volts, and currents to 25 milli-amperes in the one apparatus. Demonstrations were given of the suitability of the galvanometers for pyrometer use. The galvanometers are so designed that accurate levelling is unnecessary. A simple non-reflecting suspended-coil galvanometer for the student's use, with a sensibility of one division per micro-ampere, was exhibited.

A new design of lantern, adapted for science lectures, and for use with three Nernst filaments arranged closely together, was shown in action. It is capable of being instantly changed from horizontal to vertical projection, can be fitted with a reversing prism, and has a wide adjustment for focussing. Another exhibit was an Ayrton-Mather reflecting electrostatic voltmeter with a magnetic damping device. The instrument shown had a sensibility of 500mm. at 1m. for 80 volts. but similar instruments are made to give this deflection with pressures as low as 8 volts.

STARTING AND REGULATING RESISTANCES.

MM. Lindenstruth and O. Forster recently communicated to *L'Eclairage Electrique* an interesting article on some modern types of cheap and compactly-built metal resistances for starting and regulating purposes. The following is the gist of their communication:—For resistances which are required to absorb but small energies, the old and universally adopted design of resistances in the shape of spirals of resistance wire, suitably assembled, leaves little to be desired. If, however, this is not the case, then there is a danger of the coils coming into contact with each other. To avoid this, the resistance spirals are often stiffened by a rod of slate or a tube of asbestos placed inside the coil.

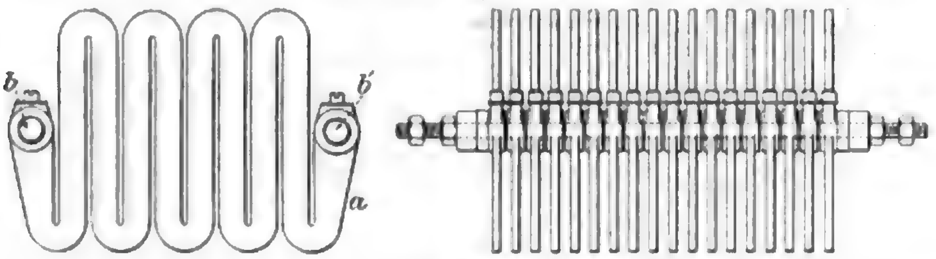


Fig. 1.

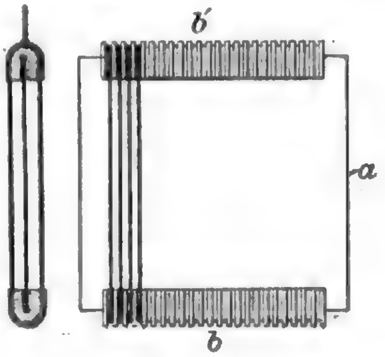


Fig. 2.

It may be stated as a general rule that rheostats for continuous service ought to be designed with a view to a most perfect ventilation, while rheostats for intermittent service are best designed with a metal cover, which quickly absorbs the heat given off by the resistances and then slowly dissipates this heat. If this is properly done, the resistances are saved from undue deformation by heat.

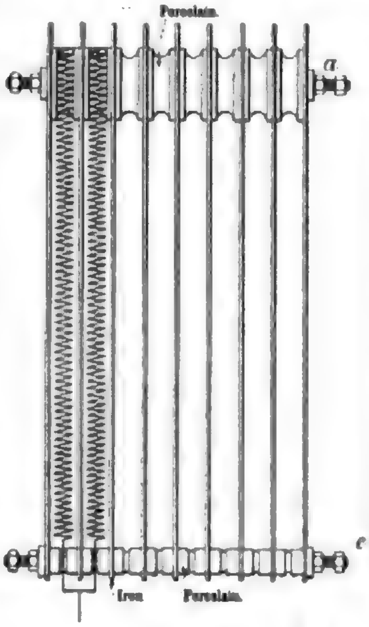


Fig. 3.

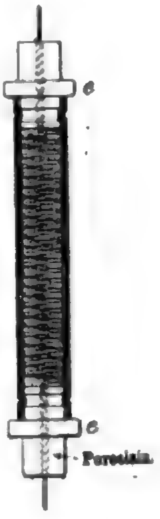


Fig. 4.

Fig. 2 represents a very compact pattern of resistance for continuous service, suitable for small currents. The resistance wire passes spirally from one of the grooved porcelain pieces *b b′* to the other, these two porcelain parts being held apart by a plate, *a*, of iron, slate or asbestos. A plate of iron is to be preferred, not only because it is stronger than the other materials mentioned, but

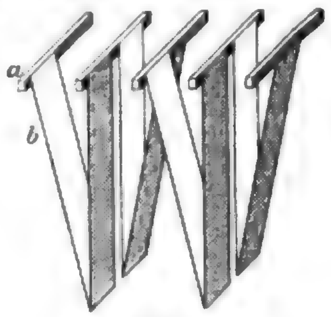


Fig. 5.

principally because it conducts away the heat so much more rapidly. Iron plates are also used in the design shown in Fig. 3, which represents a pattern made by Messrs. Voigt & Haeffner. Fig. 1 shows another type of resistance, in which the actual resistances are usually cast. For heavy currents the type shown in Figs. 5, 6 and 8 is to be preferred. As shown by the diagrammatical sketch, Fig. 5, the resistance takes the form of metal strips, *b*, which are clamped at their upper ends to a series of cross-supports, *a*. The strips are mounted in zig-zag and are kept in a stretched position by the arrangement indicated in Fig. 8. A resistance, designed upon these lines, has been used, for instance, for regulating the speed of a three-phase 1,500 H.P. 6,000-volt motor. The speed limits are 125 and 150 revs. per min., and the regulation is obtained by inserting resistance in the stator circuit.

Turning now to the design of resistances for intermittent use, Fig. 4 represents a type of this kind made by Messrs. Voigt & Haeffner. The outer tube is of iron, about 35mm. to 40mm. (1·4in. to 1·57in.) in diameter and lined with asbestos 2mm. (0·08in) thick. The resistance coil is introduced while still wound on the mandril, but when the latter is withdrawn the coil expands and presses firmly against the asbestos lining. Subsequently the tube is also filled with a suitable cement. Another form of resistance, often used for tramway work, consists of a spiral of a long flat resistance strip, wound like the spring of a clock, asbestos or mica being wound together with the metal strip, so as to separate electrically the individual turns. Several resistances constructed in this way may be connected up as shown in Fig. 9. A similar, but more open, construction is indicated in Fig. 7.

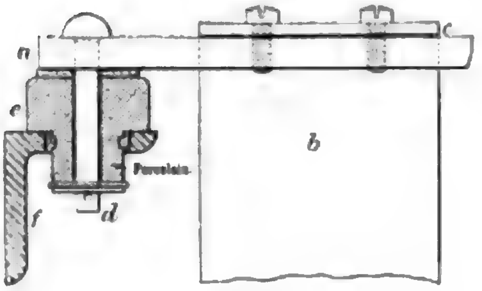


FIG. 6.

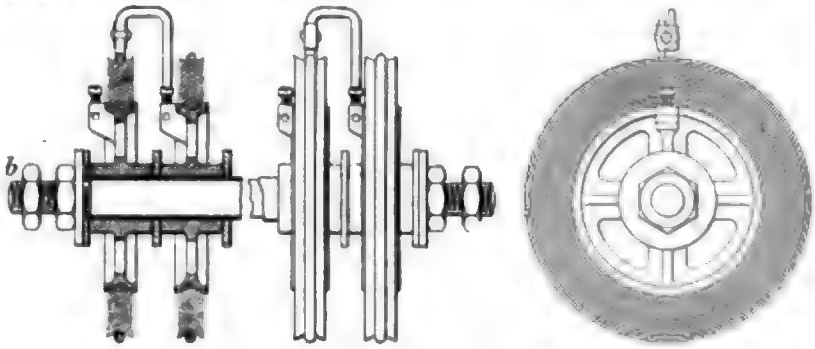


FIG. 7.

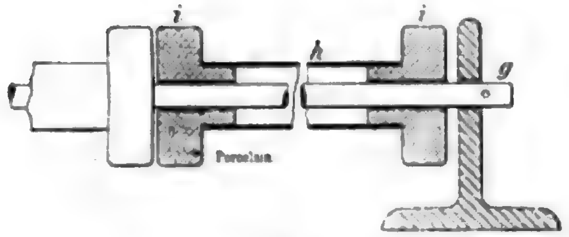


FIG. 8.

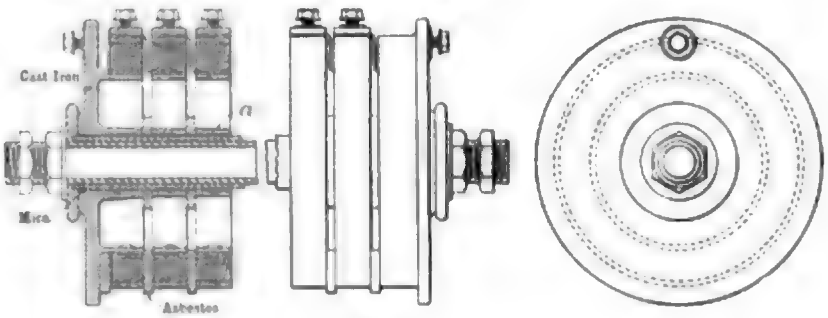


FIG. 9.

CORRESPONDENCE.

THE TESTING OF TRANSFORMER IRON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I take the liberty of calling your attention to a point in Mr. L. W. Wild's article on "The Testing of Transformer Iron" (*The Electrician*, November 11th, pp. 125, 128) which may easily occasion misunderstanding of the method if not pointed out. For carrying out measurements, Mr. Wild indicates a wattmeter arrangement which may be practical in many cases, because it allows the secondary windings of the transformer to be varied so as to obtain the best conditions for the wattmeter in all cases.

According to the way in which Mr. Wild expresses himself, it would seem that the author is under the mistaken impression that by his method *the copper losses in the magnetising coil may be entirely neglected*. Mr. Wild, indeed, says in his article that by his arrangement *the C^2R loss in the primary winding is eliminated* from the wattmeter reading. Anyone would infer from this sentence, as is also done in the editorial note on p. 125 of the same issue, that *the primary winding of the transformer is meant*, but, of course, it ought to be *the primary winding of the wattmeter*.—Yours, &c.,

Stockholm, Nov. 16. ALFRED EKSTRÖM.

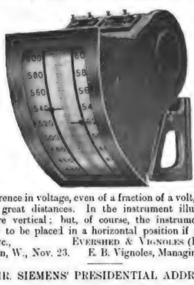
[Mr. Ekström seems to us to have missed the whole point of Mr. Wild's method. The C^2R losses in the magnetising coil have no effect on the wattmeter reading. This will be easiest understood by the following case. Supposing a test is being made at a particular **B** and ~; and that when the wattmeter reading is obtained, another magnetising coil be substituted having exactly the same sized wire and turns, but of say German silver instead of copper. In order to get the same voltmeter reading (*i.e.*, the same **B**) the E.M.F. supplied to the magnetising coil must be increased until the magnetising current reaches its former value. The same current as before will then be passing through the series coil of the wattmeter; and the same current as before will be passing through the shunt coil (for the E.M.F. acting on it will be the same); and the phase relation between these two will be the same, since this depends only on the difference of phase between the magnetisation and the magnetising current; so the wattmeter reading will be the same also; but the C^2R will be many times greater. Of course the phase relation between the magnetising current and *its* E.M.F. will be altered, but the wattmeter has no cognizance of this.—ED. *E.*]

PARALLELING VOLTMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We notice recently a description in your paper of a station voltmeter in which an attempt is made to realise the undoubted advantages which follow from the use of instruments quite close together and having identical scales for paralleling and similar purposes. It appears to be claimed that this idea is novel, but we would draw your attention to the duplex voltmeter which we have been making for some years, in which the advantages of this system, we think, are even more fully realised.

In our pattern the two movements are mounted on either side of a central framework, and one case only is used. These two movements are electrically entirely independent, but are placed in such a position that the two pointers work over the same scale. In this manner the tips of the pointers come within a fraction of an inch of one another at the moment when the voltage applied to each instrument is the same, and any difference in voltage, even of a fraction of a volt, is obvious, even at great distances. In the instrument illustrated the scales are vertical; but, of course, the instrument can be arranged to be placed in a horizontal position if required.—



Yours, &c., EVERSHED & VIGNOLES (LTD.),

London, W., Nov. 23. E. B. Vignoles, Managing Director.

MR. SIEMENS' PRESIDENTIAL ADDRESS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Byng's letter of the 16th inst. is interesting. If it were less academic and more precise it might even be valuable. Confining one's attention solely to the electrical industries, can Mr. Byng give the volume of the respective internal electrical markets of Great Britain, Germany and the United States? How many millions' worth of electrical machinery imported from abroad has found its way into our central stations, and how does this amount compare with the value which our own manufacturers have supplied? By what margin have these orders been lost? If Mr. Byng will leave generalities, and obtain the compilation of such figures as those I have indicated, he will render a great service to the general community, but possibly a disservice to the cause he has so strongly at heart.—Yours, &c., TURBIS.

London, W.C., Nov. 19.

THE ELECTRO-HARMONIC MEETING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the letter from Mr. A. H. Allen which appeared in your issue of the 18th inst., I beg to inform you that at a meeting of the executive committee of the Electro-Harmonic Society, held on the 16th inst., it was resolved: "That chairs may only be reserved up to 10 minutes to eight o'clock, after which time any vacant chair may be occupied."—Yours, &c., W. F. LANE, Hon. Sec.

London, Nov. 23.

LEGAL INTELLIGENCE.

British Accumulator Co. and Others v. Kramer.

On Tuesday Mr. Justice Kekewich heard an action brought by the British Accumulator Co. (Ltd.) and the Allgemeine Accumulatorenwerke A.G. against Arnold Kramer. There was also a counterclaim by Mr. Kramer against plaintiffs.

Mr. LAWRENCE, K.C., for plaintiffs, said this was an action against a former manager of the plaintiff companies arising out of acts done by him since the determination of his agreement for employment in December last year. Mr. Kramer had since purported to act in the name of his principals and refused to give up possession of the office and papers. One of the questions was whether plaintiffs were entitled to an injunction to restrain defendant from using the name of his principals and from opening letters which came to plaintiffs and for an account of moneys which he had received during the period of his managership. The counterclaim was brought for wrongful dismissal. Plaintiffs submitted that defendant determined his employment, or, at all events, it was determined by mutual consent. If it were held that plaintiffs did dismiss him, they then pleaded that they were justified in doing so. Plaintiffs' contention was that defendant, having been employed under an agreement, had tried to exact better terms after he had established himself in England, and used as a leverage the fact that he was not going to devote himself to the affairs of the company unless his salary was raised and he was given more extended powers under agreement. The Allgemeine Accumulatorenwerke carried on business at Vienna, and it was considered advisable to establish a branch or agency in England. In November, 1903, the agency was formed into an English limited company. The terms of defendant's employment were written out and signed in German, and the document was dated Oct. 3, 1902. In it defendant undertook the management of the establishment the company wished to open in London. He was to keep on the agency of the Rheydt Electrical Works, but he was not take over any other agency or obligation. He received an annual salary of K 6,000 monthly, and, further, 10 per cent. of the net profit of the London business, and he was to obtain the company's directions with regard to the London work, and to adhere to them. The business expenses of the London office were to be kept as moderate as possible, and as regards larger amounts defendant was to ask for the company's consent before incurring. It was understood that the London agency would get the accumulator plates exclusively from the works at Raab, who would charge the London business only the wages and general expenses, and no profit, so that the accumulator plates should be as cheap as possible for the London agency. The agreement could not be cancelled by either party for 18 months, and after that by six months' notice. Immediately on the signing of the agreement Mr. Kramer came to London and took offices for the purpose of the agency. A large number of letters which passed between the directors of the Vienna Co. and defendant were read, and counsel submitted that plaintiffs had from the first pointed out to defendant that his agreement contained no stipulation that he would be appointed managing director of the British Accumulator Co. On June 13, 1903, defendant wrote to the Vienna Co. stating that he could not undertake the extensive and difficult work in London for £250, and he wanted £600 to £700. In another letter he stated that he was ready to fill the post of secretary as well as managing director of the British Co., and stated that unless the salary he stipulated for was given, he should have to consider plaintiffs' agency as a secondary matter. On July 24 plaintiffs wrote that they had no intention of altering their relations with the defendant or of making the conditions more favourable to him. There were (continued Mr. Lawrence) heavy contracts running with certain corporations in England, and that they would not pay plaintiffs anything for the supply of accumulators till defendant assigned the contract to plaintiffs. In particular, Radcliffe Council would not pay plaintiffs a penny till the contract was so assigned.

Mr. STEWART SMITH, K.C., for defendant, said he had told Radcliffe Council that they may pay to the British Accumulator Co.

Mr. LAWRENCE: On Dec. 21, 1903, defendant wrote to the Vienna Co.: "In consequence of the formation of the British Accumulator Co. (Ltd.) behind my back, without my knowledge and consent, and as I must decline to put myself under the orders of somebody else in London . . . I am compelled to inform you that I consider our agreement of Oct. 3 terminated." He claimed £500 damages, as set out in the letter. On the 22nd of the same month the Vienna Co. wrote determining the agreement. The two letters crossed. Defendant refused to hand over the books of the office, and proceeded to trade as the British Accumulator Co. In January last proceedings were taken, and defendants gave an undertaking until the trial of the action or further order not to carry on or purport to carry on business under the style or title of the British Accumulator Co. or in any way to make use of that name for his business, and to forward unopened any letters addressed to the British Accumulator Co. to the manager or secretary of that company. Plaintiffs then got possession of the office and letters, and they now asked that the undertaking should be made perpetual or an injunction granted. In regard to the counterclaim, plaintiffs contended that there was a balance due to them, and plaintiffs also asked a substantial sum for the trouble they had been put to in removing defendant from their London office.

Mr. STEWART SMITH said his defence was that Mr. Kramer was engaged as manager by the Vienna Co., and that he acted for that company as manager until Mr. von Gerson came over with power of attorney and endeavoured to supersede him. Mr von Gerson told defendant that no act was to be done and no letter was to be written which had not his sanction or signature. Matters became so acute that Mr. Kramer wrote pointing out that there had been a breach of contract by the Vienna Co., and that he could not transfer his services to a company which had then only seven shares taken up. Mr. Kramer was entitled to remain in the London offices because they had been taken in his name, and he was responsible for the rent. On receiving proper indemnity he was willing to give up the office and the papers. Mr. Von Gerson, during Mr. Kramer's absence, had attempted to get into the office to remove the furniture, and the landlord said he would not allow it until the rent was paid. So matters remained till Jan. 22, when an agreement was come to, and Mr. Kramer gave up possession of the offices, &c. He denied that he had been carrying on business as the British Accumulator Co., or that letters addressed to that company had been opened by him since January. He contended that Mr. Kramer was never the servant of the English Co. under the contract made in Vienna. He was not bound to serve that company unless a new contract had been entered into.

Mr. F. VON GERSON gave evidence for plaintiffs, and said he had been instructed by the Vienna Co. to try to arrange all matters concerning Mr Kramer. After the agreement was determined he went to the office of the British Accumulator Co. to take possession. He was chief engineer in London of the Railway Carriage Works of Vienna. These works belonged chiefly to the shareholders of the Accumulator Co. He had orders from Vienna to countersign all orders issued by Mr. Kramer, as well as correspondence. The British Accumulator Co. was registered as a limited liability company on the instructions of witness, who was one of the directors. Mr. Kramer went abroad in December last, but did not ask permission to do so.

Evidence was then given by a customer and by the lady typewriter employed by Mr. Kramer, and this closed the case for the plaintiffs.

Mr. Stewart Smith submitted, for the defendant, that when Mr Von Gerson was to be entitled to sign every letter and every order and control every minute part of the business, it was impossible in practice for Mr. Kramer to make the 10 per cent. on the profits. The action was improperly brought for an injunction and damages against the defendant. It was not until Dec. 28 that Mr. Kramer received the letter from the Vienna Co. dismissing him. On that day he removed the word "Limited" from the door of the office, and between that date and Jan. 1 he sent all letters addressed to the British Accumulator Co. to plaintiffs' office in Parliament-street. The reason some of the letters were opened was because he believed them to contain invoices for goods for which he was liable. The invoices were necessary in order to enable him to make up his monthly accounts to his principals. On Jan. 4 the name of the British Accumulator Co. was entirely removed from the door of the office. There was no evidence that defendant had attempted to trade under the name of the British Accumulator Co. After the undertaking given by defendant, the proceedings on the part of the plaintiffs were entirely unwarranted. Mr. Kramer had due to him a large balance from plaintiffs. The letter written by Mr. Kramer to the Vienna Co. in December was not in effect a resignation of his position, but a protest against the treatment he had experienced. Even supposing the Vienna Co. had a right to transfer its business to the company it created, it could not transfer the services of Mr. Kramer to that new legal entity without Mr. Kramer's consent.

In giving judgment, His LORDSHIP thought, on the proper construction of the agreement, Mr. Kramer was to have no voice in the decision of whether the London establishment was to be an individual, commercial or share company. There was no doubt from the correspondence that the Vienna Co. thought Mr. Kramer would continue as manager of the new limited company at the same salary as formerly. He did so at first, but later disputes arose between himself and the Vienna Co. as to his position. His Lordship could not say that Mr. Kramer had been wrongfully dismissed, having regard to the letter he wrote on Dec. 21 stating that he considered his agreement at an end. With regard to opening letters after ceasing by his own act to have any connection with the company, Mr. Kramer had gone beyond his rights. It would be wrong to grant the company any substantial damages for what defendant had done after he ceased to be their servant, but the company were nominally entitled to judgment on the point. So far as the account asked for by the counter-claim had relation to damages it failed, but defendant was entitled to an account in order that he might have reimbursed any moneys that he had paid on behalf of the company. Defendant was ordered to make assignments at plaintiffs' cost of any contracts he had entered into and which had not yet been transferred to the company.

Attorney-General (at relation of Weybridge Council) v. Urban Electric Supply Co. (Ltd.).

Defendants applied to Mr. Justice Joyce on Tuesday that the injunction granted on Aug. 3 last, might be stayed until the expiration of the present session of Parliament or for such other period as might be thought just.

In this case (reported in our issue of Aug. 5) plaintiffs' had applied for an injunction to restrain defendants from supplying electric current outside their area and also to prevent them breaking up the streets in Weybridge for distributing electrical energy outside the district. The Attorney-General contended that what had been done by defendants in supplying Walton Council with energy was a breach of the Weybridge provisional order, but defendants maintained that they had a right to give supply to Walton as a local authority having power to light its own district. His Lordship held that the plaintiffs were entitled to an injunction against defendants, but suspended its operation for a certain period.

His LORDSHIP now asked why defendants did not go to the House of Lords.

Mr. YOUNGER, K.C. (for defendants) said his clients did not want to do that. The position was that everything might be put right by an Act of Parliament.

Mr. HUGHES, K.C. (for the Attorney-General) opposed any further stay. Defendants were, he urged, breaking the law.

His LORDSHIP said he would give defendants a further stay till Jan. 12 next.

After some discussion, Mr. HUGHES said plaintiffs could not dispense with pleadings. He asked that defendants be limited to supply existing customers.

His LORDSHIP: I cannot do that. Why should I inconvenience the customers?

Acetylene Illuminating Co. (Ltd.) and Others v. United Alkali Co. (Ltd.).

Yesterday, in the House of Lords (before the Lord Chancellor and Lords Davey and Robertson) the Acetylene Illuminating Co. (Ltd.) and the Willson Laboratory Co. appealed against a judgment entered for the United Alkali Co. (Ltd.) by the Court of Appeal, who thus affirmed a decision of Mr. Justice Buckley. In the action the appellants sought a declaration to restrain infringement by the respondents of Letters Patent No. 16,705 (1894) granted to Thomas Leopold Willson. Mr. Justice Buckley held that the respondents had not infringed, on the ground that, in his judgment, the patentee had restricted himself to an arc furnace, whereas the respondents had used an incandescent furnace. In the Court of Appeal the argument turned on whether the specification (i.) excluded an incandescent furnace; (ii.) whether the current was to be sent through the material. The patentee indicated that he required to get the intense heat of an electric arc, but did not say that the heat was to be obtained in an electric arc furnace.

In the Court of Appeal the appellants submitted that the construction placed upon the specification by Mr. Justice Buckley was erroneous in that he failed rightly to appreciate the evidence as to the method of manufacture adopted by the respondents. They said that the invention described and claimed in the specification was not the application for any particular furnace, whether an arc or otherwise, to the production of calcium carbide, nor had the patentee restricted himself to any particular furnace. Further, they said the respondents had not used an incandescent furnace as understood at the date of the Letters Patent, for only one such was then known—namely, Cowles furnace, and this the respondents on their own evidence had not used.

The Court of Appeal, which consisted of Lords Justices Vaughan Williams, Stirling and Cozens-Hardy, held, inter alia, that the patent was invalid for want of subject matter and on the ground of anticipation. Hence the present appeal of the appellants.

Mr. Fletcher Moulton, K.C., and Mr. Arthur Colefax appeared for the appellants; Mr. Cripps, K.C., Lord Robert Cecil, K.C., and Mr. Walter for the respondents.

Mr. Fletcher Moulton had not concluded his argument when the hearing was adjourned.

National Electric Construction Co. (Ltd.) v. Poplar (London) Council.

On Tuesday Mr. Justice Kekewich granted an application to postpone for a week the hearing of this case.

ELECTRIC LIGHTING AND TRACTION NOTICES.

We give particulars of the additional Parliamentary notices relating to electricity supply and traction, which have appeared during the week:—

Provisional Electric Lighting Orders.

Gravesend (for Northfleet), Stratford-upon-Avon and Tewkesbury Corporations; Golborne, Haydock, Hipperholme and Little Hulton Urban District Councils, and Barry Rural District Council; Metropolitan Electric Supply Co. (for Brentford, and Southall-Norwood), Lancashire Electric Power Co. (for Barton-upon-Irwell, and Tottington), Woking Electric Supply Co. (for Chertsey, Byfleet, Pyrford, Chobham and Bisley); Mr. H. J. Almond and the Sunderland Electric Tramways (Ltd.) (for Houghton-le-Spring and districts; to transfer powers granted by Houghton-le-Spring and District Electric Lighting Order, 1904, and to amend same); Mr. E. P. Harvey (for Rushden, Higham Ferrers, Irthlingborough and Thrapston).

Electric Lighting Bills.

The Metropolitan Electric Supply Co. are promoting a bill to enable them to supply and distribute electrical energy for all purposes within the metropolitan boroughs of Westminster, Marylebone, St. Pancras, Holborn, Hampstead, Paddington, Kensington, Hammersmith, Chelsea and Fulham, and in the borough of Ealing, the urban districts of Acton, Hanwell, Southall-Norwood, Greenford, Uxbridge, Hayes, Chiswick, Brentford, Heston and Isleworth, Twickenham, Teddington, Hampton, Hampton Wick, Sunbury-on-Thames, Feltham and Staines, and the rural districts of Uxbridge and Staines; to use existing stations and works and mains, and to supply energy to Acton District Council, to extend powers of company under their 1890 order to the metropolitan borough of Paddington, &c.

The Metropolitan Electric Supply Co. are also promoting a bill to authorise them to enter into an agreement with Acton Council for the supply of electrical energy in bulk, &c.

The Metropolitan Electric Tramways (Ltd.) seek (inter alia) powers to enter into certain agreements with Middlesex County Council and other authorities, and with electricity companies for supply of electricity, to postpone date of purchase of tramways by local authorities, &c.

The North Metropolitan Electric Power Supply Co. seek authority to extend the areas set out in their Acts of 1900, 1902 and 1903, so as to include the metropolitan boroughs of Islington, Stoke Newington and Hackney; to enter into agreements with electrical undertakers as to execution of works and transfer of powers, to supply electrical energy to Alexandra Palace, to railways, tramways, &c.

Ealing Corporation seek authority to supply electricity outside the borough, to make provision, where consumers have separate source of supply, to refuse supply in certain cases, to alter date of filing accounts, to suspend repayment of capital moneys until completion of works, and to extend period of repayment of capital, to authorise supply and letting on hire of electric motors, fittings, &c., to provide against energy supplied for power being used for lighting, to restrict use of overhead wires, &c.

The Charing Cross & Strand Electricity Supply Corpn. seek powers to supply electrical energy in bulk in parts of the city of Westminster, the metropolitan borough of Holborn, the City of London, and the metropolitan boroughs of Islington, Stoke Newington, Hackney, Finsbury, Shoreditch, Bethnal Green, Stepney and Poplar in the county of London, and the county borough of West Ham, also the borough of East Ham and the urban districts of Barking Town, Ilford, Romford, Wanstead, Leyton, Walthamstow, Woodford, Buckhurst Hill, Chingford and Dagenham parish, in the county of Essex, and the urban districts of Edmonton, Tottenham, Hornsey, Wood Green and Southgate in the county of Middlesex; to enter into agreements for the supply of electrical energy, and to exempt the undertaking from or modify provisions of Electric Lighting Acts, 1882 and 1888 and the Electric Lighting (Clauses) Act, 1899, &c.

Power is being sought to incorporate the East London and Lower Thames Electric Power Co. for the purpose of establishing generating stations and works, and supplying electricity in parts of the counties of London and Essex, county borough of West Ham, &c., to enter into agreements with local authorities, companies, &c.

Power is sought to incorporate the "Administrative County of London & District Electric Power Co.," to erect generating stations for the supply of electricity in the counties of Middlesex, Surrey, Essex and Kent and the administrative county of London, &c.

The Central Electric Supply Co. seek authority to acquire or erect generating station at Marylebone, to enter into agreements with local authorities and others to supply electricity in Hampstead, Marylebone, Westminster, St. Pancras and Holborn, &c., to remove restrictions imposed by Company's Act of 1899 as to breaking up streets, &c.

The Chelsea Electricity Supply Co. seek power to extinguish founders' shares and allot ordinary shares in lieu thereof, to reduce capital and to amend memorandum and articles of association, &c.

The County of London Electric Supply Co. are promoting a bill to authorise them to supply electricity in bulk to authorised undertakers and users of electricity (*e.g.*, tramway and railway companies, borough councils, &c).

The South Wales Electrical Power Distribution Co. are promoting a bill to authorise the transfer to the company of the undertaking and powers of the Carmarthenshire Electric Power Co. (incorporated 1903), and to confirm agreement for transfer of same, to extend period limited by Carmarthenshire Act for commencing works and also for the removal of restrictions as to erection of generating stations; to extend area of supply so as to include the urban district of Llanelly, and to repeal sec. 50 of 1903 Act; also to acquire electrical undertakings by agreement, to pay interest out of capital, to amend borrowing powers of the South Wales Co., &c.

The Shropshire and Worcestershire Electric Power Co. seek authority to extend their area of supply to Lichfield, Tamworth, Brownhills, Cannock, Seisdon and Walsall (Rural), to abandon portions of existing area, to alter title of company, to acquire further capital powers, &c.

Whitby Urban District Council seek authority to provide and supply and let for hire and deal in electric motors and apparatus and fittings, and to exempt apparatus let on hire from distress or execution.

Colne Corporation seek powers to purchase, sell, let on hire and deal in electric motors, fittings and apparatus for the supply or consumption of electricity, to exempt apparatus let on hire from distress, &c., to make provision where consumer has stand-by supply, to alter date of filing accounts, to supply electrical energy in Trawden and other places outside borough, &c.

Aylesbury Gas Co. wish to obtain authority to apply for provisional electric lighting orders.

A bill is being promoted for the dissolution and re-incorporation of the Great Berkhampstead Gas Light & Coke Co. and for (inter alia) power to supply electricity, &c.

Folkestone Corporation seek authority to enter into an agreement with Folkestone Electricity Supply Co. for the supply of electrical energy for pumping and other purposes, either within or beyond the area of supply authorised by Hythe Electric Lighting Order, 1900.

Tramway Bills.

Rhondda District Council are applying for powers to extend time for purchase of lands and construction of tramways, &c., authorised by the Council's Act of 1892, to amend sections 29 and 30 of the Act with regard to leasing tramways, &c.

In the bill of the Whitechapel and Bow Railway Co., power is sought to enter into agreements with the London, Tilbury and Southend, the Metropolitan District and the Underground Electric Railways Co. of London for the supply of electrical energy, &c.

In the Halifax Corporation Act, power is sought to construct tramways in West Riding of Yorks., to exempt the Corporation from payment of local rates in respect of tramways, &c., outside the borough, &c.

Blackpool, St. Anne's-on-Sea and Lytham Tramways Co., seek powers to run over and use compulsorily certain tramways of Blackpool Corporation, and to make junctions therewith and for interchange of traffic, &c.

The Metropolitan District Railway Co.'s bill seeks further capital powers.

Birmingham Corporation ask powers to construct and work additional tramways, to acquire lands for generating and transforming stations, &c.

The Central London Railway Co. seek power to extend their line from the Bank to Liverpool-street Station, returning by a loop and proceeding westwards via Ludgate-hill, Fleet-street, Strand, Piccadilly and Knightsbridge road to Hammersmith, and to the present terminus at Shepherd's Bush, &c.

The Charing Cross, Euston & Hampstead Railway Co. are seeking powers to purchase additional lands, to enter into agreements with other railway companies and make arrangements as to joint stations, &c.

The bill of the Edgware & Hampstead Railway Co. seeks authority to make deviation of railway, to abandon portion of authorised line, to enter into agreements as to the supply of electrical energy, &c.

In the Great Northern, Piccadilly and Brompton Railway (No. 1) Bill power is sought to construct new railways and works, including an extension from Kingsway to Waterloo, to alter junctions and station at Holborn, to abandon portions of authorised railway, to authorise agreements with Underground Electric Railways of London and Metropolitan District Railway Co. with regard to supply of current and leasing of working arrangements, &c. In the No. 2 bill power is sought to construct new railways and works at Shepherd's Bush Common, to provide for communication with stations of other railways, to enter into agreements with existing railway companies, &c.

Power is sought to incorporate the Hammersmith, City and North-East London Railway Co. (from Hammersmith to the City and on to Palmer's Green and Walthamstow), to acquire lands, and to enter into agreements with existing railway companies and public bodies, &c.

The Baker Street and Waterloo Railway Co. wish to obtain power to construct new and abandon existing subways, to extend time, &c.

The South Lancashire Tramways Co. seek to extend time for constructing authorised lines, to abandon other tramways, &c.

The Metropolitan Railway Co. seeks authority to acquire the undertaking of the Harrow and Uxbridge Railway Co., to raise additional capital, &c.

In the Stockport Corpn. Bill authority is sought to amend or repeal provisions of Stockport Corpn. Tramways Act, 1900, so as to authorise leasing of tramways to or by the Corporation (within or outside the borough) for longer terms than 21 years, to provide additional mode for payment of moneys borrowed under Tramways Act, 1870, by Corporation or any local authority who may have leased or agreed to lease Corporation tramways, and to make provisions for an equated period or periods in which all or any of the loans contracted by the Corporation shall be discharged, &c.

London County Council are seeking power to construct new tramways in the cities of London and Westminster and the metropolitan boroughs of Lambeth, Southwark, Lewisham and Camberwell: to apply provisions of L.C.C. Tramways (Electrical Power) Act, 1900, and other acts, &c., to repeal and amend existing acts, &c.

A bill is being promoted to incorporate the North East London Railway Co., to construct railways in the City and County of London and the Counties of Essex and Hertford, to acquire lands and enter into working and other agreements with railway companies, public authorities, &c.

The British Electric Traction Co. seek powers to extend time for constructing tramways authorised by Wellingborough and District Tramroads Act, 1900, to enter into agreements with local authorities and to establish generating stations and supply electricity for public and private purposes in portions of the counties of Northampton, Bedford and Huntingdon, &c.

Tramway Provisional Orders.

Bradford (to construct tramways in Hipperholme and Halifax rural district). Liverpool and Luton Corporations; and King's Norton and Northfield District Council.

General Powers (Lighting and Traction) Bills.

Croydon Corporation seeks powers to construct additional tramways within and beyond the borough, to work and lease lines, to supply electrical energy in bulk to local authorities and others outside the borough, to accept transfers of electric lighting undertakings in adjoining districts and to supply energy within same, to purchase, sell, let on hire or otherwise deal in or with dynamos, motors, accumulators, meters, arc and other lamps, fittings, wires and apparatus for or in relation to the production, supply, distribution, transformation or utilisation of electricity for any purpose, and to exempt same from distress or being taken in execution, also to authorise the Corporation to do any work that may be required on premises of consumers and to make a charge therefor, to make provision in cases where consumers have independent source of supply, to refuse supply in certain cases, to make special provision as to use for lighting of energy supplied for power and to make further provision in regard to the electric lighting undertaking, &c.

Bury Corporation are applying for authority to construct and work tramways within and beyond the borough, to alter or amend Radcliffe Tramway Order (1900) and Tramways and Improvement Act (1904), to enter into agreements with local authorities as to purchase, leasing, &c., of lines, to provide that (notwithstanding sec. 43 of Tramways Act, 1870) the powers of the local authorities to purchase tramways shall not be exercised until the expiration of 42 years, to borrow or raise money for the purposes of the bill or for the supply of electrical energy to the tramways, or for the purposes of the electricity undertaking, &c.

Liverpool Corporation are promoting a bill to construct and work electric tramways in and near Liverpool, &c.

West Cumberland Electric Tramways Co. are applying for an extension of time for commencing the construction and completion of lines authorised by their 1903 act, to extend period for laying down distributing mains for supplying electricity, &c.

Nottingham Corporation ask power to construct and work additional electric tramways, to enable Corporation to decline supply of electricity to persons in arrears with payments for current, &c.

Miscellaneous Bills.

A bill is being promoted to transfer to the University of London the University College, London, exclusive of University College Hospital, the medical school and the boys' school.

In the bill of the Medway & Thames Canal Co. power is sought to alter, widen or deepen, &c., any part of the canal and to execute all works necessary for adapting same to be worked by electric or other mechanical haulage, &c.

In the London Buildings Acts Amendment Bill, to be introduced by London County Council, power is sought to amend the law relating to streets and buildings in the administrative county of London and to amend the law relating to the powers and duties of district surveyors, to prescribe what materials shall, for the purposes of the act, be deemed fire resisting; to extend certain provisions of the 1894 Building Act, and to make the same applicable to any building used in connection with the supply of electricity which may now be exempt therefrom, &c.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Leigh Corporation invite applications for the position of chief engineer and manager of their electricity undertaking. Salary £250, rising by annual increments of £20 to a maximum of £350 per annum. Further particulars are given in an advertisement. Applications to the town clerk (Mr. Peregrine Thomas), Town Hall, Leigh, Lancs., by noon 29th inst.

A draughtsman is required for the electrical department of the Admiralty; must have had training in mechanical engineering works, supplemented by experience of design of electrical machinery, switch gear, &c. Applications by Dec. 5 to the superintending electrical engineer (Mr. C. H. Wordingham), Admiralty, London, S.W. See advertisement.

An experienced engineer is wanted as first assistant to the cable engineer in charge to assist in laying submarine cables in the Far East and elsewhere. See advertisement.

An experienced assistant electrician is required for submarine cable work. See advertisement.

A first-class draughtsman on h.-t. and l.-t. switchboards and switchgear is required by the Brush Electrical Engineering Co., Loughborough. See advertisement.

A senior operator and a switchboard electrician are wanted for Glasgow Corporation telephone department. Applications to general manager (Mr. John Macfee), 65, Renfield-street, Glasgow, by Dec. 5. See advertisement.

Battersea (London) Borough Council require a shift engineer. Applications by 29th inst.

Messrs. W. A. Baker & Co., electrical engineers, Newport, Mon., require an experienced working foreman electrician. See advertisement.

A demonstrator in mechanical engineering is required for West Ham Municipal Technical Institute. Salary £150 per annum. Applications to the principal before noon Dec. 5. See advertisement.

A chief assistant is required for the mechanical engineering department of Northampton Institute, Clerkenwell, London. Applications to Principal by 30th inst.

An assistant secretary is required by the Council of the British Association for the Advancement of Science. Salary £300. Applications to Burlington House, Piccadilly, W., by Dec. 2.

Marylebone (London) Electric Supply committee have appointed Mr. T. G. Bacon, electric inspector to the Council, as house service inspector, to work under the mains superintendent, at his existing salary of £190 per annum. The same committee have appointed Mr. F. Selley, formerly installation and meter inspector at Walthamstow, to a similar position at Marylebone, at a salary of £3 per week.

Mr. C. Wyatt, of the County of London Electric Supply Co., has been appointed assistant in the distribution department of Croydon Corporation electricity works.

Mr. J. D. Pember, A.M.I.E.E., of Farnworth, has been appointed chief electrical engineer to Dartford District Council at a commencing salary of £250 per annum. There were 150 applicants.

Mr. Percy Heard of the Westminster Electric Supply Co., has been appointed station superintendent at Chester Corporation electricity works.

Aberdare.—The District Council have decided to promote an electric tramway scheme estimated to cost nearly £70,000, and to erect a refuse destructor at £14,000.

Accident.—At the Woodyet Pit, Denny, N.B., on Friday, a man named Foy was accidentally killed through touching a live electric cable.

It seems that Foy deliberately seized the live conductor, a trick he had (it is reported) been in the habit of doing, though he had been warned not to do so.

Bath.—Bath Electric Tramways (Ltd.) propose to extend their present lines and to construct a new line.

Battersea (London).—The agreement entered into between the Council with the County of London Electric Supply Co. for the supply of energy in areas transferred under the provisions of the London Electric Lighting Areas Act, 1904, has been confirmed by the Board of Trade, to take effect as from Jan. 1. It was resolved to put in hand at once the work necessary to enable the Council to supply customers in the transferred areas at an estimated cost of £5,900.

Belfast.—At a meeting of the Tramways and Electricity committee last week it was proposed, upon the report of the tramways manager (Mr. Nance), to engage all the officers and clerks in the employ of the Tramways Co., with one exception. It was decided that Mr. Nance prepare a further report.

The Corporation have received nearly 100 tenders for the construction and electrical equipment of the local tramways, and the tenders have been referred to the consulting engineers, Messrs. Lacey, Sillar and Leigh.

Birmingham-Dudley Tramways.—Col. Yorke and Mr. A. P. Trotter last week officially inspected the Birmingham and Midland Tramways Co.'s new electric route between Lionel-street, Birmingham and Dudley. The route is now open for traffic.

Bethnal Green (London).—At a special meeting of the Council yesterday (Thursday), it was decided to proceed with the electric lighting scheme prepared by the consulting engineers (Messrs. Robert Hammond & Son), at an estimated cost of £80,000.

Bradford.—The local Drapers' Association recently petitioned for a reduction in the charges for electric current, and the Electricity committee have now asked the borough electrical engineer (Mr. A. S. Blackman) to prepare a report upon the question.

Bradford Technical College.—Bradford Educational committee have received sanction to the proposed extension of the Municipal Technical College. Electric lighting and driving is to be adopted throughout.

Burton-on-Trent.—The Council decided at a recent meeting, on the recommendation of the Gas and Electricity committee, to alter the present maximum demand system of 6d. for the first 1½ hours and 3d. after to 6d. for the first 1¼ hours and 3d. after, with quarterly rebate instead of half-yearly. There is to be an alternative flat rate of 5d. A reduction in meter rents was also approved of, the rent per quarter now varying from 2s. for a 10-ampere size, instead of 3s. 6d. previously, according to the various sizes, other sizes being reduced in proportion.

The total receipts of the Corporation tramways for the half-year ended September were £9,948. 0s. 4d. 2,139,873 passengers were carried and 229,634 car miles run, the total receipts per car-mile being 10·39d. The number of passengers carried was 9·31 per car-mile and the traffic receipts per passenger 1·085d. 300,052 units were consumed by car motors, or 1·306 units per car-mile

In the electricity supply department 402,350 units were disposed of in the six months (an increase of 238,740 over the corresponding half-year of 1903), including 296,989 units for traction (increase 74,115). There are 358 consumers connected (against 301), representing 27,771 8 c.p lamps, with 130 H.P. in motors (against 78·5 H.P.)

British Trade with South America.—Mr. Pedro A. Costa, of Queen Victoria-street, London, E.C., and Buenos Ayres, has prepared an interesting pamphlet on the subject of "British Trade with South America," which is intended as the first of a series of such brochures to be devoted to this subject. Mr. Costa writes from a South American's point of view, and, if for this reason alone, his comments and remarks will be read with interest, more especially as he "talks straight." Certain commercial developments in Argentina lend point to his observations.

Canada.—Current was first supplied in the city of Kamloops, British Columbia, in 1900, by the Quebec Jacques-Cartier Electric Co., whose undertaking supplies a population of 85,000. At October, 1904, there were 92,100 equivalent 8 c.p. lamps connected (including 200 H.P. for motors). The total plant capacity is 8,500 H.P., and is normally operated by water power, the distance of transmission being 20 miles. Steam plant is utilised as a relay for peak load, or in case of accident or temporary repairs to the hydraulic plant.

At Smith's Falls, Ontario, the Smith's Falls Electric Light Co. serves a population of 6,000, and has an equivalent of 8,000 8 c.p. lamps connected, including 200 H.P. for motors. Here the power is supplied by water power aggregating 500 H.P. The Citizen Electric Light Co. is also doing business in this city, and employs water power and steam plant. This company has the equivalent of 4,200 8 c.p. lamps connected.

Reports from Canada are to the effect that there is a good market for single-phase and polyphase induction motors, and also possibly for insulated wires and cables; but a correspondent informs us that much complaint has prevailed on account of the time occupied in obtaining the execution of orders from England.

The Otonabee Power Co., of Peterborough, Ontario, commenced the supply of current in October, 1903, and serves a population of 20,000. The total connections at Nov. 1 were the equivalent of 20,000 8 c.p. lamps, including 1,500 H.P. for motors. The number of consumers on the company's mains is 660. Water power from a distance of 5 miles from the town is utilised. The Canadian General Electric Co. have works at this place employing over 1,000 men.

The Peterborough Electric Railway Co. owns 7 miles of electric standard gauge line, which commenced operations on Sept. 1, 1904. Nine cars are at present employed on the service. In the county of Peterborough there is a watershed of 800 sq. miles area, the available fall being 150ft. and the estimated horse power 10,000. All the water power belongs to the Government and is leased by compounds.

Cardiff.—The borough electrical engineer and tramways manager (Mr. Arthur Ellis) explained to the Finance committee on Monday the necessity for borrowing £87,868 for extensions of the electric lighting plant and mains, which have already been sanctioned by the Electricity and Lighting Committee.

In order to keep down expenses as far as possible, Mr. Ellis stated that he had decided not to put any more plant in for the present winter, The result was that they were running both their Canton and their Roath stations without any spare plant. They would be bound to put in more plant for next winter, otherwise they would have to shut down. Already they had had to give notice to local contractors that they could not take further consumers for the present winter. The proposed new loan would cover the whole of their requirements for the next two or three years. They had already contracts in hand in one district alone for power equivalent to over 4,000 8 c p. lamps, and contracts for a similar number in another district. The Electricity committee had borrowed altogether from the rates £11,000. During the last two or three years their accounts had been in a better position, with the result that they had been able to pay back the whole of that, and to credit the rates to the extent of £1,800 in addition. In two years they had put on nearly 60.000 8 c.p. lamps out of 110,000 during the past 10 years.

The committee unanimously decided to sanction the application.

At the meeting of the Tramways committee on Wednesday it was decided to recommend Council to give six months' trial from Jan. 1 next to a scheme of fares at the rate of 1d. for 2,200 yds., and 1½d. for 3,300 yds. There would be no ½d. fares.

Church Lighting in India.—Electric light and fans are being installed in the churches of St. Peter and St. Patrick, at Fort William, Calcutta.

Church Stretton.—The new works of the local Electric Lighting Co. were formally opened last week.

Dartford.—The Council have decided to give private consumers the option of being charged a flat rate of 5d. per unit instead of the old maximum demand rates of 7d. and 2d.

Dundee.—The Tramways committee have been asked to reduce the hours of their tramway employés from 60 to 54 per week, but have (after obtaining a report on the practice in other towns) declined to accede to the request.

East Barnet.—As announced in our last issue, the Council has decided not to proceed with the agreement with the National Electric Construction Co. for electricity supply in the district. The company have now, however, withdrawn their offer, and the North Metropolitan Electric Power Supply Co. is again asked to submit a fresh offer.

Eastney.—The church and barracks at Eastney are to be lighted electrically, current being taken from Portsmouth Corporation mains.

Egypt.—The text of a contract between the municipal authorities of Tanta and Messrs. Eugène Nahman & Co., of Tanta, for the construction and working of electric supply is contained in a supplement to the Egyptian "Journal Officiel" of Nov. 9.

Electric Plant at Goods Depots.—At the North British Railway Co.'s enlarged College goods station, Glasgow, all the machinery for handling goods is now worked electrically and engines are not permitted to enter the building, the waggons being hauled by electric capstans and traversers.

Electrical Engineers Volunteers.—The annual dinner took place on Saturday. In addition to about 200 members, including the commanding officer (Col. R. E. B. Crompton, C.B.), Prof. J. A. Ewing and Col. Maxwell were present.

Fulham (London).—It was announced at the Council meeting on Wednesday that the British Thomson-Houston Co. had declined to accept the contract for the main generator switchboard under the Council's conditions, and that the British Westinghouse Co. having agreed to abide by the conditions, the contract had been let to the latter company.

Galway.—The Urban Council recently accepted the tender of the Galway Electric Lighting Co. for street lighting, and the company are erecting poles and overhead wires. But the local gas company now intimate that they will discontinue lighting after 30th inst., that is before the Electric Lighting Co. will be in a position to give supply.

Greenock.—On Tuesday the Corporation decided to increase the electrical energy supplied to Greenock and Port Glasgow Tramway Co. from 500,000 to 600,000 units per annum, the company to pay for the additional 100,000 at 1¼d per unit. The arrangement will date from Aug. 1 last, and will continue till the next term for revising rates. It was also agreed to allow the company the use of the existing spare ways at a rent of 3d. per yard per annum for each way.

Hackney (London).—Freehold reversion of some cottages in Millfields-road has been conditionally purchased for £450 for extending the electricity works.

Tenders are to be invited for an automatic coal-weighing machine at an estimated cost of £250.

The Finance committee have insured with the Municipal Mutual Insurance (Ltd.) the boilers at the electric lighting and destructor works. The present policy with the Vulcan Boiler Insurance Co. will remain in force without any alteration in its terms and conditions or the amount of the premium, the only change effected being that, by arrangement, instead of the premium being forwarded direct to the Vulcan Co. it will be paid to the Municipal Mutual Assurance (Ltd.).

Hornsey.—The Electricity Supply committee are considering the question of holding a local exhibition of electric light fittings, &c. Demand indicators in shops are to be disconnected for the week before Christmas in cases in which applications are received before Dec. 15.

Hull.—An unopposed inquiry was held last week into the application of the Corporation to borrow £4,600 for electric lighting extensions.

Kilmarnock (N.B.).—On Wednesday the Council agreed by 14 votes to 10 to run a "restricted" tramway service on Sundays.

Light Railways.—An inquiry was held at Plymouth on Wednesday into the application of the Devonport and District Tramways Co. for an order to extend their tramway at Pennycomequick to the borough boundary at Devonport, and from that point to construct a light railway or tramway to Pound-street, Plymouth.

Mr. Morse, for the company, explained the scheme. Evidence in support was also given by Mr. J. Endean, manager of the Devonport District Tramways, and Mr. J. S. Raworth, chairman of the Devonport and District Co. The commissioners reserved their decision.

London County Council.—At Tuesday's meeting it was agreed to sanction a loan of £27,840 to Hampstead on electric lighting account.

L.C.C. Technical Institute, Sydenham.—The offer of the South Metropolitan Light & Power Co. to supply current at 4½d. per unit was accepted.

Northern Tramways.—The Highways Committee's recommendation as to the payment of rent by the North Metropolitan Tramways Co. for the tramways in Rosebery-avenue (set out in our last issue) was approved.

Mr. Dolman had given notice of a motion instructing the Highways committee to report on the question of the relative advantages of the conduit and overhead systems of electric traction before proceeding further with the tramways in North London. Mr. Dolman now withdrew his motion.

London County Council Tramways.—Islington Council will hold a special meeting to consider a report of the proceedings at the recent conference on the system of electric traction to be adopted for the northern tramways.

Stepney Council have decided to oppose any Parliamentary bill promoted by London County Council for the purpose of getting rid of the obligation imposed by their 1900 Act to obtain the consent of the various borough councils as to the use of the overhead system of traction.

Long Eaton.—The accounts of the electricity department for the 15 months ended March last show total capital expenditure £16,799. 15s. 6d.

Receipts totalled £3,153. 8s. 11d., and working expenses were £1,411. 9s. 6d., a gross profit £1,714. 19s. 5d. Redemption of loans and interest absorbed £827. 8s. 7d., leaving £914. 10s. 10d. net profit. 293,808 units were generated, 75,170 consumed by public lamps and 167,564 supplied to private consumers. The maximum supply demanded was 192kw.

Maidstone.—In a lengthy report on proposed extensions of the Corporation's tramways the consulting engineer (Mr. Stephen Sellon) advises that application should be made for powers under the Light Railway Act. The total estimated cost of the extensions, &c., is £49,467. A resolution to apply for light railway orders for the extensions has been adopted by the council.

The Light Railways committee at last week's meeting proposed the purchase of an additional tramcar at the contract price, that the wages of motormen should be 4s. 6d. and of conductors 3s. 6d. per day, and that they be paid for Sundays whether they work or not. The proposals were also adopted.

Mansion Lighting.—Wentworth Woodhouse, Earl Fitzwilliam's seat in Yorkshire, is in future to be lighted electrically.

An independent generating station has been equipped under the supervision of Mr. E. Wingfield Bowles. The lights provided for are equivalent to 3,000 8 c.p. There are two 60kw. dynamos, two 90 H.P. steam engines and two economic boilers included in the plant. A 111-cell storage battery will supply current at night. The dynamos and boosters have been supplied by the Electric Construction Co., the boilers and engines by Davey, Paxman & Co., the cables by W. T. Glover & Co., and conduits by the Howard Conduit Co. The wiring was executed by Mr. V. G. Middleton. The grand saloon is lighted by 400 lamps and the Vandyck room is fitted with an electrolier with imitation candle lamps. Four elaborate standards, each bearing 20 lamps, have been erected in the "Whistlejacket" drawing room and the dining room is both lighted and heated electrically. The whole of the installation will be in work by Christmas.

The independent electric lighting plant at Culford Hall, the residence of Earl Cadogan, near Bury St. Edmunds, has been augmented by the installation of a larger engine and boiler, and considerable extensions of the wiring have been carried out.

Melbourne (Victoria).—Melbourne Corporation electricity supply, which was started in 1894, has now a total connection of 148,300 equivalent 8 c.p. lamps supplied to 1,415 consumers. The public lighting consists of 758 arcs and 1,124 series incandescents. 787 rc lamps and 94 "lilliputs" are included in the private lighting, f which number 661 arcs are hired from the Corporation. The charge for current has been recently altered to a flat rate of 5d. per unit, or the maximum demand system at 8d. for the first 1½ hours and 2d. after, the charge for power having been reduced from 3d. to 2d. per unit.

Marylebone (London).—At the meeting of the Council last evening the first business in connection with electricity supply was the election of the Electric Supply committee, which resulted as under:—J. Anglim, G. Cornwallis-West, E. R. Debenham, E. T. Fowler, A. H. Garrould, A. J. Hopkins, P. Leach, J. Lewis, J. A. Michell, J.P., G. Paxton.

The Finance committee reported the payment of certain advances from the general fund on electricity account, and also having considered an estimate of expenditure by the Electric Supply committee on capital account of £13,847 for the purchase and fixing of 5,784 maximum demand indicators, and this estimate was submitted to the Council for consideration. In connection with this last mentioned matter, the Electric Supply committee's report contained the following note:—

Mr. Wright, the consulting electrical engineer, has reported to us the necessity of the future tariff for Marylebone being settled by the Council as soon as possible, and that as this question depends largely on the use the individual consumers make of the plant required to meet their demands, it is necessary to obtain a sufficient number of demand indicators to obtain complete information during the next three winter months of the consumer's maximum demands. The data obtained will be valuable whether the maximum demand system of charging is ultimately adopted or not, as it will enable the distribution problem to be much more exactly studied. We have, accordingly, through Mr. Wilkinson, the resident engineer, obtained prices from the Reason Mfg. Co., and the Schattner Electricity Supply Co. for the hire and possible purchase of a sufficient number of instruments. After hearing the report of Mr. Wilkinson we have selected the Reason Mfg. Co., their instruments being the more suitable for the new system of supply. We propose in the first place to hire the indicators, with the option of buying the same at the end of the year if the demand indicator system is adopted by the Council, in which case the amount paid for the hire of the indicators will be allowed off the purchase price. The number of instruments required will be about 5,784. We have submitted an estimate of the proposed expenditure to the Finance committee.

On the subject of the change of pressure of supply the Electric Supply committee presented the conditions stipulated for by London County Council. These conditions, which had already received the formal approval of the committee, were now submitted to the council and agreed to. The conditions are, briefly, as under:—

When an installation in any consumer's premises is to be changed to higher pressure, the undertakers shall themselves carry out, or bear the cost of, any alterations necessary in the wiring or the fittings of such premises, and that consumers' lamps in use and in stock shall be replaced by the undertakers, free of charge, with new lamps of similar make, suitable for the higher pressure; except that (as regards any installation of 100 lamps or more) the number of lamps in stock to be replaced shall not exceed one half the number installed. This condition not to apply to the stock of an electrical contractor, in regard to which arrangements shall be made as may be agreed between the parties.

In the case of special fittings, and for lamps of small candle power, the new lamps shall be arranged in series when so desired by the consumer.

When supply is to be changed to the higher pressure, the undertakers shall offer to the consumer to communicate with the fire insurance companies concerned, and shall take all reasonable precautions to prevent the policies being affected, and to have the same properly endorsed. When a policy has been endorsed, or should the insurance company decline to endorse the policy, the undertakers shall give notice thereof to the consumer.

The undertakers shall make good, at their own expense, any defects which may develop in any installation within three months of the date when the pressure is changed or the alteration completed (whichever may be the later date), where such defect can reasonably be attributed to the increase of pressure.

Subject to the approval of the Board of Trade, the middle wire shall be earthed as directed by that Board.

In all cases where three wires are brought into any premises with any pressure above 240 volts between the outers, either one outer wire shall be removed, or adequate precautions shall be taken to prevent any risk of shock to any person.

When any dispute or difference arises under these conditions the same, if it cannot be agreed, shall be submitted to arbitration, and shall be decided by an arbitrator to be agreed upon between the undertakers and the consumer, or, failing agreement, to be appointed by the Board of Trade on the application of either party after notice to the other, the expenses of the arbitration to be borne and paid as the arbitrator may direct.

Municipal Telephony.—At the meeting of Portsmouth Telephone committee on Wednesday, it was reported that there were now in use 2,000 revenue-earning lines, the completion of these and the other lines having been carried out within the sum sanctioned by the Council.

The National Telephone Co. recently gave Hull Corporation notice of objection to the assessment of their undertaking in the parishes of Holy Trinity and St. Mary, on the ground that the Corporation telephone system was not equally assessed, but at a subsequent meeting of the Assessment committee the chairman pointed out that the assessment of the Corporation telephones was of necessity a tentative figure, and the company's representative thereupon stated that having called attention to the matter he would let it drop.

The accounts of the first year's working of the Swansea municipal telephone department show rentals amounting to £3,979. 0s. 9d. Of this sum £3,135. 9s. 11d. has been actually collected.

It is reported that the increase in the number of the National Telephone Co.'s stations at Glasgow during the year ended Oct. 31, 1904, was 4,923, and at Swansea 661, increases of 37 and 56 respectively.

Norwich.—The Electricity committee have decided to reduce the maximum price of current for lighting to 4½d. per unit on Jan. 1 next.

Parcel Carrying on Tramways.—Gravesend Tramways Co. have commenced the carriage of parcels on their cars.

Poplar (London).—The accounts of the electricity department for the year to March last show capital expenditure £194,300. 16s. 4d., an increase of £7,108. 15s. during the year.

Receipts from sale of current were £10,388. 5s. 11d. (695,503 units) for private lighting, £5,950. 6s. 7d. (832,055 units) for power and £9,281. 11s. 9d. (678,840 units), public lighting, the total net receipts being £25,458. 12s. 7d. Working expenses were £14,671. 6s. 8d. Redemption of loans required £1,463. 6s. 1d. and interest £6,331. 7s. 11d. After taking into account the balance from previous year (£3,908. 0s. 8d.) there remained £6,892. 13s. 5d. In all 2,466,098 units were generated against 1,972,179 in the previous year. The maximum supply demanded in 32 watt lamps was 38,250 against 28,500.

Provisional Order Revocation.—The Board of Trade have revoked the West Riding Electric Lighting Order, 1902.

Rosario.—In our last issue we stated that Rosario Municipal Council had rejected the application of Mr. Keenan for a concession for constructing and working electric tramways in this city, and that the mayor had decided to invite "tenders" for a municipal service. The source of our information was the "Review of the River Plate" for Oct. 15 last. We are now informed that Mr. Keenan's offer has been accepted.

Rowley.—The Council's new electric tramway between Old Hill and Blackheath was opened on Saturday.

Stirling.—The Stirling & Bridge of Allan Tramways Co. offer to sell to the Council the line from King-street to St. Ninians for £5,000 and the burgh electrical engineer (Mr. A. C. Hanson) has been asked to report upon the offer.

Walthamstow.—On Wednesday the Lighting committee reported having instructed the Fire Brigade superintendent to report as to the best means of fire protection at the generating station. Tenders are to be invited for supplying new locks for the arc lamps. Six electric incandescent lamps are to be erected in different parts of the district with two 16 c.p lamps near to 32 c.p. lamps for comparison purposes. A report is to be presented as to the advisability of erecting bracket lamps in different parts of the borough.

Wandsworth (London).—At Wednesday's meeting of the Council a further letter was read from the Board of Trade on the subject of the accounts of the County of London Electric Supply Co.

The Board repeat that they are not prepared to say that the requirements of the Electric Lighting Act of 1882 have not been complied with by the company, and that they do not consider that they can call on the company for more details.

The Lighting committee reported having considered the present offer of the County of London Co. to supply current for street lighting at 2d. per unit, and a notification from the company that if a comprehensive and extended scheme of lighting were adopted they would be prepared to reconsider this offer.

The committee, after reviewing the circumstances under which a somewhat similar offer was made by the company about two years ago and declined by the Council, decided that the offer be again declined on the present occasion.

Westinghouse Awards at St. Louis Exposition.—The Westinghouse companies claim to have received the largest number of awards ever bestowed upon one industrial name at any world's fair. In addition to the special award in the department of machinery for the best, most complete and most attractive exhibit, 12 grand prizes and 25 ordinary awards have been obtained.

Workhouse Lighting.—Ormskirk guardians have purchased some electric lighting plant, including two engines and dynamos, switchboard, &c., from Arthur Guinness, Sons & Co., of Dublin, for the electric lighting of their workhouse buildings.

Worsley.—The question of the revocation of the Council's electric lighting order has been deferred for a year.

York.—At the last City Council meeting Councillor Scott stated that a tender had been accepted for the installation of electric haulage plant at the works on Foss Islands in connection with the coal storage, at a cost of £735, by which they hoped to save 6d. per ton on the coals, or £125 a year.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Salford Corporation electricity department invite tenders for the supply, delivery and erection of a feeder booster at their Frederick-road works. Specifications, &c., from the borough electrical engineer, Mr. C. D. Taite. Tenders to the town clerk (Mr. L. C. Evans), by Dec. 3. See also advertisement.

The directors of the *North-Eastern Railway Co.* invite tenders for telegraph apparatus, telegraph wire and line stores for six or 12 months from Jan. 1, 1905. Forms of tender from the telegraph superintendent (Mr. C. H. Ellison). Tenders to the secretary (Mr. R. L. Wedgwood), York, by Dec. 8. See advertisement.

Edinburgh City Council invite tenders for electric lighting installation at the branch free library, Morningside-road. Specifications, &c. (after Nov. 30) from the engineer, Mr. Frank A. Newington, electricity supply station, Dewar-place. Tenders to Dr. Hew Morrison, Free Library, George IV. Bridge, Edinburgh, by Dec. 14. See also advertisement.

Cheltenham Corporation invite tenders for the supply of a traction storage battery. Specifications, &c., from the town clerk (Mr. R. Owen Seacome) Municipal Offices, Cheltenham, where tenders by noon 30th inst. See also advertisement.

The Visiting Committee of *Worcestershire County Council* invite tenders for supply and erection at their new lunatic asylum (in course of construction) near Bromsgrove, of engines, dynamos, booster and steam services; storage battery and accessories, main switchboard, ring main, feeders, distribution boards, wiring, lamps and accessories. Specifications from Mr. Robert J. Oliver, Shire Hall, Worcester.

The *Dublin United Tramways Co.* invite tenders for the supply of general stores, including electrical supplies, car fittings, iron, steel, castings, oil, &c., for 1905. Forms of tender from the secretary (Mr. R. S. Tresilian), 9, Upper Sackville-street (where patterns may be seen), up to 30th inst. Tenders (addressed to chairman) to Mr. Tresilian by Dec. 5.

Tenders are invited by Dec. 12 for wiring, bell and telephone-fitting at the new infirmary, Stepping Hill, near *Stockport*.

Ashton-under-Lyne Tramways committee invite tenders by noon 29th inst. for construction of tramway track (1,180yds. single).

TENDERS RECEIVED AND ACCEPTED.

Hackney (London) Electric Supply committee have provisionally placed the following orders:—

Reason Mfg. Co., 250 demand indicators (thermal type), and the Schattner Electricity Meter Co., 250 (magnetic type), at schedule prices.

Reavell & Co. (B.T.-H. motor) air compressor, £83. 9s. 6d.

Johnson & Phillips, arc lamps and pillars, £999. 5s.

The tenders of the following firms for supply of stores, including electric fittings, cables, &c., have been accepted by London County Council:—British Insulated & Helsby Cables (Ltd.), Estler Bros., Falk, Stadelmann & Co., General Electric Co., Highton & Co., St. Helens Cable Co., Siemens Brothers & Co., Craigpark Electric Cable Co.

Portsmouth Telephone committee recommend that an order be placed with the International Electric Co. for a further 100 wall instruments, at £2. 5s. 9d. each, to be delivered as required, and that the tender of Mr. R. W. Paul be accepted for the supply of test instruments at £32. 17s. 6d.

London County Council has accepted the tender of Donnison, Sillem & Co. for wiring and fittings for an electric light installation at Kensington fire station at £176. 10s. Other tenders submitted ranged from £183 to £215.

St. Pancras (London) Council have accepted the tender of the British Westinghouse Co. at £108. 10s. for electric motors for driving machinery at Whitfield-street Baths. There were five tenders, ranging from the accepted to £123.

Brussels Corporation have accepted the tender of W. F. Jones & Co., 50, Cannon-street, London, E.C., for 2,500 cable connectors, with special pilot wire terminals.

Dundee Tramways Committee have accepted the tender of Muir, Son & Patton for 4,000 tons of single nuts from a Lochgelly colliery at 8s. 2d. per ton.

Walthamstow Council has accepted the tender of Frank Suter & Co. for engine wipers at 42s. per cwt.

It is announced that tenders will be adjudicated on Dec. 14 at the Bourse de Commerce, *Brussels*, for the supply in 17 lots, of various materials for use in connection with electricity installations. Particulars can be obtained from the Direction des Voies et Travaux, 11, Rue de Louvain, Brussels.

BUSINESS NOTICES.

Rhodes Electrical Manufacturing Co. (Ltd.) have opened a branch office at Newcastle-on-Tyne (17, Eldon-square) under the management of Mr. Joseph P. Sleigh, late of the British Thomson-Houston Co.

The business hitherto carried on under the style of the Bergmann Electrical works will be continued under the same management, but will be known in future as the Adnil Electric Co.

BANKRUPTCIES, LIQUIDATIONS, &c.

In the failure of Walter C. Bersey, Dacre House, Arundel-street, London, W.C., (late of 34, Queen-street, E.C.), electrical engineer, the first meeting of creditors was held on Tuesday. Debtor has for six years been engaged managing various motor-car companies, in which he held shares. With another person he proposed to purchase the assets of Garage (Limited) for £10,000, payable in shares. The arrangement to purchase however, fell through and he afterwards joined a Mr. Terrell in partnership, as engineers. In Nov., 1901, he was connected with another business carried on in Long-acre, London. He lost various sums in other undertakings. Gross liabilities £4,371 (£3,863 unsecured), assets £21.

In the failure of Hy. Coles, electrical engineer, 10, York-street, Swansea, the first meeting of creditors will take place on 29th inst., at Bankruptcy-buildings, London, W.C., and the public examination on Dec. 16 at the Town Hall, Swansea.

A first dividend of 6s. 6d. will be payable on 28th inst. at the office of Mr. R. J. Ward, 2, Clement's-inn, London, W.C., in the failure of Chas. Aubrey Smith, electrician, 28, King-street, Regent-street, W., and 6, Granard-road, Wandsworth Common, S.W., London.

A receiving order has been made against Wm. Summer, electrical engineer, 140, Dale-street, Liverpool.

Albert Smith, formerly trading as the Electric Motor Supply Co., at 54, Hound's-gate, Nottingham, has been adjudicated bankrupt. First meeting of creditors 30th inst. at 4, Castle-place, Park-street, and the public examination Dec. 2 at the County Court House, St. Peter's-gate, Nottingham.

Claims against Wm. Wenham, electrical engineer, 5, Century-buildings, London-road, Croydon, by Dec. 5 to Mr. A. Mackintosh, 24, Railway-approach, London Bridge.

The trustee in the bankruptcy of A. J. Noble, formerly electrical engineer, 567, Battersea Park-road, London, S.W., has been released.

Creditors of the McGuire Manufacturing Co. (Ltd.), must send particulars of their claims by Dec. 31 to Mr. F. W. Pixley, 58, Coleman-street, London, E.C.

Deed of Arrangement.—Louis Brandes, electrical engineer, trading as Brandes & Co., St. John-street, Coventry, has executed a deed of arrangement. The trustee is Mr. S. T. Peirson. Unsecured liabilities, £1,127. Estimated net assets, £289.

Winding-up Petition.—A petition has been presented by Mr. Charles Rimmer, 10, Cambridge-road, Southport, for the winding up of the Sir Hiram Maxim Electrical and Engineering Co., Ltd., and will be heard at the Royal Courts of Justice, London, W.C., on 29th inst.

Transformers for Sale.—St. Marylebone (London) Council invite tenders for the purchase of about 1,000 house transformers of from 1kw. to 5kw. capacity. Further particulars may be obtained on application to Mr. F. A. Wilkinson, resident engineer, 11, Manchester-street, W. Tenders to the town clerk (Mr. James Wilson), Town Hall, Marylebone-lane, London, W., by noon, Dec. 5. See also an advertisement.

Plant for Sale.—Four Dick-Kerr, two B.T.-H. and one Westinghouse electric motors are offered for sale. See advertisement.

Premises to Let.—Warehouse premises, 222, Upper Thames-street, comprising four large well-lighted floors with total floor space of about 7,000ft., are to be let on lease. See advertisement.

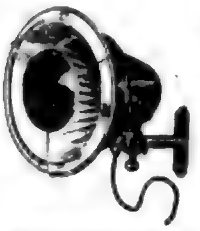
Three rooms are to be let, separately or as a whole, in a third floor flat in 64, Victoria-street, Westminster, S.W. See advertisement.

"**Kryptol.**"—A short time back we published particulars of a new resistance material for use with electric heating apparatus, styled "Kryptol." We subsequently received numerous requests for the names of the manufacturers of this material. In reply to inquirers, we find that the owners and manufacturers are the Kryptol Aktiengesellschaft, G.m.b.H., 56, Unter den Linden, Berlin.

Nernst Lamps and Fittings.—A number of excellent examples of electrical illumination by means of Nernst lamps are given in a pamphlet just issued by the Lamp Department of the Electrical

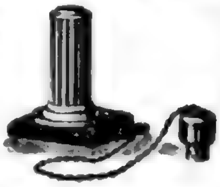
Co., 121-125, Charing Cross-road, London, W.C. The illustrations show Nernst lamps employed in a variety of situations, and some particulars received from the company inform us that in one very large establishment no less than 10,000 Nernst lamps are in use. Illustrations of street lighting are shown at Barnes, Maidstone and Gravesend. Over 50 Corporations have placed orders for these lamps with the company, there being now more 2½ million Nernsts in operation. Ornamental fittings and accessories are now available in variety, and inspection by the trade of the company's showrooms, 162, Shaftesbury-avenue, London, W.C., is invited. We are further informed that the company's works are about to bring out a new lamp (type "D") in ½ amp. size for street lighting for high voltage. This lamp will be similar to the small "B" type at present in use, but will be specially suitable for street lighting, and will be supplied at a very large reduction on the "A" type of lamp at present in use for that purpose. There is also to be a new type of lamp placed on the market shortly, suitable for 500 volt circuits.

Catalogues, &c.—In the "General" Electrical Progress Sheet, No. 54, besides many other matters illustrated and described, particulars are given of electric side or head lanterns for motor cars and of an electric curling-iron heater of vertical pattern. These items are shown in the accompanying illustrations. In connection with the lanterns, advantage is taken by the General Electric Co. of the use of small dynamos on motor cars for charging accumulators direct from the engine to design a lamp suitable for mounting on the dashboard or frame of the car. This lamp is so fitted and is of such substantial construction that it is claimed to withstand the utmost vibration. Fitted with a heavily silvered parabolic reflector the lamp gives a powerful light, and is provided with a lens of coloured glass to provide a less intense glare than that given out by many of the lamps now in use.



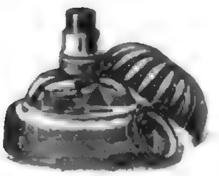
Electric Side or Head Light for Motor Vehicles.

The curling-iron heater, which is an electrical accessory in very general use where electricity supply is available, has been designed to combine the high electrical efficiency of the earlier types of this apparatus supplied by the General Electric Co. and to be in keeping with the ornamental requirements of many rooms and other places where curling irons are used As will be seen, the heater can be connected up with the supply by means of the plug with which each heater is supplied. The current used to heat up to the required temperature is approximately the equivalent of that needed for lighting an 8 c p. lamp for three or four minutes.

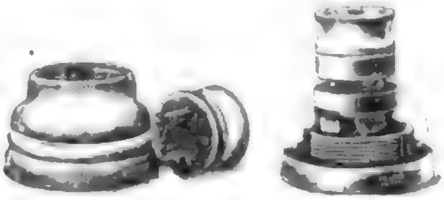


Pillar Pattern Electric Curling Iron Heater.

Switches and switch plugs are illustrated and described in leaflets Nos. 2,085 and 2,086 respectively, issued by the Edison & Swan Co. The accompanying illustrations show a 5-ampere Ediswan H.V. switch plug and the Ediswan button switch with wedge movement. The switch plug has been specially designed to meet fire insurance requirements, &c., and the demands of the supply authorities. It comprises a quick-break double contact switch, which is closed and opened by the insertion or withdrawal of the plug. This latter is made with a sharp prong which pushes over a cam on the switch spindle when making, and engages a detent on the cam when breaking, the circuit, the action being entirely automatic. The button switch is claimed to have, besides the advantages of the tumbler switch, an independent break, the cycle of operations being effected by means of one push only.



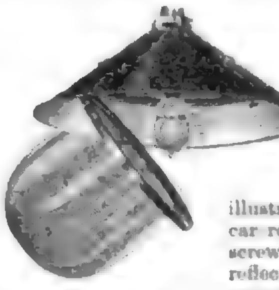
Standard Pattern "Ediswan" Button Switch.

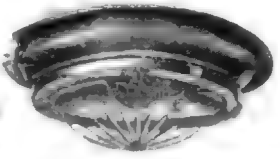


"Ediswan" 5-amp. Automatic Action Switch Plug.

In a catalogue issued by Mr. R. W. Paul, of 68, High Holborn, London, W.C., some new instruments are described and illustrated, supplementing Mr. Paul's main catalogue of electrical instruments which was reviewed in our columns some time ago. These instruments include single-pivot moving-coil galvanometers, milli-voltmeters, micro-ammeters and megohm-meters, also pyrometers, &c., which Mr. Paul claims to be a unique series of instruments of novel and highly successful design, capable of almost universal adaptability to the requirements of electrical testing and measurement.

A new catalogue of ship, factory, colliery, street and traction fittings is also issued by the Edison & Swan Co. The accompanying illustrations show (1) a cast brass tram-car roof light fitted with hinged door, screw lock and key and enamelled iron reflector and (2) a street lamp with enamalled ventilating iron shade fitted with brass hinged rim supporting a heavy well glass.



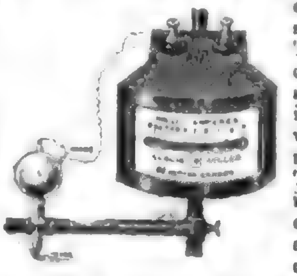


The R.E. type of motors (manufactured by the Rhodes Electrical Mfg. Co., 70–71, Bishopsgate-street Within, London, E.C.) are illustrated and described in a pamphlet just issued. Particulars are given of the outputs of these machines at different speeds.

Messrs. Beanland, Perkin & Co., of Neville-street, Leeds, are placing on the market "Gre-Solvent," a material which contains no acid or sand, and is claimed to promptly remove from the hands machine grease, axle grease, paint, printers' ink and similar adhesive substances. It is said to have reached a large consumption in the States.

A new type of "Bifluid" tachometer is described and illustrated in a list sent out by Messrs. Mouldsdale & Co., 24, Chapel-street, Liverpool. A number of different forms of this apparatus are shown suitable for every class of machinery, including electric generators, steam or hydraulic turbines, &c.

Milli-Ammeter for X-ray Tubes.—By means of the instrument shown herewith the intermittent current that passes through an X-ray vacuum tube can be measured as easily as is the primary current of the induction coil which supplies H.T. current to the X-tube. The instrument consists of a delicately pivoted soft iron needle, with a long aluminium pointer attached to it, which works inside a coil of fine wire. The controlling force is a permanent magnet fixed under the coil. The best place to fix the instrument is usually on the tube stand, but it can be screwed to a wall or table or anywhere not too near the induction coil. With a properly acting mercury break the needle is quite steady, but with a platinum hammer break some swinging is unavoidable. We understand that the instrument also reads quite correctly when used as an ordinary milliammeter for continuous current. Mr. Leslie Miller, the maker of the instrument, suggests that it is especially adapted for hospital work.



October Imports into the United Kingdom.—The value of imported telegraph cable and apparatus imported into the U.K. in October was £7,316, compared with £5,419 in 1903. The exports of similar goods were valued at £69,186, compared with £47,065 in 1903. For the first 10 months of 1904 these imports were valued at £40,352, compared with £50,199 in 1903, and the exports at £690,708, compared with £1,619,628.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Nov. 16 to Nov. 22, with the ports of destination :—

Aden, £122 (telegraph material) *Africa*—Alexandria, £136; Cape Town, £518; Chinde, £17; Durban, £2,908 (including £117 telegraph material); Port Elizabeth, £12. *Argentina*—Buenos Ayres, £93. *Australasia*—Adelaide, £1,020 (telegraph material); Fremantle, £11; Lyttelton, £1,210; Melbourne, £326; Otago, £29; Perth, £118; Sydney, £1,679. *Belgium*, Ghent, £15. *Ceylon*—Colombo, £11 (including £6 telegraph material). *China*—Shanghai, £123 (including £95 telegraph material). *Cochin China*, Saigon, £17. *Egypt*—Suez £184 (telegraph material). *France*—Marseilles, £44; Paris, £779. *Germany*—Bremen, £293 (including £236 telegraph material); Cologne, £12. *Gibraltar*, £15. *Holland*—Rotterdam, £93. *India*—Bombay, £2,325; Calcutta, £347 (including £7 telegraph material; Madras, £34. *Leeward Islands*—Antigua, £110.

Maltese Islands—Saffi, 34. *Norway*—Aalesund, £63; Christiania, £21. *Straits Settlements*—Penang, £210; Singapore, £235 (including £33 telegraph material). *Sweden*—Gothenburg £16. *West Indies*—Trinidad, £269 Total, £13,364 against £16,205 in the corresponding week last year (Nov. 18 to 24).

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

CHAMELEON SIGNS (LTD.) (82,545).—Reg. Nov. 11, capital, £2,700 in £1 shares, to adopt agreement with H. J. Pearce and W. R. F. Avery and to carry on business of manufacturers of and dealers in signs and advertising devices, manufacturers of and dealers in electric, mechanical, automatic and optical devices, &c. First directors, O. P. McFarlane, C. S. Beale, W. R. F. Avery and H. J. Pearce. Reg. office, 318, Dashwood House, London, E.C.

DAIMLER MOTOR CO. (1904) (LTD.) (82,613.)—Reg. Nov. 19, capital £200,000 in £1 shares (100,000 6 per cent. cumulative preference), to acquire undertaking and assets of the Daimler Motor Co. (Ltd.), and to carry on business as motor, cycle, wagon, &c., manufacturers, electricians, mechanical engineers, electro-platers, &c. First directors, Sir C. G. Jenkinson, K.C.B., Capt. C. C. Longridge, R.A., J. M. Gorham and E. Manville. Reg. office, Daimler Works, Coventry.

DELAFON BATTERIES SYND. (LTD.) (82,567.)—Reg Nov 14, capital £1,000 in £1 shares, to acquire certain patents and inventions relating to improvements in electric and galvanic batteries, to adopt an agreement with P. Delafon, and to carry on business as makers of batteries and primary and secondary cells, suppliers of electric light, electrical engineers, manufacturers of cables, wires, accumulators, lamps and electric accessories, &c. Reg. office, 102, Bloom-street, Manchester.

H. F. HILL (LTD.) (82,615.)—Reg. Nov. 19, capital £100 in 5s. shares, to adopt an agreement with H. F. Hill to acquire certain patents and to carry on business as electricians, mechanical engineers, suppliers of electricity, manufacturers of and dealers in electrical apparatus, &c.

MILL, ENGLISH & CO. (LTD). (82,558).—Reg. Nov. 12, cap. £30,000 in £10 shares, to acquire business of mechanical and electrical engineers, indiarubber merchants, general mill furnishers, &c., of Mills, English & Co., and the business of ironmongers, iron and steel merchants, &c., carried on by Paton & Co. First directors, C. H. Mills, W. E. English and R. B. Phillips. Reg. office, 4, Castle-square, Swansea.

STATUTORY RETURNS.

DIRECT WEST INDIA CABLE CO. (LTD.)—Return to Oct. 13 gives capital as £120,000 in 24,000 shares of £5 each, of which 12,000 have been taken up. £2. 10s. per share has been called up and £30,000 has been received. Mortgages and charges £81,800.

MONTE VIDEO TELEPHONE CO. (LTD.)—According to return to Nov. 9 the capital is £160,000 in 87,000 preference and 73,000 ordinary shares of £1 each, of which 86,492 preference and 72,680 ordinary shares have been taken up. £159,172 has been received. Mortgages and charges nil.

PRESTED MINERS' GAS-INDICATING ELECTRIC LAMP CO. (LTD.)—In return to Nov. 7 capital is £15,000 in £1 shares, of which 14,600 have been taken up. 15s. per share has been called up on 5,000 and 10s. per share on 2,100 shares, resulting in receipt of £4,798. 15s. 7,500 shares are considered as fully paid. Mortgages and charges nil.

SANITAS ELECTRICAL CO. (LTD.)—Return to Oct. 8 gives capital as £5,000 in £1 shares, of which 4,250 have been taken up. £1 per share has been called up on 2,250 shares and £2,250 has been received. 2,000 shares are considered as fully paid. Mortgages and charges nil.

MORTGAGES AND CHARGES.

BENHAM & FROUD (LTD.)—Lien reg. Nov. 1 for £4,600 5½ per cent. third debentures, part of £12,000 authorised; no trustees; charged on undertaking and all property, present and future, including uncalled capital, subject to first debentures for £8,000 and second debentures for £12,000.

BROOKER & GOSS (LTD.)—Two debentures, both dated Oct. 31, 1904, securing £100 and £300 respectively, have been registered. Property charged, company's undertaking and property, present and future, including unpaid capital. The two debentures rank pari passu with each other and with a prior debenture for £500. Holders, H. V. Esmond (£100) and G. F. Paxon.

BURNAND TRANSFORMER CO. (LTD.)—Lien reg. Nov. 3 for 1,000 second debentures; no trustees; charged on all property, present and future, including uncalled capital, subject to debentures for £1,000.

ELECTROLYTIC ALKALI CO. (LTD.)—Issue on Oct. 31 of £1,850 first mortgage debentures, part of series created July 9, 1904, to secure £50,000, charged on the company's undertaking and property, present and future, including uncalled capital. Trustees, Liverpool Mortgage Insurance Co. Previously issued of same series, £10,350.

KEYNSHAM ELECTRIC LIGHT AND POWER CO. (LTD.)—Issue on Nov. 9 of £300 debentures, part of series created Nov. 30, 1903, to secure £1,500, charged on premises at Keynsham and company's undertaking and property, present and future, including uncalled capital. Holders, E. E. Mills and Miss E. J. Mills. No trustees. Previously issued of same series £1,200.

LLANDUDNO & COLWYN BAY ELECTRIC TRACTION CO (LTD.)—1,000 5 per cent. first mortgage debentures of £50 each and 49,440 ordinary £1 shares have been offered for sale this week.

LODGE ELECTRIC LIGHT & POWER CO. (LTD.)—£1,000 debentures dated Oct. 31, 1904, charged on company's undertaking and property present and future, including uncalled capital, have been registered. Holder, Sir P. E. Bates.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—Issue on Nov. 5 of a 4 per cent. debenture for £400, part of series created June 3, 1896, to secure not more than two-thirds of subscribed and paid-up capital for time being, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £32,200.

UNDERGROUND ELECTRIC RAILWAY CO. OF LONDON (LTD.)—Trust deed dated Oct. 25, and an instrument of charge under Land Transfer Acts (1875 and 1897), bearing same date, to secure £850,000 debentures created by resolution of Oct. 18, 1904, have been registered. Property charged, company's generating station, plant and machinery at Lots-road, Chelsea, with cables and ducts therefrom to Earl's Court; company's interest in certain contracts for supply of electricity and otherwise; and loose plant and machinery, tools, stores and similar loose chattels belonging to company in or upon the said generating station or any part thereof. Trustees and holders of charge, J. Trotter, H. Cockburn and J. A. Dawes.

CITY NOTES.

MEMORANDA (Nov. 17).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 27d. per oz. Consols 88$\frac{1}{16}$—88$\frac{3}{16}$ for money, 88$\frac{3}{16}$—88$\frac{5}{16}$ for account; 2½ per cent. annuities 87¼—87¾. Consols Pay Day, Dec. 1; Stocks and Shares Continuation Days, Nov. 28 and Dec. 13; Ticket Days, Nov. 29 and Dec. 14; Pay Days, Nov. 30 and Dec. 15; Mining Share Carry-over Days, Nov. 25 and Dec. 12.

AFRICAN CONCESSIONS SYNDICATE (LTD.)—At the meeting on Tuesday the chairman (Mr. W. A. Wills) said that the stagnation that has prevailed in the financial markets of the world had, to some extent, retarded progress, and they thought it inadvisable to proceed this year with the survey of the Falls preliminary to the installation of their power plant. They had applied to the Chartered Co. for, and had obtained, an extension of the period during which they were to make the preliminary survey. The total H.P. in the flood season running over the lip of the Falls was 35,000,000 H.P., or about five times the amount running to waste at Niagara Falls. The Falls were situated in a great mineral centre, and in one of the healthiest countries, probably, in the world. Within a comparatively few years they should see a great power city carrying on innumerable industries supplied with electrical power from the Falls. In addition to tramways, railways, and lighting, Niagara Falls were supplying power for manufacturing aluminium, the operation of water works, alkali works, and many other manufactures. In two directions it might be looked upon as certain that the power from the Victoria Falls would be used on a large scale, first in connection with the country as a cotton-producer and, secondly, as a copper producer. Their engineers reckoned that the cost of putting up a 10,000 H.P. plant would be approximately £50,000.

ARON ELECTRICITY METER (LTD.)—The directors' report for the year to Sept. 30 states that, after providing for general charges, depreciation and share of expenses and discount on issue of debentures, the net profit was £10,679. 19s. 1d., which will be applied to remove from balance-sheet trading loss of 1901-2 (£4,645. 1s. 9d.), set aside for debenture sinking fund (£2,500), 2½ per cent. on account of preference dividend in arrear (£3,122. 8s.), leaving £412. 9s. 4d. to be carried forward. The directors state that the demand for meters continues to increase, especially in Germany, and the business in England has also assumed a brighter aspect. The additional factory buildings in Schweidnitz were completed early in the year, and the facilities thus obtained have considerably helped to improve the results of the year's trading. The new alternating-current motor meter placed on the market some time back appears to meet with favour. The demand for the double tariff meter, the time switch and other recent inventions is constantly increasing, and Prof Aron, who is mainly responsible for their effective design and construction, continues to devote his attention to the development of all requirements connected therewith. The transfer books and register of members will be closed from 28th inst. to Dec. 17 inclusive.

DE BEERS CONSOLIDATED MINES CO.—The chairman (Sir Lewis Mitchell) stated at the meeting last week that the electric power and lighting station had been completed, and the work of constructing an electric tramway to Alexandersfontein was well forward.

GENEVA TRAMWAYS CO. (LTD.)—The report for the year ended Sept. 30 states that the gross profit on the working of the Swiss company was 215,400fr., and, after making provision for debit balance of 12,307fr., &c., the balance was 56,390fr., which has been carried forward. The gross revenue was 1,953,486fr., against 1,890,775fr. in 1902, gross expenditure 1,742,037fr., against 1,745,151fr. The ratio of expenses to revenue was 89·18 per cent., against 92·3 per cent.

LANCASTER AND DISTRICT TRAMWAYS CO.—The chairman (Mr. A. Bell) at the meeting on Saturday referred to the proposed purchase of the system by Lancaster Corporation, to link it with their present electric tramways. The company had had an opportunity two or three years ago of selling their undertaking for £45,000, and during the year they had had other opportunities of disposing of their property, but had not done so.

MAY-OATWAY FIRE APPLIANCES (LTD.)—Although the automatic fire alarm industry is a comparatively new one in the United Kingdom, the report of the May-Oatway Fire Appliances (Ltd.), which we give below, is, as far as we remember, the first report of any company engaged in this branch of work which has reached a self supporting stage. We understand that this measure of success has been obtained without the company having to apply to the Insurance Companies for discounts. We learn that the May-Oatway Co., now that the magnitude of their business and the low average and maximum fire loss over a term of years seems to the directors to warrant recognition, are about to ask the Insurance Companies to give to those who in the Mother Country improve their risks by the use of the May-Oatway system the premium rebate that has been allowed for some time in the Colonies. There can be no question that the judicious and methodical adoption of such systems of fire alarm instruments as are offered to insurers by the May-Oatway Co. has done much to reduce the number of fires, and consequently has served to materially benefit the Insurance Companies, who will doubtless, in recognition of such prudent insurance against disaster, give the company's application every consideration.

The directors' report to Nov. 12 shows a profit, after providing for depreciation of stock and plant, of £2,038. 18s. 3d., equal to a dividend of about 6 per cent. upon the issued capital. The directors are now able to make good the deficiency of £1,765. 3s. 2d. which accrued during the earlier years of the company's working, and recommend writing off exhibition expenses £71. 9s. 7d. and £145. 7s. 2d. from preliminary expenses, carrying the balance forward. Exhibition expenses for the past 16 months have already been charged against current revenue. Since the last meeting the company have put in some of the largest installations of automatic alarms in existence, and the directors believe that that supplied to Messrs. J. & P. Coats constitutes a world's record, while the preference shown for the company's appliances by the great railways and manufacturers having expert engineering departments, and the orders received for repeat installations or extensions from Glasgow Corporation, Messrs. Harrods, J. & B. Stevenson and others, must be regarded as highly gratifying to the shareholders. The favourable fire loss experience has been maintained, and in no case where an outbreak has originated in any building protected by the company's system has damage exceeded nominal figures. (A number of instances are quoted in the report.) Application has recently been made to the London County Council for permission to transmit to the Metropolitan Fire Brigade stations calls received from the company's various City installations, and the Council's terms are now under consideration. Several additional fire brigade stations have been fitted with the company's apparatus, and protected buildings have been placed in connection therewith. It is stated that the value of the property protected by the company's appliances exceeds by millions of pounds sterling that covered by all other existing systems of similar intent within the British Empire, and this pre-eminence is claimed to be due solely to the essential merits of the system and not to reductions in premiums by the Associated Fire Insurance Offices. Agency arrangements have been entered into with the Société Industrielle des Telephones, Paris, to develop the French patents. The agency arrangements have been extended in various parts of the United Kingdom, and branch establishments have been opened in Glasgow, Liverpool and Manchester.

MORECAMBE TRAMWAYS CO.—At the meeting on Monday the chairman said negotiations were proceeding with the local authorities for the conversion of the company's tramways to electric traction.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—An extraordinary meeting will be held on Dec. 9 to authorise the creation and issue of the third £50,000 debenture stock, which the company will presently be enabled to issue under the provisions of its act, in respect of a further subscription of £100,000 of ordinary share capital.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to appoint special settling days in and grant quotations to a further issue of 20,000 £5 ordinary shares (£3 paid) of the *Calcutta Electric Supply Corpn. (Ltd.)*, and a further issue of 5,000 4½ per cent. £5 fully paid cumulative preference shares of *W. T. Henley's Telegraph Works Co. (Ltd.)*.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The directors' report for the half year ended June 30 states that the amount to credit of revenue is £34,581. 11s. 7d., against £34,203. 10s. 11d. for the corresponding half-year of 1903. Expenses have been £23,437 14s. 3d., against £23,051. 14s. 2d., leaving £11,143. 17s. 4d., to which is added £1,825. 1s. 8d. interest on investments and £710. 15s. 1d. from last account, making £13,679. 13s. 8d. The directors propose payment of 7s. per share on account of arrears of dividend to June 30, 1904, on first preference shares, taking £12,097. 1s., leaving £1,582. 12s. 8d. to carry forward. Expenses of repairing cables during the half-year amounted to £8,589. 12s. 9d., or £1,211. 17s. 4d. less than for the corresponding period. This is, however, exclusive of a further expenditure of £3,467. 18s. 2d. (charged to reserve) in respect of 40 knots of new cable used in February last in the repair and partial renewal of the St. Lucia-St. Vincent section, which was interrupted by volcanic disturbances in Sept., 1902. The company's repairing steamer "Henry Holmes" was chartered to the Cuba Submarine Telegraph Co. in September last to repair one of their cables, but the charter has since expired, and the ship has resumed her ordinary work on the company's system. The Danish colonies of St. Thomas and St. Croix have renewed their subsidies for a further five years.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Nov. 19	1,119	+ 79	25	87,465	+ 5,791
Airdrie	,, 11	206	...	40	8,085	...
Ayr Corporation	,, 19	182	+ 11	27	9,790	+ 501
Barnsley	,, 11	160	− 9	45	7,651	− 565
Barrow	,, 11	203	...	40	7,960	...
Bath Electric Trams, Ltd.	,, 16	585	...	46	29,701	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 20	947	+ 12	...	...	...
Birmingham Corporation	,, 19	319	...	43	13,811	...
Birmingham Tramways Co.	,, 19	5,251	+ 377	20	108,969	+ 5,174
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 19	383	+ 60	33	41,921	+ 5,910
Blackpool and Fleetwood	,, 19	194	+ 8	20	30,454	+ 881
Blackp'l, St. Anne's & Lytham	,, 17	155	− 14	¶12	[illegible]	− 114
Bolton Corporation	,, 20	1,050	+ 45	34	63,579	+ 479
Bournemouth Corporation	,, 16	879	+ 95	‡38	88,910	+ 2,107
Bradford Corporation	,, 19	3,715	+ 804	32	155,293	+ [illegible]
Brighton Corporation	,, 20	795	+ 44	33	[illegible]	+ 3,022
Brisbane Tramways	Sept. 28	2,296	+ 5	13	30,903	+ 145
Bristol Trams & Carriage	Nov. 18	4,671	+ 878	13	136,156	+ 1,410
Buenos Ayres & Belgrano	Oct. 16	8,470	+ 393	27	67,951	+ 3,098
	,, 23	[illegible]	+ 216			
Burnley Corporation	Nov. 19	1,055	+ 261	7	7,836	+ 1,615
Burton Corporation	,, 2	269	− 20	*48	12,004	
Calcutta Tramways Co.	,, 19	a37,792	+ a3,257	21	a745,916	+ a77,565
Camborne-Redruth	,, 21	101	− 21	3	344	− 114
Cardiff Corporation	,, 19	1,732	− 8	38	63,909	+ 1,626
Carlisle Tramways Co.	,, 19	176	+ 17	46	9,179	+ 217
Central London Railway	,, 19	7,057	− 41	20	121,918	− [illegible]
Chatham & Dist. Lt. Rys.	,, 17	196	− 7	46	27,238	+ 2,199
City & South London Rly.	,, 20	2,963	− 67	[illegible]	52,775	− 1,914
Colchester Corporation	,, 17	175	...	16	4,610	...
Cork Electric Trams Co.	,, 17	449	+ 38	46	21,746	− 2,514
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 11	475	− 59	45	21,925	+ 3,2[illegible]2
Dover Corporation	,, 19	163	+ 6	34	7,090	− 190
Dublin & Lucan Railway	,, 18	96	− 5	20	2,257	− 21
Dublin Southern District	,, 18	642	+ 116	20	101,920	− 2,793
Dublin United	,, 18	8,703	+ 348			
Dudley—Stourbridge	,, 11	775	− 7	43	39,500	+ 1,419
Dundee Corporation	,, 16	817	+ 94	...		...
East Ham Council	,, 19	563	27	33	21,737	+ 1,458
Gateshead & Dist. Trams	,, 11	914	+ 15	45	41,115	+ 1,572
Glasgow Corporation	,, 19	14,471	+ 1,078	†25	339,301	+ 10,119
Gosport	...	...	...	...	...	...
Gravesend—Northfleet	,, 11	205	− 23	45	11,637	+ 409
Gt. Northern & City Rly.	,, 19	1,365	...	40	60,[illegible]	...
Greenock & Port Glasgow	,, 11	590	+ 90	45	[illegible]	+ 1,328
**Halifax Corporation	,, 16	2,625	+ 278	33	50,567	+ 5,872
Hartlepool Tramways	,, 11	247	+ 4	45	13,346	+ 1,15[illegible]
Huddersfield	,, 19	1,187	+ 78	33	46,098	+ 2,068
Hull Corporation	,, 19	2,180	+ 201	33	73,455	+ 9,615
Ilford District Council						
Ilkeston Corporation	,, 16	105	− 15	7	816	− 78
Ipswich Corporation	,, 19	828	...	33	17,006	...
Isle of Thanet Co.	,, 19	271	+ 3	7	2,049	− 110
Keighley Corporation	...	...	...	...		...
Kidderminster & District	,, 11	163	+ 6	45	5,863	+ 24
Kirkcaldy Corporation	,, 23	218	− 25	46	10,518	...
Lanarkshire Trams Co.	,, 17	657	+ 63	44	30,195	+ 19,017
Leeds Corporation	,, 23	5,491	+ 88	33	[illegible]	+ 11,548
Leicester Corporation	,, 19	1,[illegible]	...	27	34,[illegible]	
Liverpool Corporation	,, 17	10,842	+ 179	45	477,850	+ 13,470
Liverpool Overhead Rly.	,, 20	1,445	147	‖21	[illegible]	− 1,729
London County Council	,, 17	12,898	+ 8,072	§31	417,611	+ [illegible]
*Lowestoft	...	...	...	...	...	...
Maidstone Corporation	,, 17	101	...	18	2,923	
Manchester Corporation	,, 19	11,[illegible]	+ [illegible]	33	411,571	+ 18,101
Mersey Railway	,, 19	1,567	+ 194	20	[illegible]	+ 2,447
Merthyr	,, 11	195	− 7	45	9,104	+ 68
Metropolitan Elec. Trams	,, 18	1,[illegible]	+ 513	20	37,951	+ 10,400
Middleton	,, 11	234	+ 19	45	11,919	+ 314
Nelson Corporation	,, 19	109	− 30	31	4,104	+ 1,251
Newcastle-on-Tyne Corp.	,, 19	3,575	+ 77	20	78,185	+ 3,827
Newport (Mon.)	,, 19	[illegible]	+ 84	7	8,490	+ 367
Oldham, Ashton & Hyde	,, 11	5[illegible]1	− 31	45	24,570	− 1,183
Oldham Corporation	,, 12	1,240	− 151	33	40,1[illegible]	+ 521
	,, 19	1,049	+ 211			
Perth (W. A.) Elec. Trams	,, 18	1,348	+ 38	46	[illegible]	+ 6,216
Peterborough	,, 11	118	− 85	45	6,897	− 218
Poole and District	,, 11	157	+ 1	45	13,585	− 6
Portsmouth Corporation	,, 19	1,461	+ 144	§31	49,171	+ 5,07[illegible]
Potteries	,, 11	1,[illegible]	− 171	45	77,585	+ 6,109
Reading Corporation	,, 19	580	+ 41	7	4,299	
Rossendale Corporation	...	...	...	...	...	...
Rothesay	,, 11	31	− 5	45	6,752	− 2
Salford Corporation	,, 21	3,725	+ 125	23	114,515	+ 5,267
Sheerness	,, 9	60	+ 7	45	[illegible]	[illegible]
Sheffield Corporation	,, 20	4,143	+ 107	§34	15[illegible]	+ 9,[illegible]
Southampton Corporation	,, 17	8[illegible]6	+ 82	33	33,097	− 2,1[illegible]
Southend Corporation	,, [illegible]	[illegible]	+ 26	31	13,101	− 1,[illegible]
Southport Tramways	,, 11	225	− 14	45	14,893	+ [illegible]
S. Staffordshire Trams	,, 11	621	− 170	45	24,854	− 6,[illegible]
Stockport Corporation	,, 18	460	+ 130	33	19,678	+ 7,7[illegible]
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	,, 11	467	− 40	45	24,641	972
Taunton Trams	,, 11	[illegible]	− 6	45	2,206	− 259
Tynemouth and District	,, 11	194	− 21	45	13,224	− 880
Tyneside Trams Co.	,, 1[illegible]	[illegible]	+ 17	46	18,070	− 3,057
Wallasey District Council	,, 1[illegible]	240	+ 17	§31	[illegible]	− 1,[illegible]7
Walsall	,, 19	450		44	22,[illegible]	...
Warrington Corporation		...		...		
West Ham Corporation	,, 17	1,007		33	35,828	
Weston-super-Mare	,, 8	31	− 5	45	[illegible]	+ [illegible]
Wigan Corporation	...	...	...	...		...
Wolverhampton District	,, 11	[illegible]	4	45	17,711	− 70
Worcester	,, 11	293	+ 173	40	12,[illegible]	− 6,371
Wrexham	,, 11	80	− 37	45	4,088	− 373
Yorkshire Woollen District	,, 11	421	− 141	45	26,610	− 5,[illegible]

(a) These comparisons are with the corresponding period last year.

Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

** Fortnight.

ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND.	NAME.	Price Wed., Nov. 22.	RATE PER CENT. YIELD.	DIVIDEND DUE.	BUSINESS WEEK TO NOV. 22.	
				£ s. d.		High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	3/0	Anglo-Argentine Ordinary Shares	6¾—7¼	4 4 0	April, Oct	7⅛	6¾
5	2 6	Do. 5% Cum. Pref.	5⅛—5⅜	4 10 3	—	5⅜	5⅛
St.	6%	Do. Permanent 6% Deb. Stock	143—146	4 2 9	—	144½	143½
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	106—107	4 15 3	—	106½	106
10	6%	Barcelona Tramways Ord.	9—10	5 0 0	—	..	..
10	5/0	Do. 5% Cum. Pref.	9—10	5 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91—96	4 14 0	—	..	..
100	5%	Do. 5 per Cent. Debs.	98—101	4 19 0	..	100	99½
1	..	Bath Elec. Trams Pref. Ord.	½—¾	..	..	..	..
1	..	Do. 5% Cum. Pref.	¾—1⅛	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 8	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	98—100	4 11 9	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19—20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10—10½	3 18 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107—109	3 13 4	Feb, Aug	..	..
St.	6%	†British Columbia Elec. Rlwy. Def. Ord.	100—105	5 18 6	—	101	..
St.	5%	Do. Pref. Ord. Stock	102—105	4 15 3	—	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10¾	4 13 0	—	..	..
60	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103%—104%	4 6 9	—	..	..
100	4½%	Do. Vancouver Power Debs.	97—100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	9¾—10¼	5 17 8	..	10¼	9⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾—11	5 9 1	Feb, Aug	11	10¾
St.	5/0	Do. 5 per Cent. Perpetual Debs	117—119	4 4 3	—	118½	117½
St.	4½	Do. 4½ per Cent. 2nd Deb. Stock	95—97	4 12 10	..	96½	..
5	1/6	Buenos Ayres and Belgrano Ord.	3½—3¾	5 14 0	—	4	3¾
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5½—5¾	5 2 3	—	5¾	..
5	3/0	Do. "B"	5¼—5½	5 11 6	—	5⁷⁄₁₆	..
St.	5%	Do. 5 per Cent. Debs.	106—108	4 13 6	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	102—106	4 16 3	—	101½	103
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. 5% Deb. Stk.	96—99	5 2 6	..	..	..
5	3/0	Calcutta Tramways	7½—7¾	3 15 6	—	7¹¹⁄₁₆	7½
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106—108	4 4 0	—	..	..
1	1/0	Cape Electric Tram Shares	1½—1¾	6 3 0	—	1⁹⁄₁₆	1½
St.	4%	Central London Ordinary Stock	93—95	4 4 2	June, Dec	96	95½
St.	4%	Do. 4 per Cent. Pref. Stock	101—103	3 17 9	..	..	..
St.	4%	Do. Deferred Stock	84—86	4 13 6	..	..	..
100	4%	Do. 4 per Cent. Debs.	108—110	3 13 4	..	109½	..
5	2/6	City of Birmingham Trams.5% Cm. Prf.	4½—5	5 0 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98—101	3 19 3	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	46—47	4 11 3	Feb, Aug	47	46½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122—125	4 0 3	Feb, Aug	124½	..
St.	5%	Do. (1896)	117—120	4 3 6	..	119	..
St.	5%	Do. (1901)	114—117	4 6 0	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104—107	3 14 9	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	101—104	4 16 3	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13—14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15—16	3 15 0	—	..	..
10	3 0½	Gt. Northern & City Rly. Prf. Ord. (4%)	5¾—6	..	—	6⅛	6
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8¾—9¼	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19—20	5 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	110—113	4 0 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¾—4¼	5 17 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90—93	4 7 8	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3¾—4¼	3 15 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10—10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10¼—10¾	4 12 0	..	10¾	10⁷⁄₁₆
St.	4%	Do. 4% 1st Mort. Deb. Stock	104—108	3 16 9	..	105½	..
St.	..	Madras Elec. Trams 5% Deb. Stk.	103—105	..	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6—9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10—13	..	..	..	..
1	..	Metropolitan Electric Trams Def	½—¾	..	..	..	¾
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	—	1	..
St.	11/7	Do. 4½ Deb. Stock	103—106	..	..	..	..
100	5%	Montreal St. Ry. St'g 5% Mrt. Dbs.(1908)	100—103	4 17 8	..	..	..
100	4½%	Do. Sterling 4½% Debs.(1922)	103—105	4 6 9	..	..	..
5	..	New Gen. Tract. 6 per Cent.Cum. Pref.	¾—1¼	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db.Stk.	103—106	4 16 9	..	106	..
10	10/0	Potteries Electric Traction Ord.	8—9	5 11 2	..	8¹¹⁄₁₆	8⁷⁄₁₆
10	5/0	Do. 5 per Cent. Cum. Pref.	8¾—9¼	5 5 3	Feb, Aug	9	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock	97—102	4 8 3	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	—	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	80—83	3 7 0	June, Dec	82½	82
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	⅝—⅞	5 14 2	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	⅜—⅝	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5¾—6	6 13 4	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¾—6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102—104	4 6 7	—	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1stMt.Db.	100—102	4 8 6	—	..	..
5	3/0	British Westinghouse 6% Pref.	3¼—3¾	8 5 8	—	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	89—91	4 9 6	..	90	..
2	..	Brush Electrical Engineering	⅝—⅞	..	March ..	1¼	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1—1¼	9 12 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	93—95	4 14 8	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	69—73	6 6 8	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	9½—10	5 5 0	Jan, July	9¾	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5¼	4 15 3	Jan, July	5⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	104—106	4 6 7	Nov, May	104½	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1¼—1¾	4 18 9	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	94—96	4 13 6	..	..	..
1	0/8½	Chadburn's (Ship) Telegraph Ord.	¾—1¼	8 17 6	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—1¾	4 6 2	Jan, July	1¹¹⁄₁₆	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	90—96	5 6 5	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	7½—7¾	6 8 3	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	5¾—6¼	5 9 1	Sept	6¹⁄₁₆	..
St.	4½%	Do. 4½% Deb. Stock	104—106	4 5 9	..	..	..
5	..	Edison & Swan United("A"Sh.)(£3 pd.)	½—¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1—1¼	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb.Stock(rd.)	79—83	4 17 9	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79—84	6 0 0	..	..	..
5	4/0	Edmundson's Elec. Corp. Ord.	5¾—6	6 16 8	H'lf-yearly	6⅛	5⅞
5	3/0	Do. 6 per Cent. Cum. Pref.	5½—6	4 13 0	—	6¹⁄₁₆	6
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106—108	4 4 3	..	107½	107¼
2	1/7½	Electric Construction Co.	1½—1¾	6 8 0	July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2¼—2½	5 12 3	July	2⁷⁄₁₆	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98—100	4 0 6	Jan, July	99½	98½
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90—95	5 5 3	—	..	—
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10	5 0 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91—95	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½—11½	6 4 4	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5¼—5¾	4 3 9	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort.Deb.Stock(rd.)	109—111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	20—20½	4 17 6	Feb, Aug	20¹⁄₁₆	20
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99—102	3 18 5	Mar, Sept	..	..
10	3/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾—11¼	4 5 10	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	36—40	5 18 6	Mar, July	35½	35
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	102—104	3 17 6	Jan, July	..	..
5	—	Willans and Robinson Ord.	1—2	..	Apr, Oct	..	..
5	—	Do. 6 per Cent. Cum. Pref.	2—3	—	Apr, Oct	—	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs	75—80	5 4 9	May Nov	—	—

SHARE.	LAST DIVIDEND.	NAME.	Price Wed., Nov. 22.	RATE PER CENT. YIELD.	DIVIDEND DUE.	BUSINESS WEEK TO NOV. 22.	
				£ s. d.		High-est.	Low-est.
		ELECTRICITY SUPPLY.					
..	..	Blackheath & Greenwich Dist. El. Lt. See South Metropolitan Elec. Lt. & Power Co. below	..	..	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	11¾—12¼	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9¾—10	4 10 0	..	..	—
10	6/0	Do. 6% Cum. Second Pref.	11—12	5 0 0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104—106	4 5 9	—	105½	103
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5¼—5¾	3 9 7	..	..	..
St.	4½%	Do. Do. 1stDebs	101—104	4 7 0	—	..	..
5	4/6	Brompton & Kensington Elec.Sup.Ord.	10½—11	4 10 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10¼—10½	3 6 1	Mar, Sept	..	..
5	3/0	†Calcutta Electric Supply Ord.	7¾—8	4 7 6	..	7¹³⁄₁₆	7¾
St.	4%	Central Elec. Sup.Co.4%Guar.Db.Stock	106—109	3 14 6	..	108½	..
5	4/0	Charing Cross & Strand Electric Sup.	8¾—9	4 8 9	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5¼—5½	3 11 3	Feb, Aug	5½	5⁷⁄₁₆
St.	4%	Do. 4% Deb. Stock (red.)	103—105	3 17 3	..	104½	104
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	—	..	..
5	2/3	Do. Do. (1903)	4¾—5	..	..	104½	..
5	2/3	Chelsea Electric Supply Ord.	6¼—6½	4 5 3	March ..	6⅜	6¼
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109—111	4 1 9	Jn, Dec ..	..	..
10	6/0	City of London Electric Lighting Ord.	10½—11	4 10 11	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13¾—14	4 5 9	Jan, July	13¾	13⅝
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123—127	4 0 0	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	104—106	4 5 9	..	..	..
10	4/0	County of London Elec. Supply Ord.	9½—9¾	4 2 1	..	9⁹⁄₁₆	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12—12½	4 16 0	Mar, Sept	12¼	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107—110	4 3 3	..	109	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101—103	4 7 6	..	101	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	86—88	5 7 6	..	86½	..
5	2 0	Folkestone Electricity Supply Co. Ord.	5¾—6	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	102—105	4 7 9	—	..	—
10	..	Havana Electricity Co. Shares	9¾—10¼	..	—	..	—
5	6 0	Hove Electric Lighting Ord.	7¾—8	3 6 3	..	..	..
St.	4½%	I. of W. Elec Lt. & Power 4½% Db. St (red.)	99—101	4 9 1	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf.	¼—⅜	..	—	⅜	—
5	5/0	Kensingtn & Knghtsbdge Ord.	12—13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6¾—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck.(red.)	103—104	3 17 3	—	..	..
5	..	London Electric Supply Ord.	2—2¼	..	..	2	..
5	3/0	Do. 6 per Cent. Pref.	5¼—5¾	5 2 1	..	5¹¹⁄₁₆	5⅝
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	97—99	4 2 0	Mr,Jn,S,D	..	..
10	9/0	Metropolitan ElectricSup.Ord.	16—16½	5 9 0	April, Oct	16¼	16⅛
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼—5½	4 1 10	Jan. July	5⅜	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	112—117	3 18 0	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97—99	3 10 6	..	..	..
100	4½%	MidlandElec.Corp.for P.D.1stMort. Db.	93—96	4 13 9	..	..	—
10	6/0	Notting Hill Electric Ord.	14½—15	4 0 0	March....	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	101—103	3 18 2	..	..	..
5	2/6	Oxford Electric Ord.	6—6¼	5 4 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99—101	4 0 0	..	..	..
1	..	Rand Electric	1—1½	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mt. Deb	100—102	4 8 9	April, Oct	..	..
5	6 0	St. James' & Pall Mall Elec. Ord.	14¼—14¾	4 13 4	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	8¾—9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	99—101	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3¼—3¾	6 3 1	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83—87	4 17 6	..	..	..
5	2/0	South London Electric Supply Ord.	4¼—4¾	3 6 6	—	4⁷⁄₁₆	..
1	..	South Metrop'n Elec. Lt. & Power Ord.	¾—1	..	—	..	..
1	0/8½	Do. 7% Cum. Pref.	1¹⁄₁₆—1³⁄₁₆	4 16 9	—	1⅛	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&com.)	107—110	4 2 3	—	..	..
5	2/6	Urban Electric Supply Ord.	4¾—5¹⁄₁₆	4 13 9	..	5¹⁄₁₆	5
5	2/6	Do. 5% Cum. Pref.	4¾—5¹⁄₁₆	4 18 9	..	5¹⁄₁₆	5
St.	..	Do. 4½% 1st Mort. Deb.	103—106	—	..	101½	101¼
5	6/0	Westminster Electric Supply Ord.	12¼—12½	5 2 0	Mar, Sept	12½	12⁷⁄₁₆
5	2/6	Do. 5 per Cent. Cum. Pref.	6¾—7	3 11 6	—	6¾	—
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	99—102	3 19 0	Jan, July	..	..
10	..	Amazon Telegraph	1—1¼	..	Jn, Dec ..	..	..
St.	12/6	Anglo-American	65—67	4 15 0	F,My,Ag,N	66¼	..
St.	25/0	Do. Preferred	101—103	5 6 10	F,My,Ag,N	103¼	102
St.	2/0	Do. Deferred	11¾—12	0 16 8	F,My,Ag,N	12¼	11¹¹⁄₁₆
100	$2	Commercial Cable Capital Stock	170—190	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	92—96	4 4 9	Jn,Ap,Jy,O	94	93
10	5/0	Cuba Submarine Ord.	7¾—8¼	7 6 4	Feb, Aug	8¼	7¾
10	10/0	Do. Preference 10 per Cent.	15—16	6 5 0	Feb Aug	16¼	..
5	2/0	Direct Spanish Ord.	3¼—3¾	5 14 6	April, Oct	3⅝	3⅜
5	5/0	Do. 10 per Cent. Cum. Pref.	7¼—7¾	6 9 1	April Oct	..	..
60	4½%	Do. 4½ per Cent. Deb.	99%—101%	4 9 3	Jan, July	..	..
20	2/0	Direct United States Cable	10¾—11	3 9 0	Ja,Ap,Jy,O	11¹⁄₁₆	10⅞
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	100—102	4 9 9	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	133—136	5 2 10	Ja,Ap,Jy,O	134½	133½
St.	17/6	Do. 3½ per Cent. Pref. Stock	88—90	3 18 0	Ja,Ap,Jy,O	89½	88½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106—107	3 14 9	May, Nov	106½	105½
10	2/6	Eastern Extension	13—13½	5 5 7	Ja,Ap,Jy,O	13¼	13
St.	4%	Do. 4 per Cent. Deb. Stock	106—108	3 14 3	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb.1900	101—103	3 18 6	Feb, Aug	101½	101
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 5	May, Nov	100	..
10	5/0	Gt. Nrthn. (of Copenhagen)	28—28½	5 5 6	Jan, July	28¼	28
100	4½%	Halifax & Bermudas 4½% 1stMt.Db. (red.)	100—103	4 9 6	June, Dec	..	..
25	12/6	Indo-European	44½—46½	5 7 6	May, Nov	..	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	98—100	4 0 9	June, Dec	..	—
10	6/0	West African Telegraph Shares	7—7½	5 6 5	—	..	..
2½	..	West Coast of America	¼—¾	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	98—100	4 0 6	Jan, July	..	..
10	..	West India and Panama	¼—½	..	May, Nov	½	⅜
10	6/0	Do. 6 per Cent 1st Pref.	7¼—7¾	9 0 0	May, Nov	7½	7¼
10	..	Do. 6 per Cent. 2nd Pref.	5¾—6	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	102½—104½	4 17 9	Jan, July	..	..
10	5/0	Western Telegraph ....xd & bonus	13¼—13¾	5 4 8	Mr,Jn,O,D	13¾	13½
100	5%	* Do. 5% Debs. (2nd Series, 1903)	101½—105½	4 18 6	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	101½—103½	3 18 5	—	..	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid)	5¾—6¼	6 19 3	August ..	5¾	..
1	0/7½	Monte Video Telephone Ord.	¾—1¼	..	..	..	..
St.	6%	National Co. Pref. Stock	107—108	5 11 3	..	108	107
St.	6%	Do. Def. Stock	96½—97½	5 2 6	..	97½	96½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13—14	4 5 8	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12—13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5¼—5½	4 15 0	Feb, Aug	5⅜	5¼
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97½—98½	3 12 3	June, Dec	98½	97½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104½—105½	3 17 2	..	105½	104½
..	5/0	Do. Do. Prov.Certs,25% tobepd.	67½—68½	..	..	..	..
1	0/7½	Oriental	1⅛—1³⁄₁₆	6 6 8	April, Oct	..	—
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	..	..	..
5	5/0	United River Plate	5¾—6¼	6 5 6	July.....	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 16 5	June, Dec	5½	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104—106	4 14 4	June, Dec	..	—
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5—5¼	5 9 1	—	5¹⁄₁₆	..
10	2/0	Globe Telegraph and Trust	9½—10	5 10 0	Ja,Ap,Jy,O	10	9¾
10	3/0	Do. 6 per Cent. Pref.	13½—14	4 5 9	Ja,Ap,Jy,O	13¾	13½
100	6%	Submarine Cables Trust (Cert.)	119—122	4 19 0	April, Oct	..	—
..	36/7	Underground Elec. Rys. Co. of London 5% Profit Sharing Secured Notes	99—99½	—	..	100	99½

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote

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NOTES.

SOME amendments have been suggested, by the electrical section of the London Chamber of Commerce, to the Home Office regulations for factories in which "medium" electric pressures are employed. When the regulations were first published, we pointed out that they ought to be identical with the Board of Trade regulations, and this point of view has now been advanced once more by the Chamber of Commerce Obviously, two sets of regulations, not in perfect agreement, would tend to create confusion and a feeling of bewilderment in the owner of a factory coming within the jurisdiction of both Government departments.

ANOTHER point is brought forward by the Chamber in the objection set out on p. 246 of this issue. It is scarcely conceivable that the Home Office regulations would be rigidly enforced in the testing department of an electrical manufacturing works, because, as pointed out by the Chamber, it would be quite impossible to comply with them. In spite of this, however, the regulations, as they stand, are undoubtedly applicable to such cases, and care should therefore be taken to see that they are not made final without some saving clause being inserted providing for the exemption of testing and similar departments.

MR. J. F. C. SNELL'S Paper on the "Distribution of Electrical Energy," read at the Institution of Civil Engineers last week, is a peculiar mixture of matter suitable for an elementary text-book and controversial matters inviting debate from experienced electrical engineers. We publish the official abstract of the Paper in another column. Mr. SNELL'S conclusions as to the limits up to which low-pressure distribution is economical, and the limiting economical pressure for transmission by underground cables, are somewhat at variance with recent practice in this country, and it is to be regretted that we are prevented from publishing the steps of reasoning which led him to these conclusions. We congratulate Mr. SNELL on the honour which he has earned at the hands of the parent engineering institution in having had his Paper accepted for discussion at their general meetings. On the other hand, many of the leading electrical engineers who are not members of the Institution of Civil Engineers will be unable to take part in the discussion on the Paper, and neither the full Paper nor discussion on it may be published in the technical newspapers.

IT is to be regretted that the Institution of Civil Engineers has done so little to recognise one of the most influential agents in promoting the progress of the engineering industries—viz., the technical Press. While the younger and more progressive institutions invite the editors of the leading engineering papers to send representatives to their meetings, and welcome the wider discussion of important questions and the wider and speedier dissemination of the views of their members which can be effected by this means, the Institution of Civil Engineers sits with closed doors. We trust that the Council of the Institution will soon allow itself to be actuated by the broader views which now prevail as to the usefulness of publicity, but in the meantime we would urge electrical engineers to offer the fruit of their efforts to the Institution of Electrical Engineers. In acknowledgment of the kindness of the Institution of Civil Engineers in allowing the Electrical Engineers to meet in the lecture theatre in Great George-street, the meetings of the latter Institution are open to all members of the Civil Engineers. Thus, any member of both Institutions may rest assured that, in reading his Paper before the Institution of

Electrical Engineers he will be at the same time reading it to as many members of the older Institution as care to attend the meeting.

◆

While it is possible to give approximate figures of the saving effected by conversion from steam to electric driving in collieries, it is by no means easy to effect an exact comparison. As a matter of fact, very few colliery owners have any idea as to how much it costs them per annum for power, and the waste is often appalling. We know of a colliery consisting of three pits where the consumption of the various engines varies from 60lb. to 80lb. of coal per horse power-hour. The worst case is that of a main pumping engine, situated some 400ft. below ground. At the surface the steam pressure is 100lb. per square inch, but at the stop valve of the engine it is only 35lb. per square inch. This is perhaps an extreme instance, but there are many almost as bad. It is no uncommon thing to see live steam pipes passing down the shaft with a veritable rain of cold water falling upon them. Long lengths of unlagged steam piping in the open air, leaky joints, &c., are the rule rather than the exception at coal pits, and it does not require a very highly trained engineer to discover that immense sums of money are being wasted every day. However, it is to be hoped that the time of such things is past, and that coal owners will appreciate the great economies which may be effected by purchasing their electrical energy from the power companies at rates with which they themselves cannot possibly compete.

◆

THE principle of steadying the output of an engine or motor which has to deal with a rapidly-varying load by storing energy in a flywheel during the moments of light load and taking it out again when the demand for power rises above the average is not a new one. Applications of this principle have been made to numerous purposes where the fluctuations are very pronounced, both in magnitude and length of cycle. In rolling mills, for instance, huge flywheels have been used for overcoming some awkward peaks in the load curve. Ingenious adaptations of the idea to mining work are described in articles on electrical winding plant which we publish this week. Besides securing a practically constant demand on the central station, the arrangements adopted have the further advantage of avoiding starting resistances entirely. These advantages, it is true, have been secured by the introduction of additional machinery, but it may, nevertheless, be expected that the apparatus is quite as reliable as the large starting resistances which it replaces. A considerable saving is certainly effected by the reduction in the size of the power plant, made possible by the application of the flywheel principle, but whether this gain is offset by the auxiliary machinery necessary can only be decided case for case. A somewhat similar application of the flywheel principle—viz., regulating the field automatically when the heavy load comes on, so that the motor tends to slow down and the flywheel supplies energy to the system—is made in the case of the electric driving of heavy rolling mills. Without an arrangement such as this it would be difficult to find a motor capable of driving heavy rolls which their enormous variations of power demand.

ON another page of this issue will be found a description of the Fife and Scottish Central Power Schemes, each of which gives every promise of a most successful career. Situated in the midst of large coal fields, which are, comparatively speaking, in a virgin condition, there is no apparent reason why they should not fulfil the most sanguine hopes of their promoters. The Fife scheme is in a much more advanced state than the Scottish Central, and the demand for power has become so urgent in both areas that pilot stations have been erected. Although industrial manufacturing works of almost every description will be supplied, the greater part of the load will be due to the collieries, and the load-factor will be very high. Many of the coal pits keep their machinery working 24 hours a day, and as a large number of the motors drive pumping and ventilating apparatus which works quite continuously, as distinct from winding and hauling gear which works more or less intermittently, the cost of energy to colliery owners will naturally be very low.

◆

IN our Notes last week we commented upon the notices of applications to Parliament for powers to construct tube railways in London and also upon the notices of the various electric supply companies in the Metropolis who desire to extend their areas. In another column we conclude the list of notices, but apart from the two matters mentioned above, there are less features of importance than last year, the number of Bills being also considerably fewer. The London County Council is introducing a Bill to enable Metropolitan Borough Councils to undertake the wiring and fitting of consumers premises. A similar Bill, it will be remembered, was withdrawn in 1902 mainly owing to the opposition of the London Electrical Contractors' Association. This Association has already pledged itself to offer the most vigorous opposition to the present measure, which, by the way, is somewhat more comprehensive this year inasmuch as it seeks to enable the Borough Councils to borrow money for the above purposes as if such expenditure were for the purposes of the Electric Lighting Acts. If the County Council agree that no work of this character shall be done by direct labour, of course, no opposition will be made by the contractors.

◆

THE London County Council in its Tramways Bill seeks powers to construct additional lines, but the most important portion of this Bill will be that relating to the abolition of Section 23 of their Electrical Powers Act of 1900, which gives the Borough Councils a veto as to the system of traction to be employed. Several provincial municipal Bills ask for powers of the usual wide character, but as we have more than once pointed out, these may now be quite safely left in the hands of the Police and Sanitary Committee of the House of Commons. The Bill of the Medway & Thames Canal Co. seeks authority to carry out certain structural alterations for the adaptation of the canal to electric haulage, powers for which were obtained in 1902. The Metropolitan Pneumatic Despatch Co. proposes to establish a system of pneumatic transport in London in accordance with the scheme explained by Col. R. E. CROMPTON to the Royal Commission on London Traffic. The question of running powers will once more be raised, this time by the Blackpool, St. Anne's and Lytham Tramways Co., who seek compulsory running powers over the Blackpool Corporation lines under precisely similar circumstances to those at Newcastle last Session. Beyond the matters referred to no other new schemes of importance are proposed.

The Finsen Memorial.—In connection with the proposed memorial to the late Prof. Finsen, H.M. the King has been pleased to contribute £50 and H.M. the Queen £100.

Wireless Telegraph Notes.—We are informed that the Telefunken system of wireless telegraphy has been installed on the Nantucket lightship, in place of the Marconi system, which, as we announced a few weeks ago, has been removed.

Platinum.—The Russian platinum mines in 1908 produced 13,210lb. (avoirdupois) or 6½ short tons. This is a decrease of 277lb. as compared with the previous year's product. Most of the output was exported in the form of crude material.

King's College Engineering Society.—It has been decided to hold the eleventh annual dinner of this Society at the Hotel Cecil on December 10th, and Prof. J. M. Thomson, LL.D., F.R.S., has consented to take the chair. All former students and friends are particularly invited to take tickets, price 7s. 6d., which may be obtained of either of the hon. secs., Messrs. F. W. Cramer-Roberts and B. G. Cooke.

Opening of the Hull Corporation Telephone Exchange.—The telephone system which the Hull Corporation has opened in opposition to the National Telephone Co.'s exchange in that city, was opened on Monday. The new exchange has been designed by Mr. A. R. Bennett, and is fitted for 2,000 lines and 120 junction lines. The contractors were W. T. Henley's Telegraph Works Co. and the Ericsson Bell Telephone Co.

Personal.—We are informed that Mr. Musgrave Heaphy has retired from the position of electrical engineer and scientific adviser to the Phœnix Fire Office, and is succeeded by Mr. S. G. C. Russell, who has for some time past acted as electrical engineer to the company. The directors have retained Mr. Heaphy's services as consulting electrical engineer.

It is announced that Prof. Nernst of Göttingen has been called to Berlin as Director of the Institute for Physical Chemistry.

Der Electrotechnische Verein.—The 25th anniversary of the Electrotechnischer Verein was celebrated in Berlin on Nov. 22nd, as previously announced in these columns. This opportunity was made use of for presenting a silver tablet struck in memory of Werner von Siemens and von Stephan, to Herr Wilhelm von Siemens, son of the celebrated Werner von Siemens. Two honorary members were also elected—namely, Lord Kelvin and Herr Münzdirektor Conrad.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne—Pinheiros	Aug. 13, 1903	—
[illegible]-Isse (Yemen)—Camaran	Oct. 22, 1903	—
Tarifa—Tangier	Jan. 18, 1904	—
Cayenne—Paramaribo	July 13, 1904	—
Jupiter Inlets (Florida)—Nassau (Bahamas)	Oct. 20, 1904	—
Santa Cruz (Teneriffe)—Tejita (Teneriffe)	Nov. 11, 1904	—
Sitka—Valdez (Alaska)	Nov. 11, 1904	—
Mozambique—Majunga	Nov. 15, 1904	—
St. Kitts—St. Thomas	Nov. 22, 1904	Nov. 28, 1904

Proposed Subway for Chicago.—According to the *Railway and Engineering Review* of Chicago, Mr. Geo. W. Jackson, consulting engineer to the Transportation committee of the City Council of Chicago, has made a report on a system of subways in the central part of the city for the several car lines now operating upon the surface, and for an exchange of passengers underground from one street car system to another. The plans cover six separate routes, three for south side cars, two for the west side lines and one for the north side lines. The scheme seeks to eliminate the necessity for lowering the present river tunnels by providing a subway at such a depth as will give a level underground tunnel under the river and throughout the down-town district. Mr. Jackson estimates the excavation to cost $15,610,197. The property to be purchased for egress and ingress to the tunnels will cost $1,200,000; engineering, incidentals, $1,092,713; damages, insurance of employés, $624,407. It is planned to have the stations 450ft. apart.

Train Lighting.—According to the *Zeitschrift für Elektrotechnik*, 22 turbo-dynamos of the De Laval type have been ordered by the Prussian State Railways for lighting a number of express trains. The set in each case is mounted on top of the locomotive boiler, and the turbine develops some 20 H.P. at 20,000 revs. per min. It is directly coupled to a continuous-current dynamo, which is capable of supplying 180 amperes at voltages from 68 to 90 volts. Each carriage of the train is provided with a 32-cell storage battery of a capacity of 76 ampere-hours. The lamps are designed for 48 volts; the difference in voltage is taken up by iron resistances on the same principle as in the Nernst lamp, so that the pressure at the lamp terminals is almost constant in spite of variations of the battery pressure at different stages of charge and discharge (see *The Electrician*, Vol. LIII., p. 780). Normally the dynamo and battery are in parallel, and arrangements are made by which a red light in the driver's cab begins to burn when the battery voltage has risen to that of the dynamo. The latter is then disconnected.

The Junior Institution of Engineers.—A large number of the members, accompanied by the President, Mr. W. H. Lindley, and the Chairman, Mr. Samuel Cutler, jun., visited recently the central station of the South Staffordshire Mond Gas (Power and Heating) Co. at Dudley Port. The station is in the centre of an industrial district, comprising 120 sq. miles in South Staffordshire. There are to be four units, each of eight producers, and the first unit, together with a complete set of spare towers, is now ready for working. Each producer is capable of gasifying 1 ton of fuel per hour throughout the day and night. Steam is raised by means of Climax vertical boilers arranged for burning small coal with forced draught, and also for firing by gas. Fraser & Chalmers compressors for putting the gas under pressure for distribution were seen in the machinery house and two vertical Westinghouse gas engines driving various electric motors used in connection with the plant and for lighting. The pipes for conveying the gas to Wolverhampton, Walsall and intermediate towns have been laid by Messrs. John Aird & Sons, and are mostly of the steel locking type made by Mephan Ferguson.

Installation of Lord Kelvin as Chancellor of the Glasgow University.—On Tuesday Lord Kelvin was formally installed Chancellor of the University of Glasgow. The ceremony, which took place in the Bute Hall, was witnessed by a large number of distinguished persons, and was particularly interesting owing to the fact that the honorary degree of Doctor of Laws was to be conferred upon Princess Louise (Duchess of Argyll). Shortly after Her Royal Highness had taken her seat, a procession, headed by Lord Kelvin and Principal Story, entered and proceeded to the rostrum. The Principal then opened the proceedings by reading the Latin prayer, and the formal installation of Lord Kelvin as Chancellor of the University was proceeded with. Lord Kelvin having taken the oath and signed the book, he was invested with the robe of the Chancellor by Principal Story. He then took his place in the central part of the rostrum and conferred the honorary degree of LL.D. upon the following: Princess Louise; Lord Ailsa; Dr. James Thomson Bottomley, F.R.S., Arnott and Thomson Demonstrator in Experimental Physics in the University of Glasgow for 24 years from 1875; Dr. James Donaldson, Principal of the University of St. Andrews; Admiral Sir John Charles Dalrymple Hay, F.R.S.; the Very Rev. Dr. John Marshall Lang, Principal of the University of Aberdeen; Mr. Marconi; Mr. Andrew Graham Murray, M.P., Secretary for Scotland; the Hon. Charles A. Parsons, C.B., F.R.S.; and the Lord Provost of Glasgow (Sir John Ure Primrose). After Lord Kelvin had delivered a most interesting address, containing many personal reminiscences of his early association with the University, the gathering broke up, the Chancellor subsequently entertaining a distinguished company to luncheon.

Use of Electricity in Factories and Workshops.—A meeting of the electrical section of the London Chamber of Commerce was held last week, Mr. C. P. Sparks presiding, to consider the draft regulations relating to the use of electricity in factories (*The Electrician*, October 21st, p. 18) and a large number of communications from members of the section on the subject. It was decided that objections should be sent in to the Home Office with the object of securing a *locus standi* at the inquiry which will be held in due course in accordance with the provisions of the Factory and Workshop Act, 1901. The section have pointed out generally the difficulties and inconveniencies which may arise from the existence of two sets of regulations administered in the same factory by two different Government departments, and submit that the Home Office regulations should be on identical lines with the proposed amended Board of Trade regulations under the Electric Lighting Acts of 1882 and 1888; also that the testing departments of electrical manufactories should be exempted from the operation of the regulations, as electrical manufacturers are manifestly unable to comply with the regulations in view of the special circumstances of the case. Coming to particular clauses, the section have made the following suggestions:—

Clause 1.—That alternative systems should be allowed in view of the advantages in certain cases of employing cables run on insulators and the adoption of other approved methods.

Clause 5.—That main distributing boards which are in charge of a special attendant should be exempted from the regulations with regard to the enclosing of switches. The section submit that the requirement as to the earthing of lamp-holders would be troublesome and suggest as an alternative that an approved type of lamp-holder should be permitted.

Clause 6.—That as electrical "undertakers" are already under penalties prescribed in various sections of the Board of Trade regulations to see that their work on consumers' premises is efficiently carried out, the section submit that it is unfair to put the onus of giving annual certificates, as proposed, on such undertakers.

It was reported that the Home Office had acknowledged the representations of the section with reference to electricity in mines.

Electric Lighting and Traction in Amsterdam.—On Friday last representatives of a number of engineering journals travelled to Amsterdam at the invitation of Messrs. J. G. White & Co. in order to inspect a high-speed electric railway which runs from Amsterdam to Haarlem and thence to Zandvoort. This line, which has not been converted from steam traction, is entirely new and presents a number of interesting features. We hope to describe it fully in a future issue. On Sunday morning a visit was paid to the generating station which supplies the whole city of Amsterdam with current for tramways and lighting. The distinguishing feature of this station is the abnormal size of the building for the capacity of the plant within it. There is probably sufficient space in the engine room for about 50,000 H.P., assuming the employment of turbo-generators, instead of which there are merely five horizontal compound Sulzer engines coupled to generators, each of 1,000 H.P. These sets occupy about three-quarters of the available floor space. Two of them generate three-phase alternating current at 3,000 volts for lighting purposes; two are solely for traction purposes, and generate continuous current at 600 volts; the fifth consists of an engine similar to the others, coupled to which are two generators, one continuous current and the other alternating, and each of 1,000 H.P. Thus it is possible, at times of light load, to shut down all sets but one and supply both trams and lighting from it. In addition, however, there is a 1,800 ampere-hour storage battery which is always kept in parallel with the traction generators. After 1 a.m. this battery supplies the entire traction load and also the lighting load by means of a small motor-generator. The centrifugal governors of the alternating sets can be controlled either by hand or electrically from the switchboard. On the stop valves of the high-pressure cylinders the steam pressure is 150lb. per square inch, and the steam is highly superheated. Surface condensers are employed, the air-pumps being situated in the basement and worked by an extension of the rear end of the piston. A small single-cylinder steam engine is employed for starting each large engine. A peculiar feature of the A.E.G. generators is the tie-rod construction, which takes the form of two equilateral triangles superposed one upon the other. These tie-rods are fixed on both sides of the stationary armature so as to strengthen the casting, which is very narrow, the diameter of the ring being considerable. There is a very small load on Sundays, most of it being due to the small motors employed in diamond mills. These machines take anything from ¼ H.P. upwards, but the majority do not exceed 2 H.P. The tariff for them is 2d. per kilowatt-hour, while for the first 5,000 kw.-hours per year used for lighting 4d. is charged, 3·6d. for the next 5,000, and so on. There are 10 high-tension feeders and 52 transformer stations above ground. Distribution is carried out at 220 volts and 50 ~ per second, the lamps being connected between the phases, and the central point of the star earthed. The tramways, which are 52km. long, run on the bow-collector system, and are remarkable for their easy running.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

SATURDAY, December 3rd.

Junior Institution of Engineers.

Afternoon visit to inspect the features of engineering interest at the London Coliseum, St. Martin's-lane, Trafalgar-square.

MONDAY, December 5th.

Society of Engineers.

7.30 p.m. Meeting at the Royal United Service Institution. Paper to be read: "Condensing Machinery," by W. E. Storey.

Society of Chemical Industry: London Section.

8 p.m. Meeting in the Chemical Society's Rooms, Burlington House, Piccadilly. Among the Papers down for reading is the following: "Fluorescope for comparing Substances under the Influence of Radium Rays," by C. S. S. Webster.

TUESDAY, December 6th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. Paper to be further discussed: "Distribution of Electrical Energy," by J. F. C. Snell.

WEDNESDAY, December 7th.

Institution of Electrical Engineers: Students' Section.

7.30 p.m. Meeting at 92, Victoria-street, Westminster, S.W. Paper to be read: "The Gordon Electric Light Installation at Paddington, 1884–1904," by M. G. Tweedie.

Wolverhampton Engineering Society.

7.30 p.m. Meeting at Technical School, Wolverhampton. Paper to be read: "The Parsons Steam Turbine, and some of its Applications," by J. D. Baillie.

Society of Arts.

8 p.m. Ordinary Meeting. Paper to be read: "The International Exhibition of St. Louis, U.S.A.," by W. F. Reid.

THURSDAY, December 8th.

Institution of Electrical Engineers: Students' Section.

2 p.m. Visit to the Robertson Electric Lamp Works, Brook Green, Hammersmith.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting. The conclusion of the discussion on the following Paper will take place: "Hydrodynamical and Electromagnetic Investigations Regarding the Magnetic-Flux Distribution in Toothed Core Armatures," by Prof. H. S. Hele-Shaw, F.R.S., Dr. A. Hay and F. H. Powell. The following Paper will also be read: "Studies in Magnetic Testing," by G. F. C. Searle.

Institution of Electrical Engineers: Dublin Local Section.

8 p.m. Meeting at Royal College of Science. Paper to be read: "New York Power Stations," by P. S. Sheardown.

FRIDAY, December 9th.

Physical Society.

8 p.m. Meeting at the Physical Laboratory of the Central Technical College, Exhibition-road, South Kensington. Agenda:—(1) "On a Rapid Method of Approximate Harmonic Analysis," by Prof. S. P. Thompson, F.R.S.; (2) "A High-Frequency Alternator," by W. Duddell; (3) Exhibition of Experiments to show the Retardation of the Signalling Current on 3,500 miles of the Pacific Cable between Vancouver and Fanning Island; (4) Exhibit of Ayrton-Mather Galvanometers, Universal Shunts and Electrostatic Instruments.

Electro-Harmonic Society.

8 p.m. Smoking Concert, Holborn Restaurant (King's Hall).

SATURDAY, December 10th.

Glasgow Technical College Scientific Society.

7.30 p.m. Meeting at 38, Bath-street. Paper to be read: "Electrometallurgy: Some Notes on its Present Position," by J. D. Mackenzie.

Institution of Electrical Engineers: Leeds Local Section.

2.30 p.m. Visit to the Halifax Corporation Power Station, and the power station of the Hebden Bridge Urban District Council.

ELECTRIC POWER DISTRIBUTION IN SOUTH WALES.

The South Wales Electrical Power Distribution Co. is now in active operation and is supplying power to a large number of collieries and other works in the South Wales industrial district; the connections will amount to 9,000 H.P. in a few weeks' time. By far the greater part of this load is for actual power supply, the lighting load being chiefly confined to Bridgend—a small town which is supplied "in bulk" by the company, while the Urban District Council looks after the distribution to individual consumers. The company's district covers an area of 1,034 sq. miles. Fig. 1 shows the extent of the district, but it should be noted that the towns of Cardiff, Swansea and Newport (in each of which there is a municipal electricity supply) have been practically excluded from the company's area by their own desire. The company is only allowed to supply in these towns with the consent of the Corporation in each case, and, as the Corporations have electricity works themselves, the load-factor of which they are anxious to improve with power load, it is not likely that this consent will be given. A similar proviso prevents the company from laying mains or erecting stations or sub-stations in these three towns, but in this case there is an appeal to the Board of Trade if the consent be unreasonably withheld. Some other towns distinctively marked in the map, were already blessed with electricity works before the passing of the company's act, and in these the company may only supply "in bulk," whether for light or power. Otherwise the company can supply power in any part of the area, whether provisional orders have been subsequently granted to local authorities or not, and they may supply energy for lighting to any of these power consumers, whether the power is represented by a small ventilating fan or a 500 H.P. motor. The company may also supply "in bulk" to any of these authorities holding provisional orders. The works and collieries in which the company is supplying power are also shown on the map, and the routes of the existing high-pressure and extra high-pressure feeders are marked, together with the positions of the stations and sub-stations. Considerable extension is expected within the next few months.

For the purposes of supply, the area is divided into four parts, each with its own generating station. The power house at Treforest (near Pontypridd) is the largest, and current is generated there at 11,000 volts three-phase, with a frequency of 25 ∿ per sec. At Cwmbran the same pressure and frequency has been adopted for the longer feeders, but 2,200 volts has been deemed sufficient for the works nearer the station. At Bridgend the pressure is 3,000 volts two-phase at 60 ∿, and at Neath 2,200 volts, two phase, 50 ∿. The higher frequency in the latter two stations was adopted partly because they supply alternating current for lighting to the local authorities and partly because the Bridgend station had to be started as early as possible, and the two-phase 60 ∿ plant was available from the manufacturers' stock.

A bill is being promoted in the coming Parliamentary session which, if passed, will extend the company's area into Carmarthenshire (by taking over the powers of the Carmarthenshire Electric Power Co.), thus increasing the area of its operations by 960 square miles. For the purposes of this bill the company propose to adopt extra high-tension overhead transmission, and pressures of 30,000 volts are spoken of in this connection.

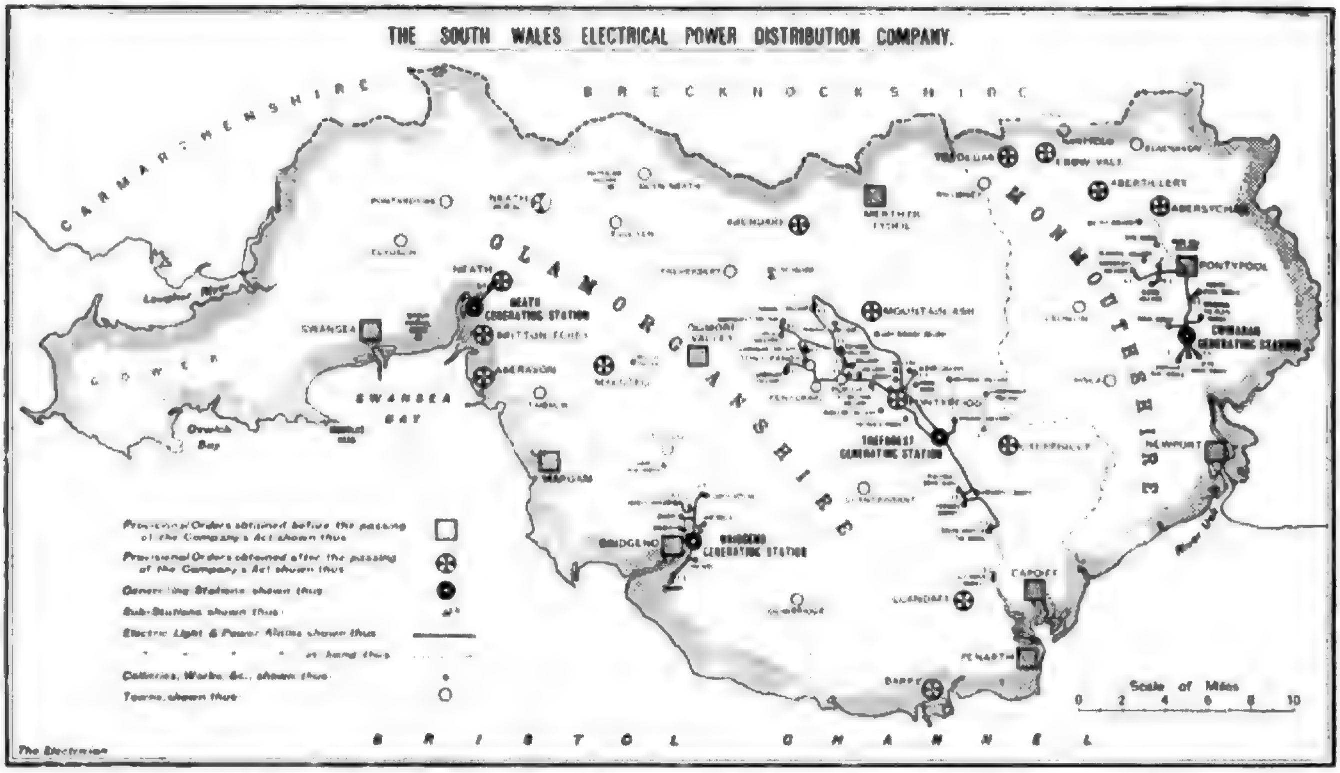
THE SOUTH WALES ELECTRICAL POWER DISTRIBUTION COMPANY.
CARMARTHENSHIRE
BRECKNOCKSHIRE
GLAMORGANSHIRE
MONMOUTHSHIRE
GOWER
SWANSEA BAY
BRISTOL CHANNEL
SWANSEA
NEATH
NEATH GENERATING STATION
BRIDGEND
BRIDGEND GENERATING STATION
TREFOREST GENERATING STATION
CWMBRAN GENERATING STATION
PONTYPOOL
NEWPORT
CARDIFF
PENARTH
MERTHYR TYDFIL
MOUNTAIN ASH
ABERTILLERY
ABERSYCHAN
Provisional Orders obtained before the passing of the Company's Act shown thus
Provisional Orders obtained after the passing of the Company's Act shown thus
Generating Stations shown thus
Sub-Stations shown thus
Electric Light & Power Mains shown thus
Collieries, Works, &c., shown thus
Towns shown thus
Scale of Miles
0 2 4 6 8 10
The Electrician

FIG. 1.—MAP OF THE SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.'S AREA, SHOWING POSITION OF GENERATING STATIONS, SUB-STATIONS AND PRINCIPAL CONSUMERS.

The power house at Treforest, near Pontypridd, is the largest, and being in the centre of the South Wales colliery district, a large load is anticipated both for driving the plant in and about coal mines and for a large number of miscellaneous works in their neighbourhood. At present the capacity of the Treforest power house is only 5,000 kilovolt-amperes, but there is room to erect generating plant up to 2½ times the capacity in the present building, and further extensions on the present site could bring up the total capacity of the works to 72,500 kilovolt-amperes. Fig. 2 is a general plan of the works, Fig. 3 a cross section, and Fig. 4 a general view. Coal is obtained from a siding off the Taff Railway which is built on an embankment, and the trucks are lowered from the embankment to a single track of rails on the ground level by means of a hydraulic lift, the compressor for which is driven by a 50 H.P. series-wound electric motor. An electrically-driven winch hauls the trucks on to the lift. Small local coal is employed, costing from 6s. to 7s. per ton. From the bottom of the lift the trucks are hauled by an electric locomotive to the coal elevator, a distance of some 500ft. The locomotive is a small one, fitted with a single 10 H.P. motor, and it takes current from a 000 S.W.G. trolley wire suspended over the track. A turntable is to be added at the conveyor end of the track, as it is sometimes necessary to turn the trucks in order to get the door at the proper side for tipping the coal into the conveyor pit. A 35 H.P. motor serves to tip the truck, to actuate a jigger plate which shifts the coal on to a chain-bucket conveyor, and to drive this conveyor, which lifts the coal to the bunkers above the boiler house. The tipping arrangement consists simply of a ram which catches the axle of the truck and is lifted by means of a chain drive from the motor. There is a self-trimming bunker with two shutes for each pair of boilers seen in the illustrations, and these are filled by the chain-bucket conveyors already referred to. Each bunker will hold 60 tons of coal. Messrs. Graham Morton & Co. were the contractors for the coal-handling plant.

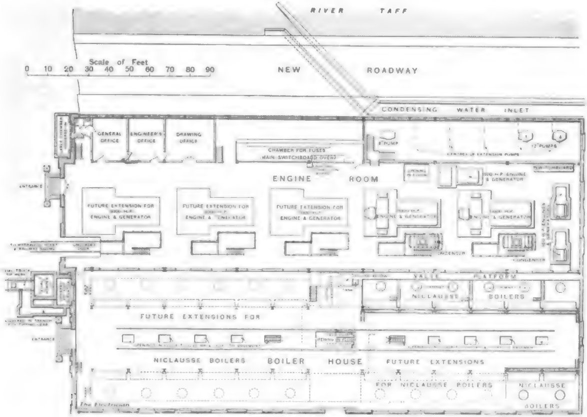
RIVER TAFF
Scale of Feet
0 10 20 30 40 50 60 70 80 90
NEW ROADWAY
CONDENSING WATER INLET
GENERAL OFFICE
ENGINEER'S OFFICE
DRAWING OFFICE
CHAMBER FOR FUSES
MAIN SWITCHBOARD OVER
ENGINE ROOM
ENTRANCE
FUTURE EXTENSION FOR ENGINE & GENERATOR
FUTURE EXTENSION FOR ENGINE & GENERATOR
FUTURE EXTENSION FOR ENGINE & GENERATOR
PUMP
PUMPS
ENGINE & GENERATOR
ENGINE & GENERATOR
CONDENSER
CONDENSER
VALVE PLATFORM
NICLAUSSE BOILERS
FUTURE EXTENSIONS FOR
ENTRANCE
NICLAUSSE BOILERS
BOILER HOUSE
FUTURE EXTENSIONS
FOR NICLAUSSE BOILERS
NICLAUSSE BOILERS
The Electrician

Fig. 2.—Plan showing General Arrangement of Plant at the Treforest (Pontypridd) Power House.

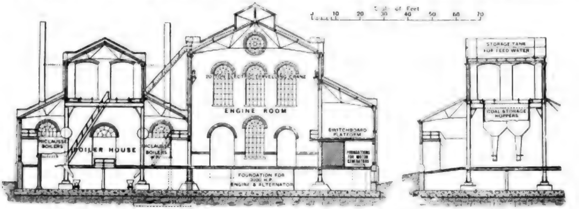
Scale of Feet
0 10 20 30 40 50 60 70
ENGINE ROOM
NICLAUSSE BOILERS
BOILER HOUSE
NICLAUSSE BOILERS
SWITCHBOARD PLATFORM
FOUNDATION FOR 3000 H.P. ENGINE & ALTERNATOR
STORAGE TANK FOR FEED WATER
COAL STORAGE HOPPERS

Fig. 3.—Cross Section of the Treforest Power House.

Twenty-four boilers will be installed in the present boiler house, which, as seen in the plan, is about 250ft. long. At present, however, only eight boilers are installed. These are of considerable interest, as they are, we believe, the first large set of Niclausse water-tube boilers which have been erected by

Messrs. Willans & Robinson in an electricity works. Six additional boilers of the same make and size are in course of manufacture. The rated evaporation of each boiler is 14,500lb. per hour, and they are constructed for a working steam pressure of 200lb. per square inch.

Fig. 4.—General View of the Treforest Power House as seen from the Taff Railway.

A feature of the Niclausse boiler is that access is not required to the back or sides, either for cleaning or for the removal of tubes. This conduces to a convenient and compact arrangement with a minimum of floor space. The tubes can be withdrawn and put in place again, and every part of the boiler can be examined and overhauled from the front alone. Each boiler is provided with an independent steel chimney 45ft. high, mounted on the top of the boiler setting. The course for the waste gases is, therefore, very direct, and a good draught is obtained with a very moderate height of chimney.

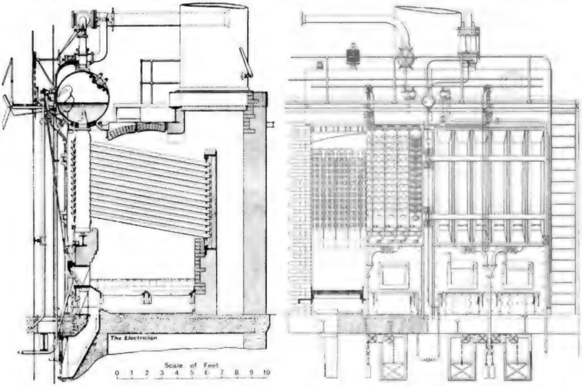

Fig. 5.—Part Elevation and Sections of Niclausse Boiler.

The headers, or steam and water "collectors," which carry the tubes, are formed out of very large solid-drawn tubes; the tubes are also solid drawn. The drums, which are of large capacity, and have a good steam disengaging area, are of ⅝in. steel plates, and a high standard of design and workmanship is preserved in the case of all the mountings and accessories.

Below the stoking level, or boiler-house floor, is a basement, and the furnaces are so arranged as to allow the ashes to be raked direct into shoots just inside the ash-pit doors, which discharge into trolleys running on the floor below. Water ash-pans are used. The boilers are at present arranged for hand-firing, but ample space has been left above the firebars to admit of any system of mechanical stoking being adopted at a later time, if desired. Meantime, the benefit of ample combustion space below the tubes is apparent.

The mechanical construction of the Niclausse boiler as now worked out by Messrs. Willans & Robinson is shown in Figs. 5 and 6. It will be seen that there is practically the beginning of a downtake flue at the back of the boiler. This has been arranged partly to give convenient access to the back wall of the boiler, and partly to enable all the boilers to discharge their waste gases into an underground flue for transmission to a high brick chimney of ordinary construction, should it ever be desired to give up the present system of independent chimneys. The Niclausse boiler is a boiler in which the heating surface consists entirely of what may be called nearly horizontal "Field" tubes—that is to say, tubes closed at the back end (by caps which can be easily unscrewed when the tube is taken out), and which receive their supply of water at the back end from an internal circulating tube, as in the well-known Field tube of vertical boilers. There is, however, this essential difference—namely, that the Field tube as usually fitted hangs vertically above the fire, and therefore exposes its closed end to the fiercest heat. As the lower end of the tube is particularly liable to accumulation of scale, the original Field tube often gave trouble through burning away. In the Niclausse boiler the Field tube (if we may so call it) slopes slightly downwards and projects through holes in a screen at the back of the boiler, which serves the double purpose of supporting the back end of the tube and of screening the extreme end from the hot gases.

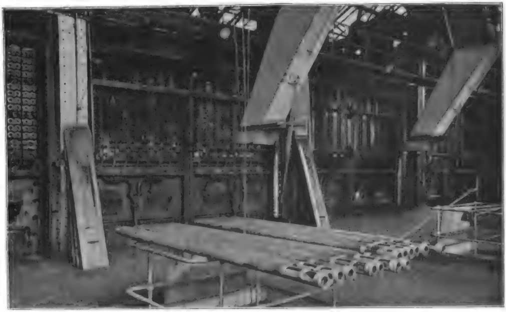

Fig. 6.—View of Boilers during Erection.

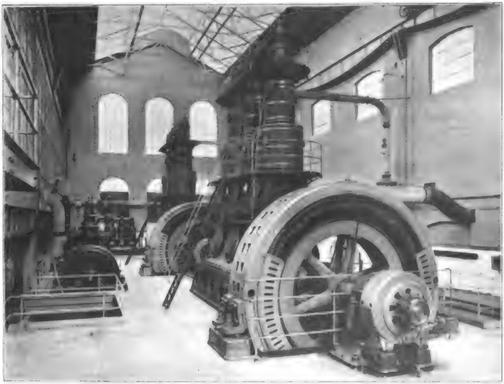

Fig. 7.—General View of Engine Room at the Treforest (Pontypridd) Power House.

This application of nearly horizontal water tubes with inner circulating pipes is not novel, but it is applied in the Niclausse boiler in a very distinctive manner. The tube is not merely expanded into a hole in the back surface of the header; the tube projects right through the header and comes out in front. It is formed with two cones upon it, one corresponding with the back of the header and the other with the front, and these fit into coned holes in the header.

The header is divided vertically into a back and front section by a diaphragm, and the tubes pass through the diaphragm through fairly-fitting holes, as well as through the back and front of the header. The back section of the header provides for the ascent of steam and water discharged from the tubes; the front section provides for the descent of water from the drum above to supply the inner tubes, and through them the main and generating tubes. Large openings are cut in the large tubes in those portions which lie respectively inside the ascending and descending channels, in such a way as to offer the minimum obstruction to the ascending and descending currents of steam and water. The inner tubes terminate in a bell-mouth in the plane of the centre diaphragm of the header, so that the water which descends the front section of the header and passes into the outer tubes by the openings referred to, is free to enter the inner tubes, and through them to supply the outer tubes with water at their back end. (The bell mouth of the inner tube fills up the section of the outer tube so as to prevent any communication by way of the outer tube between the ascending and descending channels.) The water and steam drum, which is at right angles to the tubes and is thus across the front of the boiler instead of running from front to back as, for instance, in the Babcock type, is 16ft. long by 3ft. 6in. diameter. The tubes are 9ft. long. There is no doubt that the circulation in these boilers must be very vigorous. Messrs. Willans and Robinson's design provides headers of larger section than has hitherto been usual, with the object of still further improving the circulation. Full trials of the boilers will be made before long in order to test their evaporative efficiency.

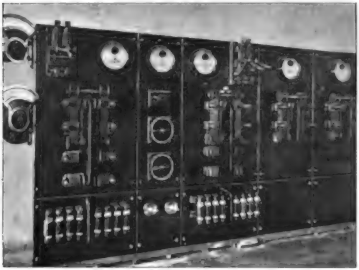
Fig. 8.—Ferranti Continuous-Current Switchboard at the Treforest Station.

All the boiler house auxiliaries are electrically driven, and the feed water arrangements differ from the usual practice, in enabling the feed water supply from the pumps to be turned on and regulated at a check valve in front of each boiler without its being necessary for the stoker to leave the boiler and go to the pumps. Two Hayward-Tyler three-throw pumps are provided, each driven by a 45 B.H.P. motor and capable of delivering 10,000 gallons of water per hour. The water from these pumps is delivered into an accumulator, and when the pressure in this falls, the circuit of a solenoid is closed which moves the starting and regulating switch of the pump motors. Thus, the pumps are kept running at the desired speed, and all the regulation of the feed is accomplished at the boiler check valve. This arrangement is particularly suitable in the case of Niclausse boilers, which have small water space. As a stand-by, each boiler is fitted with an injector. Water for the make-up feed is taken from a tank on the roof which will hold 25,000 gallons, this being supplied from the River Taff, on the banks of which the works are situated. This water is merely filtered through a sand filter, and is naturally soft. Oil is removed from the water from the condensers by Rankine filters. No feed-water heater or economiser has been provided, but the water in the hot-well can be heated up with live steam if this considered necessary. Steam from the boilers passes into a single 9in. main, from which there are 7in. branches to each engine. A steam gauge and water level indicator are fixed on the wall of the engine room against the boiler house.

At present the main electrical supply at the Treforest station is from two Willans-Ganz three-phase alternators, rated at 2,500 kilovolt-amperes each. The engines are, we believe, the largest that Messrs. Willans & Robinson have built, being similar in size to the last ones erected by the firm at Glasgow and at the Grove-road works of the Central Electric Supply Co. (London). They resemble the large engine exhibited by this firm at the Paris Exhibition, but the stroke is longer, the dimensions being: Cylinder diameters, 18·9in., 30·3in. and 48in.; stroke, 31¼in.; speed, 150 revs. per min.; height over all, 31ft. 3in. The alternators generate at 11,200 to 12,000 volts on each phase and 25 ~ per sec. They are star wound, but the centre of the star is not earthed. The alternator frames however, are earthed. The exciters are on the alternator shafts, their armatures being overhung beyond the outside bearing. They generate 420 amperes at 80 volts for full load. The slip rings are placed outside the exciter commutator, so that their brushes are easily accessible, and they are connected to the field windings by wires led through the inside of the alternator shaft. Regulation is thus effected on the exciter fields only. The fields of the alternators are wound with copper strip, on edge. Hand barring gear is provided, there being a free-wheel arrangement to prevent a jerk when the engine itself starts.

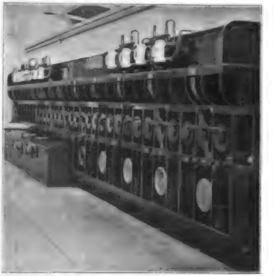
Fig. 9.—Main Ferranti Switchboard on Gallery at the Treforest Power House.

Fig. 7 is a general view of the engine room.

The surface condenser in connection with each engine has been supplied by Messrs. Willans & Robinson. The air pump in each case is a three-throw Edwards pump driven by a 20 H.P. motor and placed below the engine-room floor, and the [illegible] the charging panels are placed in a room adjoining the engine room.

In addition to the two sets already mentioned, two [illegible] kw. continuous-current sets are provided for driving the auxiliaries in the station and a [illegible] kw. three-phase set for taking the light load or for supplying at a lower pressure (2,200 volts) to consumers comparatively near the works. The former are driven by compound three-crank Willans engines, 14 17in. and [illegible] cylinders by [illegible] stroke, running at 350 revs. per min. The dynamos are [illegible]-pole shunt-wound machines supplying at [illegible] volts and presenting no particular features of interest. The [illegible] kw. alternators are Willans-Westinghouse 16-polar machines, running at [illegible] revs. per min.

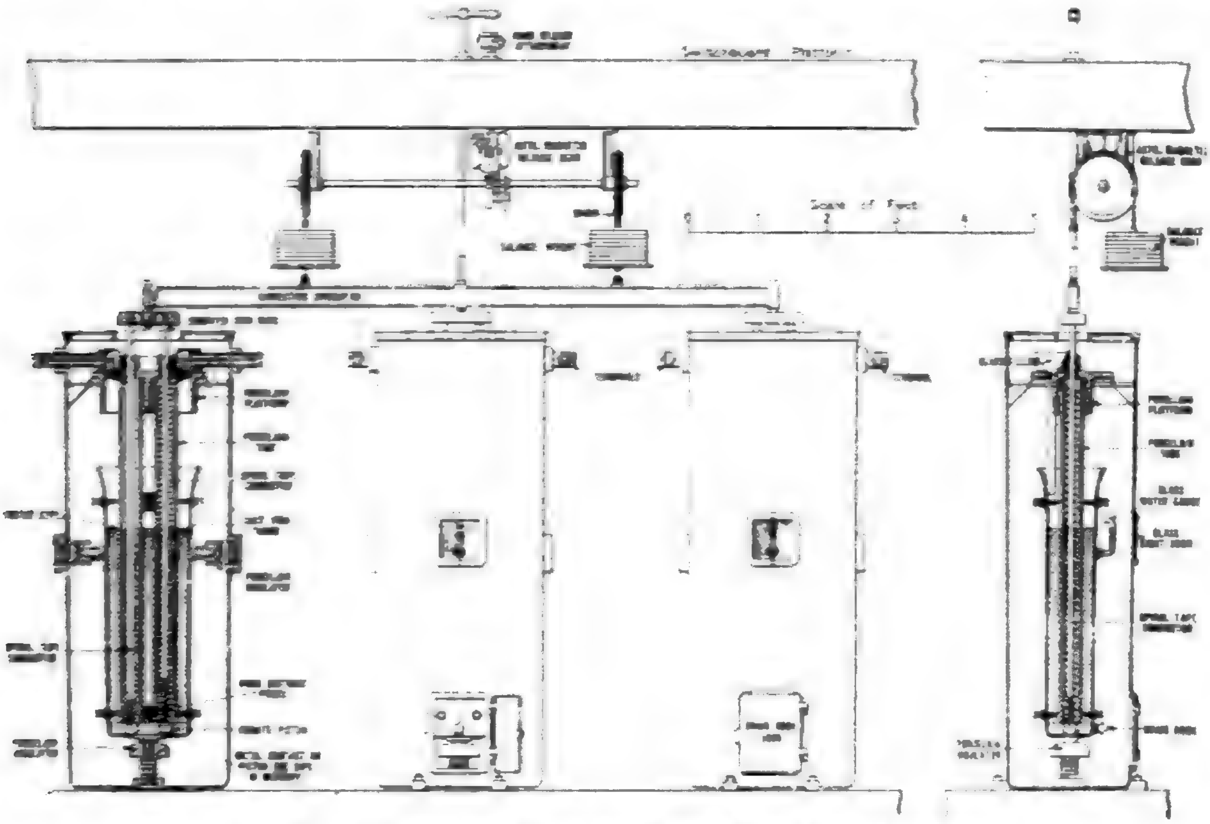
Scale of Feet
0
1
2
3
4
5

Fig. 10.—Part Elevation and Sections of Ferranti Mains Charging Device.

An interesting thing in connection with the continuous-current supply is the Ferranti low-pressure switchboard placed on the floor of the engine room. Its general appearance is shown in Fig. 8, from which it will be gathered that, contrary to the Ferranti practice hitherto, the board is not "backless." The back is neatly arranged, however, and its wiring is so tidy that we trust Messrs. Ferranti will continue to supply this type of board for small low-tension systems, upon which their backless type of board is an unnecessary luxury. An ingenious detail in connection with the main switches on the board is a cam for tightening the switch contacts after the switch is pushed in, thus securing an extremely tight contact without demanding an excessive expenditure of energy from the switchboard attendant. The fuses are a very substantial modification of the Bates pattern, if anything too substantial for their rating, but this is perhaps a good fault. The only part of the board which does not receive our commendation is the return-current cut outs, which suffer from the defects inherent in the majority of these appliances. Two independent 'bus bars are provided on this board, so that the lighting of the station may be kept distinct from the supply to the auxiliary motors.

The E.H.T. board, on which the 11,000 volt supply is dealt with, is of a more familiar Ferranti pattern, although here also there are some departures from their standard practice, necessitated by the extra high pressure. The switches themselves are on a gallery, together with the edgewise ammeters, the voltmeters, synchronisers and the usual exciter bench (see Fig. 9), but the fuses are on the ground floor, and there is a mains charger in the basement controlled by a handle on the gallery. A pattern of oil switch with several breaks in series is employed similar to that in the generating station of the Midland Electric Corporation for Power Distribution,* and the switches on the three phases are mechanically coupled. The

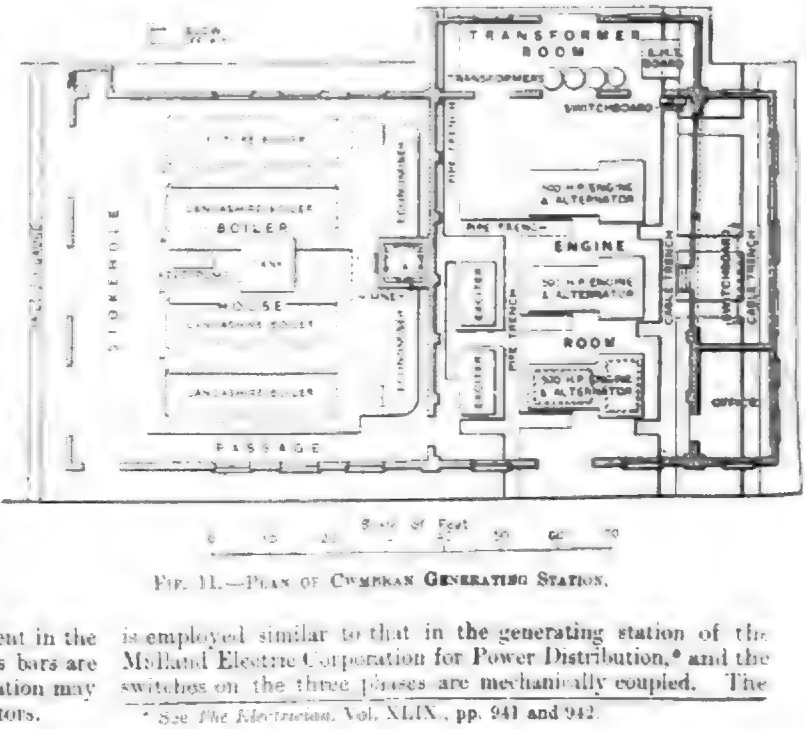
TRANSFORMER ROOM
E.H.T. BOARD
TRANSFORMERS
SWITCHBOARD
400 H.P. ENGINE & ALTERNATOR
PIPE TRENCH
ENGINE ROOM
500 H.P. ENGINE & ALTERNATOR
EXCITER
EXCITER
CABLE TRENCH
SWITCHBOARD
CABLE TRENCH
OFFICE
BOILER HOUSE
LANCASHIRE BOILER
LANCASHIRE BOILER
LANCASHIRE BOILER
PASSAGE
STOREHOUSE
Scale of Feet
0
10
20
30
40
50
60
70

Fig. 11.—Plan of Cwmbran Generating Station.

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* See *The Electrician*, Vol. XLIX., pp. 941 and 942.

feeder panels are arranged so that either of the three feeders can be switched on to the mains-charging device. This device is illustrated in Fig. 10, and it may be mentioned that a similar one has been erected at the generating station of the Stalybridge, Hyde, Mossley and Dukinfield Electricity Board in the North of England. The principle of the thing is the same as that introduced by Mr. Partridge and put into practice at the works of the London Electric Supply Corporation and the Willesden works of the Metropolitan Electric Supply Co.—namely, that the mains are first charged through a resistance instead of switching them directly on to the charged 'bus bars and running the risk of causing resonance effects and accompanying dangerous rise of pressure. The resistance in this case is a long spiral of metal tape dipping in a porcelain tube filled with water, at the bottom of which are mercury contacts. There are a pair of these spirals for each phase, and they are all connected mechanically to the same handle. When the handle is up, the current passes through the spirals and through the water resistance, and as the handle is pushed down more and more of the turns of the spirals make contact with the water and shorten the circuit until, when the mercury contacts at the bottom are reached, the whole is short-circuited and the main feeder switch may be closed and the mains-charging switch opened. On switching off the operations are carried out in the reverse order.

At present only three E.H.T. feeders leave the works, two of 0·15 sq. in. section, and one of 0.1 sq. in. section; two more of 0·15 sq. in. and 0·1 sq. in. section respectively are being laid. They have been supplied by Callender's Cable and Construction Co., and are three-core lead-covered cables, armoured with galvanised steel wires. No additional concentric copper conductor has been added under the lead, as is sometimes done to increase the conductivity of the sheath as a security against danger from faults, but the lead covering and sheathing is well earthed at frequent intervals; at the sub-stations a copper earth plate 9 sq. ft. in area is sunk in coke breeze. The radial thickness of the insulation on each core is 0·5 sq. in.—the same as on the Deptford and Metropolitan Electric Supply Co.'s 10,000 volt mains. A fine Manilla paper, thoroughly impregnated with bitumen and fine oil, specially prepared for the purpose, constitutes the dielectric, and the cores after being wormed together are passed through a wax and bitumen compound on their way to the lead press. Before leaving the factory the cores are tested at 20,000 volts, and this test is repeated after laying and jointing. Jointing is important, as, owing to the weight of the cable and the hilly nature of the district, the cable is sent out only in 110 yd. lengths. In making the straight-through joints, the copper conductors are butted together, and a copper sleeve is slipped over each pair of ends and sweated to them. The joint is then wrapped with impregnated linen tape boiled in compound, and a vulcanite spreader is put in to keep the cores apart. Mica is not employed. A lead sleeve is drawn over the joint and "wiped" on to the lead sheath each side, and to facilitate this operation a lead ring is interposed at each end between the lead of the cable and the lead sheath. The sleeve is then filled with compound through two holes, which are afterwards soldered up, and the armouring is bound over it with binding wire. The whole joint is then placed in a simple cast-iron joint box, and this again is filled with compound. The cables are laid solid in the Albion Clay Co.'s earthenware ducts, wooden bridges being employed.

Fig. 11 is a plan of the Cwmbran generating station. At present these works are equipped only with 300kw. units, but eventually they will be extended to the other side of the transformer bay seen at the top of Fig. 11, and larger units will be erected there. The 300kw. sets have already proved to be too small, as there is a 400 H.P. motor connected to the mains. Coal is supplied from the railway siding through a shute to small trucks, which are then run directly to the boiler-house floor. There are at present four Galloway boilers 30ft. by 8ft. 6in., which are hand fired with small local coal, costing 6s. 6d. per ton. Superheaters are fitted in the boilers, and 80deg. of superheat is obtained, the steam pressure being 160lb. Induced draught is used, a Sturtevant 25 H.P. motor-driven fan being fitted at the base of the short steel chimney. Current for this motor, as well as for some of the other auxiliaries and for lighting the station is taken from a continuous-current machine, which also excites the alternators and supplies the lighting circuits in the station. Feed-water is taken from an Artesian well and a brook, and there are two injectors and two feed-pumps, the latter being steam driven. Two Green's economisers are fitted in the boiler flue, and their scrapers are motor driven. A ring steam main supplies the generating sets. At present there are three alternators, all being Willans-Westinghouse 300kw. machines running at 300 revs. per min. and supplying three-phase current at 2,200 volts and 25∼ per sec. The engines run non-condensing at present, but condensing plant is about to be fitted. The 2,200 volt switchboard on a low platform in the engine room follows more or less the usual standard design of the Westinghouse Co. Two independent 'bus bars are provided so that the supply at 2,200 volts can be kept separate to the supply to the step-up transformers, which are connected to the 10,000 volt mains.

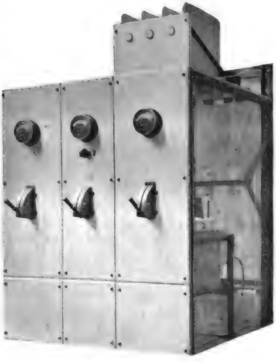


Fig. 12.—E.H.T. Switchboard at Cwmbran.

The transformers are doubly wound, one secondary coil supplying current at 440 volts for use quite near the works, and the other secondary stepping-up to 11,000 volts for the long feeders. Each of the three transformers is rated at 300kw.—150kw. each of the secondary windings. The E.H.T. windings are delta-connected, and single lead-covered cables are led from them to the E.H.T. switchboard shown in Fig. 12. This board has been supplied by Messrs. Lionel Robinson & Co. It is provided with two feeder panels and a transformer panel, the latter being connected to the transformers through a flare switch at the top of the board, and controlled by a handle below. The two feeder panels have oil switches, placed together with the other E.H.T. switch and the instrument transformers in the wire cage behind the board. These switches have four breaks in series for each phase, breaking under oil. A similar pattern of switch is employed in some of the sub-stations, and will be illustrated in a later part of this article. The instrument transformers are protected by sparklet fuses.

(To be concluded.)

ELECTRICAL WINDING PLANT AT THE LIGNY-LES-AIRE MINES.

It was necessary that this plant should be capable of hoisting 105 tons of coal per hour from a depth of 1,812ft. at a speed of 26·2ft. per second. Each cage provides accommodation for four trucks having an aggregate capacity of 4,900lb. Since one hoist occupies 60 seconds and the loading and unloading of the cage another 15 seconds, it follows that 48 hoists may be made per hour. The tower, shown in Fig. 1, was built directly over the pit mouth, the winding gear being erected at a height of 69ft. above the ground. As seen in Fig. 1, the winding gear forms, to a large extent, part of the tower itself, the weight of which is 120 tons. The base of the tower is formed by four cast-iron limbs, which rest on brickwork foundations situated at the corners of a square, one side of which is about 30ft. long. Little need be said with regard to the general arrangement of the switching and controlling gear, as this is clearly shown in the illustrations. There are two cable drums, each having a diameter of 13·1ft., and arranged in such a manner that the cables belonging to the two cages are separated by a distance of 8·6ft. Each drum has two grooves; one is for regular service, while the other one is used when a change of cable becomes necessary. The cable itself is of steel, 35mm. (1·35in.) in diameter. When hoisting coal in regular service, the two 250 H.P. motors which drive directly the upper drum run at a speed of 38 revs. per min.; but when the plant is used for conveying persons, the speed is reduced to 19 revs. per min., corresponding to a hoisting speed of about 12ft. per second; while for the purpose of examining the shaft, the motor speed may be regulated down to ¾ rev. per min. When the cage starts its journey the motors have to work at the rate of about 600 H.P., but this falls to about 300 H.P. when the proper speed is reached. Naturally, these wide fluctuations would, if no other arrangements were made, necessitate a larger generating plant than would correspond to the average power consumed, and in order to level the power demanded to a constant value of about 300 H.P. (see Fig. 2), a special set of motors and generators is provided in the central station. A diagram of connections of this power-regulating device is given in Figs. 3 and 4. With reference to Fig. 3, AM denotes a dynamo, termed the "starting" dynamo; P is the so-called "buffer" motor, while Z is a booster. These three electric machines, together with a flywheel, are keyed to a common shaft. When the winding motors, represented by FM in Fig. 3, are at rest, the starting dynamo AM, which is connected in series with the line, has a voltage equal to but opposite in sense to that of the supply. The pressure across the terminals of the hoisting motor is, therefore, at this period nil. When, however, these hoisting motors are to be started, the excitation of the dynamo AM is gradually weakened, the effect being, of course, to increase, proportionately, the pressure at the terminals of the hoisting motors. After the excitation of the dynamo AM has been completely suppressed, the hoisting motors run at half their normal speed. In order, now, to further increase the motor speed, the excitation of the dynamo AM is reversed and gradually strengthened. It is evident

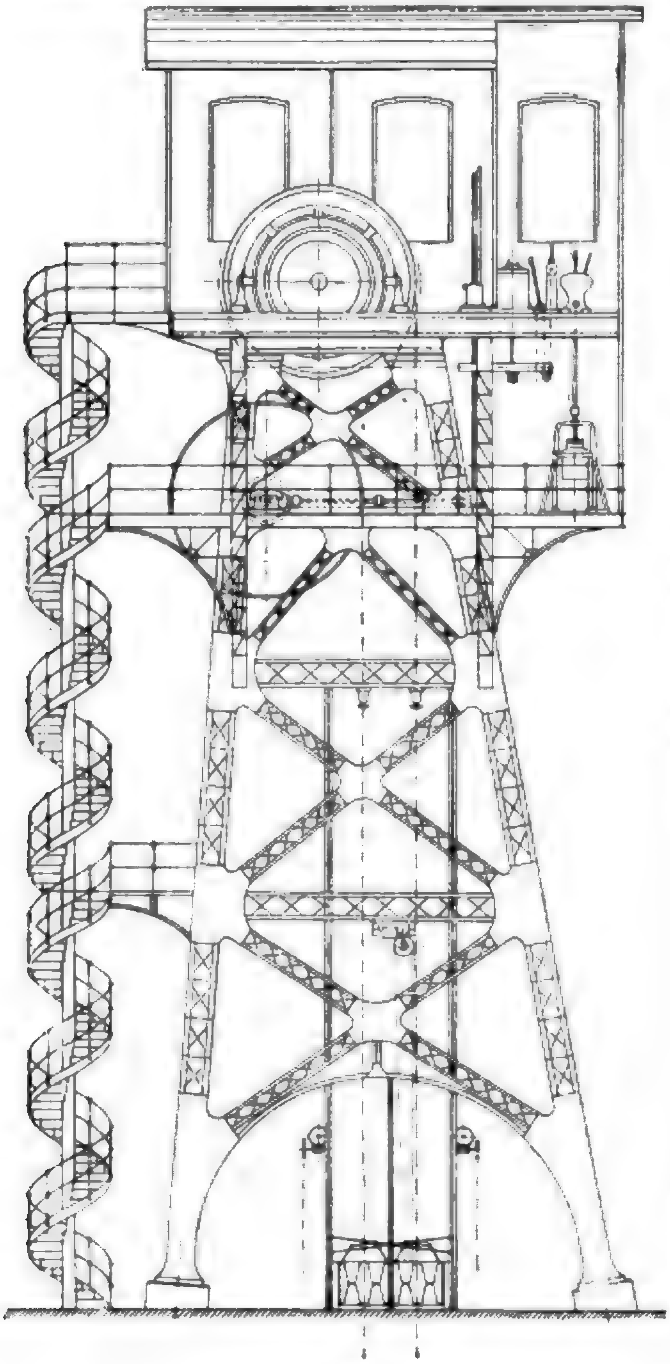


Fig. 1.

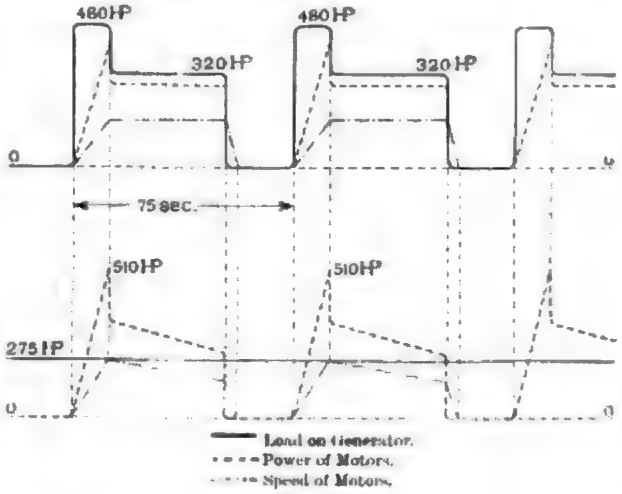


Fig. 2.

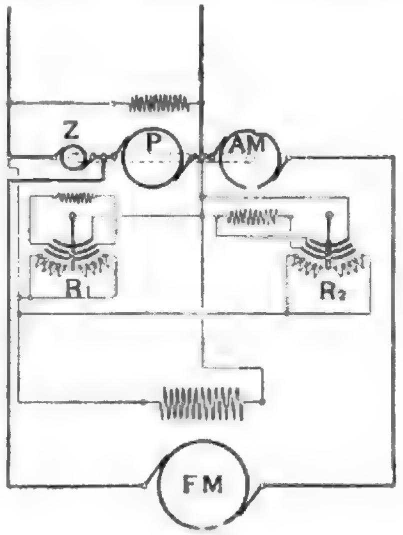


Fig. 3.

that by doing this the pressure of the dynamo is added to that of the supply, the final voltage at which the motors are fed being some 1,050 volts. The field resistance for carrying out this regulation in voltage is illustrated in Fig. 5. It will be noticed from Fig. 3 that the motor P which drives the dynamo AM is shunt-excited and connected in series with the booster Z to the power mains. By varying both the value and the direction of the voltage of this booster, the speed of the set AM, P and Z may be regulated within 30 per cent.

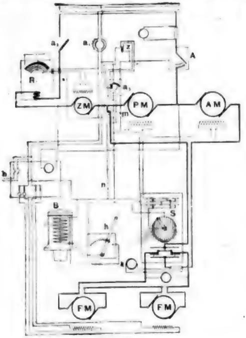


Fig. 4.

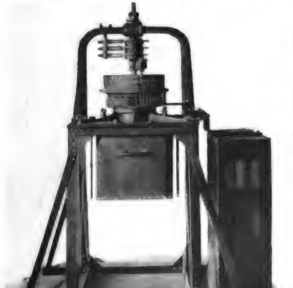


Fig. 5.

On reducing the speed of this set, the flywheel gives off some of the energy stored in it, thus reducing the demand on the central station. This variation in speed is controlled automatically by the main current by means of the regulator shown in Fig. 6. The action of this device is such that the speed of the "buffer set" (as the group of the three machines AM, P and Z is called) is decreased when the load on the central station increases, and vice versa In order to stop the buffer set, an electric brake is provided, which is automatically applied should anything go wrong with the bearings.

The braking of the cable drums is done by a double set of brakes applied to the upper drum. Normally, the shoes of this brake arrangement are held against the drum by suitable counterweights. When the brake is to be taken off, however, the counterweights are raised by the action of an electromagnet. It is also possible to operate this brake by hand. The depth indicator is worked through a number of shafts and gears from the lower cable drum. If the driver should neglect to stop the hauling machinery at the proper moment the depth indicator does this automatically by reversing the starting lever and applying the brake. In the case of failure of this device also, there is yet another appliance which will stop the cage before it can rise to a dangerous height. This appliance consists of suitably arranged switches which, when opened, cause the automatic cutouts to interrupt the main current. These switches, of course, are opened automatically when the cage reaches a given height. In front of the operator is a third lever, by means of which the main current can be cut off instantly by hand, the brakes being automatically applied at the same time. A number of automatic devices are also provided for preventing excessive strains, but they are made to operate only after the overload has lasted for a predetermined time. The breaking strain of the cable is 65 tons, and the various parts of the winding plant have been calculated on a corresponding basis.

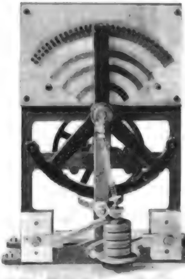


Fig. 6.

This interesting plant has been carried out for the Compagnie des Mines de Ligny-les-Aire by The Lahmeyer Electrical Co., 109-111, New Oxford-street, London, W.C., to whom we are indebted for the information given.

ELECTRICALLY-OPERATED WINDING GEARS.

The electrically-operated winding machine, of which the general arrangement is shown in Fig. 1, represents one of the standard arrangements put forward by Messrs. Witting, Eborall & Co. (Ltd.), Temple Bar House, Fleet-street, London, E.C. This machine is arranged for lifting 500 tons in eight hours from a depth of 1,800ft., making 56 trips per hour. The particular arrangement shown is for use on a polyphase system, the winding gear itself being operated by a separately excited continuous-current motor, which is driven through an intermediary motor generator, consisting of a three-phase induction motor driving a separately-excited continuous-current generator. Normally, the continuous-current generator and motor are excited from the lighting mains, but if no other supply is available, a small generator is driven either by the main induction motor or by an auxiliary motor. The field current of the continuous-current generator can be regulated by means of resistances, so that the pressure can be varied from zero up to the full voltage.

Now, since the motor which operates the winding gear works with a constant field, the speed is regulated by varying the pressure on the motor terminals; thus the whole starting and regulating of the motor is effected by varying the excitation of the generator, and none of the ordinary series resistances for starting are required. This method of starting and regulating possesses the great advantage that no power is wasted in large resistances, and, consequently, the load thrown on the motor generator is comparatively small, the working pressure of the continuous-current generator being simply that at the terminals of the motor. Further, the motor-generator set may with advantage be provided with a heavy flywheel to give steady working, and to assist the induction motor during the acceleration period of the winding gear. It is evident that with this system of working a very high overall efficiency can be obtained, as the induction motor is always running with some load on it, and is either giving out energy to the winding motor or storing it in the flywheel. In consequence the load on the main generators at the generating station is also very steady, and no large sudden load is thrown on when a winding motor is started. The system, too, is exceedingly simple as regards speed regulation, the operator, when he desires to run at a certain speed, simply putting the starting lever in the corresponding position, when the pressure of the generator falls, and the winding motor acts as a generator and rapidly drops to the required speed.

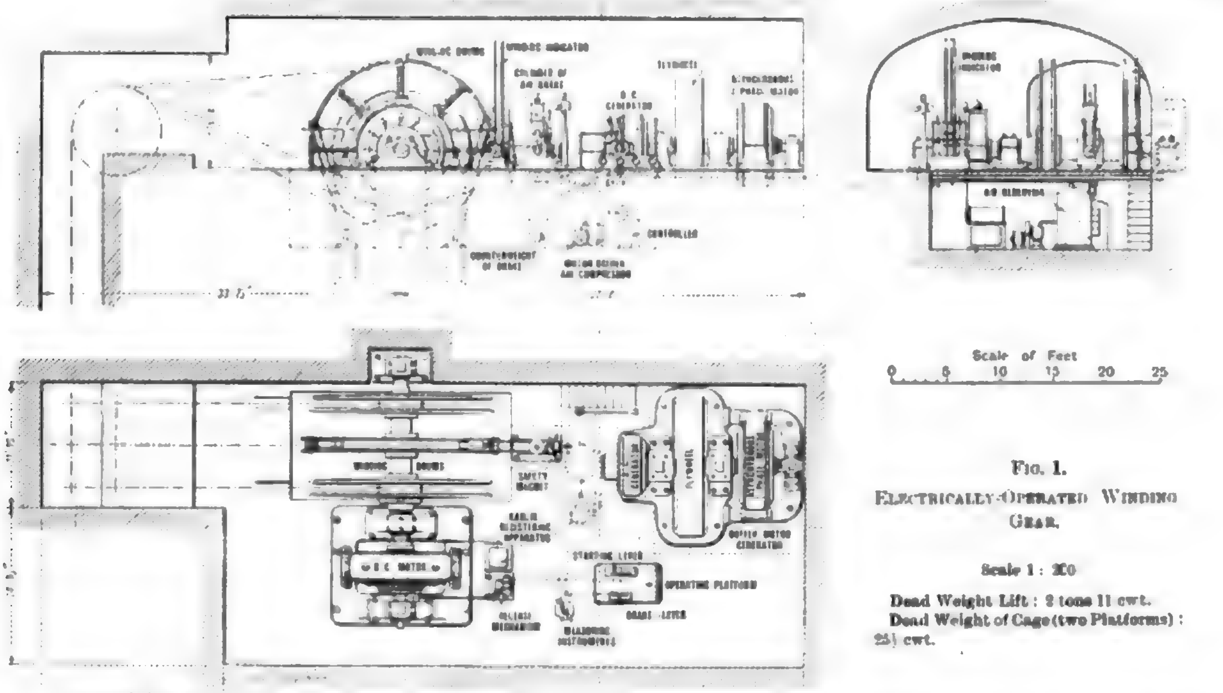


Fig. 1.
Electrically-Operated Winding Gear.

Scale 1 : 200

Dead Weight Lift: 2 tons 11 cwt.
Dead Weight of Cage (two Platforms): 25½ cwt.

The winding gear proper consists in this case of two separate drums, arranged for use with flat hempen ropes, and an entirely separate brake drum mounted between them on the shaft. If a Koepe pulley is preferred it is usually made in one with the brake drum, and not separately, as in the design illustrated. The brake itself is operated by compressed air, a small motor-driven air compressor and an air reservoir being provided in the space beneath the operating platform. This motor-driven compressor is regulated automatically; when the pressure in the reservoir falls to a certain point the motor is automatically started, and runs until the pressure rises to the normal value, when it is automatically cut out, the air pressure being thus kept constant within small limits without any attention whatever.

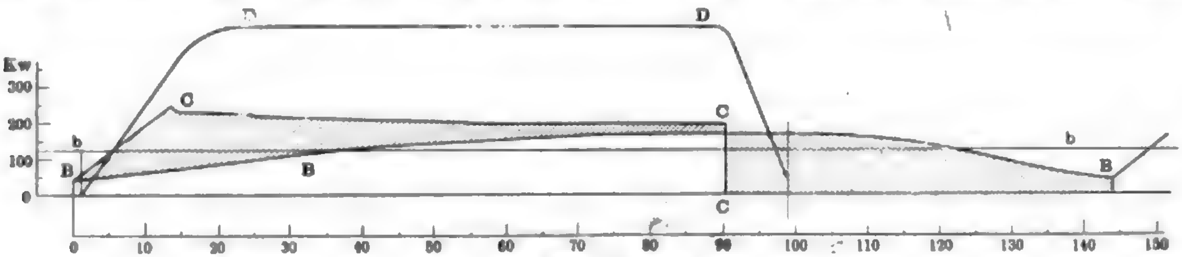


Fig. 2.

BBB, Load on the Induction Motor.
bb Average Load on the Induction Motor.
CCC, Input at Terminals of the Winding Motor,
DD, Angular Velocity of the Winding Gear.

The arrangement of the brake is of the usual counterweight type, the counterweight being lifted by admitting compressed air beneath a piston in the air cylinder, and being allowed to drop by the opening of valves in the lower portion of the cylinder. The brake system can be operated either by a lever from the operating platform, or automatically by means of an electro magnet which opens another set of valves in the cylinder. By this method of working the brake is always gradually and steadily applied, and no sudden or severe shocks are produced; such smooth and gradual working is especially necessary in the case of putting on the brake should the speed rise above the proper amount, as serious damage might be caused if the brake were suddenly and violently put on with the gear running at a high speed.

A small platform is provided for the operator immediately in front of the winding motor, and the two operating levers are carried on this platform. The first of these controls the starting, regulating and reversing of the winding motor, while the second operates the brake. In front of this small platform are placed the various indicating instruments. An ammeter, voltmeter and pressure gauge are mounted on a small column and show respectively the current taken by the winding motor, the volts on its terminals, and the pressure in the air reservoir. A winding indicator shows the exact position of the two cages, and is so arranged as to strike a gong and give warning to the operator when one cage has nearly reached the top. This device also automatically puts on the brake should the operator allow the cages to run beyond the proper position. A combined tachometer and registering apparatus shows the speed of the cage at any time, registers the number of trips made and automatically operates the brake if the speed rises above the safe limit.

The whole plant has been designed so as to give the greatest possible simplicity in working combined with maximum safety. Fig. 2 shows the calculated load curves for an exactly similar gear of larger output. These curves show clearly that the variations of load on the induction motor are very gradual, and that at no time is the load very different from the average load, thus clearly illustrating the great advantages of this system of working.

CONVEYOR AT BRIMSDOWN POWER HOUSE.

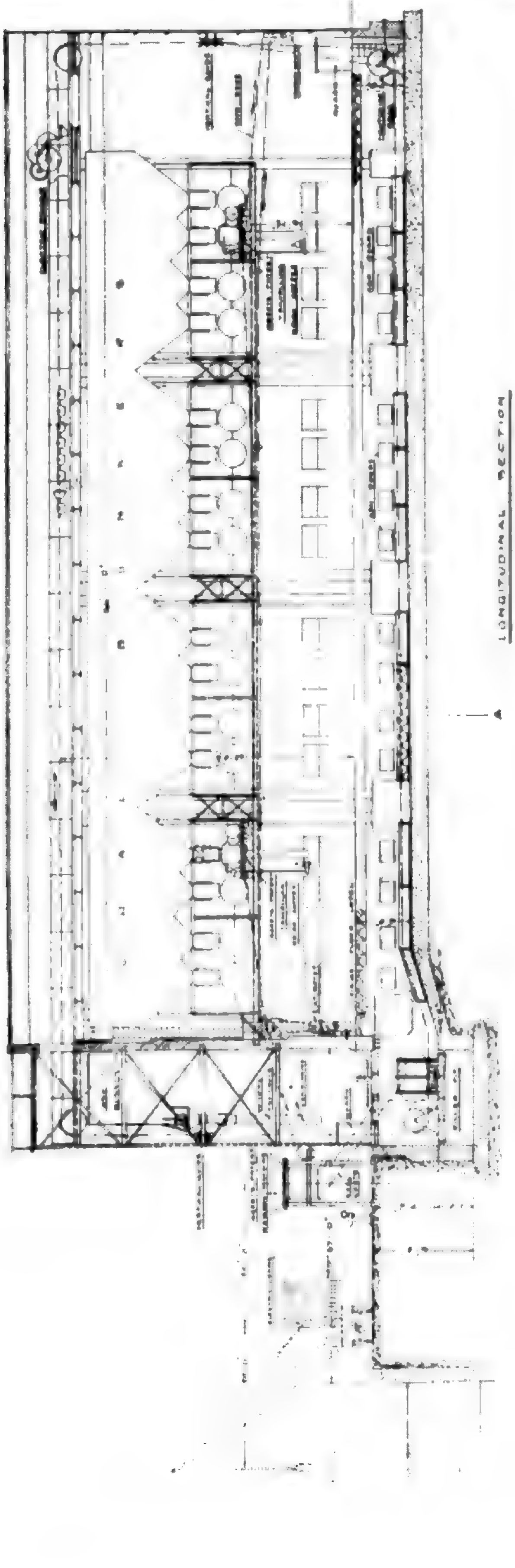
The Babcock & Wilcox "Gravity-bucket" conveyor, which has been installed at the Brimsdown generating station of the North Metropolitan Tramways Co., is illustrated herewith. The bucket and chain mechanism is absolutely balanced and entirely carried on well-lubricated bearings, so that the only energy expended is the mechanical equivalent of the material raised plus the horse-power required to drive the chain. One feature in this conveyor which contributes very largely to its success is the method of driving employed. It is well known that by the use of sprocket wheels any extension in the pitch of the chain due to wear results in a seriously-increased expenditure of power in driving. This evil is entirely obviated in the pawl driver. The pawls drop into position on the chain at the correct points, thrusting forward the two sides simultaneously, and before the pawl leaves its position on the driving stud of the chain it recedes to a considerable extent from it. Thus no friction is experienced in withdrawing the pawl from the chain, and, over and above this, the withdrawal leaves a very considerable latitude for wear in the chain, without in any way affecting its efficiency or that of the driver.

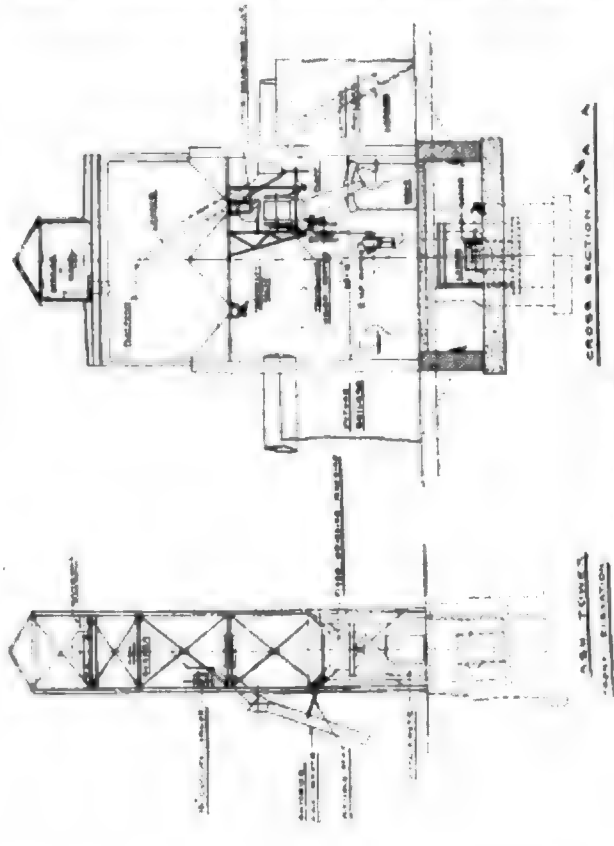
Another special feature of this conveyor is its applicability to free or revolving curves where the direction is changed either from the horizontal to the vertical in the same plane or at any angle to the first plane of motion. In descending from an upper run to any depth the maximum stress is at the point of turning to descend, and here the wheels carrying the chain and buckets cease to rotate as soon as they touch the revolving free wheels, and when movement ceases friction also ceases, and, consequently, wear on the chain, wheels and axles. The conveyor is practically automatic in its cycle of action, no handling being necessary from the point at which the material is delivered into the receiving hopper until it is "discharged" beyond moving the levers of the dumpers to fill up the bunker sections requiring to be operated on.

The buckets are of mild steel stamped out of one sheet by a special hydraulic process, and have each a pair of combined cams and trunnion bearings of malleable cast iron strongly riveted on, and formed so that a bucket can be detached in a few seconds without disturbing any other parts of the conveyor. The chain consists of two double-link chains, each link made of flat steel, and steel stud-rivets forming distance pieces for the pairs of links. The steel of which these are made has a tensile strength of about 62,000lb. per square inch section. Chain wheels are made of special close grained cast iron, accurately bored for the axles, and have recesses in the bosses for the reception of a clump of special fibre, which by capillary attraction retains enough oil to supply lubrication for considerable periods. The oil is supplied through special spring-top brass lubricators inserted in the wheel bosses, which exclude dirt.

Dumping or tipping is affected by a pair of cams carried by a cross-shaft coming into contact with another pair of cams riveted on the ends of the buckets and causing the buckets to tip up at an angle sufficient to empty completely the contents. These dumpers can be applied at any points of the horizontal runs, and the brackets are clamped to the track rails by hook bolts, enabling them to be easily shifted if necessary. The movement of a hand lever to right or left will engage or disengage the dumpers.

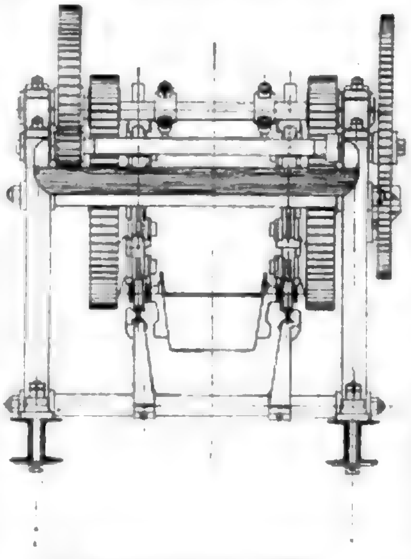
The filling mechanism consists of a series of seven hoods, with openings corresponding to the pitch of the buckets, delivering certain





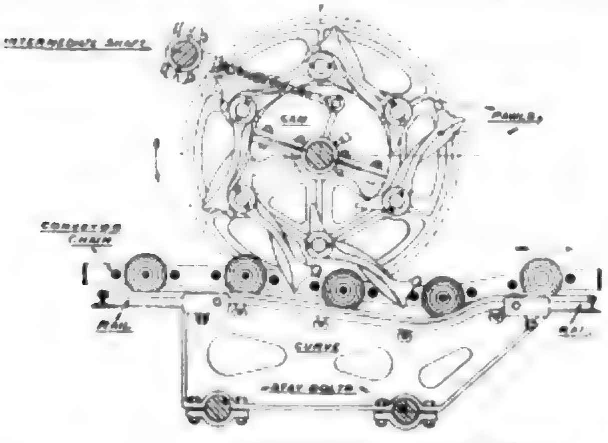
Conveyor Installed at the Brimsdown Generating Station.

quantities of material into them. These hoods are hinged and connected in the form of an endless chain and carried on wheels running on a suitable track constructed in the filler frame. The filler chain is driven direct by the conveyor chain engaging with projections or teeth of the former Two kinds of fillers are employed, "stationary" and "portable." The former is used when filling is performed at one point only, such as when coal is delivered by carts or waggons into a receiving hopper; and the second, or "portable." when coal is re-trimmed from storage bunkers to the boiler bunkers, and also when ashes are filled from spaces where considerable quantities can be stored. This portable filler travels on independent rails, and can be traversed to any position on these rails to receive coal or ashes, and is clamped down before commencing to operate. Both kinds are operated by the conveyor chain engaging with sprockets, or projections, on the filler chain, which carries a series of hoods around a track, these hoods successively covering the buckets and filling without spilling.



END VIEW WITH MOTOR REMOVED

The guide wheels take the place of the rail track at the curves, or points where the direction of the conveyor is changed, and revolve on an axle running in ample bearings, automatically lubricated, and, as previously described, save movement of the chain wheels at the points of maximum stress; in fact, forming a revolving instead of a fixed track. The application of this principle has very materially reduced wear and tear, as well as expenditure of driving power. The conveyors are made in three sizes, and are capable of handling respectively 20, 40 and 80 tons of coal per hour, but can be diminished or increased by 25 per cent. to suit circumstances.



ARRANGEMENT OF DRIVER PAWLS

DISTRIBUTION OF ELECTRICAL ENERGY.*

BY JOHN F. C. SNELL.

The Paper deals first with the attitude of the Legislature towards the electrical industry, and recites some of the points of the 1882 Electric Lighting Act, which retarded the progress of electrical development. It then deals with the improved clauses under the 1888 Electric Lighting Act. Reference is made to the removal of restrictions upon undertakers which would be effected by the Electricity Supply Bill, promoted by the Board of Trade in the last Session of Parliament, and a hope is expressed that this will soon become law. Mention is also made of the falling-in of the leases of borough tramways, and the effect of electrical traction upon the output and load-factor of the generating stations. The author then describes the various systems by which electricity is at present distributed, including direct-current two and three-wire distribution; direct-current high-tension generation, and low-tension distribution; single phase, two and three-phase currents, high-tension generation, and low-tension distribution; three-phase, high-tension, and low-tension direct-current distribution.

After dealing with the limits of pressure as defined by the Board of Trade, and the results of the work of the Engineering Standards Committee in settling upon standard periodicities, the systems of supply are more thoroughly criticised, and the single-phase system is set aside as being inapplicable for general supply, as is also the direct-current high tension system. The author is of opinion that the distributing systems which are likely to be adopted in the future are:—

1 Direct-current, two or three-wire, for small districts.
2. Single-phase high-tension for railways.
3. Two-phase high-tension generation and low-tension distribution (for existing single-phase systems of general supply).
4. Three-phase high-tension generation and direct-current low-tension distribution (for existing direct-current systems in large districts, and for railways of short length).
5. Three-phase high-tension generation and low-tension three-phase or six-phase distribution (for entirely new and large districts).

Diagrams accompanying the Paper demonstrate the economical radii of supply by direct current at 500 volts for different loads transmitted and by the high-tension sub-station method, the result being that above the undermentioned distances the high tension method is more economical, viz. :—

Kilowatts.	Economical radius.
250	1·6 mile.
500	1·25 „
1,000	1·06 „

With regard to the effect of storage at sub-stations, the author believes that storage will be more largely resorted to in the future, and figures are given in support of this view. He then proceeds to discuss the economical limit of pressure for high-tension supply by underground cables, and gives curves to show that for general purposes, in Great Britain, 6,600 volts is, approximately, the economical pressure. The effect of the cost of insulation of extra-high-tension cables is also discussed. The Paper next deals with the cost of overhead transmission of high-tension currents, and reasons for fixing upon a pressure of 20,000 volts in this country are given. As to the cost of supply, the ideal figure given by Col. Crompton in 1894 is stated to have been surpassed. A new ideal figure is given by the author, based upon further experience gained in the past 10 years, and he predicts the costs which are likely to be charged to various classes of consumer.

Turning to transmission lines, a description is given of the practice adopted in extra high-tension underground cables, and the risks which have to be guarded against. The mechanical and electrical construction of overhead lines for extra high pressures is also dealt with. The Paper then enumerates various classes of sub-station, covering static transformers for three-phase low-tension distribution; static transformers with rotary converters for direct-current distribution; and synchronous or induction motor-generators for direct-current distribution at the higher periodicity. Descriptions follow of the various sub-stations erected by the author, with curves of their outputs, and particulars of their efficiencies. The various methods of distributing energy at low pressure are classed as follows :—

I.—*Conduit or Draw-in System.*

1 Bare-copper-strip systems, strained and unstrained.
2. Cables insulated by indiarubber, vulcanised bitumen, or other dielectrics drawn into stoneware casings, Callender-Webber bitumen casings, fibrous conduits, cement casings and cast-iron or wrought-iron pipes.

II.—*Buried or Solid System.*

1. Vulcanised bitumen, dialite or other insulated single cables, laid in iron, stoneware or wooden troughing, and surrounded by molten bitumen or pitch.
2. Concentric cables, paper insulated and lead covered, laid in the same manner.
3. Single-phase or concentric cables, each protected by its own sheathing of steel tapes or wires, laid direct in the ground.

The relative merits of these systems are fully discussed, and a curve is given showing the respective capital costs of the systems. The author then deals with the systems of distribution adopted in tramway construction, and their relative advantages and disadvantages. The question of fusing the general network and the fixing of section boxes is gone into fully; the author deciding against fuses, except in concentric networks, and strongly advocating the use of section boxes for sub-dividing the network. The Paper concludes with some particulars of the supply of electrical energy to short and long-distance railways. The author believes that a modification of the present third-rail system will remain with short-distance railways, and that improved methods in the application and control of single-phase currents will be adopted for long-distance railways.

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* Abstract of a Paper read before the Institution of Civil Engineers on Nov. 22.

MR. ROBERT ROBERTSON'S PRESIDENTIAL ADDRESS TO THE GLASGOW LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.*

I am pleased to be able to state that last year showed a continued improvement in our membership, and although the increase in numbers is not very great each year, I trust it will be maintained. We cannot look for a very rapid increase in numbers, as the field we have to draw from is limited, but we can, I think, do much to increase the usefulness of the branch in other directions. To a large extent this improvement must take place in the increase in the number and variety of the subjects brought forward for discussion. This is a part of the work of the branch, the success of which does not rest with the chairman or the committee, or even with the honorary secretary, however much they, individually and collectively, may exert themselves. It rests almost entirely with the members themselves, and on that account I wish to make an appeal to the members of all classes.

Every member should feel that an obligation rests upon him individually to take some part, however small, in the work of each session. I do not suggest that every member should take part in the discussion of every Paper, but it is not unreasonable to expect that every member should during the course of each session be able to communicate something valuable to the discussion on at least one of the Papers read. As regards the question of Papers, there is, I think, a strong feeling of reluctance to prepare Papers—particularly among the younger members—unless they are in a position to give long and elaborate ones on some important subject bearing upon theory or practice, or descriptive of some work carried out by the member. I venture to assert that this is a mistake, particularly in connection with a local branch such as ours, and I would urge members to bring forward short Papers bearing on details or difficulties, or descriptive of methods of getting over such difficulties. It is quite unnecessary to confine each of our meetings to the consideration of one Paper, and it would be an interesting variety to devote an occasional meeting for the reading and discussion of short Papers or memoranda; and, personally, I shall welcome with pleasure such an evening during the present session, if some of the members will co-operate to the extent of sending the honorary secretary subjects for short Papers they are prepared to bring forward.

On the occasion of the opening of last session of this branch we listened with pleasure and interest and no small amount of instruction to the thoughtful address delivered by my predecessor in office, Mr. Chamen, an address which in a negative way has given me a suggestion of a subject for my remarks to you this evening. In the general survey of the electrical industry, which was the subject of that address, very little, if anything, was said of the use of electricity in collieries, and I hope it will not be altogether unprofitable for us to spend a little time in a survey of what has been done in this respect generally, and more particularly in the county of Lanarkshire, where the coal industry is an important one. As you are aware, a committee appointed by the Home Office has been investigating this question for the last two years, and only recently issued their report, and this has brought the subject very much in evidence. While this inquiry will, no doubt, be the means of calling attention to the importance of electricity in connection with this industry, it is of the utmost importance that no code of rules or legislative enactment should be passed which in any way trammels or hinders the legitimate development and extension of its use. The Mining Association should have the strongest support of this Institution in so far as their efforts are directed to this end. It has often been alleged, and not, I think, without reason, that legislation has already been the means of retarding the development of electricity in this country, and it would be unfortunate if anything new should be done with the same result. There is no doubt, however, that legislation on the subject—carefully drafted with the view of leaving all freedom compatible with reasonable safety—will do much to help the advancement of the industry by clearing away much doubt and prejudice against the new power in the minds of many men connected with the industry who are ignorant of the merits of the power, but have unfounded fears owing to a large extent to their anticipation of danger, where no real danger exists.

In these days, when the uses of electricity for power purposes are so well known, it is almost unnecessary to repeat the advantages of it, but there are some special features connected with mining work which make these advantages have greater weight than in other industries. The purposes for which power is required in a coal mine are probably more varied than in any other industry, and the points at which power is required are also very widely separated. On the surface the most important purposes for which power is required are the winding machinery for bringing the coal to the surface, and the fans for ventilating the workings below; but in addition to these there are waggon tips, coal screens, washing and elevating machinery, conveying plant, workshops, and also the moving of the loaded waggons under the screens, besides many other minor purposes. Underground, the uses are almost equally varied, including haulage, pumping, drilling, coal cutting, and last of all a use which has not yet been much adopted—viz., conveying machinery at the working face. These uses are not only varied, but from time to time the locations where the power is required has to be changed as the field gets worked out, and this, in itself, forms a strong argument in favour of electricity.

Owing to its efficiency, both of production and transmission, its reliability and probably most of all to its flexibility and the facility with which the plant can be changed from place to place, electricity is, without doubt, the most suitable form of power for the purpose. The only serious rival it has in this field is compressed air, and while it must be admitted that under special circumstances there may be cases where this power has advantages, and there are still many authorities who advocate its use, there is no doubt that the great balance of experience is in favour of electrical power.

After dealing with the general question of the application of electricity in collieries, the next important point to be considered is that of which of the two classes of current, direct or alternating, is the most suitable. There is no doubt that in this country up to the present time direct current has been much more used than alternating current, but I do not think that this is any guide to the relative merits of the two. My conviction is that just as electricity has in most cases a superiority over compressed air, so alternating current has in many cases a decided superiority over direct current, and that future development will confirm this opinion. I have no doubt that the advantages of this system will be increased when the single-phase series motor is sufficiently perfected to be applied to this class of work. This class of current largely predominates in the case of mines on the Continent, where we shall see that as regards magnitude and completeness of installations more has been done than in this country.

In Belgium, Germany and Austria there are many collieries which are entirely operated by means of electricity, and in some cases I have seen single motors at work there, larger than the whole installations in most of the collieries in this district. One is impressed by the elaborate and almost extravagant manner in which the electric plant and buildings are fitted up on the Continent. It appears to me that this is carried too far in many cases, and is not a feature to be copied entirely. There is no doubt, however, that it is important that within reasonable limits electric plant should be housed in such a way that it can be kept as clean as possible, a matter which is not altogether without difficulty at a colliery.

The next point of importance in connection with Continental practice is the introduction, a few years ago, of the high-speed mining pump due, I think, originally to Prof. Riedler. These pumps are run at speeds varying from 120 to 800 revs. per min. There are a great many examples of these, which have been in use for some time. In one case a pump running at 116 revs. per min. delivers over 400 gallons per minute against a head of 2,500ft., and in another example over 700 gallons a minute are pumped against a head of 500ft., the speed being 180 revs. per min. As regards hauling, the Continental colliery plants have no special features, and, so far as I have been able to ascertain, there are few examples of coal cutters in use. This, I fancy, must be due to the fact that the seams are of such a nature that these are not required.

The special feature of the application of electricity to collieries on the Continent is its use for winding coal and men in the main shafts. There are a considerable number of examples of these throughout Belgium and Germany, some of moderate size and others of large size. Of the smaller ones we may take two examples—viz.: (1) 2 tons, 1,400ft., 10ft. per second, 120 H.P.; (2) 2 tons, 420ft., 12ft. to 17ft. per second, 125 to 300 H.P. These only involve motors of moderate size, and if the generating units are large as compared with them, no serious trouble or difficulty will arise in connection with the frequent stopping, starting and accelerating of the motors. When we come to consider cases of winding where the power required is nearly equal to or in excess of the generating units, these difficulties become very serious. In Germany, there are two examples illustrating this; in one case the winding motor develops over 1,000 H.P. at its maximum and this is about double the output of each generator. Although this is only required for very short periods the effect is that the drop in pressure is very great. The difficulty has been overcome at another colliery where the Ilgner system is in use. This system depends upon the use of a heavy flywheel acting as an energy accumulator to carry the motors over the peaks of the winding load. The system consists of a motor supplied with current from the generating station and coupled on the same shaft with a generator of much larger capacity with a heavy flywheel between. This secondary generator supplies two motors directly coupled to the winding gear. When these motors are working at their maximum capacity for the short period of winding, they demand the full output of the generator, and as the primary motor coupled to it is insufficient to supply this power, the surplus required is drawn from the energy stored in the revolving flywheel. During the periods when the winding drum is at rest, the primary motor again stores up energy by accelerating the flywheel, which is again used in the next winding operation. In the example to which I have referred, the primary motor is 300 H.P., the flywheel weighs about 40 tons, the generator gives an output of 1,400 H.P. and the two winding motors are about 700 H.P. each. Regulation is done entirely through the field coils of the generator, which is separately excited. While this system appears to have been successful in operation, it is somewhat complicated, and the installation must be expensive. Careful consideration would have to be given before deciding in any particular case whether it is a system which would give economical results. In other cases storage batteries are used for making the load on the generators more uniform, and this system has also been successfully employed in connection with several collieries on the Continent.

On first consideration it would appear that as a rule the winding engines being near the boilers little advantage, if any, could be got from the employment of electricity for this purpose. The conditions under which winding engines are operated are such that it is impossible to adopt steam-saving appliances, and the quantity of steam consumed per effective horse-power is in most cases very large. The maximum power required is also very great, but this is only needed for a few seconds during the acceleration in each operation and for the remainder of the time the engine is working most inefficiently. These conditions are sufficient to warrant the careful consideration of electricity as a power for this purpose especially in the case of the equipment of new collieries.

Turning now to the consideration of what has been done in collieries in England and Wales, we find a great number of plants at work, most of which are much more extensive than those in Scotland. In making this statement, I do not wish to assert that in comparison to the relative magnitude of the industry in the two countries, England and Wales are more advanced than Scotland, and we must keep before us what that relative magnitude is before making such a comparison. The number of collieries in England and Wales together is about five times greater than the number in Scotland, and if we compare them from the point of view of the persons employed, they are over six times greater. It is just about 20 years since electricity was first used for power in connection with collieries in England. Out of a selection of some 40 or 50 collieries in England and Wales, taken at random, I find that the average horse-power of the electric installations is over 400 and cases of over 1,000 H.P. capacity are not unknown. Another interesting comparison from the same collieries is that while the direct-current system predominates, it only does so to the extent of 55 per cent. against 45 per cent. in the number of collieries, and this is very much reversed when the total horse-power is considered, the figures then being 40 and 60 per cent. respectively. These figures must not, however, be taken as giving the averages over the whole of the collieries, as they only apply to those about which I have been able to get information.

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* Delivered Nov. 8. Abstract.

We are now in a position to make a survey of our own district, and in doing so, I will confine my remarks chiefly to the county of Lanarkshire, as I have only been able to overtake the collection of definite information over this area. The importance of the coal industry in Lanarkshire may be gathered from a comparison of it with that of the rest of Scotland. If we make the comparison on the number of collieries, we find that about 45 per cent. of the collieries in Scotland are situated in this county. Taking the number of persons employed, the percentage rises to about 47½, and again, if we make the comparison of the output, Lanarkshire gets credit for about 49¼ per cent. These figures are sufficient to indicate that we are considering an industry of some importance, the number of persons employed at it in the county being over 52,000, and the output last year over 17,000,000 tons. It is not necessary to go very far back to find the earliest examples of the application of electricity to power purposes in the Lanarkshire coal field. There were earlier applications of electricity to lighting purposes, both above and below ground, and at the present time a very large number of the collieries in the county use this illuminant, but these are all comparatively small installations, and do not affect the larger question of the use of electricity for power purposes.

It is only about 12 years since this application of electricity, which we are considering, was started, but even taking this into consideration, I do not think the progress that has been made is equal to what might have been expected. I have had many opportunities of knowing what is being done in this way at many of the collieries, and I have recently supplemented this knowledge by getting information on the subject in respect of other collieries, and although the time at my disposal has not been sufficient to enable me to make my investigation quite exhaustive, the figures I now lay before you represent the facts in connection with over 80 per cent. of the collieries in Lanarkshire, and over 90 per cent. in respect of output; with one or two exceptions these include all the important collieries in the district. Of them, not more than 11 per cent. in number, or 20 per cent. on the basis of output, are using electricity for power purposes, and in the majority of these cases it is only used in a very minor degree, by having small motors installed for driving small pumps, &c., the power for which is obtained from generators originally installed for lighting only. The number of plants of 100 H.P. and over is very small, and in the majority of these the power does not exceed 200 H.P. with a few isolated exceptions where the power installed or being installed reaches 500 H.P. or 600 H.P. The use of electricity is confined mostly to pumping, underground haulage and coal cutting, and there are only a few cases where all subsidiary operations on the surface are also done by electricity, and there is only one case where electricity is applied to conveying plant at the working face.

There is not, I believe, at the present time, a single example of alternating current in use in a colliery in Lanarkshire, but a plant on this system is in process of construction. This plant will, I understand, have an example on a small scale of the Ilgner system, to which I have referred, and we may have an opportunity ere long of seeing this at work in our own neighbourhood. In other parts of Scotland there are some important installations and a few examples of alternating current.

The whole question, however interesting it may be from the point of view of the electrical engineer, must show a substantial balance in its favour in the ledger if it is to commend itself to the colliery owner. In looking at it from this point of view no generalisation can be made, and each case must be considered on its merits. Looking at a few examples of what saving has been effected will, I think, convince anyone that there is certainly sufficient justification to warrant every colliery owner giving the question consideration. In an example with which I am familiar, the substitution of a system of electric haulage in place of horse haulage underground effected a saving sufficient to repay the capital expenditure in between two and three years. In another case the saving effected by an electric pumping system over steam and rope driving cleared the cost in about three years. Numerous examples could be given, and in some cases the saving claimed is sufficient to meet the cost in two years. This is sufficient to warrant, as I have said, careful consideration of the subject, but there is a more important factor in the Lanarkshire coal field which makes the consideration of this subject a necessity, that is, the fact that the thicker and shallower seams are gradually becoming exhausted, and if the industry is to maintain its importance, measures must be adopted for working the lower and thinner seams, and in electric power, I am sure, will be found an agent, which, if properly applied, will make it commercially possible to work seams which could not otherwise be worked at a profit.

The question of the source of supply of electricity is one of some importance, and in this respect the country generally is entering upon a new era. In many districts companies have been established for the purpose of supplying electricity, mainly for industrial purposes. In one of these districts, in which this industry is of great importance—South Wales—the starting of the supply has, I believe, given a great stimulus to the application of electricity to coal mining, and a considerable number of collieries are putting in plant, which will be supplied from the Power Company's mains. A similar supply will shortly be available over a substantial part of the district we have been considering to-night, and I trust that it may become an important factor in the industrial progress of the district.

PROGRESS OF THE POWER SUPPLY COMPANIES.

Newcastle-upon-Tyne Electric Supply Co.—Complete descriptions of this scheme appeared in *The Electrician*, Vol. XLVII., pp. 319, 359 and 397, and Vol. LIII., pp. 424, 470, 513, 550 and 593. We are informed by Mr. C. H. Merz, consulting engineer to the company, that there is practically nothing of any interest to add to these articles. It is satisfactory, however, to know that energetic canvassing by various methods is being carried on, and that the progress of the undertaking is, in every respect, rapid and sound.

Midland Electric Corporation for Power Distribution.—Mr. J. Hardie McLean, manager and engineer of the Midland Electric Corporation for Power Distribution, informs us that this company is now making great progress, and is continuously connecting up power consumers, embracing a great many of the different trades and industries of the Black Country. Electric power is being supplied for the purposes of the following manufactures: Deep-mine pumping, surface-draining pumping, chain welding and making, steel-pipe making, steel-roll making, lock, bolt and nut works, foundries, tanneries, electrical accessories, builders, bootmakers, printers, millers, haulage, saw mills, glass works, boiler and tank makers, stampers and piercers, tramways supply, supply "in bulk" to local authorities, cycle manufacturers, holloware and enamellers, farmers, butchers and bridge and girder manufacturers.

South Wales Electrical Power Distribution Co.—A full description of this company's scheme is commenced in this issue of *The Electrician*, and the company is making substantial progress, especially with regard to the supply of power to collieries.

County of Durham Electric Power Supply Co.—This company has been supplying from its Gateshead and Durham works since 1900 and 1901 respectively from temporary low-pressure plant. A 10,000-volt system is being put in, however, and a large extension of the company's operations may be anticipated. The company is at present supplying and distributing in Gateshead, Durham and Jarrow, and holds several other provisional electric lighting orders within its area. The Gateshead tramways are also supplied by the company, and several other tramway lines, for which powers have been obtained, will also be supplied.

North Metropolitan Electric Power Supply Co.—A description of the Brimsdown and Willesden works of this company and of the North London Tramways, which they supply, was recently published in *The Electrician* (Vol. LIII., pp. 591, 665, 702, 742, 784, 850, 900, 940, 1,021), and a description of their latest sub-station at Hendon and the method of supplying it from Willesden by "inverted" rotary converters is given in our present issue. The company is in negotiation with the Stoke Newington Borough Council and other local authorities for the supply of the electrical energy "in bulk." In Barnet and Hertford the North Metropolitan Electric Power Distribution Co. has been supplying from temporary stations at low pressure since 1900 and 1901.

Yorkshire Electric Power Co.—Mr. W. B. Woodhouse, chie engineer of this company, has sent us the following particulars:—

The company's first power station at Thornhill is practically completed, and a supply will be given from there at the end of the year. The system of transmission is three-phase alternating-current at 10,000 volts, and the supply voltage in the majority of cases will be 400 volts. As, however, many of the manufacturing districts are somewhat straggling, an intermediate voltage of 2,000 has been adopted for distribution, a second transformation to 400 volts being made for small consumers. Large power users will be supplied either at 10,000 or 2,000 volts in their own sub-stations.

The requirements of those local authorities who are taking a "bulk" supply are various. In some cases a direct-current supply is to be given, in others single-phase distribution is to be adopted for lighting and three-phase for power supply.

The problem of distribution for lighting and power in districts such as are met with outside the large towns is an interesting one. To provide a supply of electricity throughout the whole of such a district would involve a very large expenditure on the part of the holders of the provisional order, who in nearly every case are the local authorities. As an example, the urban district of Mirfield has a population of 3·34 per acre. To lay mains throughout the whole area was obviously beyond the financial resources of the Council, who therefore have confined themselves to the lighting distribution for which a "bulk" supply is taken from the Yorkshire company, and the company are supplying large power users direct. The Corporation of Pudsey are taking a "bulk" supply from the company for all purposes. Negotiations are proceeding favourably with a number of other local authorities, and in some cases the company are offering to undertake the whole work of distribution and relieve the Council from any risk of financial loss. The area around Thornhill is being developed rapidly, and the company will proceed shortly to erect other stations as the demand arises.

The company's area is of great industrial importance, and is particularly valuable in the great diversity of trades to be found. The colliery and textile industries are of major importance, and encouraging demands for supply are being met with. Agreements have already been made with a number of manufacturers, including collieries and a large spinning mill, the latter being the first of its kind in England to take a public supply of electrical energy for all its requirements. The whole country is covered with railways, tramways and canals, and a considerable field for supply exists in this direction.

A description of the generating station appeared in *The Electrician*, Vol. LII., p. 242, and we hope to publish a more detailed description when the system is completed.

Lancashire Electric Power Co.—Mr. R. L. Gamlen, engineer and manager of the Lancashire Electric Power Co., sends us the following particulars:—

> The first generating station is now nearing completion, the boilers are erected, the buildings are finished and the switchboard and exciter sets have arrived, and we anticipate being ready to supply quite early in 1905. Owing to our Act it is necessary for us to supply either "in bulk" to the various local authorities interested, or on their behalf. We are, in consequence, entering into two forms of agreement, one in which we work the Provisional Order for the Council, and one in which we supply "in bulk" to the Council for them to distribute. In the first case the Council borrows the capital and the company pays back the interest and sinking fund. The Swinton and Pendlebury District Council have signed an agreement with us on these lines, and several other local authorities are just about to complete their negotiations. The other form of agreement is, that we supply to the local authority "in bulk" and they distribute, with a further agreement that we shall be allowed to supply direct to power users in the district of above 20kw. charging them the tariff rate and giving a percentage to the Council for the concession. The prospective demand, taking everything into consideration, seems very favourable, and as the area includes a very large number of different classes of industries, a good diversity factor should result. It is anticipated that collieries, quarries and foundries will probably be the first to come on, and it seems likely that shortly the cotton industry may find us of use.
>
> I enclose a copy of our tariff, from which it will be seen that for moderately good load factors the price of electricity is low, in fact between 15 and 50 per cent., the charge is lower than any other in England.
>
> The first line of mains will be from Radcliffe north through Tottington, Ramsbottom, Rawtenstall and Bury, and in the south through Swinton, Worsley, Tyldesley, also through Little Hulton and West Houghton.
>
> The company charges 0·45d. per unit plus the following charges per kilowatt per year:—1-100kw., £6; 101-200kw., £5; 201-300kw., £4. 10s.; 301-500kw., £3. 10s; 501-2,000kw., £3.

Cleveland & Durham County Electric Power Co.—This company is erecting its power stations, and the high-pressure scheme is in progress. Mr. Soden, chief distributing engineer to the South Wales Electric Power Distribution Co., has been appointed general manager.

Derbyshire & Nottinghamshire Electric Power Co.—This company is supplying from a temporary station at Ilkeston, but Messrs. Bramwell & Harris (the consulting engineers) have the larger scheme in hand.

Clyde Valley Electrical Power Co.—This company has two power stations in hand, and it is expected that current will be supplied from the Yoker station early next year. The equipment of both power houses includes two 2,000kw. Westinghouse-Parsons alternators. A large number of provisional orders were applied for in 1904 around the Glasgow district, but, owing to the conditions imposed by the local authorities, they were abandoned. The company owns, however, the provisional order for the town of Clydebank, and a supply will be given shortly.

Fife and Central Scottish Electric Power Schemes.—A description of the progress of these two schemes appears in an article elsewhere in this issue.

We hope to give further tabulated particulars with regard to these companies, and others which have obtained Parliamentary powers, early next year.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

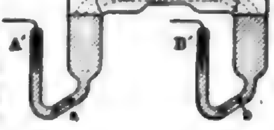
New Type of Induced Radio-activity.—K. A. Hofmann, L Gonder and V. Wölfl have discovered an induced radio-activity which they suspect to be due to a product intermediate between radium and radium emanation, or in a corresponding position with regard to the other radio-active substances. This result, if confirmed, would extend the series of radium products backwards towards the original substance. The method by which the new induced radio-activity is brought about is to obtain the radio-active body in solution, add a solution of another metal and precipitate that metal by adding another suitable solution. Thus they mixed uranium nitrate with barium nitrate, kept it for some time and then precipitated the barium in the form of sulphate. Immediately on drying, the barium sulphate displayed a strong-induced radio-activity, two or three times as strong as that of uranium sesquioxide. The new induced radio-activity, which the authors propose to call ionic radio-activity, is much more permanent than that assumed by bodies in the neighbourhood of radio-active preparations in air. But its chief distinguishing characteristic is its strongly selective character. Barium, lead and bismuth, as well as some rare earths, become strongly radio-active and retain their radio-activity for months, but iron, aluminium and titanium do not, and platinum, palladium and mercury but little. The α-rays and β-rays show a great difference in permanency. Bismuth retains the α-rays longest, and platinum the β-rays. In many quantitative chemical processes the activity undergoes no diminution, so that it cannot be attributed to the occlusion of gases.

[Hofmann, Gonder and Wölfl, *Annalen der Physik*, No. 13, 1904.]

Electric Bleaching of Flour.—M. Balland has analysed some specimens of flour before and after treatment with the new electric bleaching process recently introduced in Paris. It is described as a treatment with "electrified air." It is evident at first sight that the treatment improves the whiteness of the flour, but the product suffers in the matter of odour and taste. Analysis shows that the only constituents of the flour affected by the treatment are the fats and the acids. The acidity increases some 30 per cent. The fatty matters become slightly rancid and are less fluid and less coloured. The yellow wheat oil, which produces the aromatic flavour in malting, is oxidised and partly transformed into white fatty acids, soluble in absolute alcohol. Moist gluten loses its delicate odour to some extent, while dry gluten is less coloured. The author describes the effect concisely as an artificial ageing and whitening.

[Balland, *Comptes Rendus*, November 14, 1904.]

Cadmium Amalgam Lamp.—Some seven years ago Gumlich constructed a vacuum lamp containing cadmium amalgam instead of mercury. The lamp offered the advantage of adding the highly luminous cadmium lines to the spectrum of the mercury. But it failed owing to its short life, breaking after a few experiments, whereas a good mercury lamp may last for years. Since Messrs. Heraeus have succeeded in constructing mercury lamps of quartz it suggested itself to try this material for the construction of amalgam lamps. The attempt, in the hands of O. Lummer and E. Gehrcke, has been successful. The lamp consists of two vertical tubes A and B, joined by a horizontal one. Both tubes are bent twice at right angles below, and end in somewhat narrower tubes A′ and B′. At *a* and *b* two iridium wires are introduced. The lamp is filled through the top of B, which is then fused. Connection is made by means of iron wires dipping into A′ and B′, which are fixed in with shellac and Chatterton cement. The amalgam used by the authors contains 14 parts of cadmium to 100 of mercury. At ordinary temperatures it is a soft mass, which on slightly heating becomes as fluid as mercury, and is easily worked with. The oxidation of the cadmium is so slight as to be innocuous. The lamp may be lighted by shaking, but a better method is by using a lighting device as in the Hewitt mercury lamps. A current flowing through a parallel inductance at 110 volts pressure is suddenly interrupted. It thus generates a high potential, which suffices to bridge the gap between the amalgam electrodes. After that the lamp continues to burn steadily with one or two amperes. It is, however, necessary to heat the lamp externally with a Bunsen burner before starting or restarting it. After some use, it is necessary to keep the lamp steadily heated up in that way to make it burn continuously. But the lamp may be brought back to its original condition by renewing the exhaustion.



[Lummer and Gehrcke, *Zeitschrift für Instrumentenkunde*, October, 1904.]

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ELECTRICAL POWER DISTRIBUTION.

In engineering it is more necessary than in any other business or profession to look forward to the future, or rather to form a picture of the conditions that are likely to prevail a few years ahead, in order that the needs which will then arise may be catered for. To the electrical engineer this is certainly essential in view of the rapid progress of the electrical engineering industry. Thus it has happened that during the past two decades, while apparently the offices of electrical engineers have been filled to overcrowding with the plans, specifications and estimates for electric lighting and tramway undertakings, and while their workshops have been manufacturing machinery and apparatus for these purposes by the tens of thousands, the next product of the electrical engineering industry has gradually been evolved. All our large towns are now supplied with electric light, and the majority of them with electric tramways, but there is still a large field open for electrical engineering enterprise—viz., electrical power distribution. This branch of the industry is not a new one, for it has been evolved, as we have said, simultaneously with the applications of electricity for lighting and traction; but it is now reaching such large dimensions, and its utility is now being so widely recognised, that there is a likelihood that it will soon become the most important of all the works of the electrical engineer. Just as the employment of a special messenger, instead of the post, telegraph or telephone, is now regarded as a primitive, costly and inefficient method of transmitting intelligence from one part of the country to another, and is a method only resorted to in exceptional cases, so the use of an isolated steam engine, instead of an electric motor supplied from a station where electric power is generated wholesale, will be regarded in the future as a survival of antiquated practice, or at best a method which is only warranted under peculiar conditions.

To show that we are not going too far in this expression of opinion, we will take the case of electrical power distribution in the coal districts, which has, during the past few years, taken a quite unexpected development. It was realised years ago, in the earliest days of electric lighting, that economy might be introduced by building electricity works at the coal pit, where fuel could be purchased at its cheapest, and by conveying the current through wires or cables to the centres at which electric light was required, instead of erecting the generating stations at these centres and carting the coal to them. Electric power companies have now been established in some of the coal districts, but the remarkable development that we have alluded to is that their chief field of enterprise has been to supply current for power purposes, not for transmission over very great distances as was formerly contemplated, but for consumption at the collieries themselves. This upsets some of the ideas that have been cherished by colliery owners almost from time immemorial. Coal, it is argued, costs them practically nothing, and therefore any old engines, however uneconomical they may be, will do for furnishing power at the pit bank. But this method of reasoning is fallacious. Coal, even slack, at the pit's mouth, must cost something, when some hundred horse-power has to be supplied continuously for 24 hours a day; the superintendence of boiler and steam engine plant is a large item that is almost entirely saved in the case of motor-driven plant; and finally, much labour and material is expended in repairs and maintenance of steam engines and shafting. We can quote actual figures: At the Cambrian Collieries, for instance, only 185 H.P. of motors was put down, entirely for driving machinery on the surface. These machines include a saw bench, power hammer, existing dynamos for lighting, a mortar pan, fitting shop, two blacksmith's shops, chaff-cutting machines, and a pump. The motors are supplied with current from the mains of the South Wales Electrical Power Distribution Co., and they actually displace three 30ft. by 8ft. Lancashire boilers, and about a mile and a half of steam main. The result to the colliery is an annual saving of £1,900 a year.

If, then, electrical power distribution can show such results when compared with isolated steam engines working under conditions in which their disadvantages are deemed to be minimised by the extremely small cost of fuel, it is evident that, in cases where the cost of coal plays a more important part, the economy of electric driving is even more pronounced. The present issue of *The Electrician* is devoted almost exclusively to this subject, and our articles show the numerous and varied applications of electric driving. While, on the one hand, its advantages have been apparent for light machinery, such as cotton mills, on the other hand it has been successfully applied to such heavy work as rolling mills and to the winding engines in collieries, which would have appeared at first sight to be essentially of a character for which direct steam drive was more economical. Two installations of electrically-driven winding gear on the Continent are described in this issue; hitherto this application has been chiefly confined to the Continent, but we anticipate that it will soon gain favour in this country. For portable tools and for work in mines below the surface, to displace the inefficient and troublesome compressed air machinery, the utility of electric power has long been recognised, and figures have been adduced over and over again to show the countershafting losses that are saved by introducing electric driving in ordinary workshops. In fact, there is hardly an application of power in which electricity does not promise to be the most flexible and most economical agent, and we look forward to the time when, in industrial centres, the steam engine and gas engine will only be found in the form of large units employed for driving the main electric generators.

TWO SCOTTISH ELECTRIC POWER SCHEMES.

The Fife Electric Power Co. obtained Parliamentary Powers in 1903 for the supply of electrical energy, both in bulk and otherwise, throughout the county of Fife, the actual area covered by the act being about 500 sq. miles in extent and including about 50 local authorities. There are five power houses—viz., Cowdenbeath, Leven, Markinch, Comrie and Cupar, scheduled in this act, but the company also have powers to build generating stations elsewhere. Only one is being erected at the outset; it is in close proximity to Dunfermline, about 20 miles from Edinburgh, on the north of the Forth.

Dunfermline will quite probably become a town of considerable importance in the near future, owing to the large works and collieries with which it is surrounded. Another reason is that a new naval base is to be established near Queensferry, which is in proximity to Dunfermline, and this will doubtless stimulate the business of the town. In these circumstances it is by no means surprising that negotiations have been opened between the company and the Town Council with a view to the latter taking a supply, in bulk, from the former. A wish has, however, been expressed, in certain quarters, that Dunfermline may see fit to build its own generating station, but we hardly think that the canny Scot, with his eye to a good bargain, will commit this mistake. The advantages in cost of taking a supply from a works with a capacity of thousands of kilowatts with a good load-factor, instead of from a works with a capacity of a few hundred kilowatts and a bad load-factor, will duly be appreciated by him when explained in non-technical language.

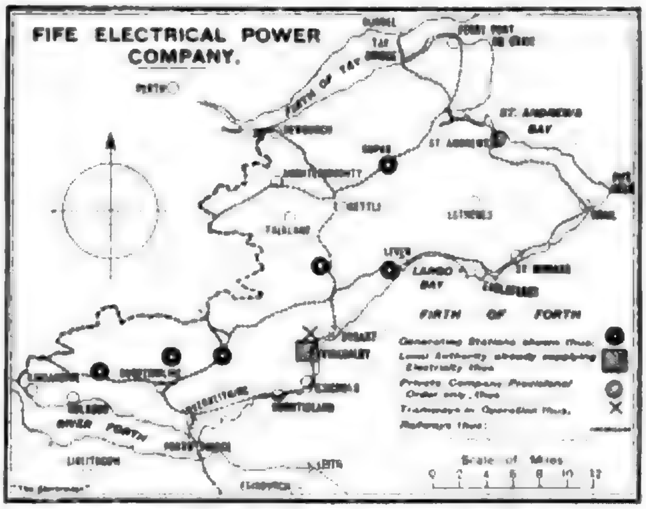

FIFE ELECTRICAL POWER COMPANY.
FIRTH OF TAY
TAY BRIDGE
ST. ANDREWS BAY
ST ANDREWS
CUPAR
LEVEN
LARGO BAY
FIRTH OF FORTH
RIVER FORTH
LEITH
Generating Stations shown thus:
Local Authority already supplying Electricity thus
Private Company Provisional Order only, thus
Tramways in Operation thus,
Railways thus:
Scale of Miles
0 2 4 6 8 10 12

Fig. 1.—Map of Fife Electrical Power Co.'s Area.

Other generating stations will be built by the company as occasion demands, and it is anticipated that in the course of a very few years some half-dozen or more large stations will be running. Each of these works has been designed with a view of accommodating 60,000 H.P., but in order to meet local demands a smaller pilot station is being erected, and it is our present purpose to describe this station in some detail.

Fig. 1 is a map of the Fife Company's area, and Fig. 2 is a block plan of the site of the Dunfermline station. It will be observed from the latter that it is not intended to add to the pilot station when extensions are required, but to erect an entirely separate and very much larger structure. About 25ft. above the ground level is a siding of the North British Railway Co., and from waggons standing in this siding coal will be obtained for the smaller station. A rather novel bunker arrangement has been devised in connection with this siding, as shown in Fig. 3. Concrete shoots have been built on the side of the embankment, at the bottom of which are the bunkers. The tops of the shoots are closed by heavy wooden gates hinged at the bottom. When these gates are opened, they are supported by struts so as to form sloping shelves upon which coal can be thrust direct from the waggons. Coal then passes down the shoots by gravity and comes to rest in the bunkers below. On the ground level a narrow gauge railway track has been laid, and this passes under the bunker outlets, which are controlled by iron sliding doors. When coal is required it, is only necessary to open a bunker outlet and permit coal to fall into a small truck, which is then taken to the firing floor and emptied of its contents. The method of getting the trucks to the bunkers from the power station, and vice versa, may be seen by reference to Fig. 2. Hence all necessity for automatic conveying devices has been obviated. A different arrangement will, of course, be adopted in the case of the large station, when a standard-gauge siding will be taken to the building itself.

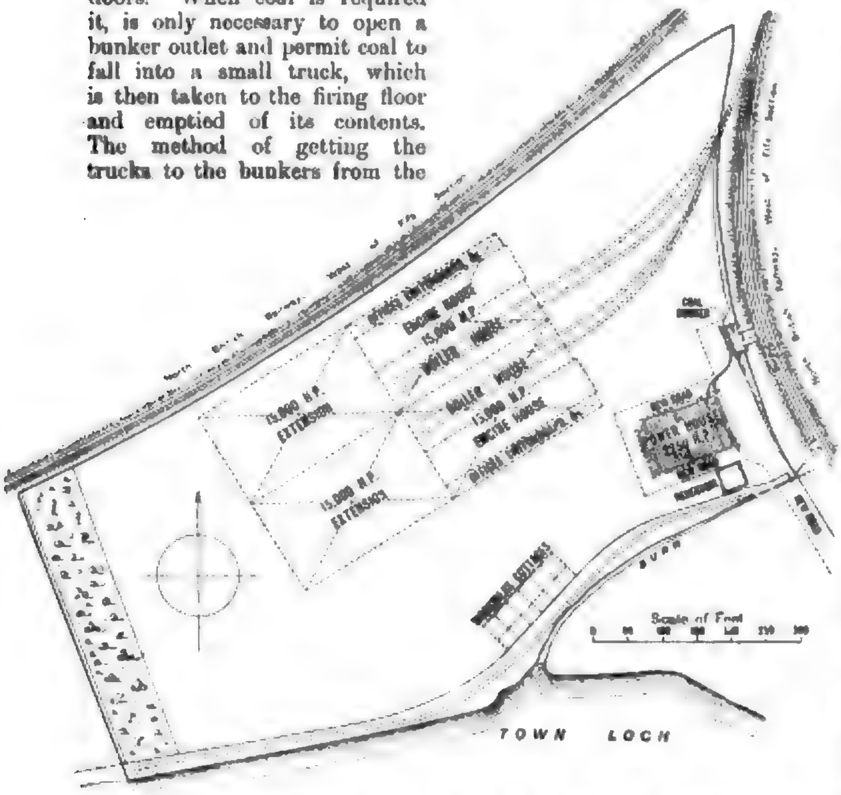


FIG. 2.—BLOCK PLAN OF SITE OF DUNFERMLINE STATION.

Both the boiler house and engine room (Fig. 4) are constructed of red brick, the former being 67ft. in length and 63ft. in width by about 20ft. in height, and the latter 67ft. in length, 59ft. in width, including the switchboard platform, and 31ft. high from the floor level to the underside of the shoes of the principal roof. A steel chimney, having an internal diameter of 7ft. and a height of 60ft., is stayed by means of four steel-wire ropes having a diameter of ½in. and anchored to the brickwork of the gable ends. Brickwork lined with 4½in. firebrick is employed for the base of the shaft, while for the first 15ft. the chimney is formed of $\frac{5}{16}$in. plates, the remainder being $\frac{3}{16}$in. plates. In the boiler house are four Lancashire boilers by Messrs. G. Sinclair & Co. They are 30ft. in length, with an inside diameter of shell of 8ft. 6in., and work at 160lb. per square inch when evaporating 8,500lb. of water per hour each. A superheater is provided for each boiler, capable of imparting 60deg. of superheat when the boiler is working at its full capacity. In the main flue is a Green economiser of 144 tubes fitted with electrically-driven scrapers and the usual accessories. The steam pipes are of lap-welded mild steel with flanges of the same material riveted on in the case of the large pipes and screwed on in the smaller ones. There is a single main steam header in the boiler house with branches passing through the wall to the engine room. For feed purposes there are two Hall feed pumps, each capable of delivering 3,000 gallons of water per hour; they are of the slow-speed, compound vertical type. In addition to the feed pumps there is also an injector capable of delivering 3,000 gallons of water per hour to the boilers. A feed tank, 10ft. by 6ft. by 3ft. 6in. deep, is situated above the pumps, and the exhaust from the latter is passed through a copper heating coil fixed in the tank. From the feed tank the suction pipes are taken with a by-pass, so that the pumps and injector can be supplied directly from the water-supply tank or from the reservoir outside the building.

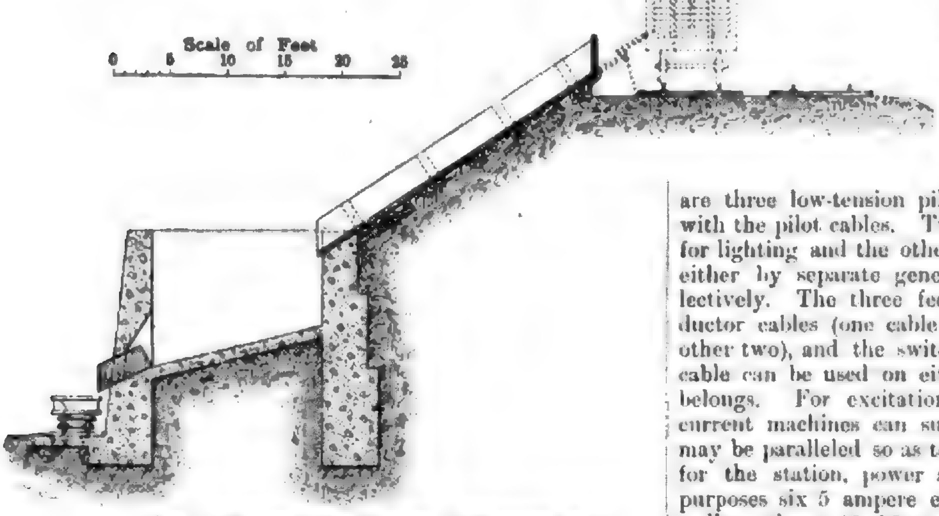


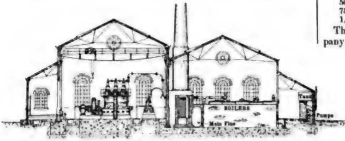
FIG. 3.—BUNKER ARRANGEMENT AT DUNFERMLINE.

The engine room contains two 500 H.P. and one 1,200 H.P. Willans engines directly connected to two phase alternators. There are also two 75 H.P. Willans engines directly connected to continuous-current machines for excitation purposes. The large engines are of the vertical, compound, three-crank, non-condensing type, and when supplied with steam at 150lb. run at a speed of 300 revs. per min. Electrical energy is generated at 3,000 volts, two-phase, and at a frequency of 50 ∽ per second. Those engines which drive the exciters are of the vertical compound two-crank non-condensing type, and the voltage of the dynamos is 110. Not only do these machines supply current for excitation purposes, but they also provide the necessary current for the generating station power and lighting circuits.

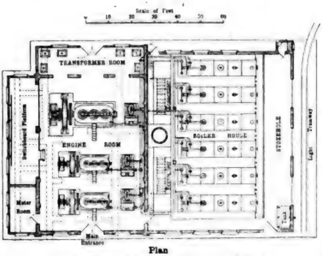
Along one side of the engine room is the switchboard, by Messrs. Cowans, which is so arranged as to permit of future extension if necessary. There is one panel for each generator set, the usual panels for the exciters, and one for each of the nine feeders. The usual instruments are provided, and there are three low-tension pilot voltmeters for use in connection with the pilot cables. Two sets of 'bus bars are arranged, one for lighting and the other for power, so that they may be fed either by separate generators or by all the machines collectively. The three feeders each consist of three two-conductor cables (one cable in each main being a spare to the other two), and the switchboard is so designed that the spare cable can be used on either phase of the main to which it belongs. For excitation purposes each of the continuous-current machines can supply a separate alternator, or they may be paralleled so as to supply exciting current and energy for the station, power and lighting. For station lighting purposes six 5 ampere enclosed arc lamps are employed, as well as about 40 16 c.p. incandescent lamps. An overhead hand-worked travelling crane, capable of lifting a dead load of 10 tons, spans the engine room.

All cables are of Messrs. Callenders' two-conductor concentric type, armoured and laid directly in the ground. They are insulated with paper and covered with a lead sheath, which is then served with a layer of jute yarn impregnated with bitumen to form a bed for the steel armouring. The pilot cables are similar in construction, and are intended to work at a pressure not exceeding 500 volts. Power cables are laid, as a rule, three in a trench, the third acting as a spare to the other two. It is specified that the cables are to be tested, before laying, at 10,000 volts between conductors and at 3,000 volts between conductors and earth, the readings being taken after 20 minutes' electrification. After laying and jointing, and before having current from the generating station put through them, the cables must be tested at 6,000 volts between conductors, and at 1,000 volts between conductors and earth; this test must be maintained for one hour. One pole of the system will be earthed. Eventually a complete telephone system between the generating and sub-stations will be installed.

The greater part of the area of the Scottish Central Electric Power Co. lies on the opposite side of the Firth of Forth and covers approximately 400 sq. miles. Parliamentary powers were secured in 1903, and empower the undertakers to supply electrical energy in the whole of the counties of Linlithgow and Clackmannan, and portions of the counties of Dumbarton and Stirling, including the towns of Falkirk, Stirling, Bathgate and Linlithgow. As may be seen from Fig. 5 there are three generating stations scheduled at Bonnybridge, Westfield and Alloa respectively. The first of these is now being constructed, and will be almost exactly the same as the Dunfermline station described above. Fig. 6 shows the block plan of the site of this station. As a matter of fact, the contracts for the plant have not yet been settled, but the specifications for the two stations are almost identical.



Section



Plan

FIG. 4.—PLAN AND SECTION OF DUNFERMLINE STATION.

The above two schemes are of considerable importance in view of the fact that they are situated in the centre of a vast coal field, and are surrounded by a large number of works carrying on industrial processes. Already, agreements have been arrived at with three collieries in the Fife area, by which no less than 5,500 H.P. will be required, and it is anticipated that, in the near future, further arrangements will be made with other collieries involving about 30,000 H.P. There is also a possibility that the Dunfermline tramways will decide to purchase energy from the Power Company, and in this event special continuous-current generators will be put down in the generating station. The Falkirk tramways authority, on the other hand, have definitely decided to follow this course, and no separate power house will, therefore, be erected for the nine miles of single track. In one coal pit in the Scottish Central area no less than 700 H.P. will be required for pumping, and the plant will be at work continuously for 18 hours out of every 24. There are also a number of large paper mills each requiring about 1,000 H.P., and these are at work night and day. Below we give the schedule of prices which the Fife Electric Power Co. is issuing to possible consumers.

Quantities.		Per unit.
Under 100,000 units per annum		1½d.
100,000 to 200,000	,,	1⅜d.
200,000 to 300,000	,,	1¼d.
300,000 to 500,000	,,	1⅛d.
500,000 to 750,000	,,	1d.
750,000 to 1,000,000	,,	⅞d.
1,000,000 to 3,000,000	,,	¾d.

The prices stated are for polyphase current from the company's mains, transformed to any standard pressure required by the consumer. "Authorised Distributors or" other consumers requiring continuous current or current of a different frequency from that prevailing in the company's mains will be charged ¼d. per unit in addition to the above prices. In the case of authorised distributors paying these higher prices, the company are prepared to assume the obligations as to limits of variation in pressure, imposed by the Provisional Orders or Acts of Parliament of these authorised distributors. The above prices are for current supplied in any quantities at any time during the 24 hours when the consumer may require it; but in such cases as those where a consumer is prepared to agree to take current at a practically constant rate, either for, say, 14 hours out of the 24 hours of each day (the time or times when this current is taken being agreed between the consumer and the company), or to take current continuously for the

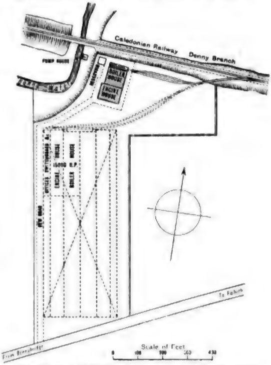


FIG. 6.—BLOCK PLAN OF SITE OF BONNYBRIDGE GENERATING STATION.

whole 24 hours of each day, then either 10 per cent. discount will be allowed, or a special bargain will be made. Also in the case of a consumer taking over 3,000,000 units per annum, a special bargain will be made. The company are prepared to agree that the consumption for the 12 months, counting from the end of the first 12 months, of use by a consumer shall govern the price for all current to that date, and a rebate will then be made in respect of any previous over-payment.

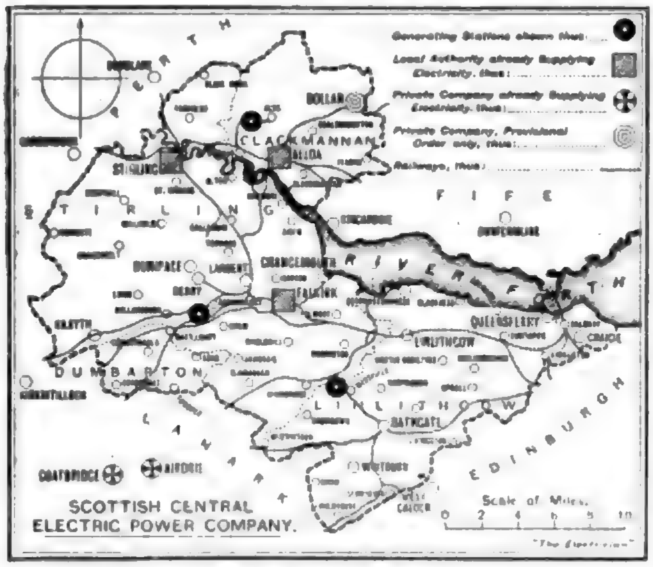


FIG. 5.—MAP OF SCOTTISH CENTRAL AREA.

We are indebted to Messrs. Bramwell & Harris, consulting engineers to both schemes, for much of the above information; and to their engineer, Mr. E. Churchward, for his courtesy in conducting us over the works.

THE CRICKLEWOOD-HENDON-EDGWARE BRANCH OF THE NORTH LONDON TRAMWAYS.

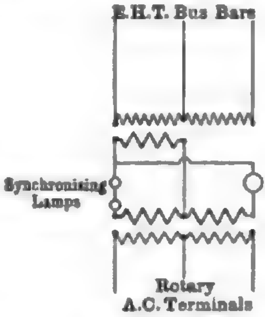
Much interest attaches to the opening next Saturday of the Cricklewood - Edgware branch of the Middlesex County Council Tramways. The line itself follows standard practice, and consists of about 4½ miles of double track fed from a trolley wire supported by span wires, and the cars are of standard design. The interest attaches to the method of feeding the line, which is by means of "inverted rotaries." A sub-station has been erected at Hendon, which is roughly at the centre of the line, and this sub-station is being supplied from the Willesden works of the North Metropolitan Power Supply Co. The sub-station is equipped with 50-cycle rotary converters, similar to those at the other sub-stations of the North London tramways, and the Willesden electricity works could only offer the choice of continuous current or three-phase current at 25 ~ per second. "Inverted rotaries" were therefore installed at the Willesden works to convert the continuous current into three-phase current at 50 ∿ per second, which is then stepped-up to 10,000 volts by stationary transformers. The 10,000-volt current is conveyed to Hendon by three-core cables, and there stepped-down again to the lower pressure to suit the converters. The 10,000 cables, it may be mentioned, form part of the mains which will ultimately connect the Brimsdown and the Willesden stations of the North Metropolitan Power Supply Co.

A description of the arrangement of the inverted rotaries at the Willesden works having been published in our columns quite recently (Vol. LIII., p. 941), it is unnecessary to repeat it, but we may say that we have seen the machines started up, and that they run smoothly and without giving any trouble. The excitation of the converters at Hendon has been adjusted so that there is unity power-factor at approximately three-quarters full load.

Mention should be made of the manner in which the pressure is regulated at the Willesden end. No variation is made in the excitation of the rotaries; this is adjusted once for all at the proper value for the desired frequency of 50 ∿ per sec. The necessary regulation, when the load is heavy, is accomplished by running the inverted rotaries from an over-compounded generator, so that an increase in load causes an increase in the impressed voltage.

The step-up transformers at Willesden and the step-down transformers at Hendon are identical. At each end are two sets of three 93kw. transformers, the low-tension windings of which are connected in mesh and the high-tension windings in star (the centre of which is not earthed). At Willesden the A.C. side of the rotaries is permanently connected to the transformers without any fuses or switches, and the E.H.T. cables are connected straight on to the secondary terminals of the transformers. The cables are three-core 0·1 sq. in. cables, lead covered and laid solid in earthenware ducts by the British Insulated and Helsby Co. Provision at the Hendon sub-station is made for two other E.H.T. cables, to connect up the Finchley sub-station and through to Brimsdown. The E.H.T. cables are brought in at Hendon through triple pole, oil break, switches, in brick cells, to overhead 'bus bars some distance behind the operating and instrument-board, beneath which are E.H.T. switches on the same level as the switchboards and the converter room floor. The 'bus bars are in two sections, which can be connected together if desired. The E.H.T. switches, which connect the transformers to the 'bus bars, are also of the oil pattern and are worked from the switchboard through iron connecting rods. A reactance coil is connected permanently between the secondary of the transformers and the main low-tension A.C. switch of the rotary.

To start up, the inverted rotaries at Willesden are first run up as described in our previous article. The main E.H.T. switch is then closed at Hendon, but the rotary switches there are left open. The rotary is then run up to speed and proper pressure by an induction motor at the end of its shaft, and a light load is placed on one phase of the rotary to steady it. The machine is then synchronised and switched on to the mains, the induction motor being immediately switched off.



The synchronising connections may be shown here, as they are now used by preference by the British Thomson-Houston Co. in their more recent sub-station plants. This arrangement, it will be seen, is such that the moment of synchronising is when the lamps are extinguished and not when they are alight, but the voltmeter shows the pressure of the machine. The voltmeter scale is marked in kilovolts, so as to be comparable with the voltmeter on the E.H.T. 'bus bars.

The rotary converters, as well as the switchgear and the stationary transformers, have been supplied and erected by the British Thomson-Houston Co.

Telegraph and Telephone Cables in the Simplon Tunnel.—According to the *Journal Télégraphique*, the Swiss budget for 1905 provides a sum of 230,000f. (£9,200) for the supply and laying of a telegraph and telephone cable in the Simplon tunnel, which is now nearing completion. At present Switzerland and Italy are connected by two telegraph lines over the Simplon Pass. They quite suffice for present requirements, but the new cables were decided upon because an increase in telegraphic traffic is anticipated after the opening of the tunnel, and also because the laying of the cable can be carried out more cheaply and with less inconvenience now than later on.

NOTES ON RECENT POWER DISTRIBUTION PLANT.

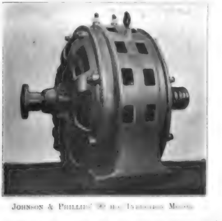
MOTORS, SWITCHES AND ACCESSORIES.

Several firms have sent us notes on their manufactures which are particularly suitable for power distribution plants.

Our first illustration shows a motor on a vertical shaft made by the Lancashire Dynamo & Motor Co., of Trafford Park, Manchester, which is a convenient form for many purposes, especially for pumping. The company inform us that this is one of a series they have recently constructed for driving centrifugal pumps for dock work, &c. It differs from the standard type with vertical shaft by being provided with ball bearings and a special oiling arrangement.

Lancashire Dynamo & Motor Co.'s Vertical Shaft Motor.

Messrs. Johnson & Phillips, of Victoria Works, Old Charlton, Kent, send us the accompanying illustration of one of their new standard types of induction motors. The one illustrated is rated at 90 h.p., and is to be directly coupled on the same bedplate to a 60kw. generator, used for excitation and for station lighting purposes. The motor is designed to work at 2,200 to 2,000 volts at a frequency of 25 periods per second, running at 485 revs. per min. at full load with a slip of 2½ per cent. The rotor is of the wound type, and is connected by slip rings to an external resistance. When the motor gets up speed, the starting rheostat is short-circuited by a switch contained within the slip rings and the brushes are then released. The stator is hand wound, as it has half-open slots. The ventilation has been particularly attended to, there being ports right through the rotor and stator cores, and the ventilation through the stator frame is well shown in the illustration.



Johnson & Phillips' 90 h.p. Induction Motor.

The British Westinghouse Electric Mfg. Co. (Trafford Park, Manchester) are putting on the market a new line of totally enclosed motors specially adapted for crane, hoist, lift and capstan work. We illustrate the pattern adopted for the two smallest sizes, for loads up to about 5 h.p. The frame is of cast iron and enclosed so as to be entirely dust-proof. The pole-pieces are made up of annealed sheet-steel stampings secured to the inner machine surface of the frame by means of bolts. They are of rectangular section and have extending tips which overlap the machine-wound field coils and so hold them in position. The armature is of the slotted core type and has two-circuit windings, so that it is in absolutely symmetrical relation with its field, and even if through wear of bearings it is not central with the poles the power will still be equally divided between the two circuits and no sparking or overheating will occur. The armature coils are also machine wound. The next type of motor ranges from 4½ h.p. to 38 h.p., and in this case the frame is of cast steel and the pole-pieces are secured to it by means of set screws. Spacing discs are provided at intervals between the core plates of the armature for the purpose of ventilation, and the core slots have small notches near their outer edge, running the full axial length on each side, and fibre wedges are driven in to hold the coils in position. These motors have also two-circuit windings. The third type for the heaviest type of work follows closely the design employed for tramway motors. They range in size from about 20 h.p. to 150 h.p.

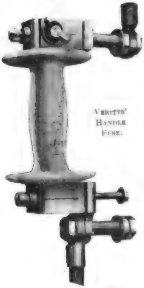
British Westinghouse Co.'s Motor.

Electromotors Ltd., of Openshaw, Manchester, in addition to making motors of larger size have made a speciality of small machines from ¼ b.h.p. to 2 b.h.p. These machines are not toys, but are of sound mechanical construction. The motor, an illustration of which is given below, has a cast-iron frame with cast-iron bearings turned to fit the frame, which contains large oil wells. They are provided with oil catchers and overflows to prevent the oil flowing into the motor and also means for drawing off the oil when it requires renewal. The bearing bushes are phosphor bronze and self-alignable with ring lubrication. The shafts are of mild steel and are fitted with oil throwers to prevent the oil from getting to the armatures. Mica insulation is used for the commutators, and carbon brushes are employed of such section that the current density does not exceed 35 amperes per square inch. The armature coils and magnet coils are former wound and the armature coils are supported on a strong cast-iron endplate which is keyed on to the shaft. The baseplate is one complete casting machined on both surfaces, and there is an adjustable screw which enables the motor to be moved in either direction.

Small Motor by Electromotors Limited.

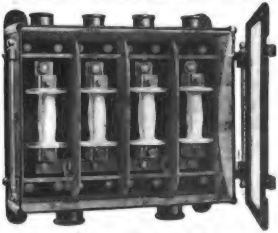
Messrs. Veritys' (King-street, Covent Garden, E.C.) new catalogue for 1905 describes a number of pieces of apparatus for electrical power distribution purposes. The illustration on next page of their "Aston" motor represents the pattern adopted for the 10, 15, 20, 25 and 30 h.p. sizes. Messrs. Veritys schedule their motors by frame numbers not by h.p. ratings. Thus, motor No. M10 900 has an output of 10 h.p. at 900 revs. per min., but also has four other ratings down to 2 h.p. at the slow speed of 260 revs. per min. The recommendations of the Engineering Standards Committee have been followed in the classification of the "Aston" machines. These "Aston" motors are reversible for crane and similar work. The temperature rise is only 70°F. after six hours' run at full load, and the motors are guaranteed to withstand an overload of 25 per cent. for one hour and 50 per cent. for 20 minutes.

From among the details of switchboards, main switches, the Peard fuses, circuit-breakers and switch gear generally contained in the controller section of the catalogue, we illustrate a new pattern of the handle type of switchboard fuse. The handles are substantially made in English porcelain which is carried right through the heavy cast contact shoes at either end. Plaster is used as a seating for these, and a pin passes right through the china at each end, thus securing the contacts firmly in position. These pins also serve to ensure that the fuse wire is held centrally in the tube without touching the sides. It will be observed that a wing-nut is provided for clamping the contacts tightly together, and this is very useful where considerable vibration is present. The contacts are reversible for front or back connection, and a feature of this fuse-holder is that should the handle be broken in an emergency, the contacts can be taken off from the front and an ordinary piece of fuse wire used. These fuses are also supplied made up into power circuit distribution boards in cast-iron boxes with solid backs, the inlet and outlet bosses of the boxes being tapped for screwed conduit. The boxes are sent out with hard-wood bushes fitted into these holes, for use on unarmoured systems of distribution. The lids, as seen in the illustration, are secured by pins either of which can be used as a hinge, so that the box can open in either direction. Every circuit has its own panel and between adjacent panels Uralite partitions are fitted. The boxes are lined with asbestos and are supplied for 25, 50, 100, 200, 350 and 500 amperes per way, single, double or triple-pole. For steel works, shipyards, collieries and power distribution generally these well-protected boxes should be most serviceable.


Veritys' Handle Fuse.

Veritys "Aston" Motor.

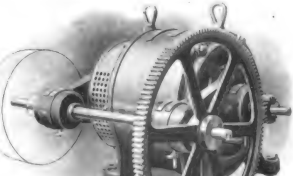
The Rhodes Electrical Mfg. Co.'s Motor


Veritys' Distribution Board.

Messrs. Veritys also make a motor starter with a very substantial cast-iron cover either with a slot through which the end of the handle projects and the contacts are exposed to view or else entirely gas-tight for outdoor and colliery use or for positions where much dust and grit are present. The resistance is composed of coils of non-corrosive resistance wire arranged on a grooved porcelain grid. The latter is supported behind the slate and the whole then embedded in a special heat-absorbing sand. Both the automatic coils and the handle are detachable from the front. Every starter is flashed to earth at 2,000 volts A.C. before leaving the makers' works.

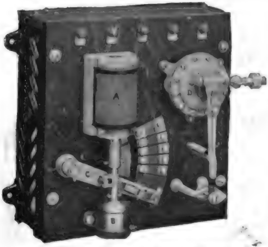
The Rhodes Electrical Mfg. Co. have adopted a new type of end shields with perforated enclosing covers, as shown in the illustration, and have published a complete list showing the speed of these motors at two voltages, together with all the necessary measurements, weights, &c. The same firm builds a special continuous-current lift motor with winding suitable for heavy starting torque, and capable of taking heavy loads momentarily. They make a special point of the insulation of the armatures and commutators, the former being tested at 2,500 volts alternating and the latter at 4,000 volts alternating before being connected to the armature. During the last nine months the firm has been experimenting with alternating-current motors, and have now placed three types on the market, one of which is a combined induction and repulsion motor, being suitable for lift work: it starts up, the makers inform us, with twice full-load torque, and takes only normal full-load current.

Messrs. CROMPTON (Chelmsford) have also sent us a catalogue of their series of continuous-current motors ranging from 2 H.P. to 125 H.P., and we illustrate their standard design of geared motor for use in workshops, &c. In addition to these motors the firm is manufacturing a series of small motors suitable for driving light machinery for industrial and domestic purposes. They can be arranged for fixing to the floor, ceiling or wall. They have a high overload capacity and the parts are interchangeable, so that repairs can be executed very rapidly. They are fitted with drum-wound armatures, self-oiling bearings, and can be supplied with removable lattice work or plain doors, making the motors ventilated-enclosed or totally enclosed.


Crompton Geared Motor.

Some new automatic motor starters for operating motors without manual intervention are being put on the market by Messrs. GEIPEL & LANGE, Vulcan Works, 72A, St. Thomas-street, London, S.E. They are suitable for use in connection with motors, driving pumps, filling tanks, air compressors, organ bellows, hydraulic accumulators, &c., in which absolute automatic starting and stopping of the motor is desirable. The starter is solenoid controlled, the circuit of the solenoid being closed and opened by a snap shunt operated by a float in a tank, the movement of a hydraulic accumulator, or, if necessary, by hand. The solenoid then moves over the starting switch, which has the usual steps. We are informed that the movement is very positive and rapid, it being impossible to open and close the shunt switch so rapidly as to prevent this return of the lever to zero. Thus a most effective no-voltage release is provided. Too sudden acceleration of the motor is prevented by means of a dashpot which is adjustable. For small motors the range of adjustment is between 5 and 30 seconds, whilst for large sizes the range is between 5 and 60 seconds.

Pressure regulators, also manufactured by the same firm, are intended for the control of motors driving air compressors, and for similar purposes. The motor is required in these circumstances to start and stop as the pressure falls and rises in the tank. The diaphragm contact maker, shown on the right of the illustration, has a pipe communicating with the tank in which the pressure is to be maintained. As the pressure rises the solenoid circuit is de-energised, and as it falls it is energised by the movement of the diaphragm causing two contacts to be made or broken.

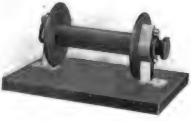


Giepel & Lange's Automatic Pressure Regulator.

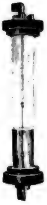
Messrs. Geipel & Lange have also sent us particulars of a goods lift controller, which is so arranged as to be entirely automatic, requiring only a small movement of the rope to carry out the whole of the operation. At the top of the controller there is a lever switch controlled by a shaft round which a rope passes. When the contact is made for running, the motor starts up immediately at quarter speed, the acceleration being effected automatically by means of a solenoid rheostat It is impossible with this switch to reverse too rapidly, as immediately the circuit is broken, for the purpose of reversing, all resistance is inserted in the armature circuit. A second type is adapted for passenger lifts, and provides many speeds which are entirely controlled by the operator. A third type is of the car switch control pattern, in which the closing of a shunt switch in the lift car operates the lift over the whole range. This type is entirely automatic and, the makers state, cannot be misused.

Messrs. Drake & Gorham, of 66, Victoria-street, Westminster, S.W., have sent us particulars of their Holden magnetic clutch. This consists of a thick disc of wrought iron or high permeability cut steel, keyed on the main shaft, and having an annular groove into which the magnet coil is placed. The ends of the coil are connected to two grooved rings insulated from each other, to which the current is conveyed by carbon contacts. A soft wrought-iron plate is fixed to the pulley to be driven. Between the magnet face of the disc and this plate a thin steel disc is placed to prevent the adhesion of the two iron faces due to residual magnetism when the current is cut off. Where cast-iron swivelling bearings are used the pulleys can be very conveniently arranged to revolve on the outside of the bearing. By mounting the step cone on a sleeve the main shafting is relieved entirely of carrying the weight of the pulleys, which not only reduces the bearing friction, but also entirely avoids the friction of loose pulleys on a running shaft when they are not in use.

Messrs. Marryat & Place (28, Hatton Garden, London, E.C.), have recently issued a new list of their ironclad accessories for use upon 400 to 600-volt power circuits. The novelties include a complete range of ironclad distribution boards from 10 amperes to 50 amperes, 2 ways to 18 ways, and in single, double and triple-pole. We illustrate a sample fuse-holder. This is of fibre, lined with a thick wall of asbestos, and hard fibre plugs are used to close in the ends after the fuse wire is inserted. These plugs fit with a bayonet behind, and render the explosion chamber practically airtight. Messrs. Marryat & Place have also recently put upon the market a line of oil-break fuses for high pressures. We illustrate one designed for 20,000 volts and 20 amperes. It consists of a toughened glass tube with flanged ends, hard black fibre collars and caps, brass rods, nuts, and terminals, fuse link, rubber washers, &c. The fuse is so constructed that, in the event of a short circuit, it can be taken apart, a new fuse link fitted, and put into use again practically without tools.

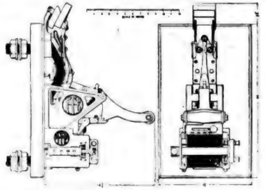


Marryat & Place Fuse Holder.

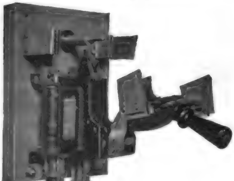


Marryat & Place Oil Fuse.

Messrs. Robert W. Blackwell & Co., 59, City-road, London, E.C., have sent us some particulars of their "Reversite" I-T-E patent reverse-current circuit-breaker, the action of which, they claim, is practically independent of drop in line voltage, and they add that excessive current in the normal working direction will not open the circuit-breaker, but as the reverse current increases the opening becomes more definite and rapid. A reverse-current adjustment is provided so that from 5 to 25 per cent



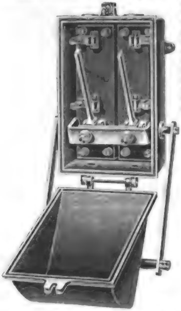
Blackwell's Reverse-current Circuit-breaker.



Blackwell's Circuit-breaker with Limit Attachment.

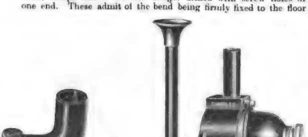
of the full-load current setting may be made at will. In connection with the general application of electrical power, chiefly to travelling and jib cranes, traversers, lifts and hoists, Messrs. Blackwell have designed a limit switch, which is practically a circuit-breaker having a shunt coil substituted for the usual series coil. A suitable arrangement of contacts is made on the runway so that the shunt coil is brought into action and opens the limit switch, thus preventing any over-travelling. A similar limit switch may be employed on a hoist motor to protect over-running the hoisting point. It is equally possible to arrange a series of switches at distant points whereby the shunt-coil circuit may be closed by hand operation. The limit switch may also be fitted with a series coil as the illustration shows, so as combine the feature of opening automatically under overload conditions.

Messrs. CECIL HODGES & Co. of Balfour House, Finsbury-pavement, London, have sent us a catalogue in which some new designs of switches and fuses are listed at a very moderate price. We illustrate a double-pole switch enclosed in a watertight iron case. It will be noticed that the handle comes through the side instead of projecting from a slot in the lid, and that the whole arrangement neat and compact.



ENCLOSED SWITCH MADE BY CECIL HODGES & CO.

The SIMPLEX STEEL CONDUIT CO., Norfolk-street, Strand, W.C. have introduced a new flange bend to facilitate the connection of motor leads. The bend is similar to an ordinary simplex sharp bend, except that it has two flanges drilled with screw holes at one end. These admit of the bend being firmly fixed to the floor in any required position. The second figure gives a view of the flange bend fitted to the brass drawing-in piece to prevent damage to the cables. The illustration on the right shows a new pattern of watertight switch, designed for use with simplex screwed conduits. It has no loose parts or caps to unscrew. These switches, we are informed, may be satisfactorily operated even under water.



SIMPLEX NOVELTIES.

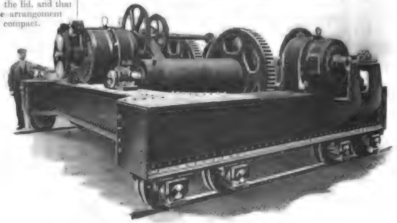
THE UNBREAKABLE PULLEY AND MILL GEARING CO., of Great Jackson-street, West Gorton, Manchester, inform us that they have recently put upon the market an improved self-oiling bearing, with which good results have been obtained in several factories.

Messrs. HUMPAGE, JACQUES & PEDERSEN, of Luckwell Works, Ashton Gate, Bristol, are now supplying their well-known Humpage reduction gear for fixing either on a bed plate and coupled between the motor and slow-running shaft, or combined with a motor and bolted to the faces of the field magnets. It is supplied for any horse-power in all ratios between 5 to 1 and 20 to 1. The gear is specially suitable for dusty positions, where counter shafts or double spur reduction gear would otherwise have to be used.

The GENERAL ELECTRIC CO., 17, Queen Victoria-street, London, E.C., have recently brought out some new conduit accessories. These include circular cast-iron flush switch boxes with one or two screwed nipples; fittings to work in conjunction with the oval tubes which the General Electric Co. are manufacturing; and a special seamless steel tube.

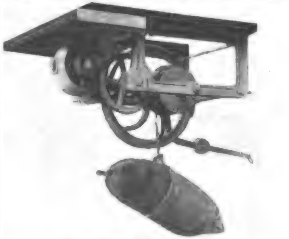
ELECTRIC CRANES, HOISTS, &c.

The crane which we illustrate below is built by Messrs. THOMAS BROADBENT & SONS, of Huddersfield, for erection at the large rolling mills at Clarence Works, Middlesbrough, and is called into requisition when the rolls are changed. These, with their housings, weigh nearly 100 tons and are lifted bodily. The crane has a span of 36ft. 6in. between centres of rails with a lifting power of 100 tons at 4ft. per minute or 15 tons at 24ft. per minute. The speed of the longitudinal travel is 80ft. per minute and that of the cross travel 40ft. per minute. All the motions are electrically controlled, the electrical equipment having been supplied by Messrs. Crompton & Co., of Chelmsford. The motors are of Messrs. Crompton's series, reversible ventilated enclosed type, and work on a 220-volt continuous-current circuit and run at a speed of 600 revs. per min. A 60 H.P. motor is used for the lifting motion, a 20 H.P. for the longitudinal travel, and for the cross traverse a 10 H.P. motor is employed.



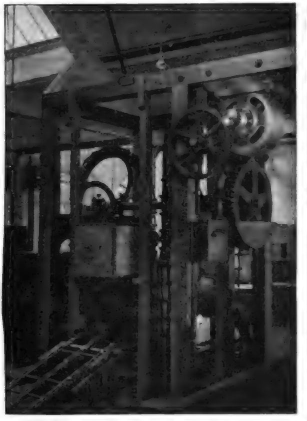
BROADBENT CRANE FITTED WITH CROMPTON MOTORS.

We also illustrate a neat little friction hoist, which ELECTROMOTORS LTD. make in 2½ cwt., 5 cwt., 7½ cwt., and 10 cwt. sizes. They are either arranged for direct driving, as shown in the illustration, or can be belted, and are usually worked at a speed of 150ft.



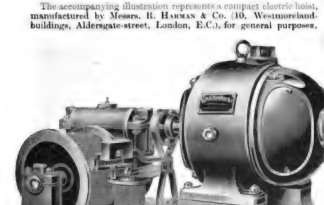
FRICTION HOIST BY ELECTROMOTORS LTD.

per minute. Another illustration shows an interesting application of an inverted motor, which is driving a conveyor used in the process of tea mixing.



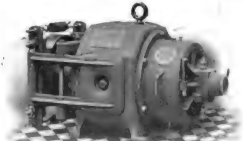
MOTOR-DRIVEN CONVEYOR FOR TEA MIXING PLANT (ELECTROMOTORS LTD.)

The accompanying illustration represents a compact electric hoist, **manufactured by Messrs. R. HARMAN & Co. (10, Westmoreland-buildings, Aldersgate-street, London, E.C.), for general purposes, but especially for contractors' and builders' work. As will be seen, the motor, the hoisting gear and the magnetic brake are all mounted on one cast-iron bed plate. The motor is series-wound and directly coupled to the worm gearing of the hoisting drum. A liquid-starting rheostat, made by Messrs. Dorman & Smith (of Salford), is used. It consists principally of a cast-iron trough, which is insulated by porcelain and asbestos from the external wooden case. This trough** contains an electrolyte, composed of about 6 gallons of water and ¾lb. of common or caustic soda. There are two electrodes of cast iron, corrugated at the bottom, where they dip into the water. These electrodes are raised and lowered from the starting handle by a lever mechanism, the arrangement being such that in the "stop" position both plates are raised out of the solution, but that in the "forward" and "backward" position of the starting lever, either the one or the other of the two plates is immersed. The worm gearing runs in oil and consists of a mild steel worm and a gun-metal worm-wheel and ball-thrust bearings. As the electromagnet of the magnetic brake is connected in series with the hoist motor, the band brake, which operates on the periphery of the coupling, is released as long as the motor runs. This release is achieved by the action of a plunger armature, which is sucked into the solenoid and thus raises the counterweight of the brake mechanism. The steel band of the band brake embraces the coupling for about three-quarters of its circumference, and the arrangement is such that the brake operates equally satisfactorily for either direction of rotation. Two standard sizes are made at present. No. 1 type is equipped with a 3 H.P. semi-enclosed motor, which is capable of lifting some 8 cwt. at a speed of about 80ft. per min. The space occupied by this set measures 4ft. 3in. by 2ft. 3in., and its weight is 7 cwt.; rope pulley 12in. in diameter, ratio of gear transmission [illegible]. No. 2 type is designed to lift 1 ton at any speed up to 100ft. per min., and is equipped with one 10 H.P. motor, a rope drum 21in. in diameter, and a worm gearing which reduces the motor speed in the ratio of 50 to 1.



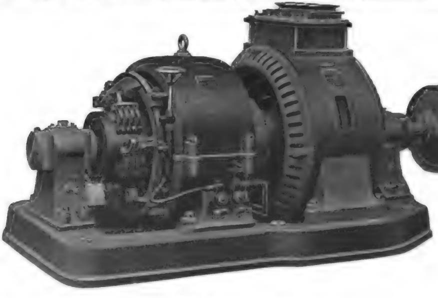
HARMAN & CO.'S ELECTRIC HOIST.

Messrs. LAURENCE SCOTT & Co., of Gothic Works, Norwich, send us particulars of a new brake for crane motors, &c., which they inform us is now being largely adopted by the makers of crane and shipyard tools, where rapid stopping and reversing is necessary. The brake gear is operated by the magnetic circuit of the motor itself, and its general arrangement may be gathered by the illustration below. The magnet being thus much stronger than the usual auxiliary electromagnet employed an ample margin of power renders it possible to arrange that the brake is held "off" until the current taken by the motor falls to one-third of the full-load current. A shunt solenoid to fulfil the same purpose, the makers point out, involves complication on the controller and extra wiring, in addition to the fine wire wiring for the magnet and a non-inductive resistance to take the spark on the brake. The shoes of the present brake, we are informed, are easily adjustable for wear, and the whole arrangement is strong and substantial, the brake gear being entirely of cast or wrought steel. The method of using the brake depends on the type of controller used, and in many cases no special precautions are necessary, as on the controller handle being put to the lowering position sufficient current will flow into the motor to take the brake off, and the load on the crane will start down. Then as the current falls to its minimum the brake will come partly on, and the speed of lowering, with all the resistances cut out of the controller, will be somewhat higher than the highest lifting speed. **On the resistance steps the speed will be decreased according to the amount of resistance in the circuit. But all the time the brake blocks will be touching the brake wheel, so that as soon as the controller breaks the circuit the brakes will come on tight and the motor will be pulled up rapidly. If great nicety of lowering is required** the resistance is cut across the armature of the motor. This keeps up the current in the field and enables, if desired, a full control of speed down to one-tenth of the full-load speed.



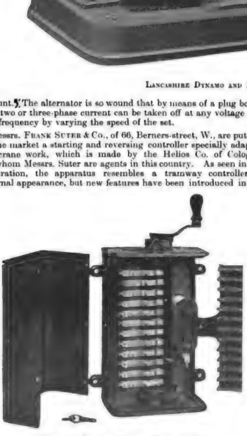
LAURENCE SCOTT & CO.'S MOTOR, FITTED WITH NEW TYPE OF BRAKE.

THE LANCASHIRE DYNAMO AND MOTOR CO.'s crane-testing set, shown on p. 272, is a dynamo-alternator, arranged to be driven from shafting or by a variable speed motor. This arrangement has been supplied to one or two crane makers, and will generate continuous current at any voltage from 220 to 500 by varying the speed and the field, or it can be wound and arranged to boost up the shop voltage, in which case its range of voltage will be raised by a corresponding amount. The alternator is so wound that by means of a plug board one, two or three-phase current can be taken off at any voltage and any frequency by varying the speed of the set.



Lancashire Dynamo and Motor Co.'s Crane Testing Set.

Messrs. Frank Suter & Co., of 66, Berners-street, W., are putting on the market a starting and reversing controller specially adapted for crane work, which is made by the Helios Co. of Cologne, for whom Messrs. Suter are agents in this country. As seen in the illustration, the apparatus resembles a tramway controller in external appearance, but new features have been introduced in the internal arrangements. The controller cylinder consists of two cast-iron parts, on which are mounted copper sliding surfaces to engage with the contact fingers. By the side of the drum the coil of a strong electromagnet is fixed. One pole of this magnet is formed by the back of the controller and the other by a long rectangular piece covering the whole length of the drum. This piece carries the insulating partitions which divide each contact finger from its neighbour, and can be turned back so that the drum and the contact fingers can easily be inspected. The greater part of the contact fingers is protected by an insulating partition. The fingers carry copper tips, which can easily be removed. A spiral spring provides for the necessary pressure on to the segments of the drum. The knife-blade switch is fixed near the point where each contact finger is hinged, and transmits the current from the terminals. The contact fingers are so arranged that they can be replaced without loosening a screw, it being necessary to unhook the spiral spring only in order to remove this part of the controller, which is subject to so much wear. The "Helios" controller is supplied to suit three different purposes: For reversing without brake connections; for reversing, with equal brake steps on either side of the "off" position (especially suitable for cross-traversing and travelling); for reversing, with different brake steps on either side of the "off" position (especially suitable for hoisting motors)



General View of Helios Controller.

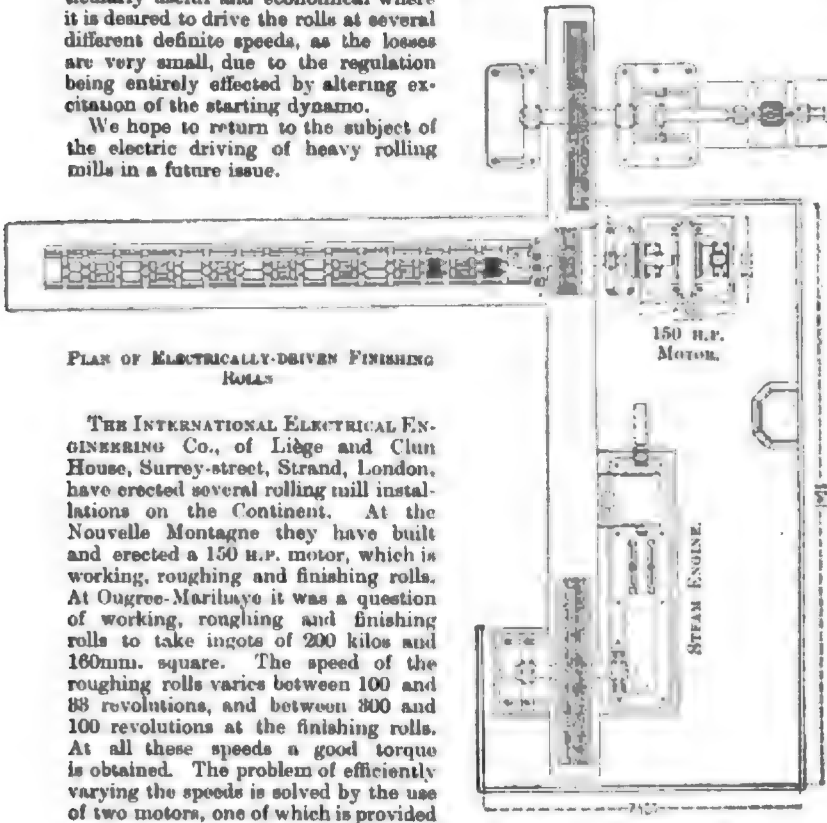
ROLLING MILLS.

The Allgemeine Elektricitäts Gesellschaft (whose agents in England are the Electrical Co. of Charing Cross-road), W.C., have equipped several rolling mills for electric driving. We give a plan of an electrically-driven finishing roll at the Bergische Stahlindustrie, Remscheid, to show the relative space taken up by the motor and the steam engine it has displaced. These rolls are driven by a 220 H.P. continuous-current compound-wound motor on 240 volts running at speeds between 225 and 350 revs. per min., the speed of the motor being controlled by a shunt resistance. The dimensions are in millimetres. The rolls are 8¾in. diameter, and are employed in preparing fine tool steel of square, flat, round and triangular sections of $\frac{1}{16}$ sq. in. or $\frac{3}{16}$ sq. in. area. The raw material as it is fed into the rolls is of 1½in. square section, and the maximum length of the finished product is 50ft.

In the case of heavier mills, the company has adopted the following arrangement in order to steady the load on the motor. A heavy flywheel is mounted on the motor shaft, and, in the case of a direct-current system, the motor is provided with a distinct field-winding which allows the armature to drop in speed when the current consumption has reached a certain predetermined value; the flywheel then gives up some of its energy to the system. By choosing suitable proportions for the flywheel and field-winding, it is possible (the company claim) to keep the overloads on the motor within reasonable limits. In the case of a three-phase system the same arrangement of flywheel is adopted, but a resistance is automatically thrown into the rotor circuit on overload, and this increases the slip, with consequent lowering of the speed, and allows the flywheel to supply the extra energy required.

In cases where the rolls have to be frequently reversed, or where the current is obtained from a public supply company, a motor generator is employed consisting of a motor which is run directly off the supply mains driving a very heavy flywheel of cast steel at a high speed, and also a special continuous-current dynamo called the starting machine, which supplies the current for the main driving motor coupled to the rolling train. The shafts of the motor, flywheel and starting dynamo, are all directly coupled together, and always run in the same direction. The motor of the motor-generator is arranged on the same principle as described above for allowing the speed to drop on an overload. The starting dynamo and the main driving motor are separately excited by means of a small machine directly mounted on the extension of the motor generator shaft. The regulation is entirely carried out by manipulating the field of the starting dynamo, which, when reversed, causes the main driving motor to change its direction of rotation. This system has the advantage that the speed of the main driving motor is independent of the load for a definite position of the shunt controller, and, therefore, is very particularly useful and economical where it is desired to drive the rolls at several different definite speeds, as the losses are very small, due to the regulation being entirely effected by altering excitation of the starting dynamo.

We hope to return to the subject of the electric driving of heavy rolling mills in a future issue.



Plan of Electrically-driven Finishing Rolls

The **International Electrical Engineering Co.**, of Liège and Clun House, Surrey-street, Strand, London, have erected several rolling mill installations on the Continent. At the Nouvelle Montagne they have built and erected a 150 H.P. motor, which is working, roughing and finishing rolls. At Ougree-Marihaye it was a question of working, roughing and finishing rolls to take ingots of 200 kilos and 160mm. square. The speed of the roughing rolls varies between 100 and 88 revolutions, and between 300 and 100 revolutions at the finishing rolls. At all these speeds a good torque is obtained. The problem of efficiently varying the speeds is solved by the use of two motors, one of which is provided with two commutators. For the Grivegnee Iron Co. the company have in hand at present orders for machinery for the driving of three sets of roughing rolls and two sets of finishing rolls. The following requirements have to be fulfilled: An effort of 450 H.P. to 900 H.P. is to be given by the two sets of rolls together at every speed between 250 and 320 revs. per min. at the finishing rolls. The two sets are coupled to the finishing rolls through an elastic coupling. To give an idea of the importance of using heavy flywheels we may mention that the rolls at Engis are provided with two flywheels weighing 40 tons each. At Ougree the roughing rolls are fitted with a 53-ton flywheel, with a peripheral speed of 115ft. per second, while at Grivegnee the flywheel pulley on the roughing rolls runs at the same peripheral speed and weighs 83 tons, and at the same time there is a steel flywheel cast in one piece weighing 17 tons, and calculated for a speed at the rim of 297ft. In order to permit the flywheels to exercise their regulating actions it is necessary to obtain a drop in speed as the load increases and a corresponding acceleration as the load diminishes. This is effected by employing a compound-wound motor, the importance of the series-winding being such that the speed is varied from 20 to 25 per cent. between full load and no load, the shunt excitation remaining constant. For the Grivegnee rolls the stored energy in the flywheels is sufficient, in conjunction with the motor, to develop 2,260 H.P. with a 20 per cent. speed drop in 10 seconds, 876 H.P. with 20 per cent. speed drop in one minute, and 186 H.P. with same speed drop in two minutes.

The **Electric Construction Co.** of Wolverhampton are supplying a large number of motors for electrical power distribution purposes including a fine 400 H.P. induction motor employed for driving the rolling mill at the wire drawing works of Messrs. J. C. Hill & Co. at Cwmbran. A description of this installation will appear in our next issue in connection with our article on the South Wales Electrical Power Distribution Scheme.

COLLIERIES.

The **British Thomson-Houston Co.**, of Rugby, have put down a large number of electrical plants in collieries in this country. A large pumping plant has been put in by them at the Birley East Pit of the Sheffield Coal Co., the pump and motor being situated over 1,000ft. below the surface. The motor is a 85 H.P. continuous-current compound-wound machine designed to stand considerable overloads, and to work without sparking, with a fixed position of the brushes from no-load to full load. It drives the pump through shafting. The generator is belt-driven by a horizontal engine, and the most noteworthy feature in connection with this machine is that it was ordered, delivered and put to work within a space of 24 hours. At the Wharncliffe Silkstone Colliery there is a 150kw. 500-volt continuous-current machine which supplies power to the pumping and haulage gear and the coal-cutting machinery. In another case a similar generator supplies current to a motor-driven pumping plant 2½ miles underground. Messrs. Pickup have two rope-driven alternators supplying power to two 50 H.P. induction motors working underground haulage, and two similar motors of 15 H.P. driving circular saws and pit bank machinery. In addition to the collieries already mentioned, the following have also been fitted with electrical installations by the **British Thomson-Houston Co.**:—The Denaby & Cadeby Main Collieries the Farnley Iron Co., Helm Colliery, the Roundwood & Walton Collieries, Bolsover Colliery, Grassmoor Colliery, Stafford Main Colliery, Wath Main Colliery, Staveley Coal & Iron Co., West Hallam Colliery, Shipley Collieries and others.

The **British Westinghouse Company** have done considerable work in the collieries of the South Wales District, and a description of one of their main and tail haulage gears, supplied with power by the South Wales Electrical Power Distribution Co., will be published in the conclusion of the article on this company's scheme in our next issue.

Messrs. **Crompton & Co.** are carrying out a complete installation for Nixon's Navigation Colliery Co., including 300kw. generating sets, three 250 H.P. haulage cars, two 250 H.P. pumps, two 75 H.P. blocking engines and one small staple engine. The firm has also quoted for the whole of the electrical equipment for the Premier diamond mines in South Africa.

We publish in this issue descriptions of two interesting winding gears erected in mines on the Continent and sent us by the **Lahmeyer Electrical Co.** and Messrs. **Witting, Eborall & Co.** respectively.

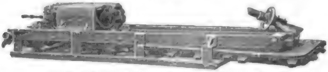
Messrs. **Frank Suter & Co.** have sent us some figures with regard to the application of electricity in the Gneisenau Colliery in Germany, where Helios plant is employed. It is a three-phase installation, the capacity of the generating plant being about 1,800kw. Efficiency tests have been made on the electrically-driven pumps at the bottom of this mine, and the following figures have been obtained: Output of steam engine, 643·45 B.H.P.; output of pump, 442 B.H.P.; mine efficiency, 68·6 per cent. As the plant was originally intended for a normal output of 800 B.H.P., it was running at the time of the test far below full load, and the results are therefore good.

In the Germania Colliery, the **Helios Co.** have erected an electrically-driven winding plant for a shaft 1,500ft. deep. The gear is constructed to lift a normal load of 2 tons at a speed of 10ft. per second, and when lowering the load may be increased to 4 tons. The weight of the cage, including the unloaded trucks, is 8 tons, which is counter balanced, and the weight of the steel winding rope, which is not counter balanced, amounts to 1·4 tons. At starting 400 B.H.P. is required, and when the cage has reached its normal speed the power decreases to 40 B.H.P. The distance between the power station and the motor-winding plant is about 1¼ miles. Three-phase current at 2,300 volts is employed, the motor being of the induction type rated at 120 B.H.P. (when running at 485 revs. per min. which is reduced by double reduction spur gearing to 16 revs. per min.), but the output may be safely increased by 100 per cent. for short periods. The rotor is star connected and provided with slip rings so that resistance is inserted at starting. The reversing of the motor is effected by reversing the connections of two phases at the stator terminals. All the operations of starting, including short circuiting the armature, reversing the motor and lifting the brushes are performed by one controller handle. The efficiency of the generator is 92 per cent., of the cable, 242yds. long, 92 per cent., and of the winding plant 76 per cent., giving a total efficiency of 60 per cent. The steam consumption is 44lb. per brake-horse-power-hour for the whole plant. The generator voltage is 2,300.

The Foreign Department of the **Allgemeine Elektricitats-Gesellschaft**, 125, Charing Cross-road, has just issued an illustrated pamphlet dealing with electric power transmission in mines, and describing the plant in use at several Continental collieries.

Messrs. **Ernest Scott & Mountain**, of Close Works, Newcastle-on-Tyne, have secured an order from the Bedminster Coal Co., of Bristol, for a complete installation, consisting of a 300 H.P. engine, driving a three-phase generator, and a complete equipment of electric motors for driving the underground haulage, pumps, &c. It is proposed at a later date to add considerably to the installation, and drive the whole of the collieries under the control of this company from one central station. The pumping machinery of the Whitwick Colliery is to be extended, and an order has been placed for a three-throw horizontal electrically-driven pump, constructed to deliver 30-40 gallons per minute against a vertical head of 500ft.

The Electrical Chain Headers manufactured by Messrs. **John Davis & Son** of Derby are made in two types, high and low, and are used for pillar and stall work, driving narrow places, and where it is necessary to drive straight work quickly. The dimensions of the low type, which we illustrate, are :—height 18½; length 10ft. 8in.; width 8ft. 2in.; weight 27cwt. The low type has the motor at right angles to the face and drives through cut bevel wheels on to a vertical shaft on which is keyed a sprocket wheel directly below the motor; on this sprocket runs the chain. The motor is fixed with its gearing on a movable frame, and is moved forward by two pinions in racks fixed on to the stationary frame. This frame is provided with two jacks fitted with hand-wheels on screws; the one in the front is fixed against the coal, and set at an angle to prevent the tools from running across the coal face, and so slewing the machine out of line. The back jack is set against the roof, and thus jambs the frame firmly into its proper position to guide the cut. The chain is composed of tool-holders and links, and runs round the front end of the movable frame on two idler sprockets. The driving sprocket under the motor is the apex of the triangle made by the chain. On the back shaft are two clutches with a single handle for operating them; one feeds the chain in and the other withdraws it, and the driver can, if necessary, let the chain run idle at any point of the cut. The feed is at the rate of about 6ft. in 3½ minutes, and the return is done in half-a-minute, but the feed speed depends upon the material being cut, and it may be made as slow as 6ft. in 7 minutes if necessary. There are knock off brackets attached to the stationary frame so that the machine may not overrun itself and so become jambed. These machines are built for undercutting to a depth of 5ft., 6ft., or 7ft., with a width of 44in., and a thickness of kerf of about 4½in. The usual time occupied to undercut a place 11ft. wide, counting the moving into position and moving out again for firing shots, is about 45 minutes, and the men have time to drill two shot holes with an electrically-worked drill whilst the machine is undercutting. If it be necessary to cut several places with the one machine, it is moved about on a truck. These are usually supplied without wheels or axles so that each colliery may suit them to its own gauge. The truck is fitted with a chain windlass worked by a hand ratchet to haul the machine on to it, and on arrival at its position it can be readily pushed off the truck by pinchbars.



Low Type Electric Header fitted with Enclosed Motor.

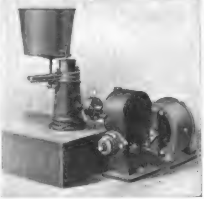
MISCELLANEOUS APPLICATIONS OF ELECTRIC POWER.

The British Thomson-Houston Co. have sent us an interesting description of a water-power plant employed for driving a large Irish cotton works. Transmission is effected by overhead wires, the generating station being about 1½ miles from the works. We hope to publish a fully illustrated description of this plant next week, as the photographs did not reach us in time for this issue.

The Alliance Electrical Co. (Northern Assurance-bldgs., Manchester) have sent us particulars of an electrically driven cotton mill, which they have recently equipped. Connection from the motor to the frame is by a flexible coupling, the former being designed to give a large percentage variation of speed by means of a shunt resistance. Apart from the decreased consumption of energy which it is said this arrangement secures, there is the additional advantage that the overlooker of any particular room in a mill can set the speed regulator to the maximum speed at which it is advisable to drive the machinery. It has been found that different counts require different speeds of the tin roller shaft of the spinning frame, and the ordinary practice has been to change the pulleys and alter the belts; moreover, the person in charge of any particular room can lock the resistance, so that the operative cannot tamper with it.

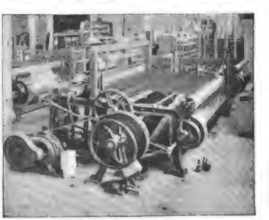
Messrs. **Mather and Platt** (Salford Iron Works, Manchester) have recently settled an important contract for the plant required for the electric driving of two spinning and weaving mills at Malaga, in Spain, which are the largest in the country and employ about 5,000 hands. Arrangements have been made for obtaining a supply of electric power from the generating station of the Chorro Power Co., some 50 miles north of Malaga. The power is transmitted by three-phase current at a pressure of 25,000 volts to a sub-station in Malaga, where the pressure is reduced to 2,500 volts, part of the energy being supplied to the Malaga Electric Lighting Station. Underground cables are to be laid from the Malaga sub-station to the two mills "La Aurora" and "La Industria," which are at a distance of about half a mile. A secondary receiving station is to be placed at each mill containing three-phase transformers for reducing the pressure from 2,500 to 400 volts for supplying the three-phase motors, which will be employed universally throughout the mills, the steam plant being entirely discarded. There will be 72 motors, varying in power from 8 H.P. to 150 H.P. and aggregating 2,500 H.P. It is anticipated that by the use of electricity in place of steam there will be a saving of considerably more than 20 per cent. in the yearly cost of power.

The small **Crompton** motors, already mentioned, have been employed for a variety of purposes. A half horse-power motor, driving a cream separator through worm gearing, is shown in the figure above.



½ H.P. Crompton Motor Driving Cream Separator.

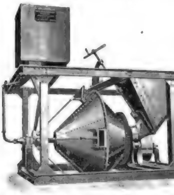
The Electrical Co. have devoted some attention to the arrangement of electrically driving weaving looms, one of which we illustrate. The coupling of the motor to the loom is effected either by belt or gear. In the case of belts, the machine is fitted with a special driving attachment, vertical or horizontal type, according to requirements, the motor being flexibly suspended from a cast-iron support, and the weight of the motor acting automatically to keep the tension on the belt. As, however, the weight of the motor would be too great for satisfactory operation, adjustable springs are provided which regulate the tension of the belt. When it is a question of coupling up by tooth gear, special disengaging gear is adopted, so that sudden stopping of the loom will not lead to the shearing off of the teeth.



Electric Driving of Weaving Looms.

The Electric Welding Co. (28, Basinghall Hall, London, E.C.) have just issued a new edition of their catalogue of electric welding machines and apparatus. This welding process is most useful in works where electric power is available.

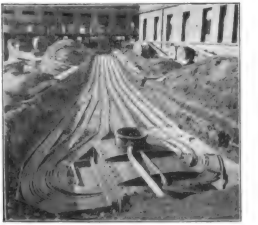
Among the electrically-equipped machines that Messrs. **Stothert and Pitt**, of Lower Bristol-road, Bath, have recently manufactured is a concrete mixer shown below. It is claimed that this mixer, which is made under Taylor patents, combines the advantages of the intermittent and continuous systems. This is obtained by the provision of a large charging hopper which enables a charge of dry material to be prepared while a preceding one is being mixed.



Stothert and Pitt's Concrete Mixer for Motor Drive.

CABLES.

An illustration shows the laying of cables by the **British Insulated & Helsby Cables, Ltd.** (Prescot, Lancs.), at Messrs. Harland & Wolff's works in Belfast. The cables are low tension, single, lead-covered, and paper insulated, laid in wooden troughs on asphalt bridge pieces. The B. I. & H Co. also tell us that the year has been a very busy one for them in extra high-tension cable work. They have supplied and laid some 800 miles of three-core three-phase cables for the Metropolitan Railway, Metropolitan Electric Tram ways, London & South-Western Railway, Metropolitan Electric Supply Co., Northern Counties Co., Sunderland Corporation, &c. They add that the Ruthven Murray bridge-piece, recently described in our columns, has "caught on" well, and a quantity approaching half a million has been disposed of in the past 10 months.



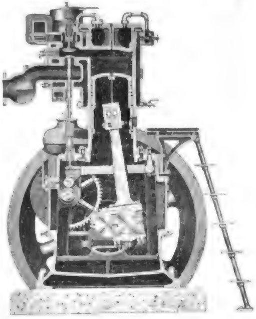
Laying Cables at Harland & Wolff's Works, Belfast.

Messrs. W. T. **Glover** & Co. (Manchester) have also executed much extra high-tension work during the year. The Liverpool and Southport feeders were completed, as well as the Leeds and Wakefield Tramway extra high-tension feeders. A further large contract in the Johannesburg lighting and tramway mains has been booked, and work is now starting out there. This contract is remarkable for the infinite variety of types of cable used, almost every known type, except dry-core, being in use: lead covered, leadless, singles, concentric, triple concentric, multicore, armoured and unarmoured, up to 3,000 volts. This has produced correspondingly numerous types of joint boxes required.

POWER HOUSE EQUIPMENT.

The **Lancashire Dynamo & Motor Co.** are supplying machines for private as well as public power houses. One of the larger alternators which they have recently constructed is a 300kw. set for Palmer's Shipbuilding Co. of Jarrow-on-Tyne. It is a 12-pole machine, running at 30 periods per second and designed for 300kw. at 440 volts with a power-factor of 0·8. The machine is directly coupled to an Alley & McLellan high-speed engine running at 300 revs. per min., and carries a four-pole exciter coupled to the alternator shaft. A motor generator is used in connection with this for providing continuous current for lighting in the shipyard. It consists of an induction motor connected to the three-phase mains and a 30kw. continuous-current generator. The Company is also building at the present time two motor-generator sets for the Urban District Council of Acton. These sets will take current from the Metropolitan Electric Supply Co. at 10,000 volts, two-phase, 60 periods, the pressure being applied directly to the stator.

The **British Westinghouse** Co. are now manufacturing single-acting gas engines from 7½ B.H.P. upwards. From 7½ to 275 B.H.P., they are vertical in form, with either two or three cylinders. The two-cylinder style includes sizes from 7½ to 55 B.H.P.; while the sizes of the three-cylinder style range from 37 to 275 B.H.P. Above 275 B.H.P. the engines are double-acting, and have either vertical or horizontal cylinders. These engines operate with either illuminating or producer gas, the larger sizes working also with blast-furnace or coke oven gas. The small sizes can also be run on petrol, which enables them to be used in isolated installations where illuminating gas is not available. The half-speed shaft for operating the igniters and valves is driven by means of toothed gearing, a pinion on the crank-shaft engaging with a toothed wheel on the cam-shaft. The cylinder heads, the upper parts of the cylinders and all such parts of the valve seats and valves as require it are thoroughly water-jacketed. In the Westinghouse gas engine, the frequency of the impulses is the same for all loads, and the relative proportions of gas and air also remain constant. What is varied is the amount of the mixture admitted to the cylinders, the strength of the explosion and impulse being thus graduated exactly to the power required.



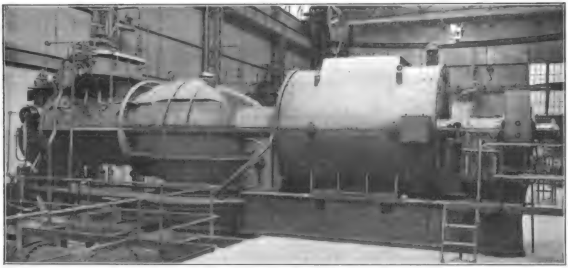
Sectional Elevation of Westinghouse Gas Engine.

The governor is driven by bevelled gearing at the end of the cam-shaft. The gas enters through one valve and the air through another, the mixture then passing through the regulating valve, which is acted upon directly by the governor. Thus the quantity of the mixed air and gas passing through the chamber to the "header" or passage leading to the inlet valves of the cylinders is so controlled as to keep the speed of the engine constant.

The engine is started by means of compressed air, the air supply being furnished by a small compressor which may be driven off the main engine, or by means of a small auxiliary gas engine or an electric motor. The air is stored in iron tanks at a pressure of 250lb. per square inch.

With ordinary town gas, 14 to 17 cubic ft. per brake-horse-power-hour are required, and with producer gas rather less than 1lb. of coal per brake-horse-power hour. As regards cooling water, under average conditions a circulation of from 4 to 5 gallons per brake-horse-power-hour is all that is necessary. With moderate-sized engines the ordinary cooling tanks are employed; but with larger sizes a cooling tower or cooling pond—such as are used with condensing steam plant—is necessary, except in cases where a sufficient supply of running water is available.

Messrs. C. A. PARSONS & Co., of Newcastle-upon-Tyne, have sent us a photograph of one of their large turbo-generators installed in the Carville Power House of the Newcastle-upon-Tyne Electric Supply Co. This machine has a normal capacity of 4,000kw., but it is also capable of dealing with 5,000kw. for one hour, or 5,500kw. momentarily. The steam consumption under working conditions is 18lb. per kilowatt hour. Adjustment of the governor is effected by hand or electrically from the switchboard. When working at 1,200 revs. per min. the frequency is 40 ∿ per second, and the voltage 5,750, the alternators being of the three-phase revolving field type. A two-pole exciter is mounted on the end of the shaft. It is interesting to observe that the turbine blades are laced in both high and low-pressure cylinders.



PARSONS 5,000KW. TURBO-GENERATOR AT CARVILLE.

Messrs. CROSSLEY BROS., of Openshaw, Manchester, have sent us the following particulars of a test on the gas engine which they supplied for the Howrah station of the Calcutta Electric Supply Co. The engine is one of the firm's "YE" high-speed type and is connected to a Crompton dynamo, the test having been made by Messrs. Crompton before shipment on September 7th last:—

Engine started with compressed air with pressure in reservoir 100lb. per square inch. Coke used obtained from Manchester Corporation gas works; sample analysed consisted of following: Ash, 15·60 per cent.; moisture, 1·30 per cent.; volatile matter, 1·80 per cent.; fixed carbon, 81·30 per cent.; having a calorific value of 12,411 B.T.U. per pound; 6,896 calories per kilogramme.

Dynamo ran sparklessly at all loads with fixed brushes, and perfectly cool. Efficiency obtained from tests at Chelmsford, 91·75 per cent. Electrical readings taken were 1 per cent. low; the instruments after test being calibrated with standards at the Manchester Technical School. After test, valves and sparking plug examined and found in good condition, no excess water present in gas pipes, expansion box or pockets.

To ensure complete accuracy with regard to the measuring of the fuel after the test run, the ashes and clinker were removed from the lower portion of the producer and the fire was made good again to a predetermined level at which the start was commenced. The actual time of the full-load test was six hours, but the producer was working 20 minutes before this to get the fire in good condition for starting for the full load, and the fuel so burnt was not deducted from the total consumption, so that the results given below would have been slightly better if any arrangement had been made to measure the amount of such coal burnt before the commencement of the full-load test.

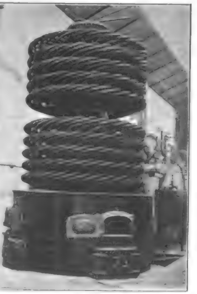
Summary.—Total fuel consumed, 488lb; total kilowatt-hours, 368·4 (corrected); fuel per hour, 81·3lb.; kilowatts per hour, 61·4; fuel per kilowatt-hour, 1·325. This is equal to 0·92lb. per brake horse-power-hour.

Messrs. MATHER & PLATT send us a new issue of their catalogue of polyphase generators, which deals with machines from 75 to 1,500 kilovolt-amperes.

Descriptions of the Niclausse boilers and the Willans engines supplied by Messrs. WILLANS & ROBINSON in connection with the South Wales Electrical Power Distribution Co.'s scheme appear on another page of this issue.

Messrs. CROMPTON & Co. have brought out the Crompton-McIntosh automatic reversible booster, a description of which we hope to publish shortly.

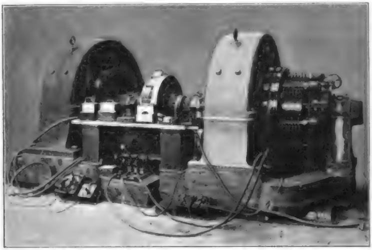
The Climax boiler, made in this country by Messrs. B. R. ROWLAND & Co., of Climax Works, Reddish, near Manchester, has already been described in detail in our columns. The illustration shows one of these boilers in course of erection at the Lincoln Corporation electricity works next to two boilers of the ordinary horizontal type.



CLIMAX BOILER AT THE LINCOLN ELECTRICITY WORKS.

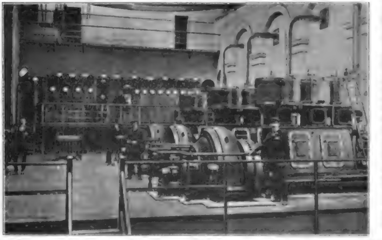
The illustration shows the boiler during erection previous to the fixing of the superheater and the upper casing of the plates. The tubes have all been expanded, and the boiler is ready for testing by hydraulic pressure. The tubular portion is divided as shown for the emplacement of the superheater, which has been specially designed for this type of boiler. The capacity of the boiler illustrated is 6,000lb. of water per hour, and the floor space occupied is only 80 sq. ft. The tubes are interchangeable, as only one size of length of end tube is employed. Both ends of each tube are expanded into one central shell, so that each tube is entirely free to expand and contract.

We illustrate below two of Messrs. JOHNSON & PHILLIPS' multipolar dynamos coupled together for the Hopkinson test at their works. These machines will each be driven by a Gilkes turbine running at 1,850 revs. per min. The output of each generator is 250kw., and they are designed to deal with a practically continuous overload of 20 per cent. or a momentary overload of 50 per cent. The machines are compound-wound, working at 550 volts at full load and 500 volts at no load, the normal current being 454 amperes. The generator efficiency at ¾-load is 98 per cent.



Two "Johnson & Phillips'" 250kw. Generators under Test.

THE ELECTRIC CONSTRUCTION Co. have installed at Wellington, New Zealand, three 300kw. sets and one 150kw. set supplying continuous-current. We give an illustration of the engine room in these works. We have also received from the same firm a fine photograph of a three-phase synchronous motor generator with an induction motor for starting. The machine has been supplied to Rowley Regis Urban District Council and consists of a 250 volt synchronous motor driving a 550-volt continuous-current generator, the rating being 150kw. and the speed 428 revs. per min.



Plant Installed at Wellington, New Zealand. Three Sets each 300kw. and one of 150kw.

The STIRLING BOILER Co., of Motherwell, announce that they have been supplying many important installations lately, including the electricity works at Neepsend, Sheffield, a description of which appeared in our issue of July 8 last.

Messrs. MELDRUM BROS. of Timperley, Manchester, inform us that they are now fitting a number of their mechanical stokers in various parts of the country. Four Babcock & Wilcox boilers at the Avonbank station of the Bristol Corporation are being thus equipped, bringing the total number up to 12. We have received a large number of drawings from Messrs. Meldrum, one of which shows a combination of their "Koker" stoker with all the forced draught features usually combined with these machines, and an induced draught arrangement in addition. One of the firm's clients has a range so fitted; his chimney was originally built for a very small steam plant, but, owing to extensive additions to the boiler and the works, and to restricted available land, the chimney became inadequate and the main flue arrangement became very unsatisfactory. An attempt was made to run the boilers with induced draught only, but this was not found feasible, and the plant is now running with mechanical stokers plus forced draught, the fan being used solely to create a sufficient vacuum to draw off the combustion gases. The forcing action only occurs in the passage of the air supply through the fuel, and we are informed that it is found more economical for this work to be done by the blowers, although the fan could be speeded up above its present rate of work. Meldrum forced-draught stokers have also been fitted to water-tube boilers under similar conditions.

Messrs. RICHARDSONS, WESTGARTH & Co., of Hartlepool, have sent us particulars of a Parsons type turbine, which they manufacture, embodying all the improvements and modifications which have been the result of Messrs. Brown, Boveri & Co.'s experience during the past few years. Machinery now manufactured at Hartlepool is being built to gauge absolutely interchangeable with that produced at Messrs. Brown, Boveri's works. Among machines already supplied is a turbo-generator of 750kw. output, which is the first example in this country of a continuous-current turbo generator built on the Brown, Boveri-Deri compensated system. The generators are tandem machines, each giving a normal output of 1,600 amperes at 240 volts, the commutation being, it is stated, absolutely sparkless with fixed metallic brushes throughout the whole range of load. Messrs. Richardsons, Westgarth & Co. have also recently taken up the manufacture of the "Nesdrum" water-tube boiler under Messrs. Hornsby's patents, in which straight upright tubes are employed.

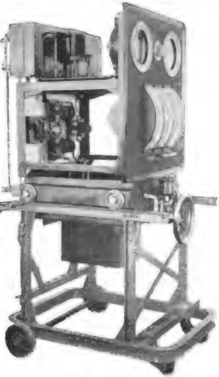
The CAPE ASBESTOS Co. of 8, Minories, London, E.C., inform us that the tests of their blue asbestos packing recently published in *The Electrician* are fully borne out in practice. This material, it will be remembered, is used not only for steam pipes but also for boilers and in addition to its high efficiency it is durable and light, so that it can be easily handled. The company recommend the employment of blue asbestos removal mattresses enclosed in blue planished steel casing secured to brass or polished steel bands, or as a cheaper alternative blue "economic" rope with canvas laced over it, the latter being painted with fireproof paint.

A description of the switchboards supplied by Messrs. FERRANTI LTD. to the South Wales Electrical Power Distribution Co., including a new low-tension switchboard and a mains charging device, appears in this issue.

Messrs. DOULTON & Co., of Lambeth, London, have sent us a detailed description of their patent water softener which we hope to publish in an early issue.

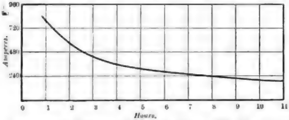
The ELECTRICAL POWER STORAGE Co., 4, Great Winchester-street, London, E.C., find there is a growing tendency towards putting larger batteries into power stations, and to meet this demand they have introduced a large type of plate called their "O.K." type, which has a good capacity for very high rates of discharge up to 100 amperes per positive for one hour. Each plate may be separately removed without interfering with the remainder or with the circuit. The floor space occupied is comparatively small, an O.K. type cell occupying only about one-half the space taken by a "P" type of equal capacity. The crates of the "O.K." cells are built up of separate lead-antimony castings mortised together at the corners and then burnt solid. Batteries of this "O.K." type have been supplied to the Corporations of Brighton, Devonport, Newport, Sunderland and Tynemouth, the Metropolitan Electric Supply Co., the Royal Mint, &c.

The ELECTRICAL Co., are introducing a "Draw-out Carriage" switchboard for high-tension three-phase work, the principle of which is illustrated below. The switches are of the oil-break pattern with tripping devices, those on the generator panel being operated by means of maximum current relays on each of the three phases, and also by one maximum reverse-current relay. All of these relays can be set for a pre-determined time limit. No fuses are used and the instruments are of the dead-beat edgewise induction type. The exciter regulators are placed below the switchboard, the handwheels being mounted on a column placed in front of the generator panel; the ammeter for the exciter circuit is also mounted on this column. As is seen in the illustration, the gear is mounted on a portable carriage, connection to the 'bus bars being made through specially designed contact clips. Should any part of the switchgear on the carriage become inoperative, the whole carriage can be taken out of its cell and a duplicate carriage substituted. Each panel is isolated from its neighbour by fireproof partitions.



THE ELECTRICAL CO.'S NEW SWITCHGEAR.

The HART ACCUMULATOR Co., of Marshgate-lane, Stratford, London, E., announce that their "C. L." type cells have been specially designed for power-station work. The plates are of heavy pattern, combining the advantages of both the Faure and Planté types of grid, and the lead oxides with which the grids are pasted are of a special character and composition, which, after 23 years' experience, the makers find to be best suited for high and rapid discharges. A particularly hard and durable nature is given to the oxide by the process of formation, and the structure of the latter is such that it retains the required degree of porosity. The plates themselves are suspended on glass slabs, the tops of which are above the level of the electrolyte, and are separated by strong glass tubes. There is a distance between adjacent plates of $\frac{3}{16}$in., which greatly reduces the danger of internal short-circuits, and a space of 5½in. is provided underneath the plates for the accumulation of deposit, so that the cells can work for several years before it becomes necessary to dismantle them for cleaning purposes. All the plates are lead burned to the 'bus bars on the site, and the bars are so designed that any one plate can be removed, if necessary, without disturbing the remainder or cutting the cell out of circuit. Up to 1,000 ampere-hours glass containing boxes can be used, but above this size the boxes are made of wood lined with sheet lead, or, if desired, lead tanks can be supplied instead. The characteristic curve given herewith indicates the capacity of a 2,040 ampere-hour cell when discharging at any rate within the 1 to 10 hour limit, the final E.M.F. throughout being taken as 1·80 volts. We are informed that numbers of these batteries are working in conjunction with automatic reversible boosters in different parts of the country on power circuits. A watt-hour efficiency of 75 per cent. on a full discharge and an ampere-hour efficiency of 90 per cent. are guaranteed.



CURVE SHOWING CAPACITY OF 2,040 AMPERE-HOUR C.L. TYPE HART CELL. WHEN DISCHARGED AT ANY RATE WITHIN 1 TO 10 HOURS LIMIT 1·80 FINAL VOLTS.

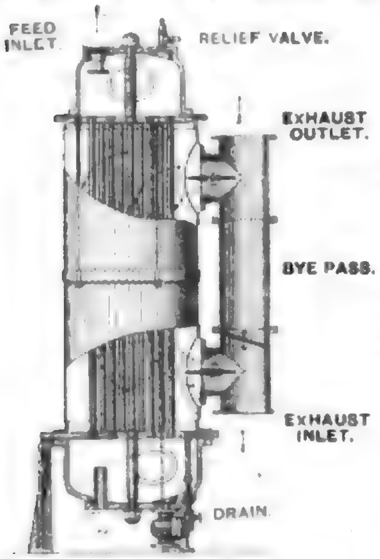
The CHLORIDE ELECTRICAL STORAGE Co. (39, Victoria-street, London, S.W.) are now supplying a novel form of separator, which consists of a thin sheet of wood veneer forming a continuous diaphragm between plates of opposite polarity. The separator is $\frac{1}{12}$in. thick, and is supported by two wooden dowels, which themselves rest on the bottom of the box. Experiment has demonstrated that the internal resistance of the cell is not affected by the presence of the wood separator, and it possesses a marked superiority in actual practice over the more usual types of glass rods or ebonite forks. The demand for cells with large outputs which are now so frequently called for, and the necessity of arranging such cells in single tiers has produced the Chloride Co.'s "Double C.R." type illustrated herewith. The plates, which measure about 35in. by 15in., are the largest that have been yet manufactured, and have a capacity of 270 ampere-hours each. They are contained in lead-lined wood boxes nearly 4ft. deep, allowing ample clearance, the plates themselves being supported clear of the acid by glass hangers. The special mixture employed for the grid ensures great rigidity even in a plate of such considerable depth. The company's new "Exide" negative is used with all sizes of the R type positive, and, in conjunction with the board separator described above, marks a considerable progress in accumulator manufacture.

NEW TYPE BOARD SEPARATOR.

"DOUBLE C.R." TYPE CELL.

A maximum demand indicator specially designed for power schemes was brought out by the REASON MFG. Co., Brighton, a short time ago on the suggestion of Mr. C. H. Merz, and was described by Mr. J. R. Dick in our issue for July 1st last. The company have recently placed on the market another demand indicator, working on the electromagnetic principle, in order to provide a somewhat cheaper means of measuring a consumer's maximum demand than the thermal type of instrument. We hope to publish a description of this meter in an early issue, as well as a description of the new prepayment meter which the firm has recently put on the market.

Messrs. **Babcock & Wilcox** of Oriel House, Farringdon-street, London, have recently fitted a fine specimen of a coal conveying plant at the Brimsdown works of the North Metropolitan Electric Power Supply Co., a description of which appears on another page. In addition to their large boiler business they have also been supplying recently a large number of exhaust steam feed-water heaters of the pattern shown in the illustration below. The drawing is, to a certain extent, self-explanatory. The feed water passes through the interior of the tubes from top to bottom and advantage is thus taken of the fact that the tubes are stronger to resist internal than external pressure. It is also more convenient to clean the inside of tubes than the outside. The steam impinges against the outer surface of the tubes and ample area is allowed between them so as to avoid back pressure on the engine. There is no contact between the water and the steam and consequently the oil from the exhaust does not mix with the feed water.



Messrs. **Chamberlain & Hookham**, of Birmingham, have devised a modification of their ampere-hour type of meter, and are putting on the market a new pattern which will record correctly the actual energy consumed on a circuit of varying pressure. We propose to publish a description of this meter in an early issue.

The **Aron Meter Co.**, of 114-118, Union-street, Borough, S.E., have brought out a new pattern of three-phase meter which they claim gives particularly accurate results and is unaffected by low power-factors, as there is no iron whatever in its construction, and the self-induction of the shunt circuit is rendered of no importance by the insertion of a large non-inductive resistance in series with the working coil. The meter contains three main coils over which two pendulums are arranged to swing.

Mr. G. **Braulik**, of Upper Thames-street, London, has sent us a description of the latest type of the "Eclipse" meters, which we also reserve for a future issue.

ELECTRIC POWER AT THE "SCOTSMAN" OFFICES.

The modern printing press used in a large newspaper office at the present time is no more like the manually-operated contrivance than a 5,000kw. turbo-alternator is like an old-time Edison dynamo. Actually the huge machines which print and fold many thousand newspapers in an hour are marvels of ingenuity and engineering—if the two are not synonymous—and it is doubtful if the intricacies of their gear and movements do not surpass those of any other machine used for any purpose whatever. When these presses are driven by up-to-date electric motors, then it may be said that the combination represents the very latest practice in this direction. Such is the equipment of the *Scotsman* printing offices at Edinburgh. These offices, which have only just been completed, are situated in a magnificent block of buildings in Bridge-street, and it may safely be said that the *Scotsman* is the first great daily newspaper in Scotland to be produced entirely by electricity; there is no other form of motive power whatsoever within the works. Trials of electrically-driven presses were made by the proprietors of the paper some time ago in the old offices, and these were so satisfactory that, on removing to the new premises, it was decided to dispense with all other sources of power.

The total of the power and lighting installations represents an equivalent of 10,200 8 c.p. lamp connections. Current is taken from the Corporation supply, entering the buildings at two separate points, and in the case of the 460-volt supply there are also special and independent feeders to guard against any serious stoppage due to breakdown of the mains. From each service three independent feeders at 246 volts are taken to three large change-over switches mounted upon a large power switchboard, this board being divided into three distinct sections controlling the following motors: Two 20 H.P. motors by the British Electric Plant Co., driving two large Musgrave fans for the hot-air heating of the building; two 50 H.P. Bullock motors, with "teaser" equipment, driving two quadruple rotary presses; two 50 H.P. Bullock motors, with "teaser" equipment, driving two four-reel rotary presses; one 25 H.P. Bullock motor, with "teaser" equipment, driving one two-reel rotary press. There are, in addition, a large number of smaller motors. Of the two 6 H.P. motors situated in the stereotyping department drive the small saws, bill printing machine, &c., one acts more or less as a stand-by, and the countershaft is provided with the necessary clutches and slipping gear for throwing the load on to either motor. A 6 H.P. motor drives lathes and boring machines, &c., in the machine repairing shop; there is a reeling machine driven by a 6 H.P. motor; another 6 H.P. motor drives a Smith and Stevens paper elevator; there is a 6 H.P. motor for the bill machine; and, finally, two 12 H.P. motors, situated in the Linotype department, work 30 Linotype machines. As in the case of the stereotyping department, the countershaft is also provided with shipping gear and clutches for throwing on the load to either motor or both. Besides the above motors, there are a number of smaller motors varying from 2 H.P. to 4 H.P. used for various purposes throughout the building, all being connected to an independent 230-volt power supply, and so arranged that other small motors can readily be connected from time to time.

In the event of breakdown with one service, current can at once be obtained from the emergency service by throwing over the "change-over" switch.

For the lighting and 230-volt power installation duplicate services are not provided, but services, in the usual way, are taken from both sides of the system at 230 volts, with large main distributing boards and fuseboards located centrally in the various sections controlled. There are three systems of lighting adopted: The inverted arc method with upper umbrella reflectors, the lamps in use being those of Körting & Mathieson's manufacture of the differential inverted type, working five in series on 230 volts, with a starting switch for each circuit. Supplementing the arcs on the large Linotype and machine room floors are numerous Nernst lamps of the "Luna" 1 ampere type. In addition to the arcs and Nernst lamps, all the compositors and individual workers are provided with independent incandescent lamps. Ordinary incandescent electric lighting is provided for all the offices and other departments throughout the building.

All cables, both for power and lighting purposes, are drawn, by means of pits and boxes, through a complete system of iron tubing fitted with iron boxes at all fittings, switch and board points, the whole system being continuous from beginning to end, and earthed. Messrs. W. Barton & Sons were the contractors for this portion of the work.

The quadruple rotary presses mentioned above are capable of turning out, ready folded and counted, 24,000 16-page newspapers each per hour, and the four-reel rotary presses have a similar output. The two-reel rotary presses turn out 24,000 eight-page newspapers each per hour. These machines require an unusually large torque on the part of the motor to start them, this being sometimes as much as five or six times the torque which the motor is called upon to produce normally at full load. In order to provide a large starting current at a low voltage without the wasteful resistances that would be required, the "teaser" equipment of the Bullock Manufacturing Co. has been adopted for the driving of these presses, this process having been in use by the proprietors of the *Scotsman* in their old premises for many years.

We are indebted to Messrs. Buchan and Hogarth, consulting engineers for the scheme, for the above information, and to the proprietors of the *Scotsman* for permitting our representative to inspect the offices.

THE USE OF IRON IN ALTERNATE-CURRENT INSTRUMENTS.*

BY DR. W. E. SUMPNER.

(Continued from page 224.)

The first instrument using this principle which I had made was of the reflecting type, having a metallically suspended coil as in ordinary moving-coil galvanometers. Its action was promising. I have since constructed two non-reflecting instruments, illustrated in Figs. 4 and 5. In each of these instruments the moving coil is exactly similar to those used in commercial moving-coil instruments for direct currents. They are pivoted and controlled by helical springs of the usual kind. That of the earlier instrument is of the Manchester dynamo type, and contained two air-gaps. The later instrument has a magnet of the Lahmeyer type, but arranged to have only one air-gap. By winding the magnetising coil on the centre limb as in Fig. 5, instead of on the two side limbs as in Fig. 4, the effect of an ampere-turn is doubled, and by reducing the number of air gaps from two to one the effect is again doubled. To further reduce the copper drop CR as compared with V_1, the voltage on the magnetising coil, this coil should be liberally supplied with copper, and should fill as much winding space as possible. Of course the air-gap should be a minimum. In the instruments shown each air-gap is $\frac{3}{16}$in. across. It is quite possible to halve this and still allow plenty of room for the free movement of the coil.

The calibration curve of the instrument outlined in Fig. 4 was obtained by passing direct currents through the fixed and moving coils. For magnetising currents producing air-gap densities similar to those found in direct-current moving-coil instruments, the calibration curve obtained by varying the current in the moving coil was always of the same shape. When the deflection was interpreted by means of this calibration curve the reading was found strictly proportional to the product of the currents in the two coils. The instrument was then tested with alternate currents against a standard wattmeter on a non-inductive load of lamps. A voltage transformer was used to reduce the voltage of the circuit to one suitable for the instrument. The minute current through the moving coil (having 50 turns and a resistance 6 ohms) used in series with a non-inductive resistance of 300 ohms, was taken from a few turns of thin wire forming the secondary of a small iron cored transformer, the primary of which consisted of two turns carrying the load current. The experiments showed that the calibration curve, or the relation between deflection in degrees, and watts, was exactly the same as that obtained with direct currents, the load being non-inductive throughout the tests. When the power-factor of the load was suddenly altered from 1·0 to about 0·1 it was, however, found that the constant of the instrument was considerably changed. This result was due partly to the fact that the copper drop in the magnetising coil was not negligible compared with the applied voltage, but it was also largely due to the phase differences introduced by the two transformers, each of which had closed iron magnetic circuits. These transformers were indeed quite unsuited for the purpose, and the copper drop in the magnetising coil of the instrument was (at 40 cycles) about 20 per cent. of the total voltage applied. But even under these circumstances the deflection of the moving coil, as interpreted by the calibration curve obtained with direct currents, was strictly proportional to the watts for a load constant in power-factor and frequency.

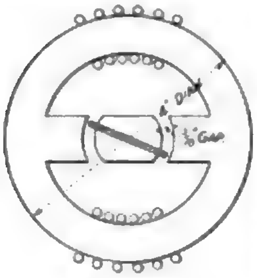


FIG. 4.

No further experiments were made on this instrument, which was constructed simply out of such stampings as were to hand, while waiting the arrival of special stampings ordered for the instrument shown in Fig. 5. In this instrument much more space was allowed for the magnetising coil, and in other ways already mentioned the construction was modified with the view of reducing the copper drop. The magnetising coil consists of 1,051 turns of No. 18 wire, having a resistance of 3·68 ohms. The section of the middle limb of the magnetic circuit is a trifle over 2 sq. in., the length of the winding bobbin is about 4in., the air-gap is $\frac{3}{16}$in. The moving coil consists of about 60 turns, having a resistance of 5·4 ohms. The structure is such that the moving coil can turn through an angle of 80deg. without leaving the field. Testing with currents of 80 cycles per second, it was found that 54 volts produced a current of 0·13 ampere through the magnetising coil. It follows that the copper drop is only 0·88 per cent. of the applied voltage when the frequency of the current is 80. This means that even supposing there are no hysteresis or other losses in the iron circuit, the phase of the applied voltage cannot differ from that of the induced voltage due to the flux in the coil by more than half a degree. If there are hysteresis losses, this phase difference will not be increased but diminished, since the vectors representing the copper drop, and the voltage due to the magnetic flux will no longer be at right angles to each other. In fact, hysteresis is an advantage from this point of view, although, of course, it increases the losses involved in producing the electromagnet. The losses in the magnetising coil are quite trifling. The copper losses for 0·13 ampere only amount to 0·062 watt. The iron losses I have not measured, but they must be small owing to low induction density and the small volume of iron. For the current transformer for this instrument I have simply wound a coil of 10 turns (resistance (0·0168 ohm) so as to surround a secondary coil of about 600 turns having a resistance of 8·5 ohms. No iron was used with this transformer. The copper losses for 20 amperes through the primary are 6·4 watts. These could easily be made negligible by using thicker wire.

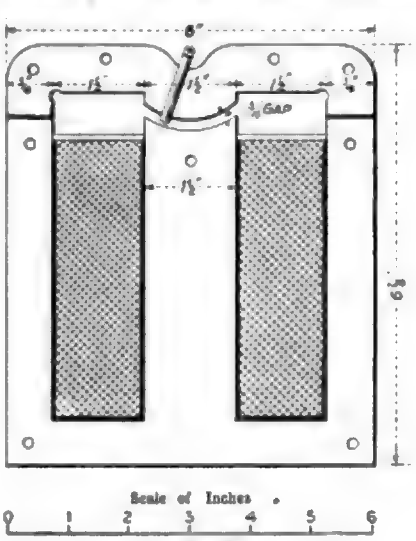


FIG. 5.

The results of several tests on the instrument with a resistance of 500 ohms in series with the moving coil and the current transformer are shown in Fig. 6. The calibration curve was first found by taking two sets of tests with direct currents. In one of these the magnetising current used was kept constant at 0·10 ampere,

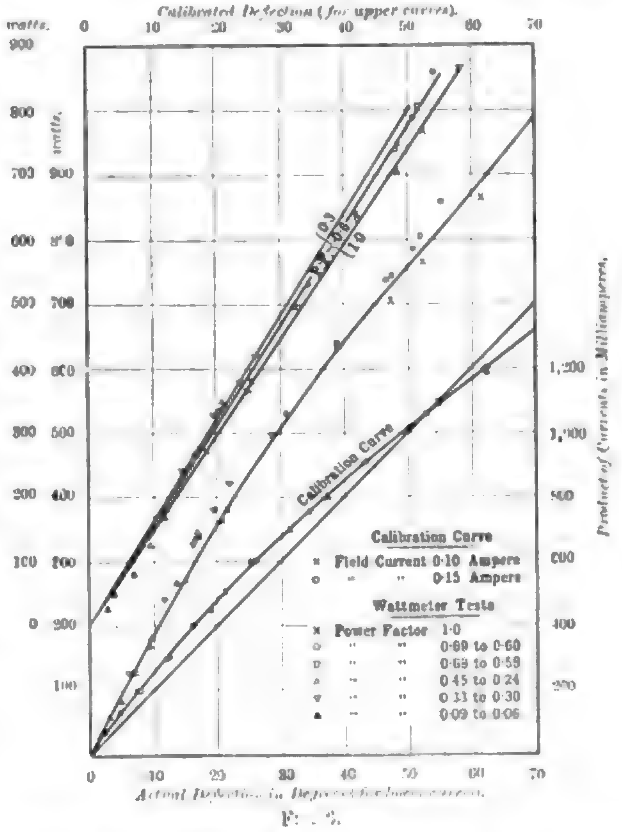


Fig. 6.

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* Chairman's inaugural address to the Birmingham Local Section of the Institution of Electrical Engineers, delivered on Wednesday, November 23rd. Slightly abridged.

and in the other set it was made 0·15 ampere. Various currents were passed through the moving coil, and the corresponding deflection in degrees shown by the pointer was noted. When the product of the two currents, each measured in milliamperes, was 1,006, a deflection of 50deg. was obtained. The observations are plotted to form the calibration curve, the two set of points being distinguished by different signs, as shown. It will be noticed that both sets of points lie well on the same curve. A straight line is drawn from the zero through the point corresponding with 50deg., in order to show the deviation of the calibration curve from strict proportionality. Six sets of tests with alternating currents were then made on loads of different power-factor, but with the current frequency kept constant at about 80 cycles, and the voltage of the circuit in all cases being about 60. In each set of tests, except for the non-inductive load, the power-factor of the load diminished as the current and deflection increased, the limiting values being indicated, and the points corresponding with different sets of tests being separately distinguished, as shown in Fig. 6. The line drawn among the points is a reproduction of the calibration curve, the ordinates of the latter being all increased by 50 per cent., in order to show how far this curve indicates the relation between the deflection and the watts. It appears from these tests, and from numerous others which I have made, that the same calibration curve holds for the instrument under all circumstances, or, in other words, that for a specially prepared scale determined from this calibration curve the reading of the pointer will be proportional to watts for a varying load of any fixed power-factor and frequency. The constant of the instrument does change to some extent for alterations of frequency and power-factor. The divergences of the plotted observations from the calibration curve drawn among the points indicate the alteration of constant with the power-factor of the load. To show this more clearly the observations have been replotted as shown in the upper curves of Fig. 6. In these curves the observed power in watts is plotted, not with the actual deflection of the instrument, but with the calibrated deflection as determined from the calibration curve for a scale properly graduated, and such that the reading is 50 for a deflection of 50deg. Under these circumstances all the observations for loads of the same power-factor should lie on a straight line drawn through the zero, and this proves to be the case. It appears from these tests that the constant for unity power-factor loads differs by about 4 per cent. from that for loads of power-factor 0·6, and by about 8 per cent. from that for loads of 0·3 power-factor. These changes are much greater than correspond with the phase difference of about 0·5deg. due to the copper drop in the magnetising coil, since reference to Table I. will show that for the power-factors mentioned, the changes in the constant should be respectively only 1·16 and 2·27 per cent. This shows that the main part of the alteration of constant is caused by the current transformer, which was not specially designed for the purpose, and the errors caused by which I have not yet had time to investigate. This view is confirmed by tests showing the effect of alteration of frequency. With the same resistance of 500 ohms, in series with the transformer secondary circuit, as used in the tests shown in Fig. 6, I found that for non-inductive loads traversed by currents the frequency of which varied from 93 cycles to 43 cycles, the alteration of the constant was 1·4 per cent. This change is very much greater than corresponds with the phase difference of half a degree at 80 cycles caused by the copper drop. The error due to the transformer can be reduced by diminishing the number of secondary turns, by increasing the number of primary turns, or by increasing the secondary resistance. Similar tests made, with a resistance of 750 ohms in the transformer circuit, showed a change of constant of less than 1·0 per cent. for frequencies varying between 100 cycles and 45 cycles. A set of tests on the effect of power-factor made with this resistance in series with the moving coil, and at a frequency of 80 cycles, showed no measurable alteration of constant for power-factors ranging between 1·0 and 0·1. Of course there must have been some error, but in such tests as I have as yet had time to make I was unable to detect it, and there seems no doubt that the error is much less than in the previous tests.

(To be concluded.)

CORRESPONDENCE.

PARALLELING VOLTMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Messrs. Evershed & Vignoles, in writing to you drawing attention to the double voltmeter arrangement of which they sent you an illustration, quite miss the point of our instrument, which you were good enough to illustrate recently in your paper—namely, that it is an illuminated dial edgewise combination of voltmeters, arranged to turn about a vertical axis, and capable of swinging through 120deg., or more if necessary. The arrangement which they illustrate is an old one which we ourselves have made for sundry supply stations during the last few years, so we hardly thought it was worth while to draw attention to this combination, which, though excellent in itself, presents no feature of novelty.—Yours, &c.,

NALDER BROTHERS & THOMPSON.
Fras. H. Nalder, Managing Director.
34, Queen-street, London, E.C., Nov. 25.

LEGAL INTELLIGENCE.

Estler Bros. v. J. Tylor & Sons (Ltd.).

In the Chancery Division on Wednesday, Mr. Justice Farwell commenced the hearing of an action for (1) damages for breach of agreement made between plaintiffs and defendants whereby defendants agreed not to manufacture, advertise or sell any castings made by them from stampings, designs or patterns belonging to plaintiffs and entrusted to defendants for the purpose of manufacture for the use of plaintiffs; (2) damages for breach of an implied contract not to manufacture, advertise or sell any castings made by defendants from drawings, designs or patterns of plaintiffs; (3) an injunction to restrain the breach of agreement and breach of confidence; (4) delivery up of all appliances, castings, fittings and patterns belonging to plaintiffs; (5) an injunction to restrain defendants from presenting or distributing any catalogues, photos, drawings or copies constituting an infringement of plaintiffs' copyright in their catalogues, "Ambroin overhead trolley line materials," and "Souvenir of the second International Tramways and Light Railways Exhibition," "The Estler Air-gap section Insulator," and "Wilkinson's patent trolley head improved patterns" (registered March 29, 1904); (6) delivery up to the plaintiffs of all copies, catalogues and drawings constituting infringement. Plaintiffs further claimed an account of the profits made by defendants on sales of fitting based on plaintiffs' drawings, designs or patterns.

Mr. UPJOHN, K.C., said this was a curious case. In 1900, plaintiffs, who had not then, as they had now, a foundry, got into communication with defendants and employed them to cast appliances which it was the business of plaintiffs to sell. It was expressly agreed between plaintiffs and two of the directors of defendant company, that whatever designs, drawings or patterns, &c., were sent to defendants for the purpose of castings should be treated as confidential, and should not be used by defendants for their own purposes or the purposes of other customers. Apart from the express agreement, it was pleaded that it was a custom of the engineers in iron and brass founding trades that, unless the contrary be expressly provided in the contract between the parties, the person employed by another to make for the purposes of sale castings, fittings or appliances or patterns from designs, drawings, patterns or samples supplied to him by the person so employing him for the purpose of such construction, shall not make any castings, fittings or appliances from such designs, patterns or samples other than those required for the purpose of fulfilling the orders of the person so employing him, and shall not use or sell for his own purposes, or in connection with his own business, any reproductions thereof. In 1902, defendants sent a letter to plaintiffs asking them for an estimate for designing electrical plant in conformance with a specification. Plaintiffs replied that, as a matter of fact, they had got these specifications and were competing themselves. They further expressed their surprise that defendants were going into that line of business. Thereupon defendants intimated that, as plaintiffs were tendering, they would withdraw. In 1904 plaintiffs were astonished to find that the defendants had got out a catalogue of electric traction equipment, and were still more astonished to find that, with a few exceptions, the illustrations in the book were photographs of castings from plaintiffs' own drawings. Defendants said that the manufacture and supply of electric traction materials formed a part of their business, but, if plaintiffs were correctly instructed, they had never issued a catalogue in connection with electric traction equipment before 1904. Defendants admitted that in October, 1900, they undertook to manufacture castings, &c., from designs and drawings supplied by plaintiffs, but they denied that the contract they entered into contained the express terms alleged by the plaintiffs or that there was a verbal agreement of the nature alleged. Defendants did not admit that any of the designs, drawings, patterns or samples supplied to them were original. They further denied that there was any such custom in the trade as that alleged. They admitted that, for the purpose of carrying out the orders of plaintiffs, it was necessary for the defendants to make metal or plate patterns, and that such patterns were, to some extent, taken from drawings or patterns supplied by plaintiffs, and that the metal or plate patterns so made by defendants remained in their possession. It was necessary, the defendants said, to manufacture such metal or plate patterns, because the drawings or patterns supplied by the plaintiffs were imperfect or faulty in design, and the defendants were obliged to manufacture plates or patterns of their own design for the purpose of carrying out the plaintiffs' orders. Defendants admitted that they had advertised and continued to advertise fittings, castings and appliances which were reproductions of some of the fittings, castings and appliances made by them for plaintiffs in pursuance of directions given by plaintiffs, and that in so doing they had made use of the metal or plate patterns manufactured for plaintiffs. Defendants further admitted that they had advertised such fittings, castings and appliances in an illustrated catalogue of electric traction equipment containing illustrations from photographs taken from some of the fittings, castings and appliances made by the defendants for the plaintiffs. The fittings, castings and appliances so reproduced and advertised defendants said were common to the trade.

In 1900 the plaintiffs and half-a-dozen other firms were the only people who carried on the business of manufacturing such electrical equipment. Even if the things defendants manufactured were common form, the defendants had no right to make goods in accordance with plaintiffs' designs, or reproduce their designs. Defendants (counsel submitted) had no experience or knowledge to enable them to make designs of their own. In their particulars defendants represented that the drawings or patterns supplied by plaintiffs were imperfect, useless or faulty in design, because the castings which would have been produced therefrom would not have been sound, as the metal became drawn when cooling owing to the design of the pattern, would be generally unsuitable for the purposes for which they were intended, and would not be of any practical utility. The plaintiffs were anxious to know the plates and patterns of defendants' own design from which defendants said they manufactured. Defendants said that, so far as they were at present able to give particulars, it was a section of an insulator.

Mr. PAUL ESTLER, in his evidence, stated that his firm was founded in 1897. Electric tramway fittings were a speciality of the firm, particularly fittings for overhead tramways. They had few competitors in 1897. The business consisted of selling completed articles, and it was a very successful one. In 1900 they could not get sufficient castings from one foundry and they had to get the assistance of another. This led to communication with defendants, who undertook to make castings from plaintiffs' design, and the directors of the defendant company undertook to treat all drawings and designs as confidential and to make no castings from them for any other firm. Witness afterwards gave evidence to the effect that many of the designs in defendants' catalogue of 1904 were similar to the designs plaintiffs had given defendants to make patterns and castings from. What defendants agreed to do was not to make any castings from plaintiffs' patterns, drawings and designs.

Mr. JENKINS, K.C., for the defence, said the catalogue showed merely pictures of insulators, and defendants did not pretend to ask for orders for the particular type shown.

WITNESS said he could not agree with that suggestion.

Mr. JENKINS: The effect of the thing was surely to invite engineers to give their own directions?—The illustration is of our insulator. I should have shown half-a-dozen different sorts if I had wished to convey that impression.

His LORDSHIP (addressing Mr. Jenkins) said at present he (the learned Judge) thought that as regarded some of the reproductions there was originality and in some not. Was that sufficient for the purposes of argument?

Mr. JENKINS: I should think that, assuming it to be relevant, it would be enough, unless I can displace what the witness has said. If my learned friend is right about the catalogue, I cannot ask the Court to express an opinion upon everything; but it might make some difference if I could displace them in a real sense in all the things.

The hearing was adjourned.

Yesterday Mr. E. P. ESTLER gave evidence, and said Mr. Bright, one of the directors of the defendant firm, had agreed not to make fittings from plaintiffs' patterns for any other person or firm. This was a new class of business defendants were now carrying on.

Mr. C. MITTLEHAUSEN, C.E., said he had been for some years traction manager to the Cork Electric Tramways & Lighting Co. He had had considerable experience of engineering foundries. For some time he had been assistant to Siemens Brothers & Co., and had had to give many orders for castings. There was a distinct understanding in the trade that patterns and designs which were sent to a founder for casting must not be used for other persons except with the consent of the customer giving these designs, patterns and samples. The custom prevailed even when the designs were not registered.

Mr. T. BATE, C.E., manager of the Electric & Ordnance Accessories Co., said he had 30 years' experience in engineering and foundry trades. With regard to plate patterns there was a custom in the trade that designs, whether applying to common articles or not, should not be used by the founder for the purposes of other customers.

For the defence, Mr. P. BRIGHT said he was managing director of defendant company. In 1900 he saw one of the plaintiffs concerning castings. There were two questions discussed, one the question of price, and the other the question of speedy delivery. He told Mr. Estler they could make castings very quickly, and that they were admirably equipped for making them. Following that interview came an order for castings. Nothing was said at any time as to what should be done with the castings. If a large quantity of castings was wanted a metal pattern was indispensable. The orders from the plaintiffs were large ones and they (defendants) had to make in most cases metal patterns to carry them out. Nothing was said as to what defendants might do with the patterns made from drawings or samples sent by plaintiffs. Defendants' business was 130 years old. All the drawings, samples and patterns sent by the plaintiffs were plaintiffs' property. He believed when he published the catalogue that all the articles in it were common to the trade. He had only sent out 40 copies of the catalogue, and when objection was taken by plaintiffs orders were given that no more should be sent out pending the trial. They had not supplied any order on the footing of this catalogue. Defendants' business was a large one. They were contractors to the Admiralty, the War Office, the India Office, &c. They had not sold articles of electrical equipment as finished goods within the last four or five years. They had sold finished electrical articles to the General Electric Co., but he had not given plaintiffs any explanation as to why he had done so, and he never heard of any such explanation being given. As to the metal patterns the defendants never charged the plaintiffs anything for them. They got out their calculations on the basis of the weight of the things to be made. If no charge were made for metal patterns by the founder he thought the founder had a right to use them for anybody he liked if such articles were common to the trade. If it were an absolutely original design, then, he did not think the founder had a right to use it at all for the purpose of selling to others. When his catalogue was issued he did not know that any of the articles illustrated in it were the subject of patterns of the plaintiffs. He thought Mr. Estler complained that he had seen some fittings at an exhibition, which he thought had been made by defendants, but he was not aware that he questioned any sale. Plaintiffs might have seen a review of the catalogue in one of the electrical papers, but he did not think defendants had advertised it in any of these papers. It was not their practice to advertise.

Mr. UPJOHN: I suggest to you that many of the photos in your catalogue are photographs of articles that were cast by you from a pattern or sample supplied by plaintiffs when you were in course of executing plaintiffs' orders?—We made our own casts from the patterns supplied by plaintiffs.

The metal or plate patterns used in making castings which are photographed in this catalogue were themselves based on drawings or wooden patterns delivered to you by the plaintiffs for the purpose of their order? Not altogether; many of them were from samples, but alterations were subsequently made on many of the samples sent to us.

How can you justify this statement in your affidavit: "I absolutely deny that some or any illustrations in our catalogue were reproduced from articles made from patterns or samples supplied by the plaintiffs. On the contrary, all illustrations in the catalogue are photographs of articles made by ourselves from patterns the exclusive property of the defendant company and for the purpose of the defendant company's business and not for the plaintiffs."—I think the words "made for the purposes of the defendant company's business" are not quite correct.

His LORDSHIP: You have sworn this affidavit yourself. You should be able to interpret it.

Before this witness had concluded his evidence, Mr. JENKINS said defendants had always contended that the articles appearing in the catalogue were common to the trade. He thought that an honest mistake had been made about that, and he was bound to confess, on the facts proved, that certainly some of the articles were not common to the trade. After what Mr Bright had stated in the box, Counsel did not propose to call further evidence to suggest that the custom was confined to patented or registered designs. He wished to make an end of the whole thing. They would destroy any copies of the catalogues still in their possession, the metal castings would be destroyed, and they would start afresh.

Defendants ultimately submitted to an injunction, and further undertook to destroy all the disputed castings in their possession, as well as copies of the catalogue.

Plaintiffs did not press the part of the claim based upon copyright, and in respect of this issue the Judge deprived them of their costs.

Acetylene Illuminating Co. (Ltd.) and Willson Laboratory (Appellants) v. United Alkali Co. (Ltd.) (Respondents).

In the House of Lords (before the Lord Chancellor and Lords Davey and Robertson) on Tuesday judgment was given in this appeal. The matter was dealt with briefly in our last issue (p. 233).

Mr. FLETCHER MOULTON, K.C., for appellants, explained that the invention was a process for the production of crystalline calcium carbide, in which an electric current was passed through a mixture of lime and carbon contained in any suitable electric furnace. The patentee stated that a Siemens arc furnace was a suitable electric furnace for that purpose, and described in his specification how the process was carried out when such a furnace was used, but he in no wise confined his claims to that particular type of furnace. In the infringing process it was contended this specification was more or less copied. On these grounds mainly appellants submitted that respondents had infringed the first claim of their patent, but the alleged infringement was not confined to the first claim, for respondents had infringed the second claim.

The LORD CHANCELLOR: The respondents attacked the validity of the patent (*a*) for want of novelty, (*b*) for want of proper subject matter, and (*c*) by reason of a prior grant to G. B. Ellis of the Letters Patent No. 16,342 of 1894.

Mr. MOULTON: That is so. Respondents, in support of their contention that the patent lacked novelty and proper subject matter, had relied on the publication in this country, prior to the date of the patent, of the print of the United States Specification No. 492,377 and of a Paper by M. Henri Moissan communicated to the Academie des Sciences in March, 1894 and reprinted in "Comptes Rendus." The United States specification contained no sufficient directions how to make calcium carbide. The words calcium carbide only occurred in the last paragraph where the inventor said "For example I have already employed it" (*i.e.*, the invention) "for reducing calcium oxide and producing calcium carbide." Whatever directions might be spelt out of the specification were wrong if the aim were the practical production of calcium carbide. Crystalline calcium carbide, which was what plaintiff claimed to produce by his patent, was not mentioned in the American specification. He submitted that appellants' process of generating the necessary heat by a current passing through the mixture, instead of heating the mixture by radiated heat, was novel at the date of the Letters Patent and being a more economical use of the necessary electrical power was obviously useful.

Their LORDSHIPS intimated that they would not require to hear counsel for the respondents.

The LORD CHANCELLOR, in giving judgment, said in this case it was to be observed that no doubt had been entertained by any of the learned judges before whom this question had come as to what should be the result of the litigation. Two points had been raised by the defence, either of which, it appeared to him, if not answered, would be fatal to the appellants. It was said that the patent was invalid because, first, it was not subject matter for a patent, and, secondly, that there had been anticipation. The argument put forward on behalf of the appellants by Mr. Moulton was really a struggle, gallant as it was unsuccessful, to read into the specification something which was not there. The patent was one which could be supported neither as a discovery nor as an invention, although a mere discovery would be not enough. Looking at the specification, it was manifest that, according to its grammatical construction, all that the patentee described was that intense heat by an electrical furnace would produce the result, and if one gave the utmost latitude to the language and looked at the subject matter with which the patentee was dealing he thought it could be expressed very simply in the most popular language thus: Whereas this crystalline calcium carbide could be, without doubt, produced, it was admitted to be capable of being produced by the mere operation of what had been described as the thermal or calorific operation of the intense heat produced by an electric arc, and the only thing for which there was a plausible case to be made was this, that whereas it seemed to have been supposed at one time that if the arc passed through the materials out of which this crystalline calcium carbide was to be produced, it might he did not think it went further than that; not that it necessarily did—it might interfere with the chemical operation, and the object, therefore, was to keep the materials from the electrolysis that might have been produced by the electricity passing through the materials, and only to expose them to the radial heat, so that while they would be exposed to what had been called the "toasting" process, the intense heat not actually passing through the materials, but the materials being exposed to it, this calcium carbide could be produced. Now, the appellants said that the discovery made that no electrolysis, or, at all events, no injurious electrolysis, would result if it passed through the materials themselves. That appeared to his lordship to be the only point of the whole argument which could be sustained with any degree of plausibility. If that was the true result of the evidence, it was not enough to sustain a patent to say that one had discovered something in a known process which did not injure the result. As to anticipation, that high authority, Prof. Dewar said, in terms that he could not deny, that Moissau, in his Paper, actually described the process which was here, and that his object was to obtain crystalline calcium carbide. After that evidence, to maintain that there was anything which could be the subject of a patent appeared to his lordship to be a little bold. The question as to the subject-matter appeared to be equally clear, because if the state of knowledge was looked at, and if the only thing that could be put forward was the finding out that the actually passing of the arc through the materials produced injurious electrolysis, it would be contrary to every principle of established law that that discovery alone should be made the subject matter of a patent. The principle had been established beyond doubt that, under such circumstances, finding out that a thing which was known and practically used could be applied to another process was not subject matter for a patent. There was, indeed, a case in that House ("Thompson v. American Braided Co.") in which the Lord Chancellor said he regretted that he had not been able to concur with the judgments delivered which was not quite reconcilable with the principles which that House had laid down. At any rate, whatever subject matter the noble and learned Lords found in that case, it was perfectly clear here that the patent could not be supported as the invention of any new manufacture, nor could it be supported as a subject matter, giving every allowance to the patentee and allowing some part, indeed, of the specification to be ungrammatically construed. The word "[illegible]" appeared unquestionably to refer to the furnace itself, or rather, to speak more strictly still, to the chamber of the furnace and not to the materials. But he was willing to agree with the learned judge that slovenly composition and ungrammatical use of words, if the rest of the patent described that which the patentee really meant was the materials and not the furnace, would not vitiate the patent. But the answer to it was that there was no such qualification or other meaning to be found if the whole of the patent was looked at. On the contrary, beyond all doubt, the patentee meant what he said, and therefore it was not a slip of language. He had read the judgments, all of which appeared to him to be extremely satisfactory. Mr. Justice Buckley had gone through the whole of the evidence in this case, and he concurred in every word that that learned judge had said. The Court of Appeal had only repeated in other words what Mr. Justice Buckley had said, but he thought that Lord Justice Stirling had put in the tersest and smallest form possible the whole essence of the case. It was, therefore, enough for him to say that he thought all the judgments of learned judges in the courts below were perfectly satisfactory, and covered the whole ground. He moved, therefore, that the appeal should be dismissed.

Lord DAVEY and Lord ROBERTSON each delivered separate judgments, in which they concurred with the learned Lord Chancellor.

The appeal was accordingly dismissed with costs.

In re the Nernst Electric Light Co. (Ltd.).

In the Chancery Division on Tuesday Mr. Justice Swinfen Eady heard a petition by the company for reduction of its capital.

Mr. EVE, K.C., said the reduction was a very large one, but the price originally obtained by the company for its patent rights seemed to be out of all proportion to their intrinsic value. The reduction involved a modification of the rights of the preference shareholders—in fact, to some extent, an extinction—upon terms that were acceded to by a large majority of the shareholders. There was no notice of any opposition, and there was not at any of the meetings any expression of dissent. The company was incorporated in 1899 for acquiring the Nernst electric lamp patents, and the original capital was £320,000, of which £140,000 was preferred and £180,000 ordinary shares. The company expended £270,000 in the acquisition of patent rights. Of that sum £180,000 was paid in ordinary, £25,000 in preference shares and £65,000 in cash. The whole of the capital had been issued, but 520 of the preference shares had been forfeited for non-payment of calls and had not been re-issued. Resolutions had been passed that the estimated capital of the company be reduced to £90,000 in 90,000 ordinary shares of £1 each, and that the reduction be effected by cancelling 260 of the preference shares forfeited and never re-issued and by writing off capital to the extent of £227,740. When it was formed the company hoped that it had acquired an article of commercial use in the land, and they proceeded to establish a laboratory and to convert it into a factory. They expended on the warehouse and these technical matters £17,355, and the only assets they had to show were machinery and plant to the value of £250. The British royalties were of considerable value. The English company was now unable to manufacture the lamp at all. What they had to do was to go to a German company who had some secret process by which the lamp appeared to be made marketable. It was now a mere selling company of the lamps which would be manufactured by the German company. The British royalties were most valuable. That asset was acquired from Dr. Walter Nernst in August, 1899, and was apart from that for which the company paid £270,000. The chairman of the company (Mr. Bernard Mervyn Drake), stated in his affidavit that arrangements had been made with the Berlin Co., who were owners of other rights in the Nernst patent not belonging to the company. Until these arrangements were entered into with the Berlin Co. the petitioners made no profits and expended large sums on development account. During the first year under the arrangement with the Berlin Co. the profits of the company amounted to £3,926 1s. 11d., but he considered it more than doubtful whether this figure would be reached in the current financial year, and he was of opinion that although the lamp was making considerable headway, it could not in its present form supplant the ordinary incandescent lamp. The process of producing the lamps was a difficult one, and in large parts of the company's districts electricity was unknown and in some other parts the lamp had shown itself to be unsuitable on account of its unreliable behaviour, especially with varying voltages, and unless the lamp could be further improved he questioned whether the earning power of the company would exceed something between £4,000 and £5,000 a year. In round figures the investments, office furniture and fittings, excess of book debts due over book debts owing and other sundry assets amounted to something like £24,000. The patents if valued in the light of real earnings and taking into consideration the fact that they would expire in 1913 could not be treated as worth more than £46,000 and the royalties on lamps sold in England to which under the agreement the company was entitled might be estimated as worth another £20,000, making a total of £90,000.

His Lordship granted the petition.

Edwards and Brown v. Anderson and Hammond.

Mr. Justice Kekewich on Tuesday concluded the hearing of an action by plaintiffs to recover £93, balance of account for services rendered under an agreement.

Mr. McCALL, K.C., said plaintiffs were two experienced mechanics who had discovered an improved method of making conduits for electrical wires and cables. In order to exploit and work their patent and, if possible, form a company to work the invention, plaintiffs were introduced to defendant Hammond. Hammond suggested plaintiffs should leave the matter in his hands. Plaintiffs were subsequently introduced by Hammond to defendant Anderson, who, however, did nothing, and subsequently became bankrupt.

Mr. HAMMOND said some years ago when he was secretary of a firm of electrical engineers he knew the plaintiff Edwards, who put his scheme before him, and witness told him he was too busy to take the matter up, but he introduced Anderson.

Mr. ANDERSON said he became bankrupt in September last. Beyond the introduction of plaintiffs to witness, Mr. Hammond took little part in the matter.

His LORDSHIP held that plaintiffs had not proved their case sufficiently. As to the evidence of Hammond, he did not believe him. If, therefore, plaintiffs' evidence had been sufficient he would have given judgment in their favour. The plaintiffs had been victims. He gave judgment for defendants.

Sir Hiram Maxim Electrical & Engineering Co. (Ltd.).

Mr. Justice Warrington on Tuesday had before him a creditor's petition for the winding-up of this company.

Mr. HY. TERRELL, K.C., for petitioner, said the company was incorporated in 1899, and its present capital was £190,000. It had entered into a contract to erect at Southport certain parts of a captive flying machine, and the petitioner did part of the work at a contract price of £1,576. He received a cheque for £100 and five bills amounting to £964, leaving a balance of £571. The first bill for £200 was dishonoured on presentation. The company had issued £20,000 debentures, and appointed Mr. Hardy, the managing director, as receiver on behalf of the debenture holders, and it had since gone into voluntary liquidation, Mr. Hardy being appointed liquidator. On behalf of the petitioner, an affidavit was put in stating that the object of the voluntary winding-up was to delay and embarrass unsecured creditors, and also that shares in the Sir Hiram Maxim Lancashire Co. (Ltd.), which were assets of the company, had been paid to certain creditors within three months of the winding-up in satisfaction of debts in order to give them a preference. Mr. Hardy, in another affidavit, replied that if this was done it was done in the interest of the company, that if the company were reconstructed there would be more than enough to pay all debts in full, and that a reconstruction scheme had been submitted to and approved by a large majority of the debenture and shareholders and creditors.

Mr. EVE, K.C., M.P., submitted that there was no case for superseding the voluntary winding-up, which would not prejudice creditors. The only honest and prudent course to pursue was to stay all possible preference or priority which could be gained by persons recovering judgment by going into liquidation. There was no evidence to support the suggestion of fraudulent preference, and the transactions in question might possibly have taken place to avoid forfeitures under contracts which were running.

His LORDSHIP did not hold, on the evidence, that there had been fraudulent preference, but Mr. Hardy's statements in reply to the petitioner's affidavit were most unsatisfactory. It was a case in which the powers of the court as to inquiry ought to be exercised, and he thought voluntary liquidation ought to be superseded by a compulsory order.

Glasgow and Paisley Tramways Award.

Lord Balfour of Burleigh has issued his award in the arbitration between Glasgow Corporation and the Paisley & District Tramways Co. as to the amount payable in connection with the running of tramcars between Hawkhead-road and Paisley Cross. His Lordship finds that:—

1. The Tramway Company is to receive £250 from Glasgow Corporation on Dec. 1, 1904, for constructing the siding.
2. The Corporation is to pay the company whole fare received from local passengers, and ½d. for each "through" passenger.
3. The Corporation is to receive from the company 3½d. per car-mile for working expenses.
4. Extra expense of checking tickets, &c., is to be borne equally.
5. Award is to last till Dec. 31, 1914.
6. Expenses incidental to the arbitration are to be borne equally, and as to other expenses each party to pay its own.

To the 3½d. which will be allowed Glasgow Corporation for working expenses, there will have to be added the cost of electric current, which is supplied by Paisley Town Council.

Jones v. Manchester Corporation.

At Manchester Assizes last week, before Mr. Justice Walton and a special jury, plaintiff, a commercial traveller, sought to recover damages for injuries received on Aug. 15, while an outside passenger on an electric tramcar. It appeared that, owing to the car having overshot a loop, the driver attempted to back it without reversing the trolley-pole. This caught on one of the span wires and was snapped off, falling on plaintiff's head and injuring him seriously. The facts were not disputed, the only question being as to the amount of damages. The jury returned for plaintiff for £790, inclusive of £40 for medical attendance, and for costs.

Stay of execution, on the ground of excessive damages, was granted on condition that £450 was paid to plaintiff forthwith with costs, and also interest on the balance.

Edwards v. Manchester Corporation.

At Manchester Assizes last week, before Mr. Justice Phillimore and a common jury, plaintiff claimed damages for injuries caused by an accident which happened to her whilst travelling in an electric car in April last, resulting in serious personal injury. Plaintiff was an inside passenger on a car proceeding towards Ardwick, and, as was her usual practice, intended to get down at a certain point. She told the guard this, she alleged, when she paid her fare, but when the car reached the place at which she desired to alight the guard was taking fares from outside passengers. The car, nevertheless, stopped, and plaintiff got down to the bottom step, with one foot on the roadway, when the car made a sudden movement forward, and she fell. In a few days internal pain developed, and her medical attendant found that she was suffering from hernia, which, as she was about 65 years of age, was likely to be chronic.

For the Corporation negligence was denied, and it was pleaded that plaintiff had been guilty of contributory negligence in leaving the car while in motion. The guard denied that he gave the signal for the car to start.

The jury found for the plaintiff, damages £200, and judgment was entered for this amount and costs.

Bolton v. Sheffield Corporation.

At Sheffield County Court last week, before Judge Mansel-Jones, plaintiff, a market salesman, sought to recover compensation from defendants for damage alleged to have been sustained by him in consequence of an emission of fine dust from the chimney of their electric power station in Sheaf-street, in such quantities as to be a nuisance and so as to damage plaintiff's goods. Defendants contended that every appliance known to science was used to prevent the emission of grit, and that it would be impossible that there could be any great emission. It was also pointed out that there were 25 other tall chimneys in the immediate locality, and that the dirt deposited by them must necessarily go into the market, where plaintiff's business was. A mass of evidence was presented on both sides, and the hearing occupied two days.

For the defence, Mr. A. B. MOUNTAIN, borough electrical engineer at Huddersfield, said he had inspected the Sheffield works, particularly the boilers, flues, chimneys and induced draught arrangements, and every precaution known to science had been taken to prevent grit escaping. The arrangements were of the most modern kind. He did not think it possible to adopt any better system to obviate trouble from dust. There were other chimneys in the neighbourhood, and the grit from the electricity works chimneys must be clean because of the intense heat of the furnaces. Of course it would soil the hands if rubbed between them, but it was hard grit, which would not stick and could be blown away from anything. The grit from an ordinary house fire was different. The grit produced by plaintiff was the class of grit that came from an ordinary factory chimney. The grit from annealing furnaces would be very hard.

Mr. S. E FEDDEN, manager of the Sheffield Corporation electric light department, produced a plan showing an area within a radius of 260 yds. of plaintiff's stall, and showing 25 factory chimneys, some of them being connected with annealing furnaces. Shortly after witness entered the service of the Corporation serious complaints were made as to the grit from the power station. Steps were therefore taken by the adoption of mechanical contrivances to get rid of the nuisance, and the character of the coal was also changed. The nuisance has thereby practically ceased, though it could never absolutely cease. It was impossible there should be showers of dust.

Cross-examined: Is it induced draught that causes the mischief?—No. It was the draught that took the grit up the chimney. There must be draught. They required induced draught because of the particular type of boiler they used, and because the chimney was not high.

Is not the excessive speed of the fans the cause of the grit?—There is no excessive speed of the fans. Only the minimum of grit came from the chimneys of the station at present, and this was certainly not by itself sufficient to cause the nuisance that had been described.

Evidence was also given by Mr. A. Cuthill, station superintendent, and Mr. S. A. Graham, manager of the marine department of John Brown & Co. The latter stated that the mechanical arrangements with which the plants in the power station were fitted would make it physically impossible that there should be a shower of grit from the chimneys.

His Honour, in his judgment, said the argument on behalf of plaintiff was entirely based upon the assumption that the grit which the plaintiff complained of came from defendants' chimneys. That was an assumption which had not been borne out by a single witness. Instead of entering a non-suit, as he was at first inclined to do, he found that defendants had made out their case completely to his satisfaction, and there would be judgment for defendants, but without costs.

Boor v. Salford Corporation.

At Manchester Assizes last week, before Mr. Justice Walton and a special jury, plaintiff sued to recover damages from defendants for personal injuries arising from an alleged electric shock sustained while travelling upon one of the defendants' cars. It appeared that on Feb. 2 plaintiff stood upon the platform whilst other passengers were getting in and out. He held the canopy pole with his left hand, and whilst in that position the conductor pressed the button to ring the bell for the motorman to go on. At the same time he turned to plaintiff and said something, which plaintiff understood was an intimation for him to take a seat. Before plaintiff withdrew his hand from the pole the car started and plaintiff received a violent electric shock. The shock, it was suggested, had produced rupture of a ligament of the leg. His out-of-pocket expenses and loss of business were put down at £965. The defence was that the injuries were not due to electric shock, but to plaintiff's knocking his knee against the step or rail in getting on the car. Plaintiff denied having said to the conductor, "Assist me, guard, my knee has given way," and was positive that he did not stumble and knock his knee. The shock came while he grasped the canopy pole, and was instantaneous. Several passengers were called who said they heard plaintiff say that he had received an electric shock.

The medical evidence was to the effect that rupture of the ligament in question was exceedingly rare. It was caused generally by a spasmodic contraction of the muscles in front of the thigh. Such contraction might be produced in many ways, but such cause of the injury was less probable than an electric shock. There was no indication that the injury had been caused by external violence.

Mr. G. E. FLETCHER, consulting engineer, after an examination of the car, expressed his opinion that such a shock as plaintiff was said to have received was quite possible. Leakages of current occurred not infrequently in cars of that type. If there were defective insulation or defects in wiring, a person might receive such a shock. A safer protection than the present insulation on the car would be an armoured steel tape surrounding the rubber and connected to earth. Such an armature was used in electric lighting and in mains, but rarely, if ever, on tramcars. The cause of the shock was defective insulation.

Mr. THOMAS L. MILLER, consulting engineer, gave similar evidence. It was possible to test and find nothing wrong and yet momentarily there might be a shock.

For the defence it was submitted that it was impossible for plaintiff to have received a shock, but that if plaintiff did receive a shock it was an accident for which defendants were not liable, as there had been no negligence. Defendants also contended that plaintiff was injured in slipping while trying to reach the platform.

Mr. C. R. BELLAMY, manager of Liverpool Tramways, said the suggestion of steel tape insulation for tramcars was new to him, and he thought it had its disadvantages. If it failed, the whole surface of the cable would be alive from end to end, and that would be a serious addition to the risks run. Any leakage in a car would be at once felt by many passengers. A casual or accidental leakage was not a thing it was thought necessary specially to provide against. He did not think it possible for plaintiff to have received a shock under the conditions described.

A WITNESS called to describe the method of testing the cars said that the car had worked perfectly, and no defect had been detected. The insulation had not been interfered with since the accident, and it had been running ever since.

Mr. C. Hopkinson and Mr. J. Swinburne gave evidence to the effect that plaintiff could not have received a shock, because while he was on the car and the car was earthed there could not be any difference in the pressure brought to bear on him, and the electric current would go direct to earth, as the rod and platform were directly connected with earth by metal.

The jury returned a verdict for defendants.

G. N. of Scotland Railway Co. v. Aberdeen Corporation.

At the Court of Session, Edinburgh, on Friday last, Lord Pearson was applied to on behalf of the Great North of Scotland Railway Co. to interdict Aberdeen Corporation from making or maintaining in Union-street and Bridge-street, Aberdeen, a tramway passing junction at less than 9ft. 6in. from the outside of the foot pavement belonging to the company, or from making any alterations so as to diminish the width of the pavement.

After arguments his Lordship refused interim interdict, and said he was very doubtful whether the note for trial of the action should have been passed.

Tramways Purchase.

In the matter of an arbitration between the Manchester Carriage & Tramways Co (claimants) and the Swinton and Pendlebury Urban District Council (the purchasing authority), a case came before the Court of Appeal (the Master of the Rolls and Lords Justices Stirling and Mathew) on the appeal of the purchasing authority from a judgment of Mr. Justice Channell. On May 28, 1903, the late Sir Fredk. Bramwell stated a special case as to whether the district council were to purchase any of the company's depots outside the district of the Council. Sec. 43 of the Tramways Act, under which the purchase was to be made, provides that where the promoters of a tramway in a district are not the local authority, the local authority may (within certain specified times), by notice in writing, require such promoters to sell, and thereupon such promoters shall sell to them their undertaking or so much of the same as is within such district upon terms of paying the then value of the tramway and all lands, buildings, works, material and plant of the promoters suitable to the need by them for the purposes of their undertaking within such district. The question which arose upon the appeal was whether the words "within such district" qualified the word "undertaking" so that a depot outside the Council's district but suitable to and used for the purposes of such part of the undertaking as was within such district was to be taken and paid for by the Council. The Council contended that the words qualified "lands, buildings, work, material and plant," and that therefore the depot, being outside their district, could not pass. It seemed that there were two depots both outside the Council's district, but at the depot at Church-street the cars and horses of the line were kept. The special case found as a fact that the Church-street depot in dispute was "suitable to and used with" the undertaking, and Mr. Justice Channell upheld the special case. Hence the present appeal.

At the conclusion of the arguments judgment was reserved.

Employers' Liability.

At Brompton County Court on Monday, before Mr. Clement Lloyd and a jury, Albert Fisher, fitter's labourer, brought an action under the Employers' Liability Act against the Underground Electric Railway Co. of London, claiming damages in respect of personal injuries, said to have been sustained owing to negligence of defendants or their servants.

Plaintiff's counsel said that in May last his client was in the defendants' employ at Lot's-road works, assisting in raising a heavy iron pipe on to a large staging. When the pipe was raised a little higher than the platform, the man in charge of the job called the plaintiff from the ground on to the platform. Suddenly the rope or sling by which the pipe was raised gave way. The pipe fell with a crash on the staging, which at once collapsed, and the men, including plaintiff, fell some 30ft. or 40ft. to the ground, plaintiff sustaining a compound fracture of the leg and other injuries. He contended that the staging was deficient for the work, and the sling was defective. The defence was that the plaintiff "exercised his option" by receiving half wages under the Workmen's Compensation Act, and so was debarred from claiming a lump sum under the Employers' Liability Act.

For the defence, a CLERK in the employ of the Employers' Liability Insurance Co. stated that plaintiff's father, after being referred to them by defendants, distinctly stated that plaintiff was willing to receive compensation under the Workmen's Compensation Act.

An INSPECTOR of the Insurance Company stated that when he paid the first week's compensation to plaintiff in the hospital he read over the document relating to the method of payment to the plaintiff and his father before they signed it.

Further evidence having been given, the jury found for plaintiff for £81. 10s. Judgment accordingly, with costs.

The Income Tax in New Zealand.

In the New Zealand Court of Appeal judgment was recently given in an appeal of the Eastern Extension, Australasia and China Telegraph Co. (appellants) and the Commissioner of Taxes (respondent). The appeal was from a decision of Mr. Justice Cooper. The commissioner claimed that the gross income received by the company within the colony and derived by the company from their business in the colony was £24,137, that deductions due to the company were £6,320, that the taxable balance was £17,817, and he, therefore, claimed £890. 17s. The company, on the other hand, claimed that the gross income as defined above was not £24,137 but £10,080, contending that the income derived by the company on its lines beyond the La Perouse station (New South Wales) was not taxable as being profits derived from the company's business within the colony. This was the chief point involved. Another point was as to what income tax was due in respect of the profits between Wakapuaka (Nelson) and La Perouse.

The CHIEF JUSTICE now held that the appellant company was entitled to succeed so far as a tax charged on the income derived by the company beyond La Perouse was concerned. The case should, however, be remitted to the lower Court to ascertain the income tax due on the Wakapuaka and La Perouse profits.

Mr. Justice EDWARDS held that only the Wakapuaka-La Perouse profits were taxable, and that the case should be remitted to the lower Court to assess that amount, the commissioner to have judgment for the amount so ascertained. The agreements in evidence before the Court of Appeal were not before the lower Court, and the case had an entirely new aspect. Mr. Justice Cooper had authorised him to state that if it had been presented to him, and had been argued upon the grounds upon which his (Mr. Justice Edwards') opinion was based, his judgment would have been different, and he agreed that the appeal should be allowed.

Justices Denniston and Chapman concurred with the finding of the other members, and judgment was accordingly given, allowing the appeal with costs, the Court below to fix the amount of the costs and to fix the costs in the Appeal Court in the amount in which the appellant company succeeds.

An application on behalf of the commissioner for leave to appeal to the Privy Council was held over pending the fixing of the amounts by the lower Court.

ELECTRIC LIGHTING, POWER AND TRACTION NOTICES.

With this issue we conclude the particulars of Parliamentary Notices relating to electricity supply for lighting and power, electric traction schemes, light railways, &c.

Electric Lighting Provisional Orders.

Woolwich Borough Council (to repeal and amend existing orders and for conferring incidental powers), Burslem (for Tunstall), Dover (for Hougham, Poulton, River, Alkham, Ewell, Whitfield, W. and E. Langton, St. Margaret's-at-Cliffe, West Cliffe and Guston), and Gravesend Corporations (extension to Northfleet); Portland (Dorset), Whitwood, and Whitworth District Councils; Bournemouth & Poole Electricity Supply Co. (for Wimborne and district); Brentford Electric Supply Co. (for Brentford); Christy Bros. & Middleton (for Brockenhurst and Milton); County of Durham Electrical Power Distribution Co. (for Durham rural district and part of Chester-le-Street rural district); County of London Electric Supply Co. (for Croydon rural district); Dorchester & District Electric Supply Co. (for Dorchester); Empire Electric Light & Power Co. (for Wanstead); Mr. Fourd Ely (for Tewkesbury); Farnham & District Electric Supply Co. (for Farnham); Foote & Milne (for Lichfield, Lytham, and Macclesfield); Marlborough Electric Supply Co. (for Marlborough); North Metropolitan Electrical Power Distribution Co. (for Barnet, and Ware); Mr. Wm. Norton (for Ludlow); St. Albans & District Electric Supply Co. (for St. Albans rural district).

Electric Light and Power Bills.

City of London Electric Lighting Co. wish to extend area of supply so as to include portions of counties of London and Kent, to supply electrical energy in bulk, to enter into agreements with local authorities and companies, to accept transfers of undertakings, &c.

Woolwich Borough Council seek power to enable them to enter into agreements with local authorities of adjoining districts for supply by or to the Council to or by such local authorities of electrical energy in bulk or otherwise, to make special provision where consumer has separate supply, &c.

In the General Powers Bill of the London County Council power is sought to enable Metropolitan borough councils who are electricity undertakers "to provide, sell, let for hire, fix, set up, alter, repair and remove wires, lamps, motors, meters and all manner of electrical machinery and apparatus, and to expend money upon the wiring and fitting and supplying with wires, fittings, &c., the premises of any of their consumers or prospective consumers of electric energy," to enter into agreements, &c., with respect thereto, and to empower the councils to borrow in the same manner and subject to the same conditions as if such expenditure were for the purposes of the Electric Lighting Acts, 1882 and 1888, &c.

Heckmondwike Urban District Council, to confirm agreement with British Electric Traction Co. as to supply of electrical energy for tramways, to purchase electricity in bulk, to supply electrical energy beyond administrative district and to provide, let on hire, fix, repair, &c., lamps, motors, fittings, &c., for lighting and motive power, to make bye-laws as to fittings, to enable Council to refuse supply in certain cases, to alter date for filing accounts, &c.

Southend-on-Sea Corporation, seek further powers as to electric lighting, to supply electricity outside borough, to provide, sell and let on hire motors, lamps, fittings, &c., to repair same on consumers' premises, to exempt fittings, &c., so let on hire from distress or execution, to make special provision where consumer has separate source of supply, to discontinue supply when payments are in arrear, to alter date of filing accounts, &c.

Morley Corporation, to make further provision in regard to their electric lighting undertaking and to enable them to lay mains in streets not dedicated to public use, to make provision in cases where consumers have separate source of supply, to provide for consumers giving notice before removing, &c.

In the Bolton bill power is sought to enable the Corporation to refuse supply of electrical energy to persons whose payments are in arrear and who have separate sources of supply, to accept transfers from local authorities or companies of powers in regard to the supply of electrical energy in and any works in any district adjoining or near to the borough; also to authorise application by Corporation for the purposes of higher education under the Education Act, 1902, of any moneys borrowed or authorised to be borrowed for the purposes of the Technical Instruction Act.

Hessle Gas Co. seek authority to supply electricity, &c.

Shepton Mallet Gas Co. seek powers to purchase, generate, produce and supply electricity, &c.

Rathmines and Rathgar District Council wish to obtain powers to acquire land compulsorily for electricity supply, to supply and let on hire electric fittings, &c., and to exempt same from distress, to cancel agreement with the National Electric Construction Co., &c.

Traction Bills.

Wigan Corporation: To construct tramways in Wigan, Upholland, Orrel and Aspull, to authorise transfer to Corporation of tramways (or powers to construct tramways), &c., authorised by the South Lancashire Tramways Acts, 1900 and 1903; to modify or exclude provisions of sec. 43 of Tramways Act, 1870; to authorise supply of electricity beyond borough; to take transfers of any undertakings, works, &c., in regard to any area outside borough; to empower any local authority or company authorised to supply electricity outside borough to transfer the whole or any part of their undertaking, works, &c., to Corporation, &c.

In Blackpool Improvement Bill power is sought to levy a contribution from L. & Y. and L. & N.W. Railway Cos. and Blackpool, St. Annes & Lytham Tramways Co. towards the Lytham-road improvement, and also to empower Corporation to construct certain short lengths of tramways, &c.

Hastings Tramways Co. seek power to construct tramways, &c., in Hastings, in Bexhill, to extend time, to abandon portions of authorised lines, to remove restrictions imposed by 1900 Act, &c.

Swansea Corporation wish to acquire tramway undertaking of the Swansea Improvements & Tramways Co. (Ltd.), &c.

Tyneside Tramways & Tramroad Co. to issue preference capital, to prevent trespass on company's tramroads, &c.

Coventry Electric Tramways Co. to extend time, &c.

Oldham and Saddleworth District Tramways Co. to construct new tramroads in Mossley and Springhead, to exclude sect. 43 of Tramways Act, 1870, power to Stalybridge, Hyde, Mossley and Dukinfield Tramways & Electricity Board, to construct proposed tramroad, &c.

Buenos Ayres Grand National Tramways Co. are promoting a bill for amalgamating the undertaking of the company and that of the Buenos Ayres New Tramways Co., &c.

Power is sought to incorporate the Cork Junction Railway Co., to construct electric railways at Cork, to enter into agreements with the Cork Electric Tramways & Lighting Co. for the supply of electricity and to enter into working agreements with the Great Western, the London & North-Western, the Great Southern & Western and the Cork, Bandon & South Coast and other railway companies.

Mexborough & Swinton Tramways Co. wish to extend time for construction of tramways authorised by their 1902 Act, &c.

Portsmouth Street Tramways Co. to construct additional tramways in Gosport and Alverstoke, to extend time for completion of authorised lines, to acquire land compulsorily, &c., to vary terms of Tramways Act, 1870, as to purchase of tramways by local authorities; to enter into agreements to purchase undertaking of Lee-on-the-Solent Railway Co., &c.

London Southern Tramways Co. seek powers to work their tramways by mechanical powers, to construct generating stations, to acquire lands compulsorily in Lambeth, to postpone period of purchase by London County Council, to enter into agreements with electricity undertakings for supply of electrical energy, &c.

Dublin United Tramways Co. (1896) wish to obtain authority to take transfer of undertakings of the Dublin United Tramways and Dublin Southern District Tramways Cos.

Tramway Provisional Orders.

Colchester (additional lines), Keighley, Leeds (additional tramways, &c.), Pudsey and Southampton Corporations and Gorton Urban District Council. A company is also applying for an order for Aberavon.

Miscellaneous Bills.

Application is being made for leave to bring in a bill to incorporate a board of commissioners for Thames harbour, to acquire lands, construct works, &c., and to use overflow waters for generating electricity and to erect electricity works, to sell, supply, distribute and otherwise deal with said plant or electrical energy generated, &c.

Metropolitan Pneumatic Despatch Co. seeks authority to establish a system of pneumatic transport, &c., in the county of London, to construct generating station and subway, to acquire lands compulsorily at Hammersmith, &c.

In the bill of the Bristol Corporation additional powers are sought for sub-stations under the streets, &c., and to limit the time within which claims must be delivered for compensation for damage arising from the exercise by the Corporation of its powers under the Public Health Acts.

Bromley Corporation are seeking powers to run motor omnibuses.

Light Railway Orders.

Application is intended to be made by Messrs. A. R. Holland, W. S. B. McLaren, G. L. Addenbrooke and H. Ruffer, for an order to incorporate a company to construct and work light electric railways in Newark district.

Messrs. R. E. C. Shann, W. F. Tempest, F. Hopper and others, are applying for an order to construct light railways in the West Riding of Yorkshire and the County of Lincoln.

Middlesex County Council are applying for an order to extend until Dec., 1907, the period limited for compulsory purchase of lands and completion of light railways authorised in Friern Barnet, Southgate, Willesden, Wood Green, &c.

Mr. P. C. Hemingway is applying for authority under the Light Railways Act to incorporate a company to construct the Tarporley and Mouldsworth Light Railway.

The Western Counties Light Railways Co. are applying for an order to construct the Bideford, Clovelly and Hartland Light Railways.

Bath Electric Tramways (Ltd.) are applying for an order to construct additional lengths of light railway, to extend borrowing powers, &c.

Portmadoc, Beddgelert and South Snowdon Railway Co. are applying for an order to authorise the reconstruction, working and maintenance as light railway of the Croesor Railway, &c.

Lindsay Light Railway Synd. are applying for an order to construct the Blyton and Frodingham Light Railway.

The Tanat Valley Light Railway Co. are applying for an order to vary and extend the Tanat Valley Light Railway Orders, 1898 and 1901, &c.

Cheshire Light Railways (Ltd.) are applying for an order to incorporate a company to construct light railways in Knutsford and Warrington.

An application for extending their light railways has been made by Maidstone Corporation.

The Mansfield and District Light Railway Co. are applying for an order to authorise extensions, &c.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Walthamstow District Council require an electrical engineer and tramways manager to take charge of their electric lighting and light railway undertakings, salary £400 per annum; also a traffic superintendent, salary £200 per annum. Applications to clerk and solicitor (Mr. C. Sidney Watson) by noon Dec. 10. See also advertisement.

A working electrical foreman is required, with practical experience in construction and working of three-wire lighting and power, testing and repair of motors, &c. Particulars from the principal (Mr. J. H. Reynolds), Municipal School of Technology, Sackville-street, Manchester. See advertisement.

An experienced engineer is wanted, as first assistant to the cable engineer in charge, to assist in laying submarine cables in the Far East and elsewhere. See advertisement.

An experienced assistant electrician is required for submarine cable work. See advertisement.

A first-class draughtsman on h.-t. and l.-t. switchboards and switchgear is required by the Brush Electrical Engineering Co., Loughborough. See advertisement.

A demonstrator in mechanical engineering is required for West Ham Municipal Technical Institute. Salary £150 per annum. Applications to the principal before noon Dec. 5. See advertisement.

Ferranti Limited, Hollinwood, Lancs., want a draughtsman for transformer design. See advertisement.

A draughtsman is required for the electrical department of the Admiralty; must have had training in mechanical engineering works, supplemented by experience of design of electrical machinery, switch gear, &c. Applications by Dec. 5 to Mr. C. H. Wordingham, Admiralty, London, S.W.

A senior operator and a switchboard electrician are wanted for Glasgow Corporation telephone department. Applications to general manager (Mr. John Macfeet, 65, Renfield-st., Glasgow, by Dec. 5.

Out of the applicants for the position of borough electrical engineer at Poplar (London) the following three gentlemen were chosen by the Electricity committee, and from these the final selection was to be made—viz., Mr. J. H. Bowden, of Blackheath; Mr. W. A. Fraser, of Nelson; and Mr. D. M. McLeod, chief assistant at Poplar. The final voting at the Council meeting was: for Mr. Bowden, 24, for Mr. McLeod, 18. Mr. Bowden was for some years with the Brompton and Kensington Co., and subsequently served with the Blackheath and Greenwich Co.

Mr. R. B. Leach, of Aston Manor, has been appointed chief assistant electrical engineer at Farnworth, R.S.O.

Mr. H. A. Fleet has been appointed superintendent to the Yorkshire Electric Power Co., and has consequently resigned a corresponding position at the power station of the Mersey Railway Co.

Awards.—Messrs. Pirelli & Co., Milan, obtained a grand prize in the group for indiarubber goods in general and two gold medals for insulated wires and cables at the St. Louis Exhibition. Special medals were also awarded to the firm's factory superintendents (Mr. E. Calcagni and Mr. F. Piazza) and to the secretary (Mr. C. Fratino), and a gold medal to the chief electrician (Ing. E. Iona) for a Paper read before the International Electrical Congress on "Insulating Materials in High-tension Cables."

The Land-und Seekabelwerke, A.G., of Cöln-Nippes, Germany, have been awarded a gold medal at the St. Louis Exhibition for their exhibit of electric cables, &c.

Belfast.—British Electric Traction Co. recently inquired as to the terms and conditions upon which the Corporation would supply electric current to the Cavehill and Whitewell tramway lines. The city electrical engineer (Mr. Victor A. H. McCowen) has been entrusted with the negotiations.

Belfast Tramway Arbitration.—The arbitrator (Mr. L. L. Macassey, M.Inst.C.E.), has arranged for the arbitration proceedings in connection with the transference of the tramways to the Corporation to take place in London in January.

Boston.—An inquiry was held on Tuesday into the application of the Corporation for permission to borrow £20,000 for electricity supply. The town clerk (Mr. R. W. Staniland) said the Council proposed to charge 8d. per unit for current for public lighting.

Cab-Rank Telephones.—Chelsea (London) Council have consented to the provision of a telephone in the Pont-street cabmen's shelter to facilitate the "hailing" of cabs.

Camberwell.—At the Borough Council meeting on Wednesday a communication was read from London County Council in regard to the accounts of the County of London Electric Supply Co., in which it is suggested that sec. 8 of the company's order might be construed as enabling the Board of Trade to direct the auditor to take into account the circumstances of the company, to allocate the capital expended between areas of the various local authorities in which the company is operating and to prescribe that any party interested should be allowed to appear and be heard before the auditor. The Highways committee of the L.C.C. suggest that the Borough Council might consider the question of applying to the Board for making regulations to meet this point. The committee feel that London County Council could not with advantage make representations to the Board on the question of the refusal to grant a competing order in Camberwell. It was resolved that the suggestion of the London County Council be agreed to, and that the Board of Trade be approached as suggested.

Cambridge.—The Cambridge Electric Tramway Synd. has not, we understand, been able to come to terms with the local Tramways Co. for the acquisition of their lines. It has therefore been decided to defer till next year the promotion of the bill for the acquisition of the lines and their conversion to electric traction.

Canada.—The Rat Portage (Ont.) Municipality have been supplying electric current for lighting and transmission of power since 1892, and the total connections at Nov. 1, 1904, were equivalent to 10,000 8 c.p. lamps, including 55 H.P. for motors. The municipality also owns the telephone service of the district, which, at Nov. 1, could boast of 150 subscribers out of a total population of about 6,000. The water power of this district comprises the Lake of the Woods, a water shed area of 1,000 sq. miles, with an 18ft. fall, and an estimated available horse-power of 40,000. The Municipality has put in electric plant for working the machinery of the Keewatin Lumber & Mfg. Co., and the Lake of the Woods Milling Co. are also operating electrical machinery, for which power is derived from the same source.

Chili—Since the big fire at Pisagua in April, 1903, when the town, built entirely of wood, was consumed in a few hours, fire insurance premiums have been considerably increased. One of the means taken by the local authorities to bring down this premium is the adoption of electric lighting, and the municipality have invited tenders for this work.

At the Jesus Maria Gold Mine, near Copiapo, a syndicate has a venture in hand to cut all the principal lodes by a long tunnel. Electric drills are being employed, driven by oil engines of German manufacture.

Dover.—The Corporation have decided to take over the powers of the River Light Railways Synd. and to extend their tramway system to River at an estimated cost of £21,000.

Dundalk Tramways.—The Judicial committee of the Irish the Privy Council heard last week an unopposed application for extension of time for completing tramways authorised by the Dudalk. Electric Tramways Order, 1897. An extension of two years was granted.

East Ham.—An inquiry was held here last week into the application of the Council to borrow £10,320 for electric lighting extensions.

Edinburgh.—The Electric Lighting committee recommend the Corporation to apply for sanction to a further loan of £90,000 for extensions of the electricity undertaking.

Edmonton.—At a special meeting of the Council last week the offers of the North Metropolitan Electric Power Supply Co., the National Electric Construction Co., the Industrial Engineering Co., and Messrs. Foote & Milne were again discussed. Mr. Hawes (of Messrs. R. Hammond & Son, consulting engineers to the Council) attended and explained an exhaustive report by the firm on the subject. Ultimately the meeting was adjourned.

Electricity and Gas Effect on Street Trees.—According to City Forester Shonnard, of Yonkers, N.Y., escaping coal gas does a great deal of injury to street trees, especially in a hard winter, and to this cause is ascribed the sudden death of vigorous trees in some of the streets. In order to inform himself of the earliest symptoms of gas poisoning, Mr. Shonnard two years ago subjected the roots of a small tree in private grounds to a strong flow of gas in the soil within the root area. This caused the death of the tree within 24 hours. The electric current, on the other hand, in the voltages used by telegraph, telephone and electric tramway companies, does no injury to the trees, according to Mr. Shonnard, but with the heavier currents used in electric lighting and transmission of power it is found that a leaking wire will cause a local injury by burning, but that no appreciable effect on the general health of the tree results.

Exeter.—The Electric Lighting committee have instructed the city electrical engineer (Mr. H. D. Munro) to report on the best method of lighting the streets through which the tramways will run, together with an estimate of the first cost and subsequent maintenance charges. The question of lighting the city generally by electricity has been deferred.

Exhibition.—Capetown exhibition was opened on Saturday by Major-Gen. E. S. Brook.

Fatality.—An inquest was held at Southwark (London) last week on the body of a cab-driver named Lockley.

Deceased was called by a fare and crossed the road. Just as his cab was leaving the second set of tram rails an electric tramcar dashed into his cab. Deceased was shot out of his seat, fell in front of the car, and was caught up by the life-guard. He died in hospital from fracture of the skull.

The driver of the L.C.C. tramcar said he received a fortnight's instruction in motor-driving two years ago from the County Council's instructor. He was then put on as a "regulator," but acted as driver in cases of emergency. He had been a regular driver only a fortnight, but he did not know what the speed limit was. He drove at any speed he considered safe. They were regulated by time, and could not, therefore, go too fast. He had never been instructed as to the speed over the whole route. He knew he had to travel not faster than 4 miles an hour at the Elephant and Castle, but he could go at the rate of 12 miles in passing Clapham Common. He had only learned that by casual conversation with other drivers. He knew nothing about the Board of Trade Regulations, nor had he received a copy of the drivers' regulations.

The jury returned a verdict of accidental death, and added a rider to the effect that there had been some negligence on the part of the driver.

German Exports.—The German exports of machinery for the first three months of 1904, including electrical machinery (excluding motors), were valued at £262,000, the value of electric motors being £195,200.

Glasgow.—During the half-year ended 26th ult. 95,718,625 passengers were carried on the Corporation tramways, an increase of 2,892,115. The revenue amounted to £372,101, an increase of £19,779.

Grays (Essex).—The Council have been asked by the London County Council to state terms for supplying electric current to the training ship "Shaftesbury."

Hackney (London).—As it has been found that a large number of ratepayers experience difficulty in finding out for themselves the average price which they will have to pay for electrical energy under the maximum demand system, a lucid letter of explanation has been sent by the borough electrical engineer (Mr. L. L. Robinson) to the local press setting forth a simple method by which the average price per unit for any class of supply can be ascertained. The particulars furnished in Mr. Robinson's circular will certainly give confidence to the consumer that he is not only paying no more than is just, but that he is, at the same time, benefiting greatly by the substitution of electricity for any other kind of illuminant. Mr. Robinson's circular is timely.

Holyhead.—An unopposed inquiry was held here last week into the application of the Council for permission to borrow £1,000 for extensions of the electric lighting mains. The consulting engineer (Mr. Price White) said the works were opened two months ago, and were making good progress. Besides the public lighting there are about 90 private consumers.

Hull.—An inquiry was held last week into the application of the Council for permission to borrow £4,600 for electric lighting extensions.

Leigh.—An unopposed inquiry into the application of the Corporation to borrow £16,115 further for electric lighting was held on Tuesday.

Leith.—The Electric Lighting committee recommend the Council to make additions to the generating plant at the station at an estimated cost of from £7,000 to £8,000.

Lewisham (London).—On Wednesday the Council decided to make claims amounting to £1,143 against various companies for reinstating roads and footpaths broken up during the quarter, including £684 against the South Metropolitan Electric Light & Power Co., £88 against the Postmaster General and £10 against the National Telephone Co.

Light Railways.—The Board of Trade have approved the order authorising the construction of a light railway from Bettws-y-Coed to a junction with the proposed Beddgelert and Portmadoc line. These and other lines in the district are to be supplied with electrical energy by the North Wales Electric Power Co. When the schemes now authorised are completed it will be possible to travel by tramway from Carnarvon to Portmadoc, through the pass of Aberglaslyn, and from either of these places via Penygwryd and Capel Curig to Bettws-y-Coed on to Corwen in the valley of the Dee.

London County Council.—At Tuesday's meeting it was agreed to lend £1,000 to Woolwich for assisted wiring of consumers' premises, to be repayable within 8 years.

Seats for Drivers and Conductors.—The Highways committee submitted a report as to the provision of seats for drivers and conductors on the electric tramcars. They had come to the conclusion that the safety of the public would be endangered if the motor men were allowed to sit while driving, and, in the case of the conductors, the experiment tried of allowing the men to rest against the end of the car had resulted in a large number of complaints. The committee were therefore unable to recommend any change.

London County Council Tramways.—Islington Council on Friday decided by 32 votes to 12 not to consider any scheme for the conversion of the tramways in the borough to electric traction which entails the introduction of the overhead trolley.

Mexico.—The State Government of Michoacan has established electricity supply at Morelia to serve a population of about 40,000. There are 600 consumers entirely for lighting, the total connections at Nov. 4 representing 220 kw. Supply is given through aerial conductors. There is no gas or other illuminant available. At Morelia the Empreza Telefonica de Michoacan owns the telephone service, which was commenced in January last, and has now 200 subscribers. In this district there is an estimated available water power with a fall of 800ft. of 1,000 H.P.

New Car Works.—It is announced that the American Car and Foundry Co. have acquired a site in Trafford Park for erecting large works for the manufacture of railway waggons and carriages.

Newark.—The Rural District Council will support the application of a syndicate for an order authorising the construction of a light railway connecting Newark with several of the parishes in the rural district.

Oldham.—The expenditure on the electricity supply undertaking account amounts to £262,424, of which £244,510 has been sanctioned. A further £14,050 has to be expended on the completion of certain extensions, making a total of £31,964 overspent. Sanction to a further loan of £48,000 is to be applied for.

Poplar (London).—The Electricity committee reported on Wednesday that a settlement has been effected in respect to the action brought by the National Electric Construction Co. against the Council for the recovery of £96. 7s., amount of payments in respect of installations on premises of consumers who have ceased to take electric current, and also for the value of an installation of wires and fittings removed from a house upon the occupier leaving the premises and his successor not requiring supply.

By an agreement made between the late Board of Works for Poplar and the company, the minimum payments in question were to be made by the Council as successors to the Board whether received from the consumer or not, or alternatively the Council was to use all proper and reasonable efforts to secure payment thereof by the consumer, and to remit the same when paid to the company. In November, 1903, the Council was requested by the solicitors to the company to sue the defaulting consumers, and an indemnity was offered against the cost of any proceedings necessary, but no step was taken upon such request and the company commenced their action, which the Council on Jan. 14, 1904, decided to defend on the ground that the agreement was one into which the late Board had no power to enter.

The terms upon which the action has been settled are:—

(1) The Council to assign to the Company the minimum payments sued for and all future minimum payments under the agreement. (2) The company to release the Council from all obligations with regard to the minimum payments. (3) The Company before commencing proceedings to enforce payment of the minimum payments sued for amounting to £96. 7s., to offer to sell the installation to the consumers under their several agreements, the prime cost to be determined in each case, if consumers so wish, by reference to an arbitrator to be appointed by the president for the time being of the Institution of Electrical Engineers, or in such other way as the Council or the consumers may desire. (4) That in consideration of the Council being released from all responsibility in the past and in the future in respect to the minimum payments referred to under the agreements, and of the company undertaking all the responsibilities in future and accepting all risks with regard to the recovery of such payments, including costs of any proceedings with reference thereto, and in further consideration of the concession in clause 3 for the benefit of consumers, the Council to contribute towards the losses which the company will suffer in respect of clauses 1, 2 and 3 the sum of £125.

Presentations.—On Thursday last week a presentation was made to Mr. J. Colbran, assistant at Barnsley Corporation electricity works, on the occasion of his marriage. In the absence of Mr. E. A. Barker (borough electrical engineer), the chief assistant (Mr. T. R. Stancombe) made the presentation.

The home and foreign staff of the Direct Spanish Telegraph Co. have presented the secretary of that company with a gold half-hunter watch, bearing the inscription:—"Presented to F. T. Preddle, Esq., as a mark of esteem, by the staff of the Direct Spanish Telegraph Co., Nov. 27, 1904."

Preston.—At the last meeting of the Tramways committee the engineer and manager (Mr. Walter H. Tittensor) submitted a statement as to the cost of working the new Corporation tramways for the 20 weeks ended Oct. 26, and at the meeting of the Council last week the chairman of the committee (Mr. E. J. Andrew) made an interesting statement on the subject.

So far, he said, they had every reason to be satisfied with the working of the tramways. Out of the 20 weeks they had been working there were only two during which the receipts fell below £500 per week. 2,525,914 passengers were carried, 230,808 car miles were run, and the receipts were £11,868. 2s. 5d. The expenditure on traffic, power and general expenses and repairs and maintenance was £4,594. 6s. 3d., interest and sinking fund on capital expended required £3,871, and interest and sinking fund on old tramway account amounted to £732, leaving £2,890 16s. 2d. for depreciation, &c. The revenue worked out at 12·36d. per car mile, and expenditure (including interest and sinking fund) was 9·269d. per car mile. During the 20 weeks 283,192 units were generated, equal to 1·23 per car mile, and the working cost came out at 8·762d. A further reduction in working costs is anticipated, as the power station up to the present has been working under adverse circumstances. The plant for a considerable time was working without economisers or lagging to the steam pipes, owing to the haste to supply energy for the tramways, and the condensing plant is not yet in operation. The weekly works costs—non-condensing—do not now exceed ·65d. per unit generated, and a further reduction is anticipated when running condensing.

St. Michael's (Azores).—Electric lighting has recently been inaugurated on this island, noted for its health resorts, its fruits and for many other features of interest. The generating plant is water driven. The island is indebted to Mr. José Cordeiro, electrical engineer, of Ponta Delgada, for this enterprise. We understand that Mr. Cordeiro has himself supplied the bulk of the capital required, a few other local notabilities having joined him. There is some probability, too, that Mr. Cordeiro will shortly construct a line of electric tramways from Ponta Delgada to Fournas, a town famous for its mineral baths, &c., and a place likely to become famous in the years to come as a health resort. At Fournas, German capitalists, who are also much in evidence in the Portuguese island of Madeira, not many miles distant, are negotiating a concession from the Portuguese Government for building sanatoriums and hotels, and we understand that Mr. Cordeiro is anxious to establish the electric tramway service while the opportunity for his so doing remains.

Southend.—An unopposed inquiry was held here on Monday into the application of the Corporation for permission to borrow £56,000 for extension of the electric lighting plant, laying mains, &c. Technical details were supplied by the borough electrical engineer (Mr. W. E. J. Heenan).

Stoke Newington (London).—A special meeting of the Council on Tuesday considered reports (summaries of which have already appeared in *The Electrician*, June 24 and Nov. 18) with respect to electric lighting.

Dr. White, chairman of the Electricity committee, moved the adoption and sealing of the agreement with the North Metropolitan Power Supply Co. referred to in these reports.

Several councillors objected, and pointed out a number of matters which they contended were either not mentioned or were insufficiently explained in the reports.

Dr. White said that when a decision had been arrived at to take a bulk supply offers were invited, and those received from Islington Council, Hackney Council and the North Metropolitan Supply Co. were in the nature of sealed tenders. The committee's sympathies naturally went to the neighbouring municipalities, but the terms of the North Metropolitan Co. were so very much better in every way that nothing could be done but recommend them for acceptance. The publication of the committee's report in June last was followed by an offer of better terms by Hackney, and further negotiations with the company resulted in them agreeing to do what no municipality had the power to do—viz., take all the risk of the undertaking so long as Stoke Newington desired that that should be done. The main object of the supplementary scheme put forward in the report of Nov. 10 was to save the rates from any risk whatever. It had now been arranged that during the first three years (and the supply was expected to commence in the spring or summer of 1905), and for such additional number of years as the Council shall think fit, the company supplying the energy should be paid for such energy the amount of the net revenue which the Council may derive from the undertaking, and that any loss which may occur shall be borne by the company. Energy was to be supplied by the North Metropolitan Co. in bulk, and Messrs. Talbot and Stevenson, the Council's consulting engineers, estimated that one-fourth would come under the 3½d. per unit charge and three-fourths under the 1d. per unit charge. Allowing for wastage it was believed that every unit sold would have cost the Council in bulk 2·16d. It was proposed by the committee to have a capital charge of £22,560, made up as follows: Cost of site for transforming station £525, building £2,400, transforming plant £3,500, battery £1,000, 100 house services at £6 each £600, mains £9,550. Contingencies, at 10 per cent. on the foregoing items, would bring the total to £19,330. Then there would be engineering £730, and finally an amount of £2,500 already spent in High-street. Interest and sinking fund on £22,560 would be £1,580 a year, and salaries and wages and maintenance were estimated at £1,020 per annum. To meet this and pay the bulk supply at 2·16d. per unit there would have to be sold each year, at the present charge of 6d. per unit, 220,000 units. The consumption in the borough now, without public lighting, was 80,000 units. But the great point he wished to impress upon the Council was that, if there was any loss, the company would bear it. The present proposal was the fruition of four years' work, but the Board of Trade was accountable to a large extent for the great delay.

After a long discussion it was decided, with only two dissentients, to adopt and seal the agreement with the North Metropolitan Co.

Stretford.—The annual dinner of the staff and employés of the Urban District Council electricity department took place on Friday last.

Councillor S. Lawton, chairman of the Electricity committee, presided, and there were also present Councillor T. Johnston, J.P. (chairman of the Council), Councillor Estcourt (vice-chairman of the Electricity committee), Mr. G. H. Abrahams (clerk to the Council), and Mr. R. Rowland (resident electrical engineer). After dinner the toast of the Council was given by Mr. Rowland, and Councillor Johnston responded. The toast of "The Electrical Undertaking" was replied to by Councillor Lawton, who complimented the staff on the interest and care they took in their duties, and referred to the successful running of the station since its opening. He said he took a great personal interest in the works.

Sydney, N.S.W.—On July 8, 1904, the City Council commenced the supply of electricity from the municipal undertaking. The total connections at Oct. 31 was the equivalent of 19,400 8 c.p. lamps. The charge for lighting has been reduced to 4½d. and 5d. for first hour and 2d. after. The charge for power is 2d. per unit.

Telephone Wires Across the Thames.—At the meeting of the Thames Conservancy Board last week it was decided, on the recommendation of the Lower River and General Purposes committee, that as the National Telephone Co. had not executed the rental agreement in respect of their four telephone wires across the Thames below the railway bridge at Staines, that notice should be given to the company requiring the removal of the lines from over the Conservators' property.

U.S. Exports.—The total value of the exports of electrical machinery and parts of machines from the U.S. to the United Kingdom in 1903 was £451,300, compared with £514,800 in 1902.

Venezuela.—It is reported that the electric lighting plant at Valencia which belonged to an American company, has been acquired by English and Venezuelan capitalists.

West Ham.—At Tuesday's meeting of the Corporation provisional arrangements made by the electrical engineer with Ferranti Limited for the firm to continue to supply certain special parts peculiar to their engines and alternators were approved, and 34 tramway trucks of either the Maguire or Brill type are to be obtained at a cost not exceeding £69 each. The tramway manager is to endeavour to arrange for the equipment of one of the new cars with the Raworth system of regenerative control.

Wicklow Tramways.—The Judicial committee of the Irish Privy Council on Thursday last granted an order authorising the construction by Lord Fitzwilliam of three short tramways to connect Wicklow harbour and railway station. Clauses were inserted for the protection of the National Telephone Co. in the event of the lines being worked electrically.

Will.—The will of Mr. Henry A. Willey, electrical engineer (Messrs. Willey & Co., Exeter), has been proved of the gross value of £91,841. 10s. 2d.

Willesden.—It was reported to the Council on Tuesday that notice of appeal had been given in the action "Attorney-General (at relation of Willesden Council) *v.* Metropolitan Electric Supply Co.," and instructions were given to take all necessary steps to support the recent judgment of Mr. Justice Farwell.

Workhouse Lighting.—Mr. J. Enright has been retained by Islington (London) Guardians as electrical engineer, at £50 per annum, to supervise all the machinery, boilers, pipes and engineering work, and repairs connected therewith; also to report from time time to the Visiting committee.

Wrexham.—The Council on Wednesday decided to adopt a hire-purchase system of wiring, the cost of the wiring with 5 per cent. per annum interest to be paid by the consumer in eight quarterly instalments, and the period to be further extended if the cost exceeds £20. Extensions of mains were also authorised.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Bradford Corporation invite tenders for miscellanous stores required by their tramways department during year ending Dec. 31, 1905, including electrical accessories, paints, varnishes, &c., asbestos and insulating materials, armature repairing material, lamp fittings, castings, springs, overhead equipment, cables and wire, hand tools, pinion wheels, transfers, trolley poles and accessories, ironmongery, coal, &c. Forms of tender at the Tramway Offices, 15, Bridge-street, Bradford, and samples may be inspected at Thornbury car depot. Tenders to the town clerk (Mr. Fredk. Stevens) by Dec. 17. See also an advertisement.

Cardiff Corporation invite tenders for the following plant for the extension of their power station on the extra high-tension three-phase system—viz., two 1,600 H.P. slow speed vertical engines, two 1,100kw. three-phase alternators, four Lancashire boilers, with accessories, steam and other piping, switchboard gallery and staircase, extensions to central service gangway, extra high-tension three-phase feeder cables. Specifications, &c., from the borough electrical engineer and manager (Mr. Arthur Ellis), Central Offices, The Hayes, Cardiff. Tenders to the town clerk (Mr. J. L. Wheatley) by Dec. 19. See also an advertisement.

Southend-on-Sea Corporation invite tenders for additional plant for their generating station, comprising two boilers, one steam dynamo, one fuel economiser, and two electrical feed pumps. Specifications, &c., from the borough electrical engineer (Mr. W. E. J. Heenan). Tenders to the town clerk (Mr. Wm. H. Snow) by Dec. 21. See advertisement.

Fulham (London) Council invite tenders for supply and erection at their generating station, Townmead-road, of a 3,000-volt steam alternator of 1,000kw. capacity coupled to Belliss engine. Specifications, &c., from the borough electrical and consulting engineer (Mr. A. J. Fuller) after 5th inst. Tenders to the town clerk (Mr. R. M. Prescott) by noon 20th inst. See an advertisement elsewhere.

Stoke-upon-Trent Guardians invite tenders for the electric lighting of a portion of their workhouse premises. Specifications, &c., from the clerk, Mr. C. Daniel, Union Offices, Stoke-upon-Trent, where tenders are to be sent by Dec. 14. See also advertisement.

Edinburgh City Council invite tenders for electric lighting installation at the branch free library, Morningside-road. Tenders to Dr. Hew Morrison, Free Library, George IV. Bridge, Edinburgh, by Dec. 14.

The *Dublin United Tramways Co.* invite tenders for the supply of general stores, including electrical supplies, car fittings, iron, steel, castings, oil, &c., for 1905. Tenders (addressed to chairman) to Mr. R. S. Tresilian, 9, Upper Sackville-street Dublin, by Dec. 5.

Kilmarnock Corporation invite tenders (until Dec. 10) for right of advertising on tramcars.

Middlesbrough Electricity committee require tenders by noon, Dec. 17, for pipe-work and valves.

Erith Council invite tenders by Dec. 19 for motor-cars, trucks, motors and equipment, track-sweeping and watering cars.

Swindon Corporation require a 300kw. steam dynamo, or alternatively a 400kw. steam dynamo.

Tenders are invited by Dec. 12 for wiring, bell and telephone-fitting at the new infirmary, Stepping Hill, near *Stockport*.

Glasgow Corporation invite tenders by 10 a.m. 22nd inst. for 100 electric motor equipments and spare parts for their tramways.

TENDERS RECEIVED AND ACCEPTED.

Belfast Tramways and Electricity committee have decided to recommend the following tenders for acceptance:—

Contract No. 1 (permanent way, road bed, paving and bonding), J. G. White & Co., £280,643. 12s. 4d.

Contract No. 2 (overhead electrical equipment), J. G. White & Co., £38,809. 15s. 5d.

Contract No. 3 (underground feeders, telephone and test wires, and spare conduits), J. G. White & Co., £63,263. 16s. 8d.

Contract No. 4 (steam dynamos, switchboard, three-phase plant, condensing plant, overhead traveller and station lighting), British Westinghouse Co., £40,933. 5s.

Contract No. 5 (boilers, superheaters, mechanical stokers, economisers, coal and ash-conveying plant, steam exhaust and feed pipes and pumps), Fairbairn, Lawson, Combe, Barbour (Ltd.), £19,740.

Contract No. 6 (double-deck electric tramcars), Brush Co., £93,624.

The value of the six contracts is £538,014. 9s. 5d. In consideration of getting the three contracts, J. G. White & Co. agree to deduct £1,000 from the total, making this £383,717. 4s. 5d. Fairbairn, Lawson, Combe, Barbour's contract stipulates that any work done in the firm's own foundries shall be done in Belfast.

West Ham (London) Council have placed the following orders in connection with electric tramway construction:—

Three cross-over roads, Edgar Allen & Co.; 10 sets temporary cross-over roads and turn-outs and Jarrah wood-paving blocks, W. Griffiths & Co.; Portland cement, Martin, Earle & Co.; drain boxes, Railway & General Engineering Co.; cartage of material, granite, rails, excavation, &c., and supply of sand and ballast, W. G. Harris and S. Wakeland; eight sets Turner's automatic point adjusters, S. Dixon & Son, £93 each.

The following tenders have been received by West Ham Corporation for 35 double deck, complete tramcars with electrical equipments:—Brush Co., £528. 10s. each; Witting, Eborall & Co., £542. 15s. (alternative, £555. 17s.); Hurst, Nelson & Co., £547; British Westinghouse Co., £552. 15s.; British Thomson-Houston Co., £575. 15s.; Dick, Kerr & Co., £582. The tender of the Brush Co. for 34 car bodies at £280 each and one complete car mounted on radial truck and equipped with Raworth regenerative control at £623. 10s. was accepted, as was also that of Messrs. Dick, Kerr & Co. for 34 electrical equipments mounted on 21 E. M. McGuire trucks at £258. 10s. each.

It is stated that the American Car and Foundry Co., which recently secured the contract from the Underground Electric Railways Co. of London to build a number of steel passenger cars, have placed an order with John Macdonald & Son, Glasgow, for the whole of the pneumatic equipment required for building them (in this country), including four Ingersoll-Sergeant air compressors; also for 125 "Haeseler" pneumatic hammers and drills and all accessories for riveting, caulking, chipping and boring.

Hammersmith (London) Council have received the following tenders for supply of cables :—

	£	s.	d.		£	s.	d.
Western Electric Co. (*accepted*)	**£2,236**	**9**	**10**	Siemens Brothers & Co	£2,448	4	0
				Imp. Eng. Supplies Co.	2,428	13	0
Lucy & Co.	3,203	6	8	Electrical Co.	2,386	5	0
St. Helens Cable Co.	2,973	6	8	Callender's Co.	2,339	11	8
W. F. Dennis & Co..	2,618	0	0	W. T. Henley's Co...	2,313	0	0

Hammersmith (London) Council have placed orders for 8 100kw. transformers with the British Electric Transformer Co. at £120 each; and for high-tension discriminating switch gear for Olympia with Cowans (Limited) at £229. 10s.

The tender of the Alphons-Custodis Chimney Construction Co. has been accepted by Torquay Corporation for the construction of a chimney stack at the new electricity works at £3,719. The tender originally accepted was withdrawn.

Middlesex County Council have accepted the following tenders in connection with the new asylum at Napsbury :—Western Electric Co., mains, £885. 2s. 2d.; Hart Accumulator Co., storage battery (115-1,050 ampere-hour standard lighting type cells), £1,026. 15s.; maintaining battery for 10 years, £70. 8s. per annum.

For the electric lighting installation at Abergavenny Asylum the following tenders were accepted :—Woods, Slacke & Co., generating plant, £2,864. 10s.; Ernest Scott & Mountain, wiring, &c., £2,640.

Westminster City Council has accepted the tender at £76 of Leo Sunderland & Co. for putting the electric wiring, bells, &c., at the City Hall in working order.

The order for covering 10 thermal storage vessels at the Wood-lane station of the Kensington & Knightsbridge and Notting Hill Electric Light Cos. has been placed with Messrs. G. Fidduck & Co.

Hire Purchase Motors.—Oldham Corporation have arranged with Veritys Limited for the hire-purchase of motors, starters and radiators.

Tynemouth Council have arranged with Veritys Limited for the hire-purchase of motors and starting switches.

One-half the starting switches required by Manchester Corporation for the ensuing 12 months have been ordered from Veritys Limited. The Improved "Aston" type will be supplied.

BUSINESS NOTICES.

Mr. Robt. Paul asks us to state that all future orders, accounts and correspondence relating to electrical and scientific instruments and materials should be addressed to Newton Avenue works, New Southgate, London, N. The premises, 68, High Holborn, will remain open as show rooms for electrical instruments and for personal interviews by appointment.

Messrs. Mountain & Gibson, Elton Fold Works, Bury, Lancs., have taken over the business of the McGuire Mfg. Co., and, besides being electric tramway engineers, are continuing to manufacture McGuire trucks for electric tramways and railways, as well as their other specialities (including sweeping and sprinkling cars, snow ploughs, &c.), and are adding to this business that of light railway engineers and manufacturers of electric locomotives and other electrical appliances.

Mr. O. L. Remington (of Messrs. McLean & Co., Melbourne, Australia) is on a visit to this country for the purpose of negotiating and taking up representations for Australia of new lines of electrical goods and appliances. Mr. Remington is general manager of Messrs. McLean & Co., and inquiries concerning the firm can be made to Mr. F. Chapman, Hopetoun House, Lloyd's-avenue, Fenchurch-street, London, E.C., who was for many years manager in charge of McLean Bros. & Rigg's London agency. Mr. Remington is staying at the Hotel Cecil.

Mr. J. W. Barnard, 4, Great Winchester-street, London, E.C., has taken up the sole agency for London and district for the "Plomo" belt dressing and gear composition. Mr. Barnard will be pleased to submit samples of these materials.

The registered office of the Newcastle-upon-Tyne Electric Supply Co. has been removed from 50, New Bridge-street to Royal Exchange-buildings, Newcastle-on-Tyne.

Messrs. W. J. Perry and H. A. Aylett, electrical and mechanical engineers, 257, Fulham-road, and 44, Pelham-street, London, S.W., have dissolved partnership. Debts by Mr. Aylett.

BANKRUPTCIES, LIQUIDATIONS, &c.

The first meeting of the creditors of Hy. Coles, electrical engineer, 10, South-street, Swansea, was held in London on Tuesday. Debtor started in business in Swansea in 1900 without capital, but with a guaranteed bank overdraft of £100, which, after 18 months, was increased to £700, secured on the deposit of certain deeds by his father. Gross liabilities are £3,727, of which £2,986 is unsecured, assets £13. Debtor attributes failure to losses by bad debts and business expenses being in excess of profits, owing to bad trade. Official Receiver acts.

A receiving order has been made against Wm. Watson & G. Huntington, electricians, 83, Battersea-rise, S.W. and Dering-street, Bond street, W., London. The first meeting of creditors will take place on Dec. 9 at Bankruptcy-buildings, London, W.C., and the public examination on Jan. 24 at the same place.

The first meeting of creditors of A. W. Wigmore, Röntgen ray expert, was held on Wednesday. Liabilities £802. Assets £58. One cause to which debtor attributes his failure is the publication in the press of statements as to the injurious effects of X-ray treatment.

Hy. Cooke, electrical engineer, 102, Buccleuch-road, Normacot, Longton, formerly of Sneinton, has been adjudicated bankrupt.

Claims against C. M. Downie, electrical engineer, 4, Bloomsbury-street, W.C., and 28, Heathville-road, Crouch Hill, N., London, by 12th inst., to Mr. C. J. Singleton, 8, Staple-inn, London, W.C.

The liquidator (Mr. G. S. Barnes) in the winding up of the Electric Railways Co. (Ltd.) has been released.

Premises to Let.—Warehouse premises, 222, Upper Thames-street, comprising four large well-lighted floors with total floor space of about 7,000ft., are to be let on lease. See advertisement.

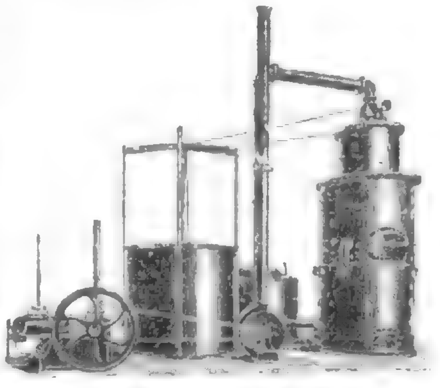
Three rooms are to be let, separately or as a whole, in a third floor flat in 64, Victoria-street, Westminster, S.W. See advertisement.

Plant Wanted.—An advertiser wants a 20 H.P. Hornsby-Ackroyd oil engine, a shunt-wound dynamo (140 v. 120 amps.) by good maker, storage battery, switchboard, &c.

Plant for Sale.—West Ham Electric Lighting and Tramways committee have plant for sale, including a fan engine and Sirocco fan, steel chimney stack, condensing set, cast-iron tanks, hot well, piping, &c. Particulars from the borough electrical engineer, Electricity Works, Tucker-street, London, E. See also advertisement.

Forthcoming Books.—Messrs. Kegan Paul & Co. announce the publication shortly of "Alternating Current Engineering," by E. B. Raymond, U.S.A.

Gas Producer Plant for Generating Electricity.—The Industrial Engineering Co., of Newton, Hyde, Cheshire, in addition to their ordinary manufacturing business, have recently interested themselves in the complete equipment of public electric supply stations. Two schemes which they have at present on hand are the Bognor electric lighting and the Dundalk (Ireland) tramways and lighting. At Bognor a three-wire continuous-current 220-volt system is being installed, the generating plant consisting of two 105 B.H.P. Industrial "Simplex" bituminous gas engines, which drive two 60kw. "Industrial" dynamos. There is also an "Industrial" balancer booster set. A similar equipment is being put down for the Dundalk scheme, which includes the lighting of Blackrock, the total capacity of the engines being 400 B.H.P., and of the dynamos 240kw. The length of tramways is 2½ miles, and 4 miles of extensions are being applied for. Work on both these schemes is to be commenced immediately. An example of the "Simplex" gas producer set is shown in the accompanying illustration.

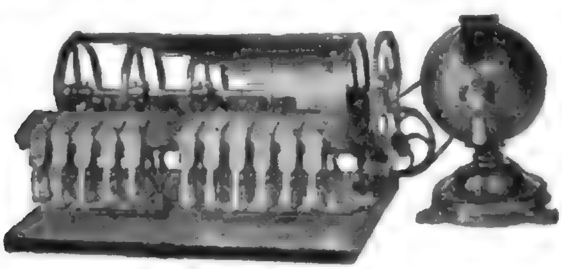


"Simplex" Gas Producer Plant.

Electric Pumping Plant.—The International Steam Pump Co. of New York, in conjunction with the Westinghouse Electric and Mfg. Co., have secured an important contract for electric pumping plant for the Comstock Mines, California, at about $80,000. The contract calls for two first-motion electrically-driven pumps, each of the units to have a capacity for lifting 1,600 gallons of water per minute, against a pressure equivalent to a height of 1,500ft., or from the 3,000ft. level up to the level of the south lateral branch of the Sutro tunnel. Each pump is to be driven by an 800 H.P. slow-speed induction motor. The contract includes, besides 600ft. of 16in. pump column pipe; a travelling crane for the pump station; an automatic oiling system; a small air compressor for filling the air chambers; a small vacuum for discharging the vapour from the suction chamber; all the piping and valves of every description for completing the installation, and a complete set of duplicate parts of the pumps.

The "Megger."—Messrs. Evershed & Vignoles' latest achievement is the "Megger," a name which they have given to an exceedingly compact combined ohmmeter and generator which is to replace the type constructed hitherto. We hope to give a detailed description of this instrument in our next issue, but in the meantime we may say that the size of the whole instrument has been reduced to 6½in. by 6½in. by 12in., and its total weight is 18lb. It gives a dead-beat reading, and there is practically no error at infinite resistance with capacities even exceeding one microfarad. The scale of the instrument begins at 10,000 ohms, and is divided into 50,000 or 100,000 ohm divisions up to 1 megohm. Between 1 and 8 or 10 megohms it is possible to compute fractions of a megohm, from 10 to 30 megohms single megohms, and between 30 megohms and infinity 40, 50 and 100 megohms are marked on the scale. Messrs. Evershed & Vignoles will forward printed illustrated particulars on request.

Catalogues, &c.—Mr. F. J. Down is introducing an effective electric sign flasher, of which he informs us thousands have been sold for electric signs, flashing the lamps on and off in single letters and entire words; for illuminated electric signs, giving the changeable colour effect; for script letter signs, lighting the lamps in rapid sequence; for electric flags, producing the waving effect; and for other uses.



The Electric Sign Flasher.

The machine is of strong construction, and consists of automatic rotary switches driven by a small electric motor. The appearance of the machine is shown in the accompanying illustration.

Archibald J. Wright (Ltd.), of 318, Upper-street, London, N., have a new illustrated price list of electrical goods and scientific and mechanical novelties just out, and as Christmas is upon us there are many of these novelties suitable for presents. This firm make a speciality of these small goods.

New lists (No. 99) of cutouts for high voltage, (100) casing and capping (102) electric lever switchgears for operating express lifts (106) lamp holders for high voltage, and (109) lamp holders for Nernst lamps, have been sent out by the Electrical Co., 121-125, Charing Cross-road, London, W.C. The lamp holders for Nernst lamps are supplied with three slots, and with the use of these fittings it is impossible to reverse the polarity of the Nernst lamps, which is a frequent cause of the filament burning out. The lever switchgears shown in No. 102 are arranged for two speeds.

The General Electric Co. have ready new sheet lists (Nos. 1,070 and 1,072) dealing with dry batteries, Leclanché cells, &c., also a pocket list of electric radiators.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Nov. 23 to Nov. 29, with the ports of destination:—

Aden, £88 (including £70 telegraph material) *Africa*—Alexandria, £194; Cape Town, £427 (including £310 telegraph material); Durban, £943 (including £50 telegraph material); East London, £7; Mozambique, £490 (telegraph material); Port Elizabeth, £58. *Argentina*—Buenos Ayres, £3,014 (including £149 telegraph material). *Australasia*—Adelaide, £13; Auckland, £166; Launceston, £60; Lyttelton, £74; Melbourne, £76; Sydney, £308; Wellington, £2,162 (including £1,594 telegraph material). *Brazil*—Rio Janeiro, £4,197 (including £4,070 telegraph material); Santos, £209. *Canada*—Halifax, £92; Toronto, £40. *Canary Islands*, £2,500 (submarine cable). *Chili*—Valparaiso, £55. *China*—Shanghai, £20. *Cuba*, £44,035 (telegraph material). *Denmark*—Copenhagen, £46. *France*—Boulogne, £15; Dunkirk, £10; Marseilles, £100 (telegraph instruments); Paris, £205. *Holland*—Amsterdam, £987 (including £208 telegraph material). *Hong Kong*, £230. *India*—Bombay, £3,551 (including £665 telegraph apparatus and material); Calcutta, £1,040; Karachi, £55; Madras, £425. *Japan*—Tokyo, £400; Yokohama, £76. *Malta*, £101. *Portugal*—Lisbon, £20 (telegraph material). *Straits Settlements*—Penang, £384; Singapore, £994 (including £180). *Sweden*—Stockholm, £51 (telegraph wire). *West Indies*—St. Lucia, £39 (telegraph material). Total, £67,960 against £17,029 in the corresponding week last year (Nov. 25 to Dec. 1).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

October 31, 1904.

23,425 J. Linkleter. Tynemouth. Live rail protections for electric railways.

23,438 H. C. L. Holden. Magneto-electric ignition for internal combustion engines.

23,452 O. B. Moore. Insulation of coils of electrical apparatus. (Date applied for, Nov. 21, 1903, date of application in U.S.)*

23,461 R. F. Rowe and W. R. Blote. Chelsea. Portable electric alarm.

November 1, 1904.

23,525 H. J. Dowsing. Electrical radiators.

23,527 W. E. Hitch. Oxford. Electric cable conductors.

23,559 E. Garsin (P. Bogni, Italy). Appliance for diverging current from a main line or for connecting cables or wires.

23,567 A. W. Hill and J. Harrington. Incandescent lamps.

23,604 E. Riethof and A. Basch. Incandescent lamps.*

23,612 R. M. Newbold. Enclosed dynamo electric machines. (Date applied for Nov. 3, 1903, date of application in U.S.)*

23,622 P. Möllmann, Liverpool. Galvanic batteries.*

November 2, 1904.

23,661 S. T. Webster. Liverpool. Dynamo electric machinery.

23,685 L. Kamm. Electric projecting lamps.

23,696 J. A. L. Dearlove. Cables for submarine use.

23,716 A.E.G. Preventing sparking of the commutators of electric motors. (Date applied for, Nov. 2, 1903, date of application in Germany.)*

23,726 C. Wirt. Rheostats. (Date applied for, Nov. 6, 1903, date of application in U.S.)*

November 3, 1904.

23,765 A. Rudenick. Germany. Insulating material for electro-technical purposes.

23,768 H. W. Wilson and East Anglian Engineering Co. Suffolk. Electromagnets for extracting magnetic impurities from liquefied materials.

23,769 S. E. Barnes. Lincs. Telephone system.*

23,797 W. H. Bristol. Temperature compensating devices for electrical recording instruments.*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

15,077 Hanson. Automatic telephone switchboards. (Date applied for, July 7, 1902.)

22,053 Martin, Lowson and Sayers. Dynamo-electric machines.

22,440 Fairweather (Kellogg Switchboard & Supply Co.). Telephone systems.

23,100 Boyden. Electric potential governors.

23,478 Arton. Electric transmissions of energy through space (Date applied for, Aug. 23, 1903.)

25,525 B.T.-H. Co. (G.E. Co., U.S.). Starting switches for electric motors.

25,663 Falk, Stadelmann & Co. and Thurnauer. Telephone systems.

26,488 Napier. Electric ignition for internal combustion engines.

26,533 Krause. Electric heaters.

26,553 Best, Best & Best. Electric ignition of miners' lamps.

26,857 Crompton & Co. and Hodgson. Arc lamps.

27,350 Le Tall (Potter). Electric, gas or vapour lamps.

28,748 Estler and Jack. Trolley wheels or collectors.

1904.

653 Saarbrucker Elektricitäts Akt.-Ges. and Emmerich. Casings for dynamo electric machines.

2,899 Struble. Electric signalling for railways. (Date applied for, Feb. 13, 1903.)

3,540 Conrad. Alternating current integrating and indicating wattmeter. (Date applied for, Feb. 20, 1903.)

8,365 Fairweather (Vesta Storage Battery Co.) Storage batteries.

15,226 Troy. Method of selecting electrical impulses. (Date applied for, July 11, 1903.)

16,396 Abel (Siemens and Halske, A.G.). Producing zinc from sulphate solutions by electrolysis.

17,236 Weller. Posts for conductors, lamps, trolley lines, &c.

17,483 Harrison. Receiving system for wireless communications. (Date applied for, Aug. 27, 1903.)

17,792 Canello. Manufacture of incandescent lamps. (Date applied for, Sept. 12, 1903.)

18,949 Sale. Safety guard for live rails.

19,245 Wilson and Marshall. Automatic signalling for electric railways or tramways.

19,611 Klinkenberg. Controlling apparatus for electric motors.

COMPANIES' MEETINGS AND REPORTS.

West India and Panama Telegraph Co. (Ltd.).

The fifty-fifth ordinary general meeting was held on Wednesday, Mr. WALTER B. KINGSFORD (Chairman of the Company) presiding.

The MANAGER AND SECRETARY (Mr. R. T. Brown) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said: Gentlemen, you will have seen by the accounts that the net receipts are £322 less than those in the corresponding half-year of 1903. The expenses are £386 more. There is, therefore, a decrease of profit amounting to £708, or about 2 per cent. of the receipts. This variation is a very small one having regard to the fact that we have to maintain 21 stations and a fully-equipped and necessarily expensive repairing steamer. Traffic receipts are the backbone of all telegraph companies, and I regret that there is not more elasticity in that part of our income. Our cables cover a very large area, extending from the Isthmus of Panama to Demerara. It is, therefore, not only a matter for regret, but a matter for surprise, that the telegraphic facilities afforded by our system are not turned to more account. For local purposes, at all events, our rates are extremely moderate, seeing that between some of the islands messages can be sent for 3d. a word. As being a matter connected with the accounts, I should like to mention here that I have received a letter from a much respected shareholder, who is unable, to my regret, to attend this meeting, suggesting that the interest on the reserve fund investments should be placed to reserve instead of being distributed in dividends. We heartily wish we were in a position to comply with this suggestion, and thereby to strengthen the reserve fund. We did, as a fact, place this interest to the reserve fund until June, 1899, when, after careful consideration, it was decided to place it in future to revenue as being, in our judgment, the course most beneficial to all classes of shareholders. The effect of adopting the suggestion of the honourable proprietor would be to cause the dividends on the first and second preference shares to fall yet further into arrear; and on that account we think it would be unwise to make any change in the present mode of dealing with the interest in question. In September last, taking advantage of a fortunate lull in our cable-repairing operations, we chartered our ss. "Henry Holmes" to the Cuba Company for the purpose of repairing one of their cables. We shall derive a profit from this, which will be dealt with in the accounts for the current half-year. The charter terminated on Oct. 9, and by a singular coincidence the cable between Trinidad and Demerara became interrupted on the same day. On the next day there was an interruption of one of the Jamaica Porto Rico cables. On Nov. 9 two other cables broke down, and on Nov. 20 two more. This series of interruptions, occurring in rapid succession after three months of unbroken communication, can only be accounted for by some unusual physical conditions prevailing at the time. I am glad to be able to inform you that all these cables, with one exception, have since been repaired. You all know our unfortunate experiences at Martinique and St. Vincent, and the very great difficulties which we have to contend with in maintaining cables in those volcanic regions. I sometimes fear, however, that our friends in the Colonies, and others connected with the Colonies, do not so fully realise how great our difficulties are, and that it costs the Company thousands of pounds every year to maintain its cables, laid, as they unfortunately have to be, on a sea bottom which is probably more injurious to submarine cables than any in the world. As you will see from the report, the Danish colonies of St. Thomas and St. Croix have renewed their subsidies for a further term of five years. I am very glad to be able to make this satisfactory statement. I now move the adoption of the report and accounts.

Mr. HENRY HOLMES seconded.

Mr. THORP asked whether, during the present half-year, the receipts had increased or decreased, as compared with the corresponding half-year.

Mr. EDMONDS asked how the rise in the price of sugar had operated to the benefit of this Company since June 30.

The CHAIRMAN: In reply to Mr. Thorpe's question, the receipts were smaller by £549. As to the effect of the rise in the price of sugar on our receipts, up to the present time no benefit had been derived.

The resolution was then carried unanimously.

A vote of thanks to the chairman and directors terminated the proceedings.

Aron Electricity Meter (Ltd.).

The seventh ordinary general meeting of this Company was held yesterday, Mr. HUGO HIRST, M.I.E.E., presiding.

The SECRETARY (Mr. M. Aron) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, on rising to address you to-day, I feel more cheerful than on the two previous occasions when I have had that honour. I am by no means proud of the document that we have placed before you recording the result of our past year's trading, but we record a progress in the right direction and indications are not wanting that a more prosperous era is in front of us. Before, however, I deal with the outlook, I wish to confine my remarks to the report, and in the sequence in which the report runs. Our profit and loss account shows a gross profit on trading of £23,256. 7s. This might just as well be called net profit on trading in so far as all the expenses connected with the manufacture and sale of meters are already deducted before this amount is arrived at. The amount written off for depreciation is considered ample by our auditors, and if we have on this item ever erred since the inception of the Company I do not hesitate to say we have erred on the generous side. Directors' fees and managing director's salary are still at the reduced amount. Maintenance of patents is this year apparently higher, yet the actual amount expended is higher still. This £1,840 only represents out-of-pocket expenses, but not the actual time and brain work of our staff and management, nor rent, power, &c. The time switch, the double-tariff meter, the automatic meter, and the new alternating current motor meter, in which we are now doing a substantial business, are entirely the outcome of the annual expenditure under this heading. The remainder of the items are debenture interest and expenses connected with the issue of debentures, which automatically get less every year. After deducting all these charges and expenses there results a balance of £10,679. 19s. 1d. which is the real amount of net profit with which we have to deal. As the report shows, we have to use £4,645. 1s. 9d. to wipe out the trading loss carried forward from 1901-1902, and in accordance with the trust deed we have to set aside for debenture sinking fund £2,500. The balance the Directors propose, and you are asked to confirm, should be used to pay a dividend of 2½ per cent. on account of the preference dividend in arrear, leaving £412. 9s. 4d. to be carried forward. I trust you will approve the policy of the Directors in not insisting on the conventional practice of deferring payment of a dividend until we have a larger balance to carry forward. Assuming the coming year to be no better than the past year, we shall not have to deal with an adverse old balance before the interests of the shareholders can be considered; it will then be time to fix a desirable amount to be carried forward from year to year. As regards the balance sheet, on the debit side the figures are very much the same as before, with the exception that the amount of debentures outstanding has been reduced and the sinking fund is increased by the amount of the yearly quota. On the credit side the first item, goodwill, patents, stock and shares in American company, &c., is increased by about £2,000. This is entirely accounted for by the additional buildings erected during last year which also had to be filled with machinery and tools, all of which expenditure was sanctioned by you at the last annual meeting. Stock of meters and parts is increased by about £6,100. Sundry debtors and outstandings is the same as last year with the exception of £3,000, which was owed to us by the American Company, and has since been paid. Therefore, the same amount of outstandings for an increased turnover is a satisfactory feature. These £3,000 have been handed to the trustees for the debenture-holders not in repayment but as security. Our liquid assets are practically the same and the Company is financially quite as sound and strong as before. These are all the remarks I have to make on the figures of our balance-sheet. As regards the outlook, the business we have done since Oct. 1 justifies us in anticipating a continuance of sound trading during the coming financial year, unless circumstances arise beyond control affecting the electrical industry generally. I personally am particularly hopeful that the new alternating-current motor meter will catch on in this country, and as the factory is now built and ready to supply, we shall not be long before we are in a position to know whether my hopes will be realised. In the meanwhile, the existing clockwork meters are being bought in increased quantities all over the Continent at prices which, I think, our balance-sheet has proved, are leaving us a reasonable profit. Dr. Aron himself and his staff continue to give the most assiduous attention to all the details of our business, and their hard work and optimism throughout the last year have been one of the most encouraging features in this business to my colleagues and myself. I now move the adoption of the report and accounts.

Mr. ROGER W. WALLACE, K.C., seconded the motion, and said that the last few years had been rather lean. He hoped that now the Company were going to enter upon a period of prosperity.

Mr. A. M. GIBBONS asked what provision had been made against the expiration of patents?

The CHAIRMAN replied that the patents had, so far, not been touched in the balance-sheet. The Company spent every year a considerable amount for new patents. At the present time the patents were more valuable than they were at the time of the inauguration of the Company.

The motion was then carried unanimously, and the payment of the 2½ per cent. dividend on the cumulative preference shares was approved.

The retiring Directors, Sir James Pender, Bart., and Mr. Hugo Hirst, were re-elected, and the appointment of Mr. Harry Kuhn to fill the vacancy caused by the resignation of Mr. S. J. Blumlein, was confirmed. The auditors having been re-elected, the proceedings terminated.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.).—For the year ended July 31 the profit was £50,550. After providing for interest, &c., a balance of £2,809 remains, which the directors propose to carry forward. A considerable sum for the maintenance of large machine tools has been charged to revenue, and latterly patterns, drawings, &c., have been charged to revenue. The directors therefore consider that the £10,500 provided for depreciation is sufficient. The buildings have been well maintained, and no special provision for depreciation thereon is at present considered necessary. The board has not deemed it necessary to write off depreciation on patents in view of new ones that have been taken out. The result obtained at the close of this the first complete year of manufacturing has shown that the general expense and outlay incident to the development required in connection with the company's plant at Trafford Park has been much greater than the management anticipated. The varied and to a large degree novel character of the work undertaken more than a year ago required additions in equipment of many kinds, and the expense met with in forming the organisation required to execute such work has involved considerable outlay. This expenditure has, however, placed the factory in an advantageous position to execute orders in the future for large generating units. The management has been active in perfecting the company's organisation in all departments, and improvements materially curtailing manufacturing costs and diminishing selling and administration expenses have resulted. A larger amount of work is now being turned out for a smaller amount of labour than formerly, and a matter of equal importance is that the proportion of contracts executed in the works, compared with finished material purchased from other manufacturers to fill such contracts, is increasing, while at the same time the margin of profit on work executed in the factory is moving upwards. While it is not possible to declare a dividend upon the preference shares, the outlook is one which encourages the directors to look forward to an improvement during the current year. Orders received during the year ended July, 1902, were of the value of £932,000; during the year to July, 1903, £1,657,114; and during the year ended July, 1904, £927,336. During the year under review business was inactive, and few large contracts were placed; but, notwithstanding the general depression, the keen competition between manufacturers at home and the vigorous efforts of Continental firms to secure British business, the company has taken orders during the first three months of the current year aggregating £311,000, compared with £210,000 for the corresponding period of last year.

BULLERS LIMITED.—The directors in their report for the year ended July 31 regret that, in consequence of the depressed state of trade throughout the country, reduced profit has to be recorded, but the year's work, in the circumstances, may be considered satisfactory. The increased development of the business has necessitated a small addition to buildings and plant to meet requirements of existing contracts. After paying directors' fees and managing directors' salaries, the profit was £31,197, which, with £834 brought forward, makes £32,031. Interest absorbs £7,500, and dividends of 7½ per cent. on ordinary shares (£11,250) have been paid, leaving £13,281. The directors propose to pay a further 2½ per cent. on the ordinary shares, making 10 per cent., and requiring £3,750, to place £5,000 to reserve and to pay a bonus of 2½ per cent. on the ordinary shares, absorbing £3,750, carrying forward £781.

INDUSTRIAL STORAGE BATTERY SYNDICATE (LTD.).—At an extraordinary meeting on Wednesday the chairman (Mr. C. Temperley) said the resolutions passed at the meeting on Nov. 14, giving the directors power to divide the 18,993 shares of £1 each at present unissued into shares of 10s. each, and also reducing the capital from £100,000, in 81,007 shares of £1 each and 37,986 shares of 10s. each, to £59,496, in 118,992 shares of 10s. each were confirmed. He was sorry to say that the directors had only received applications for 150 shares, and unless the shareholders were prepared to come forward and subscribe there was nothing else to do but let the scheme go to the wall.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

◆

BIRMINGHAM & MIDLAND MOTOR OMNIBUS CO. (LTD.) (82,681.)—Reg. Nov. 26, capital £60,000 in £1 shares, to adopt an agreement and to carry on the business of motor-car, omnibus, van and cab proprietors, carriers of passengers and goods, omnibus, motor-car, truck, locomotive and vehicle builders, engineers, manufacturers of accumulators, dynamos and other things for the manufacture and equipment of such vehicles, &c. First directors are W. J. Taylor, J. Jordan, C.C., T. Ottey, W. Roberts and E. A. Olivieri. Reg. office, Winchester House, Colmore-row, Birmingham.

CHESHIRE LIGHT RAILWAYS (LTD.) (82,669.)—Reg. Nov. 25, capital £1,500 in £1 shares, to obtain an order authorising construction of light railways in Cheshire or elsewhere in the United Kingdom or abroad, to adopt an agreement with R. H. Scotter, and to carry on the business of light railway proprietors, manufacturers of and dealers in railway and tramway carriages, motor cars, locomotives and engines, &c. First directors are J. Coxon, H. Greenall and R. H. Scotter.

LINDSEY LIGHT RAILWAY SYND. (LTD.) (82,631.)—Reg. Nov. 21, capital £1,000 in £1 shares, to apply for and obtain an order for a light railway between Blyton and Frodingham (Lincs.), and to carry on same.

NICHOLSON & ROBINSON (LTD.) (82,651.) Reg. Nov. 23, capital £2 000 in £1 shares, to carry on the business of electricians, mechanical engineers, contractors, manufacturers of and dealers in electrical apparatus, &c. Reg. office, 53, Victoria-street, Westminster, London.

CITY NOTES.

◆

MEMORANDA (Dec. 1).—Bank rate 3 per cent. (since April 21, 1904) Price of silver 27⅜d. per oz. Consols 87⅞—88⅛ x.d. for money, 88¼—88⅜ x.d. for account; 2½ per cent. annuities 87¼—87¾ x.d. Stocks and Shares Continuation Days, Dec. 13 and 28; Ticket Days, Dec. 14 and 29; Pay Days, Dec. 15 and 30; Mining Share Carry-over Days, Dec. 12 and 27.

POWER GAS CORPN. (LTD.)—The profit for the past year was £10,144, and a dividend of 3½ per cent. is recommended on the ordinary shares. The plant for South Staffordshire Mond Gas Co.'s first central station is on point of completion.

STOCK EXCHANGE NOTICE. The Stock Exchange committee have ordered a further issue of 2,732 £5 fully-paid ordinary shares of the *Calcutta Tramways Co. (Ltd.)* to be quoted.

WESTERN TELEGRAPH CO. (LTD.)—An interim dividend (payable Dec. 21) of 3s. per share (or at the rate of 6 per cent. per annum tax free) has been declared for the quarter ended Sept. 30 last. The transfer books are closed from 14th to 20th inst. inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Nov. 26	1,036	− 52	26	33,480	+ 5,739
Airdrie	,, 18	106	...	41	8,291	...
Ayr Corporation	,, 20	183	− 8	23	9,952	+ 418
Barnsley	,, 18	165	− 1	46	7,816	− 534
Barrow	,, 18	193	...	41	8,158	...
Bath Electric Trams, Ltd.	,, 21	535	...	47	30,320	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 27	675	− 95	...	...	...
Birmingham Corporation	,, 26	311	...	46	14,123	...
Birmingham Tramways Co.	,, 26	4,801	− 106	21	115,830	+ 5,168
Blackburn Corporation	,, 25	700	− 7	35	23,416	+ [illegible]
Blackpool Corporation	,, 24	279	− 7	34	42,100	+ 5,913
Blackpool and Fleetwood	,, 26	170	+ 10	21	20,424	+ 891
Blackp'l, St. Anne's & Lytham	,, 24	188	− 8	¶13	487	− 119
Bolton Corporation	,, 27	1,576	− 109	36	64,049	+ 309
Bournemouth Corporation	,, 23	742	− 36	34	30,052	+ 2,071
Bradford Corporation	,, 24	3,741	− 104	33	158,540	+ 26,140
Brighton Corporation	,, 27	689	+ 65	34	36,497	+ 3,257
Brisbane Tramways	Oct. 5	2,859	+ 59	15	36,578	+ 148
	,, 12	2,536	− 36			
Bristol Trams & Carriage	Nov 25	4,364	+ 4	16	140,410	+ 1,444
Buenos Ayres & Belgrano	Oct. 30	3,219	+ 61	9	6,631	+ 277
Burnley Corporation	Nov. 16	912	+ 161	8	8,248	+ 1,206
Burton Corporation	,, 27	249	− 51	*34	12 258	...
Calcutta Tramways Co.	,, 26	a41,325	+ a6,214	22	a787,271	+ a84,779
Camborne-Redruth	,, 28	100	+ 2	4	444	− 112
Cardiff Corporation	,, 25	1,704	− 89	31	70,957	+ 1,537
Carlisle Tramways Co.	,, 26	181	− 12	47	9,340	+ 215
Central London Railway	,, 26	7,290	+ 278	21	132,147	− 75
Chatham & Dist. Lt. Rys.	,, 24	448	− 34	47	27,631	+ 2,165
City & South London Rly.	,, 27	3,364	+ 44	23	56,159	− 1,870
Colchester Corporation	,, 24	151	...	17	4,761	...
Cork Electric Trams Co.	,, 24	341	− 25	47	23,188	− 2,230
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 18	489	+ 2	[illegible]	24,604	+ 3,244
Dover Corporation	,, 26	140	− 11	35	8,150	− 172
Dublin & Lucan Railway	,, 26	79	− 7	34	2,736	− 80
Dublin Southern District	,, 25	646	− 33	21	108,947	− 2,938
Dublin United	,, 26	3,341	+ 289			
Dudley—Stourbridge	,, 18	761	− 7	46	40,261	+ 1,413
Dundee Corporation	,, 23	776	− 10	...	...	...
East Ham Council	,, 26	517	− 31	34	25,274	+ 1,428
Gateshead & Dist. Trams	,, 18	691	− 10	45	47,046	+ 1,864
Glasgow Corporation	,, 26	12,776	− 329	†26	372,101	+ 19,719
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 18	186	− 21	46	11,715	+ 458
Gt. Northern & City Rly.	,, 26	1,346	...	41	41,751	...
Greenock & Port Glasgow	,, 18	404	+ 41	46	26,769	+ 1,365
**Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 16	289	− 6	46	15,636	+ 1,015
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 26	2,042	+ 217	31	75,501	+ 9,833
Ilford District Council	,, 19	336	+ 15	†34	16,252	+ 697
	,, 26	332	− 5			
Ilkeston Corporation	,, 23	97	− 29	8	963	− 107
Ipswich Corporation	,, 26	196	...	31	17,557	...
Isle of Thanet Co.	,, 26	243	− 31	8	2,041	− 146
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	,, 18	96	...	46	5,389	+ 21
Kirkcaldy Corporation	,, 26	201	− 31	47	10,719	...
Lanarkshire Trams Co.	,, 24	594	+ 43	47	30,788	+ 19,069
Leeds Corporation	,, 26	4,970	+ 95	34	204,736	+ 11,670
Leicester Corporation	,, 26	1,431	...	20	40,725	...
Liverpool Corporation	,, 19	10,075	+ 610	47	487,905	+ 14,081
Liverpool Overhead Rly.	,, 27	1,420	− 134	†22	31,857	− 1,389
London County Council	,, 19	19,023	+ 2 918	§33	419,034	+ 93,172
*Lowestoft	...	...	...	...	...	...
Maidstone Corporation	,, 24	91	...	19	3 014	...
Manchester Corporation	,, 26	10,410	− 849	34	424,224	+ 17,752
Mersey Railway	,, 26	1,539	+ 206	21	30,873	+ 2,633
Merthyr	,, 18	196	+ 12	46	9,354	+ 64
Metropolitan Elec. Trams	,, 26	1,504	+ 52	21	33,575	+ 10,943
Middleton	,, 18	214	+ 25	46	15,144	+ 339
Nelson Corporation	,, 26	97	+ 14	35	4,202	+ 1,265
Newcastle-on-Tyne Corp.	,, 26	8,429	+ 3	21	76,714	+ 3,850
Newport (Mon.)	,, 26	491	+ 46	8	3,972	+ 431
Oldham, Ashton & Hyde	,, 18	512	+ 1	46	25,380	− 1,027
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams	,, 25	1,365	− 9	47	61,108	+ 6,507
Peterborough	,, 18	105	− 5	46	7,002	− 314
Poole and District	,, 18	234	+ 10	46	14,219	+ 56
Portsmouth Corporation	,, 26	1,229	− 66	§34	70,190	+ 5,013
Potteries	,, 18	1,764	+ 103	46	79,209	+ 6,914
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 18	37	+ 1	46	6 790	− 1
Salford Corporation	,, 26	3,242	− 699	34	142,136	+ 7,660
Sheerness	,, 16	58	+ 9	46	2,946	− 408
Sheffield Corporation	,, 27	4,026	+ 168	§35	164,621	+ 8,075
Southampton Corp'ation	,, 24	780	− 67	34	34,477	− 2,193
Southend Corporation	,, 23	190	− 5	31	13,949	+ 1,354
Southport Tramways	,, 18	242	− 6	46	15,133	+ 499
S. Staffordshire Trams.	,, 18	613	− 312	46	35,527	− 6,916
Stockport Corporation	,, 25	407	+ 64	34	10,106	+ 7,542
Sunderland Corporation	,, 20	1,063	+ 93	34	44,547	+ 944
Swansea Trams	,, 18	473	+ 3	46	25,109	+ 975
Taunton Trams	,, 18	80	− 11	46	2,586	− 190
Tynemouth and District	,, 18	187	− 25	46	13,741	− 988
Tyneside Trams Co.	,, 23	310	+ 26	47	18,990	+ 3,161
Wallasey District Council	,, 26	560	+ 14	§31	26,534	+ 1,661
Walsall	,, 26	609	...	45	23,634	...
Warrington Corporation	,, 24	256	− 4	34	11 062	+ 870
West Ham Corporation	,, 24	970	...	30	36,707	...
Weston-super-Mare	,, 16	38	+ 2	46	6,118	+ 503
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 18	362	+ 8	46	19,074	− 61
Worcester	,, 18	251	+ 151	41	13,130	+ 6,531
Wrexham	,, 18	85	− 27	44	5,075	− 900
Yorkshire Woollen District	,, 18	485	− 40	46	25,004	+ 3,553

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

** Fortnight

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed. Nov. 30	Rate per Cent. Yielded	Dividend Due.	Business, Week to Nov. 30. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	2/0	Anglo-Argentine Ordinary Shares	7 —7¼	4 2 9	April, Oct	7⅛	6⅞
5	2/6	Do. 6% Cum. Pref.	5½—5¾	4 0 0	..	5⅝	5⅜
St.	6%	Do. Permanent 6% Deb. Stock	143 —146	4 2 9	..	144	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	106 —107	4 15 3	—	107½	106½
10	6%	Barcelona Tramways Ord.	9 —10	5 0 0	—	9½	..
10	6/0	Do. 6% Cum. Pref.	9 —10	5 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	93 —96	4 14 0	—	..	..
100	5%	Do. 5 per Cent. Debs.	98 —101	4 19 6	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	½—¾	..	..	..	..
1	..	Do. 5% Cum. Pref.	¾—1⅛	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 3	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96 —100	4 11 9	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19 —20	4 0 0	Feb, Aug	..	—
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107 —109	3 13 4	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100 —103	5 16 6	—	..	..
St.	5%	† Do. Pref. Ord. Stock	100 —103	4 17 1	—	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10¼—10¾	4 13 0	..	..	..
50	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102%—104%	4 6 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	97 —100	4 10 0	..	..	..
10	6/0	British Electric Traction Ord.	9¾—10¼	5 17 3	..	10	9¾
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—11¼	5 7 9	Feb, Aug	11	10¾
St.	5%	Do. 5 per Cent. Perpetual Debs	117 —119	4 4 3	—	119	118½
St.	4½	Do. 4½ per Cent. 2nd Deb. Stock	95 —97	4 12 10	..	96½	..
5	1/6	Buenos Ayres and Belgrano Ord.	2⅞—3⅛	5 14 0	—	3⅛	3⅛
5	2/0	Do. 6 per Cent. "A" Cum. Pref.	4¾—5¼	5 2 2	—	4¾	..
5	2/0	Do. "B"	4¾—5¼	5 11 3	—	..	..
St.	5%	Do. 5 per Cent. Debs.	106 —108	4 13 5	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	102 —105	4 16 3	—	104½	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. 5% Deb. Stk.	98 —99	5 2 6	..	..	..
5	3/0	Calcutta Tramways	7¾—8	3 15 0	—	8	7½
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —108	4 4 0	..	..	..
1	1/0	Cape Electric Tram Shares	1⅛—1¼	6 3 0	..	1¼	1⅛
St.	4%	Central London Ordinary Stock	93 —95	4 4 2	June, Dec	93½	..
St.	4%	Do. 4 per Cent. Pref. Stock	101 —103	3 17 9	..	103	101½
St.	4%	Do. Deferred Stock	84 —86	4 13 6	..	84½	..
100	4%	Do. 4 per Cent. Debs.	108 —110	3 13 4	..	..	..
5	2/6	City of Birmingham Trams. 6% Cm. Prf.	4½—5½	4 17 6	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 3	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	46 —47	4 15 3	Feb, Aug	47	46½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 3	Feb, Aug	..	..
St.	5%	Do. (1896)	117 —120	4 3 6	..	..	..
St.	5%	Do. (1901)	116 —118	4 5 6	..	116½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 —107	3 14 9	May, Nov	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	101 —104	4 16 3	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13 —14	4 5 5	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
10	3 0½	Gt. Northern & City Rly. Prf. Ord. (4%)	5½—6	..	—	5¾	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8½—9½	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19 —20	5 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	110 —112	4 0 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 6% Pf.	3½—4½	5 17 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 7 3	..	..	..
10	1½%	Liverpool Overhead Railway Ord	5½—5¾	2 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	6/0	London United Trams. 6% Cum. Pref.	10⅛—10½	4 12 0	..	10½	10¼
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 —106	3 16 9	..	104½	104½
St.	..	Madras Elec. Trams 5% Deb. Stk.	103 —105	..	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	8 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10 —12	..	..	..	..
1	..	Metropolitan Electric Trams Def	½—¾	..	..	..	..
1	0/6	Do. 6% Cum. Pref.	¾—1	5 0 0	..	..	..
St.	12/7	Do. 4½ Deb. Stock	103 —105	..	..	..	..
100	5%	Montreal St. Ry. St'g 5% Mrt. Dbs. (1908)	100 —103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 —105	4 5 9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—1½	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams 1st Mt. Db. Stk.	103 —106	4 16 9	..	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —102	4 8 5	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	88 —90	3 7 0	June, Dec	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 6% Cum. Pref.	½—¾	5 14 2	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	¾—⅞	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5½—6	6 13 4	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5½—6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —106	4 6 3	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	100 —102	4 8 6	..	..	..
5	3/0	British Westinghouse 6% Pref.	2¼—2¾	..	—	3⅛	2¾
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	87 —89	4 11 0	..	87	..
2	..	Brush Electrical Engineering	½—¾	..	March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼—1½	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	93 —96	4 14 6	Mar, Sept	95	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	69 —73	6 6 8	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	9½—10	5 5 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 13 0	Jan, July	5½	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —106	4 6 7	Nov, May	105	104½
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1⅛—1¼	4 18 9	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	93 —95	4 13 4	..	..	..
1	0/9½	Chadburn's (Ship) Telegraph Ord.	¾—1¼	8 17 6	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅛—1⅜	4 6 3	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	92 —97	5 4 6	Jan, July	96	..
5	10/0	Dick, Kerr & Co. Ord.	7½—7¾	6 8 5	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	5½—6	5 9 1	Sept	6	..
St.	4½%	Do. 4½% Deb. Stock	104 —106	4 5 9	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	79 —83	4 17 9	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 —84	6 0 6	..	..	—
5	4/6	Edmundson's Elec. Corp. Ord.	5½—6½	5 14 6	H'lf-yearly	6⅛	6
5	3/0	Do. 6 per Cent. Cum. Pref.	5½—6¼	4 17 6	—	6	5⅞
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106 —108	4 4 3	..	107½	107
2	1/7½	Electric Construction Co.	1½—1¾	6 8 0	July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2¼—2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98 —100	4 0 6	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	—	..	—
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10	5 0 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91 —96	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½—11	6 7 [illegible]	Feb, Aug	11½	10⅞
5	2/3	Do. 4½ per Cent. Pref.	5¼—5¾	4 3 9	Feb, Aug	5⅝	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	109 —111	4 1 5	Feb, Aug	..	..
10	8/0	India Rubber, Gutta Percha, &c., Wrks.	19½—20½	4 18 9	Feb, Aug	20½	20⅛
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11¼	4 8 10	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	38 —40	5 18 6	Mar, July	39	38½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	103 —105	3 17 6	Jan, July	..	..
5	..	Willans and Robinson Ord.	1 —2	..	Apr, Oct	..	..
5	—	Do. 5 per Cent. Cum. Pref.	2 —3	—	Apr, Oct	..	..
St.	6%	† Do. 6 per Cent. 1st Mort. Debs	74 —79	8 1 3	May Nov	78½	—

Share.	Last Dividend	Name.	Price Wed. Nov. 30.	Rate per Cent. Yielded	Dividend Due	Business Week to Nov. 30. Highest.	Lowest.
		ELECTRICITY SUPPLY.		£ s. d.			
..	..	Blackheath & Greenwich Dist. El. Lt. See South Metropolitan Elec. Lt. & Power Co. below	..	..	..	..	..
10	10/0	Bournemouth & Poole Elec. Sup. Ord.	12 —13	6 8 1	..	12½	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10	4 10 0	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104 —106	4 5 9	—	..	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5¼—5½	3 9 7	..	..	..
St.	4½%	Do. Do. 1st Debs	101 —104	4 7 0	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..	10½	..
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 5 1	Mar, Sept	..	..
5	3/0	Calcutta Electric Supply Ord.	7¾—8	4 7 6	..	7¾	7½
St.	4%	† Central Elec. Sup. Co. 4% Guar. Db. Stock	103 —107	3 14 9	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8½—9	4 8 9	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5¼—5¾	3 18 3	Feb, Aug	5½	5½
St.	4%	Do. 4% Deb. Stock (red.)	103 —105	3 17 3	..	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4 10 0	—	4⅞	..
5	2/3	Do. Do. (1903)	4½—5	..	..	..	..
5	2/3	Chelsea Electric Supply Ord.	6¼—6½	4 5 2	March	6⅜	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109 —111	4 1 9	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	10½—11	4 10 11	Feb, Aug	10⅞	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13¾—14	4 5 9	Jan, July	13¾	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	125 —127	4 0 0	Jn, Dec	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	104 —106	4 6 9	..	105	..
10	4/0	County of London Elec. Supply Ord.	9½—9¾	4 2 1	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —12½	4 16 0	Mar, Sept	12⅛	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 —110	4 3 3	..	108½	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 —103	4 7 5	..	..	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 —93	5 7 5	..	..	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	102 —105	4 7 0	—	..	—
10	..	Havana Electricity Co. Shares	9½—10½	—	..	..	—
5	3/6	Hove Electric Lighting Ord.	7½—8	3 6 3	..	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St (red.)	100 —102	4 8 9	..	100½	100½
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm. Prf.	¾—1⅛	..	—	1	⅞
5	5/0	Kensingtn & Knghtsbdge Ord.	12 —13	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —104	3 17 3	—	..	..
5	..	London Electric Supply Ord.	2 —2½	..	..	..	..
5	3/0	Do. 6 per Cent. Pref.	5¾—6¼	5 2 1	..	5½	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	97 —99	4 2 0	Mr, Jn, S, D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	16¼—16¾	5 7 0	April, Oct	16½	16¼
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼—5½	4 1 10	Jan. July	5¼	5¼
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	112 —117	3 18 0	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 —99	3 10 6	..	97	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	93 —96	4 18 9	..	..	—
10	6/0	Notting Hill Electric Ord.	14½—15	4 0 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	101 —103	3 18 2	..	..	..
5	2/6	Oxford Electric Ord.	6 —6½	5 4 0	March	6½	..
St.	4%	Do. 4% Deb. Stock	99 —101	4 0 0	..	..	..
1	..	Rand Electric	1⅛—1⅜	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mt. Deb	100 —102	4 8 9	April, Oct	..	..
5	6/0	St. James' & Pall Mall Elec. Ord.	14½—14¾	4 18 4	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	8½—9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	99 —101	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¾—3¼	6 3 1	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83 —87	4 12 6	..	..	..
5	3/0	South London Electric Supply Ord.	4½—4¾	3 6 5	—	4⅝	..
1	..	South Metrop'n Elec. Lt. & Power Ord.	½—1	..	—	..	..
1	0/8½	Do. 7% Cum. Pref.	1⅛—1¼	4 16 9	—	1⅛	..
St.	4½	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. Accm.)	107 —110	4 2 3	—	..	..
5	2/6	Urban Electric Supply Ord.	4⅞—5⅛	4 18 9	..	5	..
5	2/6	Do. 5% Cum. Pref.	4⅞—5⅛	4 18 9	..	5⅛	4⅞
St.	..	Do. 4½ 1st Mort. Deb.	103 —106	—	..	103	101½
5	6/6	Westminster Electric Supply Ord.	12½—13	5 3 10	Mar, Sept	13	12½
5	2/6	Do. 5 per Cent. Cum. Pref.	6½—7	3 11 5	..	6½	—
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	99 —102	3 19 0	Jan, July	..	..
10	..	Amazon Telegraph	1 —1½	..	Jn, Dec	..	..
St.	12/0	Anglo-American	54 —55	4 17 0	F, My, Ag, N	55	..
St.	25/0	Do. Preferred	102 —104	5 5 6	F, My, Ag, N	103½	101½
St.	2/0	Do. Deferred	12½—13½	6 16 0	F, My, Ag, N	12¾	11¾
100	$2	Commercial Cable Capital Stock	170 —190	4 4 2	Jn, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	92 —95	4 4 9	Jn, Ap, Jy, O	94½	93½
10	5/0	Cuba Submarine Ord.	8½—9½	5 5 0	Feb, Aug	9¼	8¾
10	10/0	Do. Preference 10 per Cent.	16¾—17½	5 14 3	Feb, Aug	17	16½
5	2/0	Direct Spanish Ord.	2½—2¾	7 5 6	April, Oct	2½	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7¾—8	6 5 0	April, Oct	7⅞	..
50	4½%	Do. 4½ per Cent. Deb.	100%—102%	4 8 6	Jan, July	100½	..
20	5/0	Direct United States Cable	10¾—11½	5 7 9	Ja, Ap, Jy, O	11	10¾
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 —102	4 9 6	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	132 —135	5 5 2	Ja, Ap, Jy, O	134½	132
St.	17/6	Do. 3½ per Cent. Pref. Stock	88 —90	3 18 0	Ja, Ap, Jy, O	90½	89
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —107	3 14 9	May, Nov	..	..
10	2/6	Eastern Extension	12½—12¾	5 2 1	Ja, Ap, Jy, O	12⅝	12½
St.	4%	Do. 4 per Cent. Deb. Stock	106 —108	3 14 3	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	101 —103	3 13 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 5	May, Nov	..	..
10	5/0	Gt. Nrthn. (of Copenhagen)	27½—28½	5 4 0	Jan, July	28½	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100 —102	4 9 6	June, Dec	..	..
25	12/6	Indo-European	44½—45½	5 7 6	May, Nov	45	44½
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	98 —100	4 0 0	June, Dec	..	—
10	4/0	† West African Telegraph Shares	7¼—7¾	6 0 2	..	..	..
2½	..	West Coast of America	⅜—⅝	..	..	½	½
100	4%	Do. 4 per Cent. Debs.	98 —100	4 0 6	Jan, July	..	..
10	..	West India and Panama	½—¾	..	May, Nov	½	½
10	6/0	Do. 6 per Cent 1st Pref.	7½—7¾	7 14 11	May, Nov	7½	7½
10	..	Do. 6 per Cent. 2nd Pref.	6¼—6¾	..	May, Nov	6½	5⅞
100	5%	* Do. 5 per Cent. Debs.	103 —105	4 17 1	Jan, July	..	..
10	5/0	Western Telegraph	13½—13¾	5 2 6	Mr, Jn, O, D	13¾	13½
100	5%	* Do. 5% Debs. (2nd Series, 1906)	102 —104	4 15 0	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	101½—102½	3 18 5	—	..	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid)	5½—5¾	5 10 3	August	5½	..
1	0/7½	Monte Video Telephone Ord.	¾—1¼	..	..	..	..
St.	6%	National Co. Pref. Stock	107 —108	5 11 3	..	108	107
St.	5%	Do. Def. Stock	96½—97½	5 2 6	..	97½	96½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 8	Feb, Aug	13½	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12 —13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5¾	4 13 0	Feb, Aug	5⅜	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	96 —97	3 11 10	June, Dec	98	97½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104½—105½	3 17 2	..	105½	105
..	5/0	Do. Do. Prov. Certs. 35% to be pd.	67½—68½	..	..	67½	67½
1	0/7½	Oriental	1⅛—1⅜	6 6 8	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼—1½	4 16 0	..	..	..
5	6/0	United River Plate	6½—6¾	6 5 6	July	6½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 15 5	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	105 —107	4 13 9	June, Dec	..	—
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	—	..	..
10	2/0	Globe Telegraph and Trust	9½—10½	5 8 0	Ja, Ap, Jy, O	10½	9¾
10	3/0	Do. 6 per Cent. Pref.	13½—14	4 5 9	Ja, Ap, Jy, O	14	13½
100	6%	Submarine Cables Trust (Cert.)	119 —122	4 19 0	April, Oct	..	..
..	36/7	Underground Elec. Rys. Co. of London 5% Profit Sharing Secured Notes	90½—91½	—	..	..	—

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

EVEN British industrial concerns, partly financed by American capital and conducted by American brains, are not exempt from the present depression in trade, and the British Westinghouse Co. has apparently suffered as severely as any. At all events, bad trade is said to be one of the causes of the Company's present unfortunate position. The chairman, Mr. W. I. BUCHANAN, at the annual general meeting, was not unduly optimistic nor did he prepare the shareholders for any great catastrophe. He merely explained, as many chairmen have done before, that results secured during the early years of the life of any large industrial enterprise are not conclusive as to what its future will be ; he also expressed the view that the large works at Trafford Park would not be found too large for the work which would, "one day," come to them. But he did not even give an approximate idea as to when the "one day" would be. Mr. BUCHANAN admitted that the character of the plant had been "apparently" too extensive at the outset, and that this gave rise to a similarly too extensive organisation. Later on he referred to foreign competition, and explained that the trouble was not so much the actual amount of business obtained by foreign firms in competition with British ones, as the influence which the presence of this competition had upon the prices quoted by British manufacturers. It became necessary for the sales department of the company "to try in advance to discount this unknown outside price," and this department has apparently rather overstepped the mark in its efforts to secure the market.

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In our Legal Intelligence columns last week we reported an application in the Chancery Division on behalf of the Nernst Electric Light (Ltd.) for a rather exceptionally large reduction of capital. This application has called forth some strong criticism from our contemporary, the *Journal of Gas Lighting*, with which we are quite in accord. In fact, in our issue for February 24, 1899, at the time of the issue of the prospectus of the company, we severely commented upon the amount of the capital—viz., £320,000, and expressed a doubt as to whether the operations of the company would result in sufficient trading to pay a dividend upon this huge sum. In reading our contemporary's remarks upon the application for a reduction of capital, however, it is apparent that the opinion is held that a diminution in the competition between gas and electricity will inevitably result in consequence. Our contemporary is scarcely familiar with the facts of the case. The company which has just applied for a reduction of its capital did not own the British patents of the Nernst lamp, and, in fact, has never yet manufactured the lamp for sale. The company on its formation merely possessed the right to apply for patents in Australasia, Africa, Asia, and South and Central America. Neither the technical nor the commercial prospects of the Nernst lamp are in any way affected by the application in question, the practical result of which will be to add another agent to the already numerous list of firms in this country who sell the lamp by agreement with the Electrical Co. (the owners of the British patents), who, in their turn, have arrangements with the owners of the Continental patents. So far from "The Fall of the Nernst Lamp," as our contemporary puts it, having taken place, improvements are being constantly made, and a series of special discounts, arranged between the holders of the patents and the various licencees, came into force on September 1 this year.

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THE announcement that the Mercers' and Fishmongers' Companies have decided to reduce their annual contributions to the City and Guilds of London Institute will be received with regret by all who have had the privilege of receiving technical instruction under the Institute. Others, also, who have not come into actual contact with the organisation, but who appreciate the vast amount of good work which has been performed by it, will share this feeling. Although the City and Guilds of London Institute has not restricted its munificence to the training of electrical engineers, yet it is unquestionable that the electrical industry of this country owes no small portion of its success to the Institute. The Mercers' Company has reduced its annual subscription from £3,000 to £2,000, and the Fishmongers' from £4,000 to £2,000, but, at a meeting of the members of the Livery Companies of the City held on Monday, the hope was expressed that the reduction would only be temporary. Whether it be temporary or permanent something will have to be done to make up the difference. Even with the full grants, the City and Guilds' Technical Colleges are by no means wealthy, and economies, sometimes detrimental to the work carried on, have to be effected owing to lack of means.

THERE are two possible ways out of the difficulty: one is for some private individual or company to supply the deficiency, and the other is to raise the fees payable by students. In any case there could be no harm in adopting the latter course, since the present scale of fees cannot be considered beyond the reach of students recruited from the middle classes. Last year students' fees at the Central Technical College amounted to £9,640, but the expenditure was £4,022 in excess of this sum, apart from £2,834 spent on an extension of the College and on the salaries of the University Professor and his assistant. Now, as the annual fees payable by each student amount to only £30, it would not be unreasonable to increase them by, say, 50 per cent., thus placing the College on a much sounder financial basis. A similar course might equally well be adopted at the Finsbury Technical College, which at present is far from being self-supporting. It is frequently argued that technical education must, of necessity, be aided by charity, and although this may have been perfectly true some years ago, it no longer follows that it is true to-day. Technical education, as then understood, meant the teaching of trades and handicrafts to those who were engaged, either as apprentices or journeymen, in those trades. Obviously such work could not be self-supporting. But engineering education of the present day is a totally different thing; the parents of those who receive it are, or ought to be, in the majority of cases, well able to pay reasonable fees. No one dreams, for instance, of subsidising a school for lawyers, and yet the average engineer eventually attains a position socially and financially equal to that of an average legal man.

THE Paper on tramway running powers which was read by Mr. STEPHEN SELLON before the Tramways and Light Railways Association last week, and an abstract of which we give in another column, unfortunately did not attract a very large audience, only about 20 persons being present. The reason for the sparse attendance was no doubt because the Institution of Electrical Engineers Annual Dinner was held on the same evening. In fact, it frequently happens that the meetings of the Association clash with those of the Institution, naturally to the detriment of the younger society. If this want of foresight in arranging the future meetings of the Tramways and Light Railways Association could be avoided the attendances at the meetings would undoubtedly increase considerably. In other respects, however, Mr. SELLON'S Paper comes at an opportune season, and from the discussion it is apparent that tramway authorities generally are now inclined to take a more reasonable attitude in this matter of running powers. No practical difficulties can be said ever to have existed in connection with through running, the deadlocks which have occurred in the past having been the result purely of sentimental objections. The prolonged negotiations at Newcastle, which ended in a Parliamentary fight costing £10,000, were occasioned by the defeat by one vote of a proposal of the Newcastle Tramways Committee at an early stage. Therefore, no unprejudiced person will see the slightest objection to the establishment of an authority to which all such cases should be referred for adjudication. Such a tribunal should be provided for in one section of a new Tramway Act which is urgently needed to take the place of the Act of 1870. This suggestion, made by Mr. VESEY KNOX, the Parliamentary lawyer, merits consideration at the hands of the Government.

MR. J. B. BURKE'S letter in our Correspondence columns this week raises some questions with regard to the much-debated N-rays which, by a fortunate accident, are answered by two simultaneous Papers of which abstracts will be found in our Contemporary Electrical Science columns. The first question touches the subjective aspect of the rays. It asks whether M. BLONDLOT can see the N-ray reactions when others beside himself or his assistants manipulate the apparatus. If the N-ray laboratory visited by Mr. R. W. WOOD was that of M. BLONDLOT himself—a matter as to which we are left in the dark—then the above question is answered in the negative. In other words, M. BLONDLOT is under the influence of a "psychological disturbance," as Mr. BURKE puts it. On the other hand, M. BLONDLOT himself anticipates Mr. BURKE'S second objection by what we must acknowledge to be a logical refutation. An objective photographic record is the most desirable kind of testimony to the reality of the N-rays. M. BLONDLOT has long ago obtained that, and he now defends its authenticity by further test conditions. And so this extraordinary controversy goes merrily on. The only way out of the deadlock seems to lie in Mr. WOOD'S excellent suggestion that joint experiments should be made by the chief parties concerned. The N-ray controversy is most remarkable for its length. The acuteness of the dispute need not cause surprise when we remember that a prominent British physicist declared, in the early days of the Lippmann photographs, that they contained "nothing in the shape of a spectrum." Such a miscarriage of judgment should make us hesitate to pronounce hastily on the merits of the French discoveries.

MR. G. F. C. SEARLE'S Paper read before the Institution of Electrical Engineers and entitled "Studies in Magnetic Testing" is an important contribution to our knowledge of the properties of iron. Owing to its great length we have been compelled to publish it in an abridged form, but enough is printed to enable the reader to follow the author's work; for fuller details reference must be made to the Paper when printed in the Institution's *Journal*. The most important part of Mr. SEARLE'S work consists in careful experimental research into the quantitative meaning of the effect of the "history" of the iron on its magnetic state, and he finds it necessary to use several new terms according to the point from which the magnetic properties of the iron is viewed. Thus we have his "apparent," "normal" and "virgin" induction, permeability and susceptibility for the same magnetising force. For the practical user of iron the result of all this is rather bewildering, and it is clear that measurements of static hysteresis and permeability can be of little value for comparative purposes unless carried out with laborious precautions that seem to place such tests quite outside the scope of commercial work. The user of iron for transformers, and even for armatures, will be even more than ever inclined to the view that, after all, wattmeter tests tell him what he wants to know; and that hysteresis loops, however important from the physicist's standpoint, have but little use for him. For all this, the general investigation of these properties must not be deprecated, for every such investigation is a step nearer understanding the real nature of the forces which the electrician uses and attempts to control.

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THE Paper on "Hydrodynamical and Electromagnetic Investigations Regarding the Magnetic Flux Distribution in Toothed-core Armatures," by Prof. H. S. HELE-SHAW, Dr. ALFRED HAY and Mr. P. H. POWELL is concluded in the present issue of *The Electrician*. It was received with enthusiasm by a crowded audience at the Institution of Electrical Engineers on Nov. 24th. Dr. HAY explained in a concise and masterly manner the objects of the investigations undertaken, and touched upon a series of methods for determining the so-called "correction coefficient" with which the length of gap along the periphery of the armature has to be multiplied for obtaining the "mean" cross-section. Once this mean cross-section is known, the dynamo calculations can be proceeded with as if the armature core were smooth. The best method, derived from a purely mathematical basis, is that of Mr. F. W. CARTER, and the close agreement of the correction coefficients when calculated from Mr. CARTER'S formula on the one side or computed experimentally by the stream-line method of the authors on the other, may be taken as an indication that the flow of magnetic lines of force may be truly imitated by a hydrodynamical process. Mr. HAY then described the electromagnetic experiments, the chief object of which was to determine the magnetic induction at the top, middle and bottom of teeth of various forms. The interesting fact was observed, as had been foreshadowed, however, by the hydrodynamical stream-line pictures, that the flux in a tooth is greatest somewhere near the middle of the tooth, being smaller both above and below this point. The hydrodynamical investigations were very ably elucidated by Prof. HELE-SHAW, who showed a number of apparatus for carrying out the experiments, and described graphically the difficulties which had to be overcome ere good results were obtained. But the *clou* of the evening was the series of beautiful stream-line pictures, illustrating the flow of a magnetic flux in and around an armature tooth, which were actually developed before the eyes of the audience, and projected by a lantern on to the screen. The experiments were conducted without a hitch, and members were unsparing in their applause.

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WE have received a shilling pamphlet bearing the title "Electricity: its Place and Power in the Universe, or a Justification of the Single Theory of Electricity and Magnetism," the author of which has modestly hidden his identity behind the nom-de-plume "Eureka." He sets forth in his 50 pages a new scheme of the universe. The "forces"—light, heat, energy, electricity, gravitation—are handled with great freedom, the last being identified with terrestrial magnetism, or electricity, or—by means of the thermopile—the heat of the earth! As for terrestrial magnetism, its complexities are traced to the effects of the earth's spin on the stream lines of gravitational energy. Unhappily the much greater orbital velocity of the earth appears to have been forgotten. All this is supported by quotations from NEWTON, FARADAY and JUDD. The author is doubtless a supporter of the kind of training called heuristic, which, we are informed, encourages independence of thought rather than mere accumulation of knowledge.

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Sir Oliver Lodge on Education.—In the course of an address at the distribution of prizes at the Birkbeck College, on Tuesday evening, Sir Oliver Lodge said there were two types to be avoided in education—the cultured man without knowledge, and the knowing man without culture.

Royal Society.—Among the Papers down for reading yesterday were the following:—"Note on a Means of Producing a High Voltage, Continuous or 'Pertinacious' Current," by Sir Oliver Lodge, F.R.S.; "The Effect of Liquid Air Temperatures on the Mechanical and other Properties of Iron and its Alloys," by Sir James Dewar and R. A. Hadfield.

Personal.—Prof. H. S. Hele-Shaw has resigned his position as head of the Faculty of Engineering at the Liverpool University in order to take charge of the new Transvaal technical institute which the Government proposes to establish at Johannesburg. The appointment is for 12 months, and Prof. Hele-Shaw will leave England early in the new year.

Electrical Contractors' Association (Incorporated).—A meeting of the Northern Section of the Electrical Contractors' Association was held at Stockton-on-Tees on Saturday, December 3rd, when Mr. J. McDermott presided over a representative attendance of members. It was reported that the membership was increasing rapidly since the incorporation of the Association, and very many matters of interest were discussed.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne—Pinheiros	**Aug. 18, 1902**	—
Beissi-Issa (Yemen)—Camaran	**Oct. 22, 1902**	—
Tarifa—Tangier	**Jan. 18, 1904**	—
Cayenne—Paramaribo	July 13, 1904	—
Jupiter Julets (Florida)—Nassau (Bahamas)	Oct. 20, 1904	—
Santa Cruz (Teneriffe)—Tejita (Teneriffe)	Nov. 11, 1904	Dec. 2, 1904
Sitka—Valdez (Alaska)	Nov. 11, 1904	—
Mozambique—Majunga	Nov. 15, 1904	Dec. 2, 1904

Surface-box Explosions and the Daily Papers.—Monday morning's newspapers contained startling announcements regarding "exploding mains" at Bermondsey, and it was alleged that "about 12ft. of the roadway was blown up and thrown some 10ft. into the air." But this was not all:—"The panes of glass in the neighbouring houses were all broken," sleepers were awakened for nearly a mile around and there were "sheets of flame." What really happened was that the lid of a distributing box was blown off and that the newspaper reporter did not arrive on the scene until after excavations had been commenced to remedy the trouble. He therefore mistook the excavation for the crater of an explosion. To add to the desolation of the scene, two houses opposite had been on fire and all the windows were broken. These, added to the windows broken by the explosion, go towards "the panes of glass in the neighbouring houses were all broken." The sensational reports which are published of these occurrences emphasise the necessity for exercising every care in the ventilation of surface boxes.

Snow and Electric Railways.—A few days ago the following statement appeared in *The Times*:—

> As some doubts have been expressed as to the practicability of maintaining electric traction on railways during snow, it is of interest to learn that throughout last week's heavy fall the electrified train service on the North-Eastern Railway Co.'s suburban lines at Newcastle was maintained in full operation without any interruption or the slightest difficulty of any kind, although on many of the steam lines considerable delay was occasioned.

The British Thomson-Houston Co. inform us that, as contractors for the electrical equipment of these lines, they have verified this statement, and find that during the recent snow absolutely no trouble whatever was experienced, and that there was not the slightest difficulty in easily keeping the schedule.

Obituary.—It is with extreme regret we learn of the sudden death on November 22nd of Mr. E. M. Reiss, secretary of the United River Plate Telephone Co. Mr. Reiss had been associated with the company for some years, and had until comparatively recently enjoyed excellent health. A short time back, however, he was attacked by an internal complaint which necessitated an operation, and from this he had apparently completely recovered. A relapse, however, occurred, and, as stated, Mr. Reiss died quite suddenly. He was only 42 years of age.

The death of an old telegraphist is announced in the *Bristol Times and Mirror*. Mr. A. M. Hazel, who, at the time of his death, was local representative of the Commercial Cable Co. at Bristol, resigned his position with the Post Office Telegraphs at Bristol 25 years ago, when he joined the service of the Compagnie Française at St. Pierre. A few years back he relinquished his post at St. Pierre and joined the service of the Commercial Company. Mr. Hazel was one of the workers in telegraphy before their acquisition by the State in 1870.

A Fault Localising Bridge.—Mr. Trubie Moore, assistant engineer to the Yorkshire Electric Power Co., has sent us a description of a simple form of stretched wire bridge for localising faults in mains by the Murray loop method. It is intended for use with a testing voltage of about 12 volts across the loop and a resistance of about 15 ohms. There is a stretched platinoid wire 1 metre in length of about 1·5 ohms resistance, this being stretched on a metre scale. A contact maker slides upon this wire. In conjunction with it there are 18 non-inductive resistance coils, each of the same resistance as the stretched wire, and connected to selector switches in such a manner that there are always nine coils and the stretched wire between the terminals, and so that the stretched wire may be made to take up any position in the sequence of the coils. This arrangement, it is seen, allows the equivalent of a longer range of scale than with the ordinary stretched wire bridge, but it is not quite so simple or so cheap to construct as the ordinary stretched wire form or the direct reading type made by Messrs. Nalder Bros., and the test will take longer and suffer greater risk of error.

Wireless Telegraph Notes.—A Reuter telegram from Bari states that the wireless telegraph station there received a message of 400 words in half-an-hour on December 1st.

The Constantinople correspondent of the *Standard* has telegraphed that a contract for the establishment of two wireless telegraph stations, one in the Island of Rhodes, on the coast of Asia Minor, and the other at Dernah, on the east coast of Tripoli, was signed with a German firm on Saturday. It is stipulated that the system shall be in working order by May 1st. If the results are satisfactory, similar stations may be erected along the Red Sea coast.

In his annual report the Secretary to the Treasury of the United States makes the following remarks concerning wireless telegraphy:—

> Preparations are being made through another branch of the public service for the erection of wireless telegraph towers at convenient intervals along the sea coast. These towers, together with those maintained by private corporations, will afford opportunity for the advantageous use of wireless telegraphy by the Revenue-cutter service of this Department. This service has now a coastguard of modern vessels, and I recommend that at least 10 of these be provided with approved wireless equipment for communication with the coast stations. The probable cost of outfitting this number of vessels will be $19,000, and I recommend that this sum be appropriated for the purpose.

Electric Traction from Gas Power.—A somewhat unique departure from established methods in electric traction has, according to the *Railway and Engineering Review*, of Chicago, recently been undertaken at Warren, Pa. The Warren and Jamestown Street Railway Co. is equipping an alternating-current single-phase electric railway system to operate between Warren, Pa., and Jamestown, N.Y., for which power will be supplied by gas engines operating with natural gas. The power station will be located at Stoneham, Pa., two miles from Warren. The initial equipment will consist of two Westinghouse gas engines each of 500 B.H.P. capacity. They will be of the horizontal single-crank double-acting type, directly connected to 260 kw. high-tension Westinghouse generators. The power equipment also comprises a 55 H.P. Westinghouse gas engine for operating the air compressor and exciter unit. Natural gas will be used, furnished by the local distributing company. In this district the gas has a calorific value of about 1,000 B.Th.U. per cubic foot. Transformer sub-stations, five in number, will be located along the right of way. These will receive the high-tension current from the transmission line and reduce the voltage suitable for use in single-phase motors. The present motive power equipment of the cars will comprise four quadruple sets of Westinghouse single-phase motors each approximately of 50 H.P. capacity. An interesting feature of the system is the arrangement for operating the alternating-current motors upon the direct-current trolley lines within the city limits of the termini.

Ignition as Applied to Internal Combustion Engines.—This was the title of the opening lecture of the session, given by Sir Oliver Lodge before the Automobile and Cycle Engineers' Institute in the theatre of the Institution of Mechanical Engineers on Monday last. Sir Oliver briefly referred to the general principles of gas and vapour engines, and then laid stress on the circumstances that bring about rapid and complete combustion of the gas or vapour—namely, (1) concentration of the mixture, (2) compression, (3) high temperature, (4) excess of hydrogen, (5) ignition in several places, (6) ignition in the proper place, and possibly (7) dilution with other light quickly-moving gases. Sir Oliver is given to prophecy, and he thought in time the water-jacket, as a means of cooling, would be looked upon as inefficient as that employed in the Newcomen steam engine; possibly the solution might lie in the direction of the Pelton wheel. The lecturer was not content to deal only with engines, and in his remarks on the proper place for ignition he showed that when combustion took place at a relatively slow rate, as in the internal combustion engine, the proper place was far from the piston, yet in certain circumstances, when the combustion was of the order that took place in a modern gun, the proper place might be near the projectile. In the first case the "running away" of the piston made it difficult for it to be properly hit when the combustion started near, whilst in the second case, to use the whole energy of a high explosive, the rate of combustion should be as slow as possible; in the extreme case of dynamite it would probably be impossible to make the explosion slow enough to prevent the bursting of the gun. Sir Oliver next showed lantern slides and explained various forms of flame and tube ignition; and, continuing, he explained briefly but lucidly the effects of self-induction and capacity. A description of the various modern forms of electrical ignition, which are worked either by magnetos or by the breaking of a circuit, naturally followed. In conclusion, Sir Oliver showed his B-spark experiments which have now taken practical shape in the form of an electrical igniter, consisting of a small induction coil and two condensers with outer coatings connected to terminals on the case and shunted by a leak. From these terminals the leads are taken to the B-spark knobs in the combustion chamber. It was shown how the B-spark took place in water, with bad insulation, and even with smut and oil nearly filling the air-space, whilst the A-spark of the induction coil was most sensitive to adverse influences.

Institution of Electrical Engineers' Dinner.—The sixteenth annual dinner of the Institution of Electrical Engineers took place at the Hotel Cecil on Thursday, December 1st, when the total number present was 439, among whom were :—

Mr. Alexander Siemens, President, in the chair, Lord Alverstone, Lord Biddulph, Lord Strathcona, Sir W. de W. Abney, F.R.S., Sir A. B. Binnie, Sir H. Buckley, Sir E. Carbutt, Rear-Admiral Sir A. J. Durston, Sir Douglas Fox, Sir C. Fremantle, Sir R. Hunter, Col. Sir H. Jekyll, Sir W. Lee-Warner, Sir J. Norman Lockyer, Sir. P. Magnus, Sir H. C. Mance, Sir A. Noble, Sir W. Ramsay, F.R.S., Sir A. W. Rücker, F.R.S., Sir Marcus Samuel, Sir J. W. Swan, F.R.S., Major-Gen. Sir A. E. Turner, The Dean of Westminster, Col. R. E. B. Crompton, Capt. H. O. Mance, D.S.O., Dr. R. T. Glazebrook, Profs. W. E. Ayrton, Callendar, S. P. Thompson, E. Wilson, Messrs. W. I. Buchanan, T. O. Callender, S. Dobson, W. Duddell, A. C. Eborall, W. B. Esson, S. Z. de Ferranti, J. Gavey, F. Gill, R. Kaye Gray, R. Hammond, C. Hawkesley, J. S. Highfield, J. E. Kingsbury, C. H. Merz, W. M. Mordey, S. Morse, W. H. Patchell, R. W. Perks, A. H. Preece, J. S. Raworth, J. H. Rider, C. E. Spagnoletti, J. Swinburne, and C. H. Wordingham.

After the usual loyal toasts had been proposed by the President, and duly honoured,

Lord Alverstone gave "The Institution of Electrical Engineers." In a few well-chosen words he carried his hearers back through 35 years, when the Society of Telegraph Engineers had been founded by seven men who were very dubious as to its ultimate success. To-day it was one of the most successful, one of the best-supported, and one of the most powerful of existing scientific societies. This phenomenal advance he attributed to the fact that the Institution had kept well abreast of the times, and had been indefatigable in its efforts towards the distribution of technical information. He reviewed briefly the development of the telegraph, lighting and power transmission. It was not possible to say what would happen before the Institution attained its jubilee. The previous day had seen two of its past-presidents honoured by being awarded Royal Society medals—he referred to Sir Wm Crookes and Sir J. W. Swan. No man in England was more worthy than Sir J. W. Swan of the distinction, too long deferred, which had recently been conferred upon him by the King. Mr. Alexander Siemens bore a name which would for ever be revered by engineers, and he himself had received many kindnesses at the hands of his kinsman, Sir Wm. Siemens.

The President, in his reply to the toast, referred to the election of Lord Kelvin to the Chancellorship of Glasgow University. He then read telegrams of congratulation from the Belgian and Italian Societies of Electrical Engineers, and expressed gratification at the kind way in which the Institution was received whenever it went abroad. He attributed the great development of electricity throughout the world, in large measure, to its international character.

Mr. R. Kaye Gray, in proposing "Our Transatlantic Kinsmen," referred to the great esteem in which Lord Strathcona was held, both in this country and in Canada. The work that the newer hemisphere was doing and had done in the electrical industry was such that it would have been impossible to forecast. This was not astonishing if we remembered who our kinsmen were. They had been unhampered by the moss which grew with age in the older countries, and they had had a freedom of action which was impossible with us. With their great merits, they had the faults of their merits. Success had bred an optimism which was admirable in its way, but a time would come, and, in his opinion, it was nearer in the United States than in Canada, when things among our Transatlantic kinsmen would have to be conducted more and more on the lines followed in the older countries. If this prudence came to the rescue then the future of our kinsmen would be built on a stable foundation. He then referred to the Institution visit to America, when their hosts spared neither personal trouble nor purse in providing personal comfort and instruction.

Lord Strathcona (High Commissioner for Canada) and Mr. W. I. Buchanan (managing director of the British Westinghouse Co.) replied. The latter, in a humorous speech, said he was glad when he found that there was a fixed time-limit for the delivery of the speeches, as this was the sort of thing they were used to in consulting engineers' specifications. While British engineers were struggling with industrial and fiscal problems, he could assure his hearers that Americans took a keen interest in the fight, and would be quite ready to adopt such measures as would protect themselves when some arrangement had been arrived at. He then indulged in some pleasantry at the expense of the English consulting engineers, and spoke of the "exuberant enjoyment and poetic imagery" which was to be found in many specifications.

Mr. R. Hammond then proposed the toast of "Our Guests," coupled with the name of Sir Henry Buckley, who, he said, was held in high esteem by all electrical engineers. Many an electrical patent action had been fought out before Sir Henry, and he feared that the latter would think electricians were very quarrelsome folk, that night he saw them in a different guise.

In replying, Sir Henry Buckley said that he had never yet received an answer to the question, "What is electricity?" He touched upon the theory of matter, and expressed the conviction that the ultimate atom will prove to be nothing more than a mere vibration. It was a great intellectual pleasure to hear eminent experts argue out an important patent case, and if anyone came and offered to explain what electricity really was, the Court would receive him with open arms. This concluded the toast list.

On the adjournment to the reception room, an appeal was then made by Mr. W. H. Patchell on behalf of the McMillan Memorial Fund. He pointed out that the required amount of £2,000 had not then been reached, and that this sum was really the minimum which would provide proper education for the late secretary's children. About £120 was immediately collected, and has been placed to the credit of the fund, while some £16 more is promised. It is intended to keep this appeal open for a few days longer, to enable members and friends to send in any further contributions. To bring up the fund to the total amount of £2,000, the sum required is now only about £65.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day), FRIDAY, December 9th.

Physical Society.

8 p.m. Meeting at the Physical Laboratory of the Central Technical College, Exhibition-road, South Kensington. Agenda :—(1) "On a Rapid Method of Approximate Harmonic Analysis," by Prof. S. P. Thompson, F.R.S. ; (2) "A High-Frequency Alternator," by W. Duddell ; (3) Exhibition of Experiments to show the Retardation of the Signalling Current on 3,500 miles of the Pacific Cable between Vancouver and Fanning Island ; (4) Exhibit of Ayrton-Mather Galvanometers, Universal Shunts and Electrostatic Instruments.

Electro-Harmonic Society.

8 p.m. Smoking Concert, Holborn Restaurant (King's Hall).

SATURDAY, December 10th.

Glasgow Technical College Scientific Society.

7.30 p.m. Meeting at 38, Bath-street. Paper to be read : Electrometallurgy : Some Notes on its Present Position," by J. D. Mackenzie.

Institution of Electrical Engineers : Leeds Local Section.

2.30 p.m. Visit to the Halifax Corporation Power Station, and the power station of the Hebden Bridge Urban District Council.

MONDAY, December 12th.

Institution of Electrical Engineers : Newcastle Section.

8 p.m. Meeting at Durham College of Science. Papers to be read : "The Measurement of Vacuum" and "On Batteries with Reversible Boosters," by C. Turnbull.

Institution of Mechanical Engineers : Graduates' Association.

8 p.m. Meeting at Storey's Gate. Paper to be read : "Gas-Engine Testing," by A. C. Hess.

Institute of Marine Engineers.

8 p.m. Meeting at Romford-road, Stratford. Paper to be read : "Fuel Economy by Insulation," by Mr Lyddon.

TUESDAY, December 13th.

Institution of Electrical Engineers : Manchester Section.

7.30 p.m. Meeting at Owens College. Paper to be read : "High-Tension Switch Gear," by L. Andrews.

Institution of Electrical Engineers : Glasgow Section.

8 p.m. Meeting at 207, Bath-street. Paper to be read : "Armature Reaction in Alternators," by J. B. Henderson and J. S. Nicholson.

WEDNESDAY, December 14th.

Institution of Electrical Engineers : Birmingham Section.

7.30 p.m. Meeting at the University. Paper to be read : "Stand-by Charges and Motor Load Development," by A. M. Taylor.

Society of Arts.

8 p.m. Ordinary Meeting. Paper to be read : "The Patent Laws," by C. D. Abel.

THURSDAY, December 15th.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting. Conclusion of the discussion on Mr. G. F. C. Searle's Paper : "Studies in Magnetic Testing," after which the following Paper will be read : "The Combination of Dust Destructors and Electricity Works, Economically Considered," by W. P. Adams.

Institution of Electrical Engineers : Leeds Local Section.

8 p.m. Meeting at Yorkshire College. Paper to be read : "Electric Driving of Textile Mills," by W. B. Woodhouse.

Rugby Engineering Society.

8 p.m. Meeting in the Benn Building, High-street. A discussion will take place on "Premium System *v.* Piece Work System."

FRIDAY, December 16th.

Institution of Electrical Engineers : Manchester Students' Section.

7.30 p.m. Meeting at the Municipal School of Technology. Paper to be read : "Battery and Booster Working," by E. D. S. Shelmerdine.

ELECTRIC POWER DISTRIBUTION IN SOUTH WALES.

(Concluded from page 253.)

Up to the present, practically all the sub-stations on the system are fitted with stationary transformers as two-phase or three-phase current is employed at nearly all the works. The chief exception is that of a large iron and steel works, where continuous current has been preferred. At present a temporary steam-driven installation is in use there, but a motor-generator sub-station is being erected in the works. This sub-station will be run by the owners of the works, the South Wales Company supplying three-phase current to it at a suitable pressure for the motor-generators. An interesting application of electric power at these works is the Wellman furnace charger, used for charging open-hearth furnaces. This machine has four motions, each driven by a separate Westinghouse series motor and controlled by a separate controller. The first motion is a longitudinal travel, the whole machine moving up and down in front of the furnaces; the second is the cross traverse of the crab carrying the "porter" bar, at the end of which is a tub to take up the charge for the furnace. The third motion tips this bar up or down, and the fourth rotates it. A charge is thus picked up and carried to the furnace; the tub carrying it is pushed forward at the proper angle right into the furnace and then rotated so as to empty the charge in the furnace. A few seconds only are occupied by the whole process, the only hand labour required being the manipulation of the controllers on the cab of the charger and the opening of the furnace door. Charging similar furnaces by hand or with the assistance of an ordinary travelling crane would take many minutes, and moreover the furnace door would be open longer. As the position of the trucks from which the scrap or ingots are carried and the height of the furnace doors are always the same, the operation of the car by the driver is very quick and almost automatic, and the great advantage is gained over a travelling crane that the charge is conveyed right into the furnace and not merely to the door Some results of tests made with a similar machine were published by Mr. A. D. Williamson in a Paper read at the Institution of Electrical Engineers last year.*

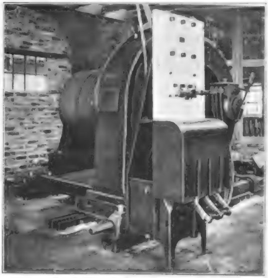
Fig. 13.—400 H.P. E.C.C. Motor for driving Wire-rolling Mills at the Oakfield Steel Wire Works.

At present the largest motor on the South Wales Company's mains is a 400 B.H.P. induction motor, which runs off the 2,000-volt 25 ∼ three-phase supply from the Cwmbran station. This motor drives two sets of rolls at a wire-drawing mill. Fig. 13 is a general view of the motor and switchboard, both of which have been supplied and erected by the Electric Construction Co. The motor takes current directly at 2,000 volts, and the rotor is of the wound type, with a three-phase winding, and a water resistance is inserted in the rotor circuit at starting. The handles working this resistance are seen at the bottom of the panel. At the end of the motor shaft there is a handle which short-circuits the rotor coils and lifts the brushes from the slip rings, it being operated by hand as soon as the motor has attained its full speed and all the resistance is out of the rotor circuit. The stator circuit is closed by a three-phase oil switch, the handle of which is seen above the water resistance, both the switch itself and the three fuses in series with it being at the back of the board. Rope drive is employed between the motor and the rolls; the motor runs at 280 revs. per min., and the rolls at 208 and 480 revs. per min. respectively.

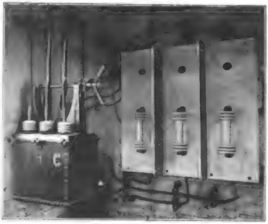
Fig. 14.—E.H.T. Plug Board and Oil Switch at Sub-station.

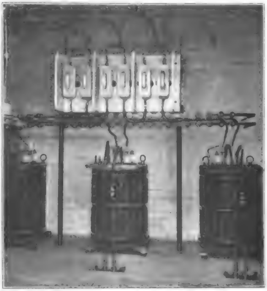
Fig. 15.—100kw. Transformers and E.H.T. Fuse Board at Sub-station.

Some smaller E.C.C. motors (20 H.P. and 8 H.P.) are in use at the same works. These have short circuited rotors, but are started by means of an "auto-transformer." In this the mains are connected together through choking coils, in the starting position, and tappings are taken off to the stator of the motor so that the motor starts up under reduced pressure. As soon as speed is attained the mains are switched over direct to the stator. The connections are shown in Fig. 16. It may be mentioned that this method of starting is employed in the majority of cases for motors above 6 H.P. and below 35 H.P.; above 35 H.P. the South Wales Company insists on the employment of starting resistances in the rotor circuits.

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* *Journal* of the Institution of Electrical Engineers, Vol. XXXII., p. 954.

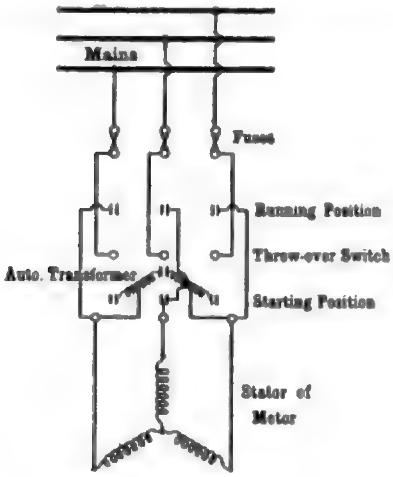


Fig. 16.—Diagram of Connections for 3-phase Auto-Transformer Starting Switch.

Probably the greatest part of the load on the South Wales network is by "main and tail" haulage gear at various collieries. We describe and illustrate, as a typical example, the gear at the Albion colliery, Pontypridd, which has been put in by the British Westinghouse Co. Referring to Fig. 17, it will be seen that the main and tail drums run loose on the shaft with a central steel claw clutch operated by one of the hand wheels. The other hand wheel operates a two-speed gear through coil clutches, giving speeds of 8 or 5 miles per hour at will, by clutching in the larger or smaller pinion without stopping the journey. This arrangement is very convenient when starting or running on a short piece of heavy gradient. Each drum is provided with a powerful foot brake and all the details of the gear, such as size of shafts, bearings, frame, &c., are of the most substantial character. The gear, as will be seen, is rope-driven from two Westinghouse variable-speed three-phase motors. These motors are designed to work on a 440-volt 25-period circuit, and to develop as normal full-load 200 B.H.P., a load of 300 B.H.P. for two hours, with considerably greater overloads for shorter periods. The motors run at 475 revs. per min. and are provided with enclosed slip rings and an outboard bearing. The motors in other respects are of the British Westinghouse Co.'s standard induction type.

The reversing controller is situated conveniently between the hand wheels on the haulage gear, and is arranged to control the two motors giving seven speeds in either direction by the insertion of resistances in the rotor circuit. It is additionally fitted with an isolating switch for cutting out either motor in case of accident. The face plate is provided with a pawl and ratchet arrangement, by means of which it is impossible to move too rapidly from one contact to another or to hang in a midway position, the whole being of solid construction and immersed in oil. The resistances are of the grid type, designed for continuous running on any notch of the controller. One of the most interesting features about this gear is that the drums are operated by claw clutches, and not, as is more usual, by friction clutches, so that all the starting and jockeying has to be done by the controller, and the controller and resistances have in consequence to be of very substantial construction. Conforming to the new Home Office recommendations, in addition to the controller, there is a switch panel with non-automatic three-pole oil switch and wattmeter, and also a distributing panel at the pit bottom, fitted with Westinghouse non-automatic oil switches. The gear has been in active operation for some time without the slightest hitch having occurred. The British Westinghouse Co. have in hand an exact duplicate gear for the same colliery, which will be installed shortly, and when this is done the whole of the coal raised at this colliery, amounting to from 10,000 to 12,000 tons per week, will be hauled from the various districts to the pit bottom electrically.

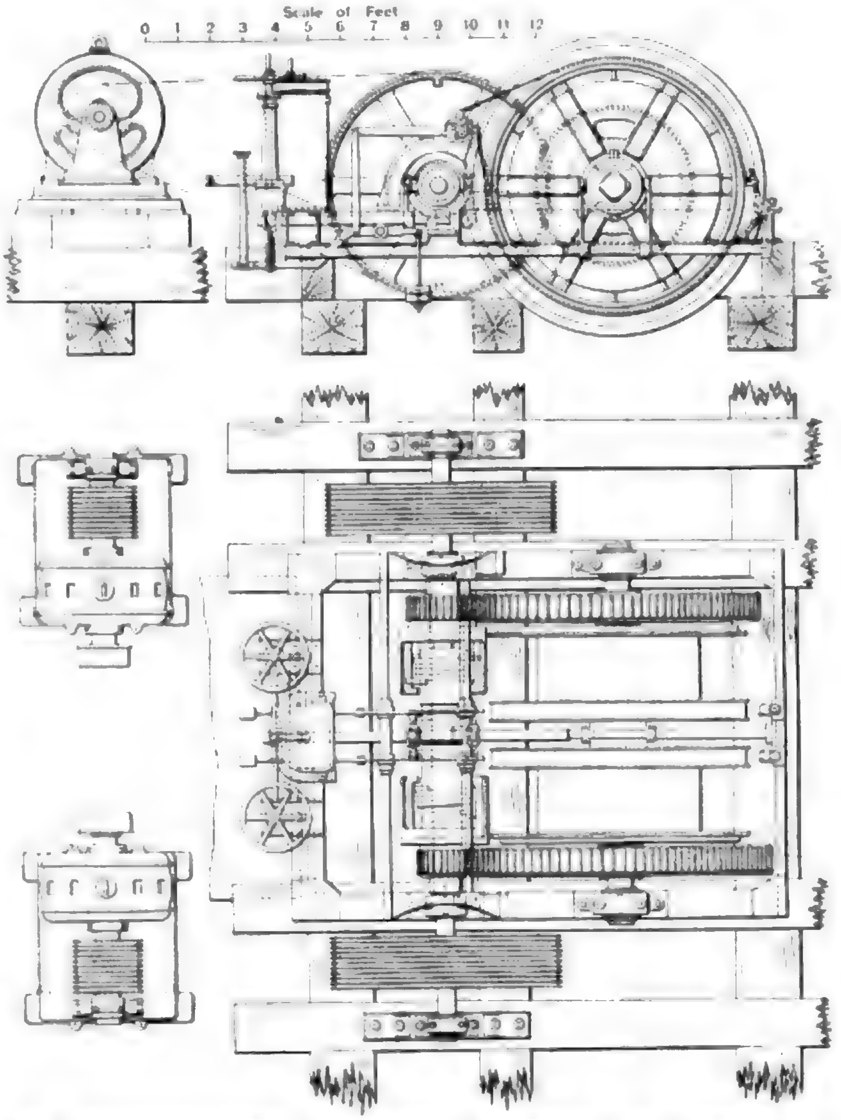


Fig. 17.—Plan and Elevation of Main and Tail Haulage Gear at the Albion Colliery.

Figs. 14 and 15 show the arrangements adopted in the majority of the sub-stations, the switch gear being supplied by Messrs. Lionel Robinson & Co., of Ferry Works, Thames Ditton. Each sub-station equipment consists generally of three three-phase oil switches of special design, and an E.H.T. three-phase and a low-tension three-phase fuse board, one board dealing with each side of the transformers. The E.H.T. fuse board is fitted with Partridge sparklet fuses. On the low-tension fuse board the fuses are of Messrs. Lionel Robinson & Co.'s porcelain plug tubular type (Fig. 18) the fuse being placed inside a thick asbestos tube made from one piece of asbestos paper.

The incoming and outgoing three-phase cables, carrying the 11,000-volt current, are each controlled by one of the main oil switches, the third oil switch being used for disconnecting the sub-station and is designed for breaking the magnetising current of the transformers only. The main 11,000-volt three-phase oil switches are of a special design, four breaks in series per phase being provided. The switches are of a capacity of 120 amperes per phase. The whole of the live parts are under oil. Each of the three switches is fitted into a separate brick cubicle with a concrete top, a 9in. brick wall being between the operator and the switches. The operating gear for the switches is brought to the front of the wall to the handle, and all the switch framing and metal work is earthed.

through joints have failed to withstand this test out of a total of some 1,150. On entering the sub-station the cables are led from trifurcating boxes, lead-covered vulcanised rubber cables being led out. All four cables are jointed to a sleeve on the box by means of a wiped joint.

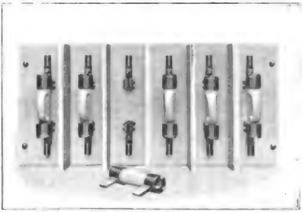


Fig. 18.—L.T. Sub-station Fuseboard.

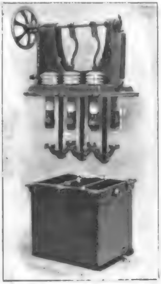


Fig. 19.—E.H.T. Sub-station Disconnecting Switch.

Fig. 21 is a reproduction of the danger board used in connection with all the high-tension and E.H.T. machinery and switchboard. The actual size of the board is 6⅝in. by 4⅝in., and it is of white enamelled iron, the letters and skull and crossbones being raised and coloured blue.

The mains feeding the sub-stations are all laid on the ring principle and are looped in, one main coming in and the other main going out at each sub-station, and both ends of the ring terminating at the generating station. In this way there can be no interruption of the supply should any section of the main break down. So far, however, there have been no breakdowns in the cable (except in one instance in which the cable was pulled up by the roots of a tree which had fallen down), although some 72 miles are already laid. The cables are all tested at double pressure after being laid, and only two of the straight

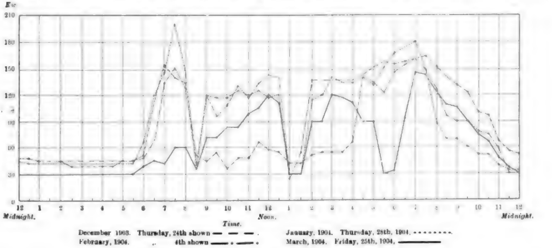


Fig. 20.—Load Curve of Bridgend Station.

We have given in the early part of this article full description of the Treforest and Cwmbran power houses, and it will only be necessary to add brief descriptions of the remaining generating stations. At the Bridgend station there are at present only two 200kw. sets and one 70kw. set. The larger units are Willans compound three-crank engines, driving Westinghouse dynamos at 300 revs. per min., and generating 50-period two-phase current at 3,000 volts. Steam, with 80deg. of superheat, is supplied to them from three 30ft. × 8ft. Danks-Galloway boilers, and they run non-condensing. The exciters are belt driven from the alternator shafts. The switchboards at the Bridgend station and the sub-stations have been supplied by the Westinghouse Company. The station is situated in the town itself, and it feeds a sub-station for the "bulk" supply of Bridgend and two sub-stations at the

Glamorgan County Council Asylums. From all three of these, alternating current is supplied at 210 volts on each phase. Each of the asylums has an equivalent of between 6,000 and 7,000 8 c.p. lamps, and in one of them there is 70 H.P. of motors. They are under contract to take at least 50,000 units per annum each, but as a matter of fact they consume nearly 150,000 units per year between them. In the station itself there are also two 100kw. transformers (and one spare one) transforming down the two-phase pressure to 500 volts. Current is supplied at this pressure to about 320 H.P. of motors, to a joinery, brewery, brickworks, two quarries, a blacksmiths' and fitting shop and a pottery, all within a short distance of the power house. Arrangements are also being made for a 16-hour pumping supply, the South Wales Company to choose the 16 hours of the day during which the supply is to be taken and the charge being correspondingly reduced.

For the week ending November 12th, 11,720 units were generated at the Bridgend works, of which 78·2 per cent. was sold, the load-factor being 31·9 per cent. and the total works cost 0·79d. Fig. 26 shows some typical load-curves, and it will be seen that they present the peculiar characteristic of having four peaks instead of one. The load-curves of the larger power houses, when they are more fully loaded, will be even flatter than this.

The power house built at Neath may be described as being a building similar to Cwmbran, with plant similar to Bridgend. It has been built mainly to satisfy the requirements of the Neath Corporation and Rural District Council, and arrangements are also being made with three other local authorities—viz., Briton Ferry, Aberavon and the Margam—for "bulk" supply.

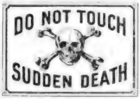


Fig. 21.—Danger-Board. ¼-scale.

When the district has been a little more developed it is proposed to connect all the power houses together by overhead mains, in which a pressure of 25,000 or 30,000 volts will be employed.

In concluding this article we desire to express our thanks to the consulting engineers, Messrs. Bramwell and Harris, for the loan of drawings and for other assistance; and also to Mr. E. L. Hill, the General Manager, and Mr. E. E. Soden, the chief distribution engineer (who has just left South Wales to take up the position of General Manager to the Cleveland & Durham County Electric Power Co.), for courtesy extended to us during a two days' visit to the South Wales district, during which time every information was placed at our disposal.

Erratum.—In connection with the mains-charging device on the switchboard at the Treforest station, described in our last issue, it was stated that this was similar to the one on the Partridge principle employed on the switchboard at the Stalybridge, Hyde, Mossley and Dukinfield generating station. Messrs. Witting, Eborall & Co. inform us that this is incorrect, their firm having supplied the mains-charging device at the latter works. This is on the Partridge principle, as described by Mr. Partridge in our Correspondence columns (*The Electrician*, Vol. L., p. 820). Messrs. Ferranti's charging device used at Treforest station, on the other hand, differs from Mr. Partridges', and is of the design illustrated in our last issue. The principle upon which it works is described by Dr. C. C. Garrard in our Correspondence columns this week.

Royal Institution.—Among the lecture arrangements at the Royal Institution before Easter are two lectures on engineering by Prof. W. E. Dalby; three lectures on electrical properties of radio-active substances, by Prof. J. J. Thomson; and three lectures on some controverted questions of optics, by Lord Rayleigh. The Friday evening meetings will begin on January 20th, when a discourse will be delivered by Prof. Sir James Dewar, on "New Low Temperature Phenomena." Mr. G. Marconi, Prof. J. J. Thomson, Lord Rayleigh, and other gentlemen will probably deliver subsequent discourses.

THE "MEGGER."

Messrs Evershed & Vignoles have selected the "Megger" as a name for their new pattern of ohmmeter and generator. This new pattern presents several novel features, foremost among which is the combination of the generator and instrument into one case, resulting in a great gain in compactness and weight. In order to render this possible it was necessary to compensate the moving-coil system for stray field from the generator, and this has been accomplished most successfully.

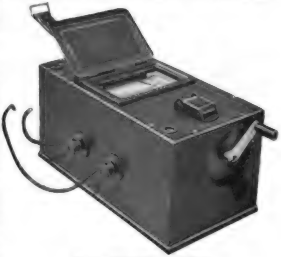


Fig. 1.—The "Megger" in Use.

Figs. 1 and 2 are general views of the instrument, and before passing on to the internal details attention may be drawn to the neat, detachable handle and the bronzed cover to protect the glass over the scale. To use the instrument it is unnecessary to open the box. All that the tester has to do is to connect up the insulation resistance to be measured between the two terminals, turn back the scale-cover and the detachable handle, pull out the handle of the generator and turn the latter at a sufficiently fast speed.

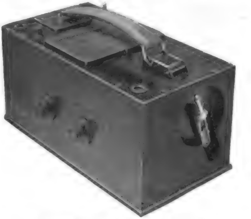


Fig. 2.—The "Megger" Closed for Carrying.

The generator itself is similar to that in use in the previous patterns of Evershed ohmmeter, with the exception that a friction clutch is added in the case of the high-range instruments for measuring insulation resistances with high capacity such as concentric cables and long telegraph circuits. This ensures a constant speed and thus prevents unsteadiness of reading. The generator is a continuous-current magneto machine with a four-coil armature and a commutator formed of two divided discs, two pairs of narrow grooved wheels taking the place of brushes. Roller bearings are employed, as it is necessary that the armature should run very smoothly on account of the high gear-ratio between the handle and armature.

The ohmmeter is a dead beat moving-coil instrument, and, as seen in Fig. 3, the same pair of permanent magnets (which are magnetised to about 2,000 lines per square centimetre) are employed for the magneto-generator and the ohmmeter. The current and pressure coils are free to rotate in this field, and are wound at an angle slightly less than a right angle, the current coil being in the most intense part of the field. The pressure coil will take up the position seen in Fig. 4 when there is "infinite" resistance in circuit with the series coil, and when there is a current through the series coil the latter will have an opposing turning moment, so that the moving system rotates, the angle made with the "infinity" position being a function of the resistance in circuit with the series coil and being independent of the voltage of the generator.

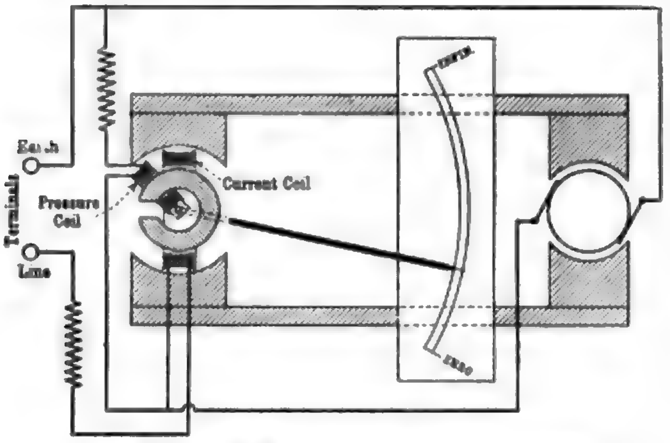
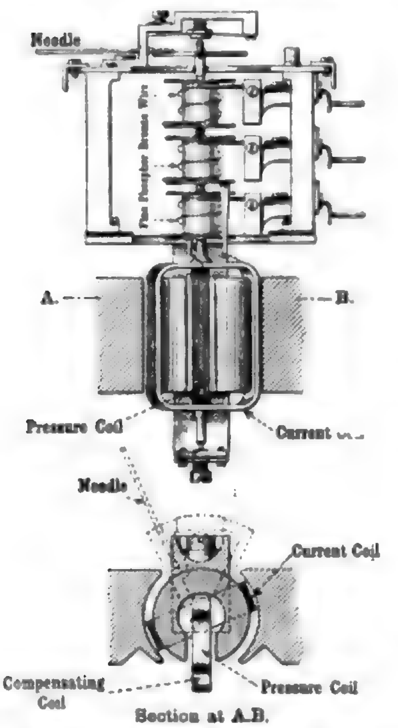


FIG. 3.—DIAGRAM OF CONNECTIONS AND MAGNETIC CIRCUIT.



Section at A.B.

FIG. 4.—ELEVATION AND SECTIONAL PLAN OF MOVING SYSTEM. One-half actual size.

The pressure coil, it will be noticed, extends from the centre to one side of the cylindrical magnet keeper, and not right across, as does the current coil. In order to protect it from the influence of external fields a compensating coil is added outside the pressure coil, and is connected in series with it.

Particularly fine wire is necessary for leading the current into the moving coils, as it is essential that there should be no controlling force, otherwise the law of the instrument will be incorrect. The wire employed is of phosphor-bronze, and its diameter is 0·4 mil. Such fine wire is very springy, and, to prevent any danger of its becoming entangled when the instrument is travelling, it is wound round the comparatively large aluminium drums seen in Fig. 4. The control of the leading-in strips is of the order $\frac{1}{400}$th of the moment of the pressure coil at "infinity."

The pivots of the instrument are large and substantial, their extremities being about the size of a pin's head. This causes no deleterious friction, however, as the instrument is kept in vibration when the handle is turned. The absence of fine pivots results in the jewels which support them having an almost infinite life, and also renders it unnecessary to lock the needle when the instrument is being carried about. No levelling is required.

To avoid troublesome effects from leakage, the Price guard-wire principle is used on all parts of the instrument. Fig. 5 shows the scale of the "low-range meggers," which are fitted with generators giving 250 and 500 volts respectively at 100 revs. per min. The "high-range meggers" read from 5 to 1,000 and 10 to 2,000 megohms respectively, with voltages of 500 and 1,000 at, or over, 100 revs. per min. The size of the instrument is 6½in. by 6½in. by 12in., and its weight is 18lb.

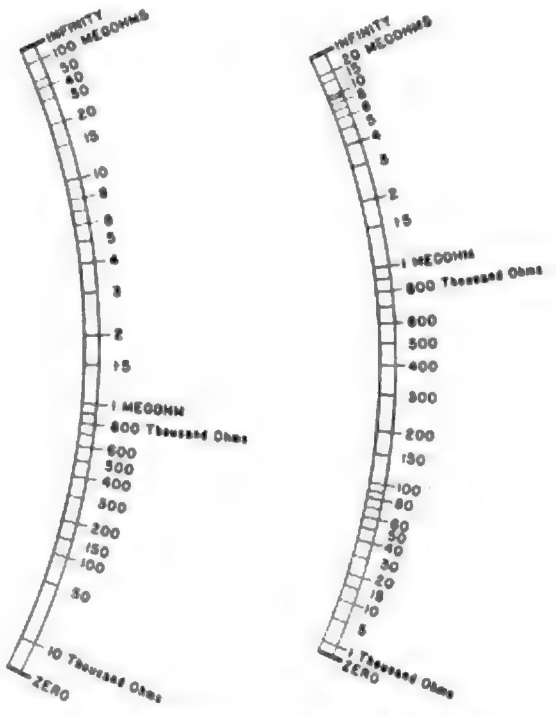


FIG. 5.—SCALES OF "LOW-RANGE MEGGERS."

We may add that we saw the instrument tested with a capacity of 1 mfd. in parallel with a high insulation resistance, and could observe no change in the reading when the capacity was switched in and out.

SOME NEW ELECTRICITY METERS.

The Reason Manufacturing Co.'s new prepayment meter is of the mercury motor type, consisting of a copper disc in a mercury bath and caused to rotate by the action of a magnetic field on the current which is passing through the disc. The electromagnet, round the coil of which the main current passes, consists of two soft iron cores, between the faces of which is placed the mercury bath. The other ends of the two cores are expanded into large pole pieces in the form of flat plates. These flat plates are designed so that the magnetic lines will have as short an air path as possible. There is, in addition to the main magnetic field thus produced by the coil, an auxiliary magnetic field produced by a set of permanent steel magnets in the form of pillars screwed between the two pole plates. The object of these permanent magnets is to produce a considerable field of force when very little current is passing through the meter, thus giving it an initial starting torque. It will be recognised that, as the permanent magnets are already fully saturated, there can be practically no further induction through them when the main coil is excited by the current, and, therefore, all the magnetic lines produced by the working current of the meter pass through the air. The "open" magnetic circuit secures the great advantage of absence of residual magnetism, and the curve of registration of the meter is not in the least altered by overloads, as is the case when a closed iron magnet circuit is employed.

A conical mercury bath is employed, and the rotating disc is open at the top of the cone, so as to prevent air bubbles remaining under it, thus interfering with early starting. The armature being of large diameter, the torque obtained is considerable, and is sufficient to counterbalance the effects of frictional resistance at low loads. It further enables the meter to give a very straight curve.

Adjustment of the ratio wheel, which determines the registration of the meter in Board of Trade units in accordance with the working voltage, is very simple. The train of wheels is so designed as to enable both the wheel and pinion to be taken off and exchanged for others, without having to remove any other part of the meter train. During transit the mercury in the bath is sealed by a very simple device.

The prepayment attachment has been designed with the view of reducing friction to a minimum, thus putting so inappreciable a strain on the working parts of the meter that its early starting, as well as the straightness of its curve, remain altogether unaffected. It has the advantage of being acted upon directly by the inserted coins, without the aid of levers and handles, which very often prove a source of trouble. The mechanism is certain in its action, both in making and breaking the circuit at the required time, the switch itself consisting of two mercury cups bridged over by a copper rod, and therefore free from the frictional resistance found even in the smallest knife switch. Owing to the design of the inclined shoot it is impossible for the switch to be operated fraudulently through the coin opening, by means of a wire or similar device.

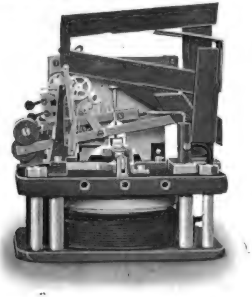


FIG. 1.—VIEW OF INTERIOR OF REASON PREPAYMENT METER.

After having been inserted the coins slide down the shoot one by one direct into the coin receiver, each coin operating the mechanism on its passage through the lower end of the shoot. This is a distinct improvement over those types of prepayment meter where the coins in reserve remain in the shoot, and are liable to wedge together owing to their different thicknesses. The attachment may be made for any coins, except small ones such as sixpenny-pieces. Those adapted for pence have, besides the ordinary shoot, an arrangement by which half-pence (should these be inserted) are prevented from actuating the mechanism, and drop directly into the money box.

The coin, being inserted through a slot in the meter case, slides down shoot A, and drops into the coin receiver B, fixed on one end of the coin lever C, pivoted at *c*. This coin lever is counterweighted, so that in its normal position the coin receiver B is always ready to receive another coin. Directly the coin drops its weight depresses that end of the lever C a certain distance, and then it falls into the money box. The movement of the lever C is utilised for actuating both the switch and the counting mechanism, as shown further. As soon as the coin has left the receiver B the counterweight brings this lever C back again to its original position. The coin lever C carries an arm, D, against which the contact lever E, pivoted on *e*, rests when the circuit is broken. The other end of this contact lever E also carries a counterweight. On the coin lever C being depressed, as above described, the arm D brings down with it the contact lever E, the end of which carries the copper contact bridge E_1 which then dips into the mercury in the cups F, and thus completes the circuit. A pin, G, fixed on the contact lever E, then engages a click piece, H, which keeps it locked in that position. The other end of the coin lever C carries an arm, I, which in its turn carries a pawl, J, at its further end. This pawl has a pin, J_1, fixed to it which engages a star wheel, K, and moves it the distance of one tooth for each downward depression of the coin lever C. Thus the star wheel K is moved forward a number of teeth corresponding to the number of depressions of the lever C. This star wheel, K, is fixed on the sleeve of a wheel, L, forming one element of a differential gear; the other wheel M of the same differential set being geared to the meter train. These two wheels rotate freely on a steel staff, M_1, which carries fixed to it the differential pinion N and the switching-off pin O.

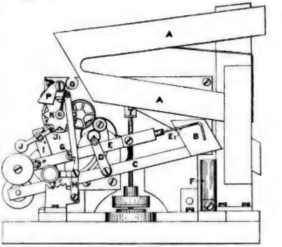


FIG. 2.—ELEVATION OF PREPAYMENT MECHANISM.

When the star wheel K is rotated by means of the coin lever, the wheel L moves the pinion N, and the pin O a proportional distance forward; the spring P pressing between two teeth of the star wheel K retaining it in position after each advance. The contact lever E having been locked, and the circuit completed, the meter train will begin to register as soon as any current is being consumed, so that the differential wheel M being geared to it will cause the differential pinion N and the switching-off pin O also to revolve through a distance proportional to the current used and to the price per unit for which the meter has been adjusted. This motion of the pinion N and pin O is in the backward direction, so that when the prepaid electricity has been consumed they have reached their starting point again. The switching-off pin O will then press the click piece H just sufficiently far back to free the pin G of the contact lever. This being released, it will jump back against the arm D of the coin lever and break the circuit. The steel staff carrying the differential pinion and switching-off pin carries also an index, which shows at any time on the registering dial how many coins or parts of a coin are left unused. A small counter, also actuated by each depression of the coin lever, indicates the total number of coins paid into the meter. The coin receptacle is designed so as to be easily removed from the meter case, emptied, replaced and sealed, and is made large enough to contain the greatest possible number of coins that may be paid into the meter between periodical inspections.

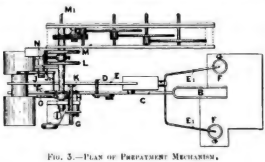


FIG. 3.—PLAN OF PREPAYMENT MECHANISM.

The Reason Co. are also bringing out a new maximum demand indicator, which we illustrate below. This indicator works on the electromagnetic principle, and provides a somewhat cheaper means of measuring a consumer's maximum demand than the thermal type of instrument. Referring to Fig. 4, it will be seen that the working parts consist of a plunger, which is attracted into a solenoid, through which the main current passes. This action of the plunger tilts the registering part, which consists of a glass vessel containing liquid and suitably attached to the plunger. The effect of tilting is to cause the liquid to flow gradually through the constricted part of the branch tube seen to the left at the top of the scale, and to collect in the reading tube. When no current is passing, there is a small quantity of liquid at the bottom of the reading tube, which serves to mark the zero reading. The body of the liquid in the vessel is in a position to commence overflowing into the reading tube should any tilting take place. The tube is mounted on a plate of zinc, capable of swinging about a pivot, which carries, in addition to the plunger, an adjusting counterweight, by means of which the tube can be accurately set to its zero position.

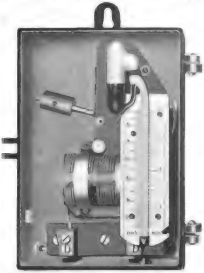


FIG. 4.—VIEW OF ELECTROMAGNETIC DEMAND INDICATOR—OPEN. 5-AMPERE SIZE.

The narrowness of the constricted branch of the tube causes a sluggishness in the registration of the instrument, and it can be varied so that full reading is not obtained until the current has been on for any desired interval. The period for complete registration, in fact, can be adjusted between the limits of five minutes to three hours. A typical time curve is given in Curve A (Fig. 5), and is the one usually preferred, as it agrees fairly closely with what is obtained with the thermal type of demand indicator. A typical calibration curve is given in Curve B, from which it will be seen that the instrument can be made to have an almost exact proportional scale. By adjusting the relative positions of the counterweight arm and the plunger, the readings may be made more open either at the upper or lower part of the scale as desired. The makers inform us that by suitable adjustment an accuracy of 3 to 4 per cent. throughout the range of the instrument can be guaranteed.

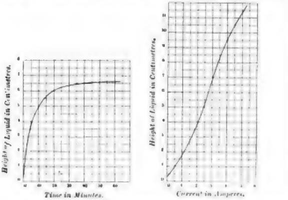


FIG. 5.—CURVE A, SHOWING TIME-LAG: CURVE B, CALIBRATION CURVE.

The moving parts of the instrument (Fig. 6) are all supported on a strong steel spindle. The counterweight arm is fixed in a boss, which is then secured to the large brass collet by means of two lock nuts after the necessary adjustment has been made, as explained in the previous paragraph. The plunger arm is rigidly fixed to the bracket carrying the plate supporting the tube.

The instrument is made in standard sizes, from 5 amperes (with a full-load drop of 0·48 volt and an average power consumption of 2·1 watts) to 100 amperes (with a full-load drop of 0·03 volt and an average power consumption of 3 watts).

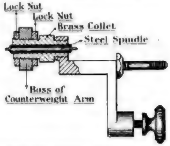


FIG. 6.—DETAILS OF MOVING PARTS OF ELECTROMAGNETIC DEMAND INDICATOR.

Should an excess current, due to a short circuit, pass through the coil, the plunger will, of course, receive a sudden impetus, but two springs are provided to take the shock of the movement. Except in the case of those instruments which have been made specially quick reading for specific purposes, only a very slight rise in the reading is observed in consequence of a short-circuit.

Messrs. Chamberlain & Hookham have brought out a modification of their ampere-hour type of meter. This new type (Fig. 7) records correctly the actual energy consumed on a circuit of varying pressure such as that of a tramway system. For this purpose it is only necessary to replace the permanent magnet driving field by an electromagnet; the permanent magnet being still retained for the brake. The cylindrical armature is like that used in the 1902 type meter with brake disc above it, and the mercury is contained in a chamber bored out of an ebonite block and having conducting strips embedded in it. The pole-piece of the electromagnet projects up inside the armature, and carries the bottom pivot as in the ampere-hour meter. In order that the field of the electromagnet may

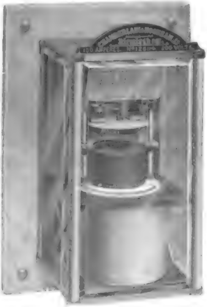


FIG. 7.—CONTINUOUS CURRENT WATT-HOUR METER.

respond perfectly and instantly to changes of pressure, there is no external pole-piece to the outside of the armature, so that the magnetic circuit is completed through the air. The coil of the electromagnet (which is of fine wire) is below the mercury bath. It is wound upon a straight core which carries the one pole-piece at its upper extremity. In order to ensure entire absence of residual magnetic effects in this core a special method of construction has been adopted. Instead of being turned from a solid bar, it is made up of a pile of iron washers with insulation between them. When magnetised, therefore, the entire iron circuit is made up of a number of very short magnets of great section in proportion to their length. These short magnets have, therefore, a very great self-demagnetising tendency, which operates the moment the magnetising current is withdrawn or diminished. The meter itself is constructed to carry a maximum current of 50 amperes. If it is required (as is usually the case) to measure greater currents than this, the current is passed through a shunt which can be fixed to the back of the switchboard, and the meter terminals connected to the shunt by flexible cables. The ends of these cables coming from the shunt terminate in copper plugs, which are inserted into mercury cups forming part of the main mercury bath. Small ebonite glands screw over these small cups, and secure the cables in position. The top of the main mercury bath is covered with a metal cap, in the centre of which is another gland which may be turned readily by its milled edge. When raised this gland lifts the armature off its jewelled bearing, holds it tight during transport, and prevents loss of mercury. After the meter is fixed, it must be screwed down as far as it will go. Although the armature is considerably larger than in the ordinary ampere-hour meter, the very important feature that its weight is entirely borne by the mercury is retained, so that there is no tendency whatever for the pivots to wear. The advantages claimed for this type of meter are:—(1) No commutator; (2) not affected by stray fields, neighbouring conductors or short circuits; (3) no wear on pivots; (4) no shunt running.

Another type of electricity meter is the "Eclipse," manufactured by Mr. Geo. Braulik, who informs us that the single-coil watt-hour meter (Fig. 8) has a very small starting current, a low voltage drop, small shunt and series losses and a degree of accuracy which does not vary (Fig. 9). The special feature in the design of the meter, which is of the motor type, is the open armature, which is constructed with only three coils and three discs, thus reducing the liability of breakdown at the points of connection from 14 to 16 in the drum armature to three in this open type. Brush friction is a minimum on account of the commutator diameter being reduced to the smallest possible size, while sparking is said to be entirely avoided by a patent arrangement The meter is a true watt-hour meter and can consequently be used with equal advantage on continuous or alternating-current circuits. The field of this meter is produced by one coil through which the main current flows.

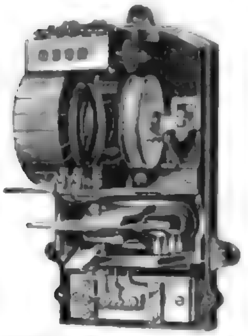


FIG. 8.—WATT-HOUR METER.

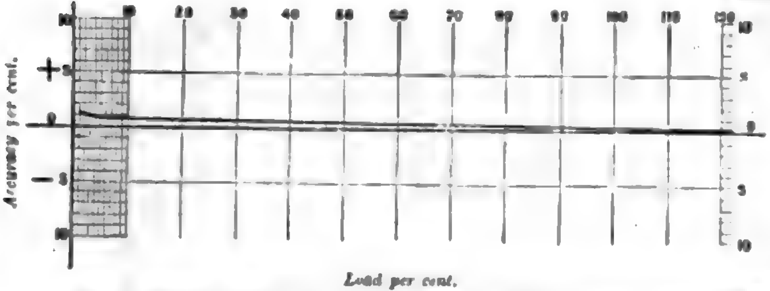


FIG. 9.—CURVE SHOWING ACCURACY OF "ECLIPSE" WATT-HOUR-METER FROM 1 TO 120 PER CENT. FULL LOAD.

Another type of "Eclipse" meter is the ampere-hour meter (Fig. 10) for continuous current only; this consists of a motor with armature free from iron and is placed in parallel with a resistance through which the current to be measured passes. There is no constant shunt loss in this meter, and it is only influenced by the current passing through it, while it commences to register at rather less than 1 per cent. of its full load. It is suitable for two-wire pressures up to 500 volts and for capacities from 1 to 50 amperes.

The third and last class is a special meter for inductive alternating-current circuits (Fig. 11), constructed on the Ferraris principle and calibrated as a wattmeter. It can be used with equal advantage on incandescent lamp and power circuits, and also in polyphase installations. This meter is said to be very sensitive and will commence to register at less than 1 per cent. of full load; the readings are very correct even at low loads, while overloads or vibrations do not affect its accuracy. The shunt current is about 0·015 ampere, while the loss in the series coil is about 2 watts.

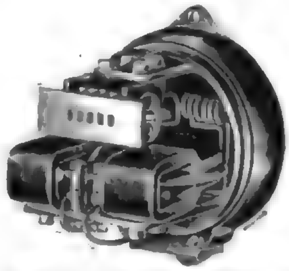


FIG. 10.—AMPERE-HOUR METER.

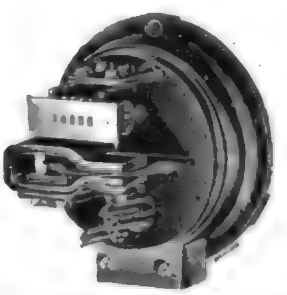


FIG. 11.—ALTERNATING-CURRENT METER.

HYDRODYNAMICAL AND ELECTROMAGNETIC INVESTIGATIONS REGARDING THE MAGNETIC-FLUX DISTRIBUTION IN TOOTHED-CORE ARMATURES.*

BY PROF. H. S. HELE-SHAW, F.R.S., LL.D., ALFRED HAY, D.SC., AND P. H. POWELL, M.SC., M.ENG.

(Concluded from page 215.)

Previous to the appearance of Mr. Carter's Paper various attempts were made to deal with the problem, and it is interesting to compare the results furnished by some of these older methods with the correct values now at our disposal.

Method I.—A first very rough approximation may be obtained by assuming that none of the lines pass down towards the slot, but that they all crowd into the tops of the teeth, forming a series of isolated patches as shown in Fig. 10. The correction coefficient is on this assumption given by $(t+s)/t = 1 + (s/t)$, and leads to a very considerable over-correction, which increases with increase of s/t.

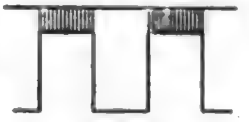


FIG. 10.

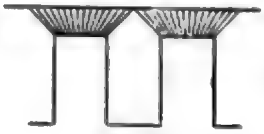


FIG. 11.

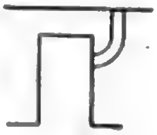


FIG. 12.

Method II.—It is assumed that the effective area of the air-gap is the arithmetic mean of the polar area and that corresponding to the tops of the teeth. The correction coefficient is given by $(t+s)/(t+\frac{1}{2}s) = \left(1+\frac{s}{t}\right)/\left(1+\frac{1}{2}\frac{s}{t}\right)$. This method leads to an over-correction when s/g is small, and to an under-correction when s/g is large.

Method III.—The lines are assumed to be straight, and to be distributed in wedge-shaped masses as shown in Fig. 11. The reluctance over a width of one tooth and slot, of a thin layer of unit breadth (measured in a direction parallel to the shaft), and at a distance x from the top of the tooth is $dx/\left(t+\frac{s}{g}x\right)$, where dx is the thickness of the layer. The total reluctance is thus

$$\int_0^g \frac{dx}{t+\frac{s}{g}x} = \frac{g}{s}\log\left(1+\frac{s}{t}\right).$$

But the reluctance corresponding to a smooth core is $g/(t+s)$. Hence the correction coefficient is $\left(1+\frac{t}{s}\right)\log\left(1+\frac{s}{t}\right)$. This method leads to an over-correction in most cases. The three methods so far considered take no account of the ratio s/g.

Method IV.—This method, due to Messrs. Hawkins and Wightman,† assumes that the lines which fall outside the space immediately above a tooth consist partly of straight lines and partly of quadrants of circles whose common centre is at the edge of the tooth, as shown in Fig. 12. The reluctance of the air-space above the tooth is, per unit length of tooth measured in a direction parallel to the

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[*] Paper read on Thursday the 24th ult. before the Institution of Electrical Engineers.

[†] *Journal* of the Institution of Electrical Engineers, Vol. XXIX., p. 436.

shaft, equal to g/t, while the reluctance of an equal length of air-space above a slot is

$$\frac{1}{2\int_0^{s/2}\frac{dx}{g+\frac{1}{2}\pi x}}=\frac{\pi}{4\log\frac{g+\frac{\pi}{4}s}{g}}.$$

Hence the joint reluctance of the two air-spaces is, per unit length along shaft, given by

$$\frac{\pi g}{4t\log\frac{g+\frac{\pi}{4}s}{g}}\Bigg/\left(\frac{g}{t}+\frac{\pi}{4\log\frac{g+\frac{\pi}{4}s}{g}}\right)=\frac{\pi g}{\pi t+4g\log\frac{g+\frac{\pi}{4}s}{g}}.$$

Now, since the value of the reluctance for a smooth core is $g/(t+s)$, it follows that the correction coefficient is given by

$$\frac{1+\frac{s}{t}}{1+\frac{4}{\pi}\cdot\frac{g}{t}\log\left(1+\frac{\pi}{4}\frac{s}{g}\right)}.$$

For the sake of comparison the values calculated in accordance with each of these methods are included in Table I., and an examination of the results shows that none of these older methods is reliable.

RELUCTANCE OF TEETH IN A SLOTTED ARMATURE.

The problem of determining the reluctance of the teeth has generally been dealt with on the assumption that the equipotential surfaces in the teeth and slots are cylindrical surfaces coaxial with the core discs. This assumption is far from being correct, as is at once evident by an inspection of the stream-line diagrams and an examination of the experimental results given below. Nevertheless, for practical purposes the assumption yields sufficiently accurate results. The problem is considerably more complicated in the case of armatures of small diameter, where the taper of the teeth may produce a very considerable difference between the cross-sectional areas of the top and bottom of a tooth. The most satisfactory method of dealing with the problem in such cases is that given by Mr. W. B. Hird in a Paper contributed to the *Journal* of this Institution.*

The object of the experiments about to be described was to investigate the exact distribution of the magnetic flux in the teeth and slots of a slotted core under varying conditions of excitation, and with varying length of gap and width of tooth.

DESCRIPTION OF APPARATUS.

The apparatus used was specially designed for the purpose, and was costructed in the workshops of the University of Liverpool.

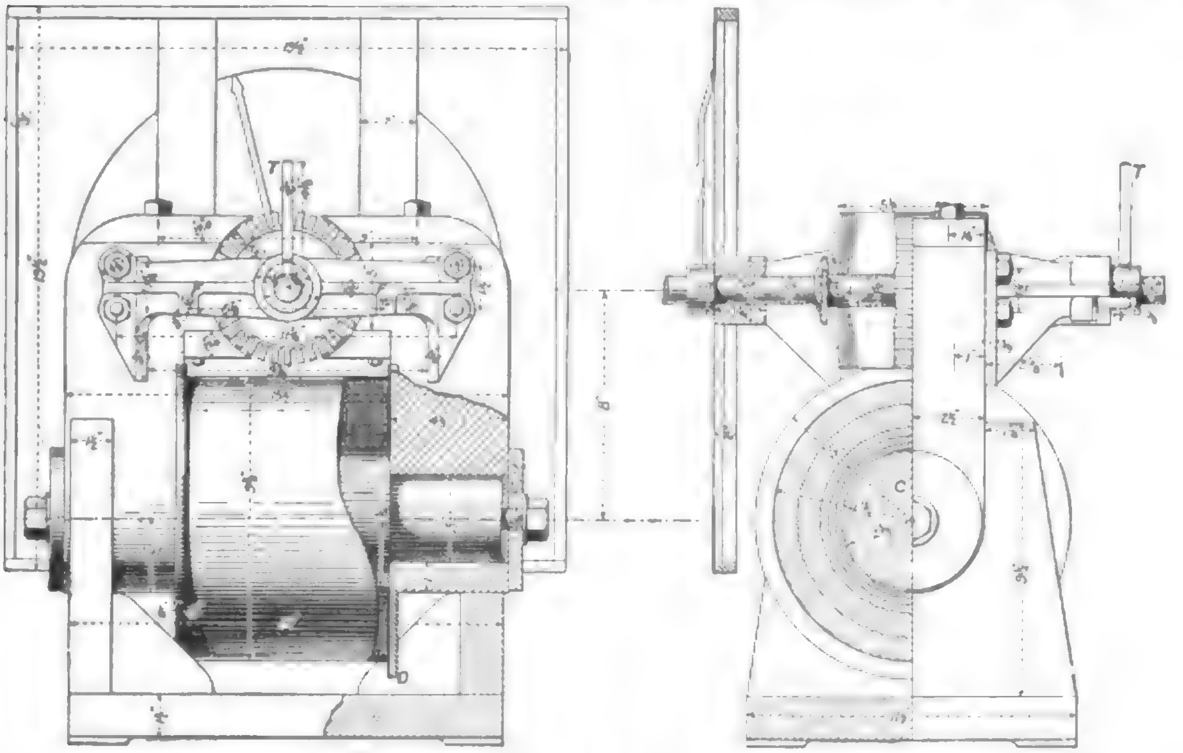
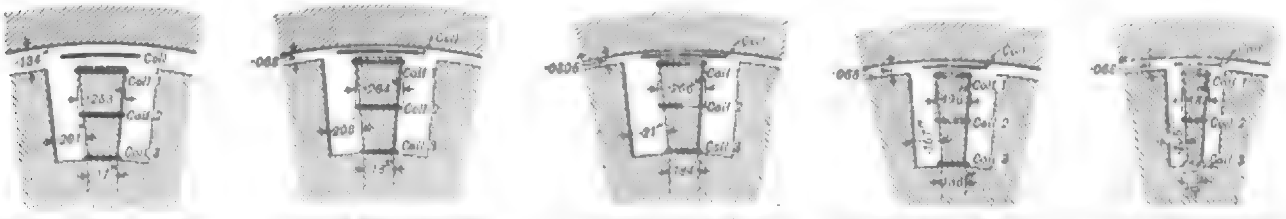


FIG. 13.

The dynamo (Fig. 13) was of the single-bobbin type, with field core and pole-pieces of Allen's dynamo steel. The pole-pieces were bored out to a diameter of 5⅞in., and into the space between them could be introduced any one out of a set of five experimental armature cores. The cores consisted of sheet-iron stampings—supplied by Messrs. Sankey & Co.—threaded on the shaft, and maintained in position by means of a feather key. The details of the five cores are given in Fig. 14, which also shows the positions of the search-coils by means of which the flux at three different cross-sections of a tooth was determined. The three cross-sections correspond to the top, the middle and the bottom of a tooth. In addition to the three coils surrounding the tooth, a fourth coil, of width equal to that of a tooth and slot, was used for the purpose of determining the total flux per tooth and slot, and the mean value of the gap induction. This coil was slung in position by means of silk threads suitably supported from the armature shaft, and provided with a device for adjusting the coil in the exact position required (the middle of the air-gap). Each of the three coils surrounding the tooth consisted of five turns of No. 46 wire. Considerable difficulty was experienced



Armature 5¾in. diameter. 36 Teeth.

Armature 5¾in. diameter. 36 Teeth.

Armature 5 11/16in. diameter. 36 Teeth.

Armature 5¾in. diameter. 48 Teeth.

Armature 5¾in. diameter 72 Teeth.

FIG. 14.

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* *Journal* of the Institution of Electrical Engineers, Vol. XXIX., p. 933.

in insulating the coils satisfactorily, but this was successfully overcome.

In order to avoid the various difficulties and uncertainties connected with the measurement of the magnetic flux by the methods of breaking and reversing the exciting current, we decided to produce the reversal of flux by a bodily rotation of the armature with its search-coils through 180deg. For this purpose the armature was first placed in such a position as to bring the tooth carrying the search-coils opposite the middle of one of the pole pieces. The particular search-coil in use being in connection with the ballistic galvanometer, the armature was then suddenly rotated through half a revolution, the tooth being thereby brought opposite the middle of the other pole piece. This operation occupied an interval of time not exceeding one second. In order to limit the motion of the armature, the shaft was fitted with a striker T (Fig. 18) capable of moving between two steel stop-pins, FF. In order to prevent excessive shock due to the sudden stoppage of the armature, buffer springs, S (Fig. 15), were provided, and in order to prevent subsequent recoil suitable catches, one of which is clearly shown in Fig. 15, were fitted. Each catch is forced outwards by a spring, G, which is normally in compression, and which surrounds the core R of a solenoid, the catch being attached to the end of the core. When the solenoid is excited, it sucks in its core, withdrawing the catch and leaving the armature free to rotate through 180deg. A similar coil-and-plunger release was fitted to the catch on the other side. In order to arrive at a correct estimate of the nett cross-section of iron in the tooth, a large number of measurements was made of the thickness of the discs forming the different cores, and the number of discs in each core was carefully counted. The exact dimensions of the various exploring coils were also determined with great care. The results of the more important of these measurements are given in Table II.

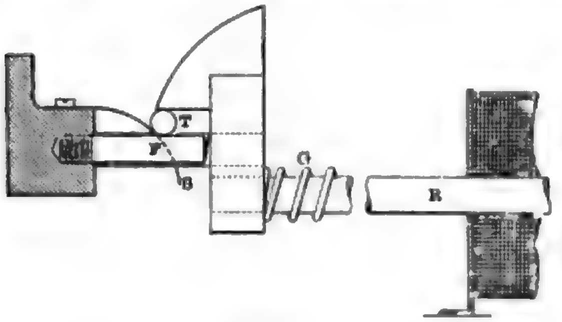

Fig. 15.

Table II.—*Details of Armature Cores and Search Coils in Gap.*

Diameter of core, in inches……	5¼	5⅜	5⅜	5⅜	5$\frac{7}{16}$
Number of teeth ……………	36	36	48	72	36
Length of single air-gap, in cms.	0·340	0·173	0·173	0·173	0·100
Width of slot, in cms. …………	0·5105	0·528	0·399	0·267	0·533
Width of tooth at top, in cms. ..	0·640	0·671	0·498	0·330	0·675
” ” middle ” ..	0·510	0·528	0·399	0·267	0·559
” ” base ” ..	0·430	0·457	0·345	0·211	0·467
Width of coil in gap, in cms. ….	1·165	1·15	0·833	0·62	1·20
Length ” ” ” ….	9·70	9·68	9·5	9·39	9·49

The moving-coil ballistic galvanometer used in these experiments was of special construction; we found that no suitable commercial instrument could be obtained. A detailed account of the principles underlying the design of such an instrument has already been published by one of us.* It may, however, be mentioned that the periodic time of the instrument was about 80 seconds, and that the electromagnetic damping device consisted of a copper disc suspended below the coil and acted on by a small electromagnet. Throughout the experiments the galvanometer was very frequently calibrated by means of a standard solenoid.

Results of Ballistic Experiments.

The magnetic flux through the top, the middle and the bottom of the tooth was determined for five different values of the mean gap induction, ranging from about 8,000 to about 9,000 C.G.S. lines per square centimetre, for each of the five armature cores experimented upon. The results obtained are given in Table III., and are graphically exhibited in Figs. 16-20, the curves there shown having the mean gap induction for abscissæ and the magnetic fluxes through the various cross-sections of the tooth for ordinates. The full-line curve in each case refers to the total flux through the top of the tooth, the dotted curve to the flux through the middle of the tooth, and the chain-dotted curve to the flux through the base of the tooth. The three readings marked with an asterisk in Table III. are open to some doubt, and are almost certainly too low; unfor-

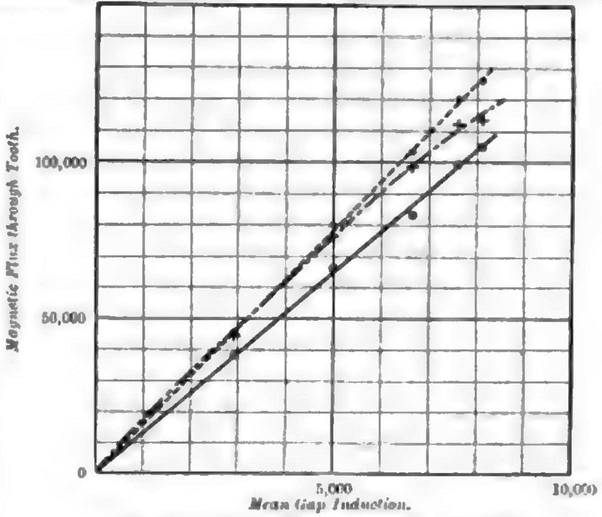

Fig. 16.—Armature 5¼in. diameter. 36 Teeth.

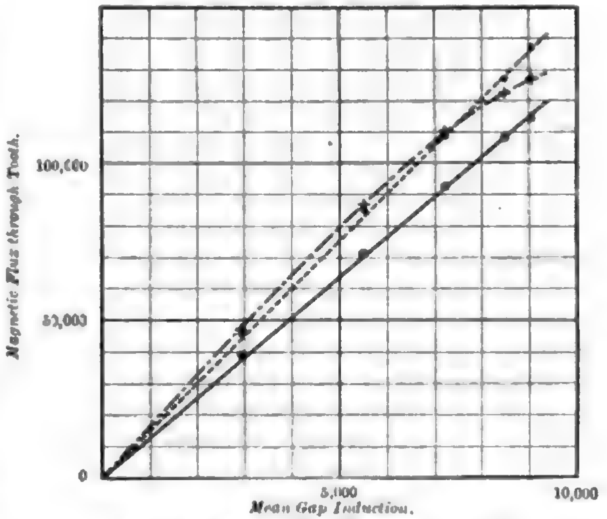

Fig. 17.—Armature 5⅜in. diameter. 36 Teeth.

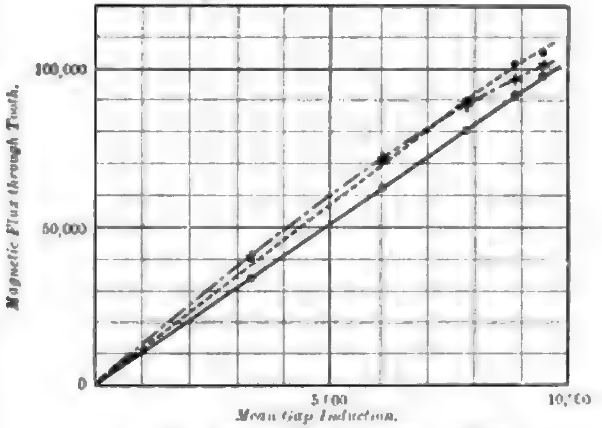

Fig. 18.—Armature 5⅜in. diameter. 48 Teeth.

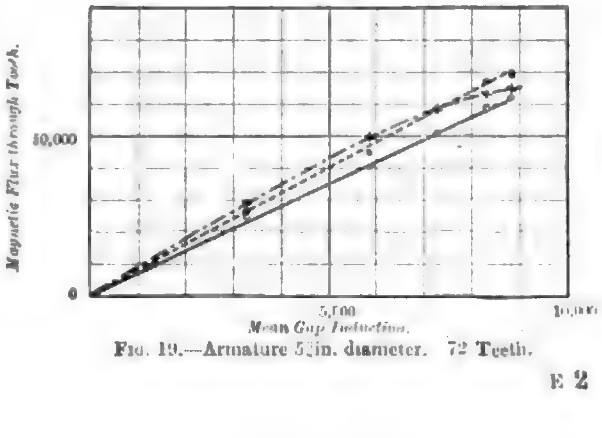

Fig. 19.—Armature 5⅜in. diameter. 72 Teeth.

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* B. A. Report for 1903; or *The Electrician*, Vol. LI., p. 1,013.

Table III.

Mean gap induction.		Total magnetic flux.			Magnetic induction.		
		Top of tooth.	Middle of tooth.	Base of tooth.	Top of tooth.	Middle of tooth.	Base of tooth.
Armature 5¼in. in dia. 36 teeth.	2,890	37,000	44,400	43,800*	4,790	7,040	8,570
	5,010	65,600	79,100	75,900*	8,520	12,600	14,850
	6,650	81,900	102,500	97,400*	10,600	16,300	19,060
	7,610	98,500	118,900	111,400	12,750	18,870	21,800
	8,110	103,200	125,000	112,300	13,370	19,850	21,980
Armature 5⅜in. in dia. 36 teeth.	2,950	38,900	45,200	46,300	5,070	7,120	8,920
	5,540	71,200	84,600	86,000	9,280	13,400	16,600
	7,240	92,200	108,500	109,400	12,250	17,100	20,940
	8,550	107,800	126,400	121,800	14,060	19,900	23,500
	9,120	113,800	136,200	126,000	14,800	21,500	24,300
Armature 5¼in. in dia. 48 teeth.	3,290	33,200	39,100	39,600	5,850	7,440	8,760
	6,020	61,800	69,300	70,000	9,950	13,200	15,350
	7,860	79,500	89,500	87,600	12,800	17,000	19,200
	8,840	91,000	101,900	96,200	14,700	19,400	21,100
	9,440	97,500	105,400	101,000	15,700	20,000	22,140
Armature 5¹¹⁄₁₆in. in dia. 72 teeth.	3,280	24,300	26,800	28,600	6,070	8,130	10,560
	5,810	40,300	44,900	46,000	10,080	13,600	17,000
	7,270	50,900	57,800	57,300	12,700	17,500	21,160
	8,380	58,400	66,200	62,300	14,600	20,100	23,000
	8,870	61,300	68,900	64,400	15,300	20,900	23,800
Armature 5⁵⁄₁₆in. in dia. 36 teeth	2,680	36,100	43,400	43,500	4,280	6,020	7,450
	5,260	68,400	83,100	83,700	8,100	11,540	14,350
	7,630	100,700	122,000	122,700	11,900	16,950	21,000
	9,200	122,400	145,800	142,200	14,500	20,200	24,400
	10,000	133,800	154,100	150,200	15,800	21,400	25,700

tunately, the core had been dismantled before the discrepancy was noticed, and the readings could not be repeated.

A glance at the stream-line diagrams shows that the total flux through a cross-section of the tooth some distance below the surface of the armature is considerably greater than the flux through the top of the tooth. This is fully borne out by the ballistic measurements, which show clearly the steady increase in the magnetic flux as we proceed down the tooth—so long, at any rate, as the induction at the base of the tooth does not exceed about 20,000. When the induction is pushed beyond this limit, another effect, not indicated by the stream-line diagrams (in which the permeability is constant), comes into play. The flux, after reaching a maximum value at a certain depth, begins to decrease, lines of induction leaving the flank of the tooth and crowding into the slot. This effect is very strongly marked for all the higher values of the gap induction, and is indicated by the crossing of the curves in Figs. 16–20. For the range of gap induction used, the curves connecting the total flux through the top and middle cross-sections of the tooth with the mean air-gap induction are almost indistinguishable from straight lines which necessarily pass through the origin. Such, however, is no longer the case for the curves relating to the base of the tooth, the initial portion only of which is straight. It is, of course, obvious that if it had been possible to push the induction far enough, the curves for the top and middle of the tooth would have commenced bending towards the horizontal axis in a manner similar to that of the curve for the base of the tooth—in fact, this tendency is clearly marked in the case of the dotted curves of Figs. 18 and 20.

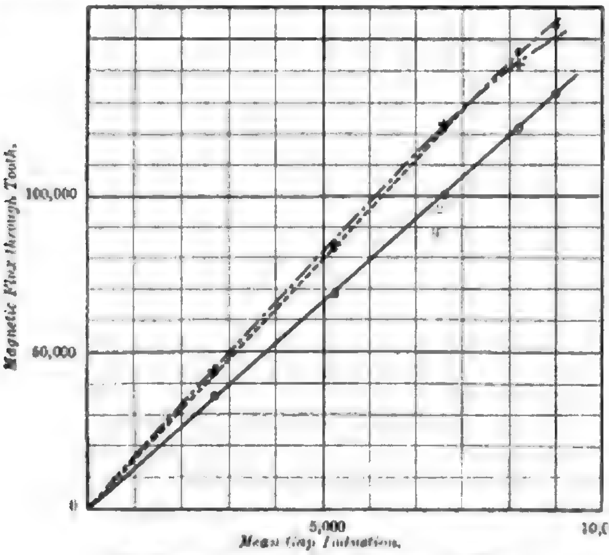

FIG. 20.—Armature 5⁵⁄₁₆in. diameter. 36 Teeth.

CONCLUSION.

The experiments described in the present Paper occupied the greater part of two years, and the expense of constructing the apparatus and photographing the stream-line slides was defrayed out of a research grant made by the Royal Society. We are indebted to Prof. E. W. Marchant, D.Sc., and several of his students for valuable assistance in connection with the somewhat laborious experiments which form the subject of our Paper.

ERRATUM.—The last word on p. 214 of our issue of Nov. 25, *i.e.*, inversely, should be omitted, and in the table on p. 215, the figures 1·89 in the fourth column of the second row should read 1·98.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Sensitive Moving-coil Galvanometers.—In all galvanometers a counter-E.M.F. is produced by the motion of the coil or magnet, which seems to cause a damping effect. When there is no appreciable waste of energy and when the counter-E.M.F. is sufficient to make the motion just barely aperiodic, the galvanometer has the maximum possible efficiency, as far as utilising the energy of the current is concerned, and this efficiency is the same for all such galvanometers. The power of the magnet in moving-coil galvanometers renders easy the securing of the above condition in ordinary cases. A further result of the magnetic power of the moving-coil galvanometer is the ability to replace part of the wire of the coil by other masses without loss of sensibility. This type is thus by far the best when pointers, &c., are to be moved, as in lecture-table apparatus. A change in the width of the coil has, electrically, the same effect as a change of the size of wire in the coil. Trouble arising from magnetic impurities in the coil is reduced to one-sixtieth by using a radial instead of a uniform field. It is easy to make a simple and strong moving-coil galvanometer that shall have an effective sensibility of 560 megohms for 100 ohms resistance and a period of 1·3 seconds. The internal resistance cannot then be brought much under 20 ohms. In securing high stability a device which can be supported by a basement floor is preferable to any arrangement, in itself equally good, which hangs from a wall or ceiling. A tank or float may thus be of greater advantage than a Julius suspension. The influence of air tremors is, as a rule, largely underestimated.

[W. P. WHITE, *Physical Review*, November, 1904.]

Rotation of Electrons.—E. Kohl investigates mathematically the possibility of part of the energy of a moving electron being stored in the form of a rotation about an axis passing through its centre. This possibility has an important bearing upon the theory of magnetism and of radio-activity. The calculations are based upon Abraham's assumption that the electrons may be regarded as rigid spherical surface or volume charges. The author works out equations for an electron in any state of motion, which allows him to determine the ratio of the rotational to the translational motion. This ratio depends upon the rate of change of the electric field, or what the author terms its inhomogeneity. He shows that the rapidity with which the equator of the electron rotates will only attain a value comparable to its translational motion if the inhomogeneity is of infra-molecular dimensions—*i.e.*, when the field changes by an amount comparable with its original value within a distance from the centre of the electron larger than the diameter of a molecule. It disappears in comparison with the translational speed when the inhomogeneity is of ultra-molecular dimensions. Thus, while in the more rapid cathode rays, with a field whose inhomogeneity is of molecular dimensions, the frequency of rotation of the electron may reach hundreds of billions, this rotation is negligible in comparison with the translation, since it does not contribute perceptibly to the kinetic energy of the electron, and does not affect its internal field. This implies that in the usual fields employed for the projection of electrons their rotation need not be considered. Only when the electric particles are themselves of molecular dimensions, as in the case of the canal rays, the production of a considerable rotation is possible in some parts of the field. Nor must such rotation be excluded in the case of Becquerel rays, where the mechanism of projection is unknown, and may have its seat in molecular processes.

[E. Kohl, *Annalen de Physik*, No. 13, 1904.]

Generation of Ozone.—A. W. Gray has made a series of tests of the Siemens ozone generator with a view to determining the conditions favourable to its economical production. He finds these to consist in good surface insulation of the generator, dry oxygen, and charging and discharging as suddenly as possible. To fulfil the last condition, the resistance and self-induction of the circuit should be as small as possible, and possibly a Leyden battery might give better results than the ordinary method of employing an induction coil or an alternating-current dynamo, as these machines could not give such a rapid change in the difference of potential between the electrodes. The author's results are in fair agreement with those obtained by Warburg in the case of the silent electrical discharge from points. He found that the production of ozone seemed to be closely connected with the amount of illumination, and that when the positive brush discharge made its appearance, the ozone formed per coulomb increased rapidly with the current strength, although the ozone produced by the negative discharge seemed to be independent of the current. In the author's experiments, increase in potential was accompanied by increase in current. In the Siemens generator both positive and negative light are present, and it also seems reasonable to expect that the amount of illumination would be influenced by such things as the resistance in the circuit, the nature of the gas, and the presence of water vapour. The Siemens generator, however, gives a much greater yield of ozone for a given quantity of electricity sent through the gas. It is possible that the great difference in current density may have considerable influence.

[A. W. Gray, *Physical Review*, November, 1904.]

Electric Dissipation in Hot Air.—E. Brunner has investigated the electric dissipation from some metals placed in an enclosure surrounded by a superficially oxidised brass wire not connected to earth. He worked at atmospheric pressure, but raised the temperature gradually to about 700deg. There was no perceptible influence of the temperature until over 400deg. were attained, and then the effect depended upon the nature of the metal, its surface condition, and the sign of the charge. Thus, in normal platinum the temperature at which an effect of heat began to appear was 515deg. for both negative and positive electricity. In freshly-oxidised copper the temperature was 410deg. for positive and 460deg. for negative electricity. An increase of temperature amounting to 15deg. produced as a rule a doubling of the rate of dissipation. Fresh platinum, silver and brass dissipate negative electricity much more rapidly than when they have been glowing for some time, and the fresher platinum and silver are, the more does their behaviour towards negative and positive electricity tend towards equality. Copper oxide, calcium oxide and hydrogen deposited on metals encourage the dissipation of positive electricity, but do not affect negative, whereas zinc oxide slightly raises the negative dissipation. All these results go to show that the ionisation of the gases is not spontaneous, but depends upon ions which proceed from the metals. The fact that both dissipations are affected by high temperatures shows that the electrodes must project both kinds of ions. The different behaviour of positive and negative ions cannot be simply due to a difference in their mobilities, since the attracted ions have as much to do with the convection of the current as the ions which are repelled from the electrode. The author believes that the total ionisation is not due to the ions given off by the metal, but that some ions are the result of the impact of those projected.

[E. Brunner, *Annalen der Physik*, No. 13, 1904.]

N-Rays.—R. W. Wood reports having visited the laboratory of one of the physicists who have described N ray phenomena, though he does not give his name. He witnessed all the usual test experiments, and finally came to the conclusion that none of them placed the existence of N-rays beyond a reasonable doubt. He could not detect the variations of brightness in an electric spark or a feebly-illuminated surface which the physicist in question and his assistant claimed to perceive quite clearly. The photographic records did, indeed, show a difference of illumination, but the author considers that the possibility was not excluded of the observer unconsciously exposing the plate longer when the N-rays were supposed to be acting. To eliminate the personal element, he arranged that he himself should hold his hand in the path of the rays, and let the other observers judge as to whether it was there or not. The result was negative, the observers never giving the right version, and sometimes seeing variations when the hand was kept steady. The author suggests that the question ought to be finally decided by experiments conducted jointly by, say, Lummer and Blondlot, as was done in the Crémieu-Pender controversy. They should use a photographic method, and arrange it so that the person making the exposures should be ignorant of the action of the rays. This might be secured by a number of screens consisting of a double layer of aluminium foil, with either dry paper or moist paper between.

[R. W. Wood, *Physikalische Zeitschrift*, December 1, 1904.]

Photographic Records of N-rays.—R. Blondlot publishes the results of several further tests intended to place the action of N-rays on an electric spark beyond any doubt. They refer to the arrangement in which a photographic plate is exposed to the action of an electric spark containing N-rays with or without the interposition of a lead screen. The objection that the screen itself might by its capacity increase the brightness of the spark is effectively disposed of by eliminating the N-rays by means of a moist paper screen and showing that then the introduction of the lead screen produces no effect on the photographic record. The more serious objection that the time of exposure might not be quite the same with and without the rays, and might be unconsciously made in favour of a positive result is met as follows: A chronograph is employed to give time signals and to register the times of exposure. The operator counts 25 seconds for each exposure and exposes alternately with and without the rays. The greater impression is invariably associated with the presence of the rays, and the chronograph records show that the exposures are equal to within half a second. For further security, the author then made a practice of always counting an extra second in the absence of the rays. The superiority of the impression in the presence of the rays was still well marked, and the chronograph records showed that the exposure without the rays had been one-half to one-third of a second longer. A similar result is obtained by making two exposures of 50 seconds each. The author claims that these photographic records are the unexceptionable evidence of the existence of the rays.

[R. Blondlot, *Comptes Rendus*, November 21, 1904.]

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"Science Abstracts." November, 1904. Section A, Physics. Section B, Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

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ELECTRIC TRACTION AND RURAL SCENERY.

Last Tuesday's *Standard* contained an eloquent appeal for Protection—protection not against the foreign manufacturer (although this is now a theme upon which our contemporary will doubtless have much to say in view of the political opinions of its new proprietor), but against the hardworking and energetic English electrical engineer. The leading article to which we refer is a strongly-worded protest against the proposal for an electric tramway in North Wales from Bettws-y-Coed through Capel Curig and Pen-y-Gwyrd to Llyn Gwynant These villages, with the exception of Bettws, are not served by any line of railway at present, but by coaches running once or twice a day, the traffic being almost entirely a tourist traffic. During the summer, Bettws and Capel Curig are much resorted to by artists, as the scenery in this district to the east of Snowdon has peculiar charms which appeal with great force to the lovers of nature. The delightful combination of rock, trees and stream, the fine variations in colouring in the Gwynant Valley, the contrasts between the two lakes, Llyn Gwynant and Llyn Llydaw, and the sombre aspect of the mountains to the north of Capel Curig have beauties which we trust will never be marred. But the writer in the *Standard* has formed an exaggerated idea as to what the proposed "desecration" consists of. The railway, with "its stiff outlines, its bridges and banks," figure merely in the imagination of the writer, and not on the plans of the engineers. All that is proposed is a modest line of electric tramway, of the design usually adopted in rural districts, which is to run along the existing coach road between the points mentioned, and will probably displace the existing coaches. The cars will be no more unsightly and far less objectionable to the other senses than the motor-cars which have already invaded this part of North Wales, and the only permanent additions to the road will be a harmless line of rails and a row of poles and wires upon which the artist may turn his back with no great effort. We predict, in fact, that the tramway will not keep artists away from the precincts of Snowdon; it will—literally—bring them there.

We have always maintained that electrical engineers should avoid, as far as possible, giving annoyance to those whose susceptibilities may be offended by the intrusion of tramways in places where they would actually constitute an eyesore. For instance, we have consistently opposed the laying of a line of tramways along the Thames Embankment, for the institution of an unbroken succession of these vehicles along one of the few beautiful highways in the heart of London would be indeed deplorable. The London County Council is again endeavouring to obtain sanction for such a line this year, and it will doubtless meet with its annual rebuff in Parliament—a sure sign that those in authority will be kept alive to the inexpediency of sacrificing too much in favour of the doctrine that "utility is the sole standard of morality, so that the rectitude of an action is determined by its usefulness." On the other hand, we fail to sympathise with the Borough Councils in the North of London, who persist in their objection to the overhead trolley. Islington has no rural scenery to disfigure, nor any fine thoroughfare whose beauty would be marred by an overhead trolley wire. The "New River" has no embankment to vie in splendour with that on the Thames. In fact the inhabitants of Islington want electric traction, horse tramways are running on the proposed routes, and the Islingtonians want the lines to be electrically equipped. But they insist on having the slotted conduit system—because South London has it—and not the overhead system. The conduit line will cost twice as much as the overhead line, and, of course, the receipts would be the same in either case, so that it simply means that the former system will necessitate higher fares than the latter, or else a loss will fall upon the ratepayers. The laying down of the conduit will take far longer than the erection of a trolley line, and, in fact, there is everything to gain by the adoption of the simpler system in this case.

STUDIES IN MAGNETIC TESTING.*

BY G. F. C. SEARLE, M.A.
(Cavendish Laboratory, Cambridge.)

Introduction.

§1. I was led to make the investigation described in the following Paper by noticing, in August, 1902, that the magnetic treatment of specimens of transformer plate may exert so great an influence upon the change of induction subsequently found on the reversal of a given magnetic force as to make ballistic tests of transformer iron liable to great uncertainties. I therefore decided to investigate the effects of magnetic treatment with the hope of finding how to obtain a definite value for the change of induction due to the reversal of a given force, and of gaining some information as to the effects produced by some selected modes of magnetic treatment upon the change of induction subsequently found on the reversal of a given force.

The investigation has, however, gone a little beyond these limits, for I have, in addition, examined the effects of the mechanical disturbances involved in the preparation of the specimen for testing, and have also considered how far the results obtained with a single specimen may be taken as representative of the magnetic quality of a whole batch of sheets of transformer iron. The work may therefore be looked on as a rough attempt at a critical examination of the use of the ballistic method in magnetic tests of transformer iron.

§2. Throughout the paper I employ C.G.S. units, and I adopt the recommendation of the International Electrical Congress, which met at Paris in 1900, and use the word *Gauss* to indicate the C.G.S. unit of magnetic force, and the word *Maxwell* to indicate the C.G.S. unit flux of magnetic induction through a circuit. Thus, if the total flux of induction through a circuit at any time be N maxwells, the E.M.F. induced in the circuit is $-\frac{dN}{dt}0{\cdot}10^{-8}$ volts.

Effect of Continued Reversals of the Magnetic Force.

§ 3. The ballistic method involves the *reversal* of the magnetic force acting upon the specimen, and a confirmation of the value of the change of induction due to a reversal of the force can only be obtained by making a second reversal. This at once brings us to an effect which compels us to count these very reversals of the magnetic force, which are necessary for the measurement of the corresponding changes of induction, as part of the magnetic treatment of the iron. For continued reversals of a definite magnetic force generally cause, at least in soft iron, a diminution of the corresponding changes of induction, which at first is rapid, but after a few reversals is very slow, one hundred reversals being sufficient to bring the iron to a practically "steady" state for any fresh value of the force. This result is the basis of the practice, adopted by those who make magnetic tests, of making observations for the change of induction due to the reversal of a given magnetic force only after many reversals of that force. Of course no other magnetic operation must intervene between this series of reversals of the magnetic force H and those reversals of the same force H which are made for the measurement of the change of induction.

Though a large number of reversals of the force is necessary for obtaining a steady value for the change of induction due to the reversal of a given force, yet the series of reversals will not, of itself, in all cases make the steady value of the change of induction a definite quantity depending only upon the magnetic force employed. To obtain a definite result in all cases, we must subject the specimen to a special preliminary magnetic process—viz., demagnetisation by reversals.

Apparent Induction and Permeability.

§ 4. It will be convenient to give a name to the steady value to which half the change of induction, due to the reversal of a given magnetic force H, settles down after many reversals of that force, and I shall employ the term *apparent induction* for the purpose, and shall use the symbol B' for the quantity in question. Extending the nomenclature, I shall give the name *apparent permeability* to the ratio of the *apparent induction* to the corresponding magnetic force, and I shall use the symbol μ' to denote the ratio; thus $\mu'=B'/H$.

The adjective *apparent* is used because the ballistic method, when applied in the usual manner to rings, gives only the values of *changes* of induction. The absolute value of B at any time can only be found by some special device such as that described in § 17.

Demagnetisation by Reversals.

§ 5. Throughout the work special attention was paid to the demagnetisation of the specimens by the method of reversals; the details are given in §9 below. In this process the specimen is subjected to a large number of reversals of a magnetic force, whose amplitude is slowly and continuously reduced from some maximum value D to zero; thus, during the process the specimen is not subjected to any force outside the limits $\pm D$. If the maximum amplitude of the force be 10 gausses, we may, for brevity, describe the whole process by saying that we demagnetise the iron with $D=10$. The object of the process is to reduce the iron to a standard state such that the apparent induction, B', subsequently found for a given magnetic force, H, depends only upon that force, and not upon any magnetic operations which may have been done before the demagnetisation. It is to be understood that no magnetic operation is to intervene between the demagnetisation and the test with the force H. With any brand of transformer iron the desired result will almost certainly be obtained, provided D be not less than 10 gausses. The process is then called "effective demagnetisation." For the iron used in the experiments, effective demagnetisation was secured with values of D much smaller than 10 gausses; but for the present it will suffice to say that transformer iron is effectively demagnetised if D be not less than 10 gausses.

Normal Induction and Permeability.

§ 6. Since it is only after effective demagnetisation of the specimen that the apparent induction B' depends only upon H and not upon any magnetic operations performed before the permeability test, for all, even small, values of H, it is clear that we must employ this definite value of B' when we have to give an account of the magnetic quality of a given specimen. I therefore call the apparent induction found with a force, H, after effective demagnetisation, the *normal induction* for that force, and I denote it by B_0; I also call B_0/H the *normal permeability*, and denote it by μ_0.

The Critical Magnetic Force.

§ 7. From the experiments described in the present paper it appears that, corresponding to each specimen of iron, there is a certain critical magnetic force, which I denote by M_0. The importance of even an approximate knowledge of this critical force may be judged from a brief summary of some of the results obtained in the course of the work.

When H at the least somewhat exceeds M_0, the iron is quite indifferent to its magnetic history, with the result that we find the same apparent induction for a given value of H whether the specimen is in a virgin state and has never previously been magnetised, or whether it has been powerfully magnetised, or, again, whether it has been effectively demagnetised by reversals, and thus permeability tests for values of H exceeding M_0 are quite simple. But, on the other hand, when H is less than M_0, the apparent induction for a given value of H depends greatly upon the magnetic history, and thus we find, for a given specimen and for a given force, one value for the apparent induction when the iron is in the virgin state, a greater value when it has been effectively demagnetised, while, within limits, we can obtain any value we please by suitably choosing the magnetic history.

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* Paper read before the Institution of Electrical Engineers last night. Specially abridged for *The Electrician* by the author.

If we were given a ring of iron and knew nothing as to its magnetic quality or its magnetic history, the first step towards obtaining the "normal" permeability curve would be to make the following set of observations:—Wind the ring with primary and secondary coils in the usual manner and subject it to 100 reversals of a magnetic force of 0·2 gausses, and find the apparent induction B'. Then increase the magnetic force to 0·4 gausses, and after 100 reversals find B' for $H = 0·4$, and continue this process step by step until B' reaches 15,000 maxwells per square centimetre or thereabouts. Calculate the apparent permeability μ' for each value of H and draw a curve showing μ' in terms of H, when it will be found that μ' rises to a maximum, when H has some value M', and then diminishes. The magnetic force M', corresponding to the maximum of μ', has a nearly definite value for a given specimen, for it is found that its value is but little affected by the magnetic treatment experienced by the specimen before this series of permeability tests. In fact, in my experiments the highest and lowest values of M' did not differ by more than 0·5 gausses in the case of any specimen.

My experiments show that when M' has been found in this way we shall be able to obtain effective demagnetisation by reversals if we make certain that at the least D somewhat exceeds M'. For transformer iron we shall be quite safe if we make D greater than M' by 3 or 4 gausses.

For any brand of transformer plate effective demagnetisation will probably be secured if we make D not less than 10 gausses. We need not then go to the trouble of drawing a preliminary $\mu' - H$ curve.

I shall now define the critical magnetic force M_0, corresponding to a given specimen, as the magnetic force for which μ_0, the normal permeability for that specimen, attains its maximum value. Though, on account of the narrowness of the limits within which M' lies, *any* value of M' is good enough as a guide in practical testing, yet it is convenient, for the sake of precise descriptions, to have a definite specification of the critical magnetic force.

Magnetic History.

§ 8. By effective demagnetisation we are enabled to reproduce a definite state of the iron to form the starting point for each experiment, and are thus able to study the effects of any magnetic operations done *after* the demagnetisation without any disturbance arising from magnetic operations done *before* the demagnetisation. It is therefore permissible to use the words *magnetic history* to indicate the magnetic treatment to which the specimen has been subjected *after* effective demagnetisation and before the series of reversals of the force H necessary for reaching a steady value for the apparent induction for the force H.

Method of Demagnetisation.

§ 9. In demagnetising the iron by reversals, I used an alternating current to give the necessary reversals of the magnetic force; I thus obtained about 90 cycles per second. I diminished the amplitude of the alternating magnetic force very gradually by means of a liquid resistance slide. This consisted simply of a narrow glass trough containing dilute $CuSO_4$ solution and furnished with two copper electrodes, one of which was movable; by tilting the trough so that one end was dry the current could be reduced to a very small value before the circuit was actually broken. A commutator allowed either the continuous current from storage cells or the alternating current to pass through the magnetising solenoids. This method of demagnetising the iron has the advantages of being speedy and of reducing the amplitude of the magnetic force in the very gradual manner which is necessary if the demagnetisation is to be really successful.

§ 10. To estimate the maximum amplitude of the magnetic force, I measured the "effective" current in some cases by means of an amperemeter made for use with alternating currents, and in some other cases by means of a sensitive electrodynamometer. I had no means of finding the "wave form" of the current, and I had therefore to be content to treat the current as a pure sine function of the time and to take the maximum current to be $\sqrt{2}$ times the effective current.

Determination of the Normal Induction and Permeability.

§ 11. The normal induction B_0 and the normal permeability μ_0 were very frequently found in the course of the work, and so, to avoid repetition, I shall describe, once for all, the method employed in determining them. Having settled upon the magetic force H, for which B_0 was to be found, I so adjusted the continuous current, by means of a rheostat, as to obtain the desired force. By means of a two-way key, I then stopped the continuous current and allowed the alternating current to flow through the magnetising coils. After bringing this current to its full strength, I gradually diminished it to (practically) zero by means of a liquid resistance slide, so demagnetising the iron. In order to obtain effective demagnetisation, I took care that D, the maximum magnetic force due to the alternating current, exceeded M_0, the critical force correspoding to the maximum normal permeability.

By putting the two-way key back into its first position, I stopped the small residual alternating current and re started the continuous current, and corrected by the rheostat, if necessary, any very slight deviation from the value required to give the chosen magnetic force H. After the force H had been reversed many times, the number varying from 50 to 200, the ballistic effects of at least one pair of reversals of H were noted. From the mean of these effects the value of B_0 was calculated, while μ_0 was found by dividing B_0 by H.

This process, including the preliminary adjustment of the current and the demagnetisation of the iron was repeated for *each* value of H used in the experiments, unless the contrary is stated.

The Magnetic Square.

§ 12. In all but one or two experiments I used specimens of the thin iron or steel plates manufactured for the construction of transformers and dynamo armatures, and the apparatus was specially designed for testing such specimens.

Three brands of transformer iron were used—viz., "Tagger Plate," "Schultz" and "Sankey." In each case the thickness was about 0·085cm.

The magnetising arrangement consisted mainly of four solenoids, which I shall denote by A, B, C, D, each 52·25cm. in length and 7·66cm. in diameter, wound on wooden tubes, the mean number of turns per centimetre being 5·693; the diameter of the wire was 0·127cm. The four solenoids were arranged symmetrically with their axes along the four sides of a square, each side being 62·4cm. in length.

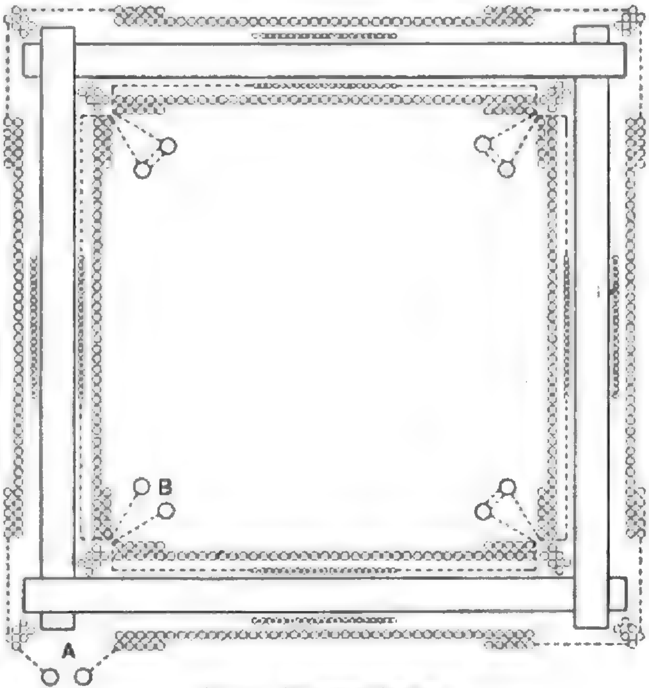


Fig. 1.—Magnetic Square.

The sheet metal was cut by shears into strips, each 4cm. wide and about 68cm. long, which were placed in the solenoids with their planes parallel to the plane of the square. The length of the strips was sufficient to allow the parts of them projecting from two adjacent solenoids to overlap at the corresponding corner of the square. Here the strips from the two solenoids were arranged alternately, and were clamped together by a non-magnetic clamp in order that the magnetic circuit might be as perfect as possible. By first putting one strip in A, then one in B and so on in cyclical order, the strips were easily assembled in the required manner. The number of strips in each solenoid was, of course, the same.

When I used only the main solenoids for magnetising the iron, I found that the induction near the ends of the strips was seriously less than at their centres. To remedy this defect I arranged 12 extra coils in series with the main solenoids, and by roughly adjusting the number of turns on them I was able to make the inductions at the ends and at the centres of the strips nearly equal. At each corner, one coil of 30 turns was placed with its plane making angles of 45deg. with the two adjacent sides of the square, and a coil of 20 turns was wound at each end of every solenoid over the main winding. The total resistance of all the coils in series was about 5·5 ohms.

Making a small correction of about 0·3 per cent. on account of the finite lengths of the solenoids, and on account of the 12 extra coils at the corners, I found that the magnetic force at the *centre* of any solenoid was 75·15 gausses per unit C.G.S. current.

All the magnetising coils were arranged in series and the magnetising current was measured, when desired, by a Weston milli-voltmeter used with a suitable shunt. I found it more convenient, however, to put a suitable extra resistance in series with the voltmeter so as to change its effective sensitiveness, as I could then read directly from the voltmeter, without calculation, the value (in gausses) of the magnetic force produced by the current at the centres of the sides of the square.[†]

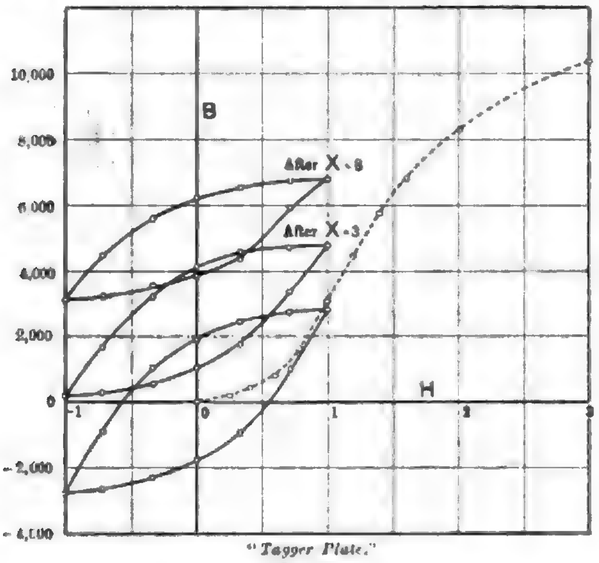
Within the wooden tubes were placed four non-magnetic tubes, and on the central parts of these tubes the secondary coils were wound. These coils, which were connected in series, were so arranged that I could use 3, 9, 27 or 81 turns on each side of the square, and suitable resistance coils were arranged to make the resistance of the secondary circuit independent of the number of turns. The secondary circuit included a ballistic galvanometer and an earth-inductor by which the galvanometer was standardised.

The magnetic square is shown diagrammatically, but roughly to scale, in Fig. 1, where A indicates the terminals of the primary coil and B those of the secondary coil. The arrangement of the four corner coils and of the eight extra coils wound on the ends of the four solenoids will be apparent from the figure.

The magnetic square is very convenient in magnetic tests of sheet iron, as a practically perfect magnetic circuit can be built up by simply slipping the iron strips into the four solenoids, without the least interference with either the primary or the secondary circuits; the labour of winding a new primary and a new secondary on each fresh specimen is thus avoided, and the resistances, which have been adjusted to allow the magnetic force to be read directly from the milli-voltmeter, require no fresh adjustment.

PRELIMINARY BALLISTIC EXPERIMENTS.

§ 13. In most of the ballistic experiments described in the present paper I confined myself to the examination of the effects of its magnetic history (§ 8) upon the apparent induction, or the apparent permeability of a specimen. But I think it may be useful, in opening the subject, to give an account of some experiments made to find the effect of previously applied magnetic forces upon the actual forms of the **B**-**H** loops in cycles with the limits ± 1 for **H**.



"*Tagger Plate.*"

FIG. 2.

The iron, which was tested by means of the magnetic square, was in the form of 16 strips of "Tagger Plate."

§ 14. I first tested the 16 strips for permeability, and found that the "normal" permeability reached a maximum value of about 4,200 when **H**=1·6. Thus M_0 is 1·6 for this specimen. The observations for permeability were taken in the manner described in § 11. The value of **D** was about 4·8; this was found to give effective demagnetisation. The resulting normal B_0-**H** curve is shown in Fig. 2 as a dotted line.

In obtaining the "normal" **B**-**H** loop, I first demagnetised the iron and then applied the force **H**=1, and reversed this 200 times before taking the observations for the loop. This loop is shown in Fig. 2; it lies symmetrically with respect to the origin.

To show the effects of magnetic history I made two other loops with the same limits (±1) for the magnetic force. In these cases, after demagnetising the iron, I subjected it to 50 reversals of a magnetic force, **X**, breaking the circuit finally in such a way that the force sank from +**X** to zero. I then applied the force of 1 gauss and, after reversing it 200 times, made observations for the **B**-**H** loop. The two loops obtained in this way are shown in Fig. 2, where they are marked "After **X**=8" and "After **X**=8" respectively.

§ 15. In order to place the **B**-**H** loops in their true positions on the diagram it is necessary to know the absolute value of the induction for some one point on each loop. This value was obtained by the devices which will be described in §§ 16, 17. Meanwhile, it will be seen that the experiments show that the application of the force **X** has resulted in reducing the range of **B** for cycles with the limits ± 1 for **H**, in displacing the **B**-**H** loop along the axis of **B** and in diminishing the area of the **B**-**H** loop. The following tables give the numerical details. The first table gives the value of **B** for **H**=+1 and its value for **H**=−1. Half the difference of these values gives the apparent induction **B**′, while half their sum gives the "mean induction" and indicates how far the **B**-**H** loop has been displaced along the axis of **B** by the after-effects of the magnetic force **X**. The energy dissipated through hysteresis per cubic centimetre per cycle is denoted by W.

	B – Normal loop.	B—After X=3·0.	B—After X=8·0.
H=+1·0	+2,780	+4,824	+6,780
H=−1·0	−2,780	+ 114	+3,106
H= 0	+1,872	+4,040	+6,125
H= 0	−1,872	+1,026	+3,917

—	Normal B-H loop.	Loop after X=3·0.	Loop after X=8·0.
Apparent induction B′	2,780	2,355	1,837
Mean induction	0	2,469	4,943
Hysteresis loss W	390	318	222

§ 16. I will now explain the method employed in the determination of the *absolute* value of the induction at any point on the **B**-**H** loops.

In the case of the normal loop I made the usual assumption that the values of **B** at the two tips of the loop are equal in magnitude and opposite in sign. To test the legitimacy of this assumption I made the following experiment: I demagnetised the iron and then applied a magnetic force of 1 gauss and noted its ballistic effect. On the assumption that the demagnetisation was complete, this first application of the force raised **B** from 0 to +2,842. On reversing **H** there was a change of induction of 5,738, so that the value of **B** for **H**=−1 was 2,842−5,738 or −2,896. Continuing the reversals, I found in succession the values +2,896 − 2,903, +2,909 for **B**.[*] These numbers agree so closely with each other that we may fairly suppose that after 200 reversals the values of **B** at the two tips of the loop are equal in magnitude and opposite in sign. We may thus take the absolute induction at the tip of the normal loop for **H**=1·0 as equal to the normal induction.

With the larger forces of 3·0 and 8·0 we may safely take the absolute induction at the tip of the normal loop as equal to the normal induction.

The residual induction left when **H** was removed was found from the absolute value of **B** for the force **H** by subtracting from it the change of induction calculated from the ballistic effect of removing **H**.

§ 17. In finding the absolute values of **B** for the two displaced loops, I proceeded on the assumption that, provided the iron has not been subjected, since its demagnetisation, to any magnetic force numerically greater than a "large" force **Z**, the value which **B** assumes, when **Z** is applied, is independent of the particular force, within the limits ± **Z** from which the step to **Z** is made. I use the adjective "large" to denote a force which is considerably greater than the critical force M_0.

Of the two points of intersection of the **B**-**H** loop with the axis of **B**, I selected that one where **B** has the algebraically greater value as the point for which the absolute value of **B** was to be determined. In the cases of the loop marked "After **X**=8·0," I first demagnetised the iron and then subjected it to 50 reversals of a force of 8·0 gausses, breaking the circuit finally in such a way that **H** sank from +8·0 to zero. I next applied a force of 1·0 gauss and reversed it 200 times, breaking the circuit finally in such a way that **H** sank from +1·0 to zero. I then applied a force of +8·05 gausses and found that the ballistic effect corresponded to an increase of induction of 7,750 maxwells per square centimetre. The magnetic force was next reversed from +8·05 to −8·05 and the corresponding change of induction was 27,760. On again reversing **H** the change in **B** was 27,820, the two numbers agreeing within the errors of observation. Assuming that the force of 8·05 is relatively so large that its reversal causes B to change in sign but not in magnitude, we may take 13,900 as the value attained by B when the force of +8·05 was applied for the first time after the small cycles. Hence the absolute value of the residual induction left, when the force of 1 gauss was removed at the end of the 100 cycles is 13,900 − 7,750 or 6,150.

[†] I have explained this plan in detail in *The Electrician*, June 12, 1903 (Vol. LI., p. 319), in an article "On the Measurement of Magnetic Force."

[*] The 200 reversals, which were made before **B**′ was found, caused half the change of induction, due to the change of the force from +1 to −1 or *vice versa*, to diminish from about 2,900 to 2,780. (See § 8.)

A verification of the value 13,900 was obtained by demagnetising the iron and observing the ballistic effect of the first application of a force of 8·05, when it was found that B rose from zero to 13,890.

I repeated the observations with a force of 6·10 in place of 8·05 and found that the absolute value of the induction at the selected point was 6,100.

In a similar manner, using a force 8·05, we found 4,040 as the absolute value of the induction at the selected point on the loop marked "After $X = 3$."

(To be continued.)

RUNNING POWERS.*

BY STEPHEN SELLON.

It has been my lot during the last two sessions of Parliament to hear many objections raised against running powers. It is difficult to treat any of them seriously; and it is, therefore, not surprising that the learned counsel, obtaining no solid grounds for rejection from the mouths of his witnesses, found himself forced to claim the application as unprecedented. This was the continued cry of the learned counsel for Birmingham, and for Newcastle-on-Tyne during the recent running-power cases brought before Parliament. The only other objection urged is founded altogether upon ignorance of what "running powers" really means. Again and again the objection has been raised that the running company is desirous of usurping the rights of the owners of the tramways, and confiscate to itself the management of the tramways run over. I cannot do better than quote as an example the class of objection I mean—viz., a petition which was seriously and gravely presented to Parliament in the session of 1904 against the proposals made in the bill of the Tyneside Company—for running powers over the tramways of the Newcastle Corporation.

"We the undersigned citizens of the City and County of Newcastle-upon-Tyne do humbly pray that your honourable house in considering the bill entitled 'An Act to Confer Further Powers upon the Tyneside Tramways & Tramroads Co.' will refuse your consent to those clauses in the bill in which the company asks for compulsory running powers over the tramways of the Newcastle-upon-Tyne Corporation, because we are strongly of opinion that the proposals in the company's bill are objectionable, retrograde, and against the public interest by reason, amongst other things, of their interference with the principles of municipal self-government—the adverse effect which (if carried out) they would have upon the smooth and efficient working of the present excellent tramway system of the Corporation, the curtailment of the existing through fares in the city, and loss of central control so essential to the working of a good tramway system, the making subservient of the great central system to the small outside system, and the inconveniencing of hundreds in order to convenience a few individuals, and because we consider them an invasion of our rights as a self-governing community."

Obviously the lack of a precedent or objections of the character indicated do not condemn a proposal, but as so much importance is attached to it and there is some interest and guidance to be obtained from the history of running powers. There are abundant examples of running powers by agreement between railways, sometimes one-sided, sometimes mutual, and there are a number of cases where Parliament has granted running powers by compulsion. In the latter case Parliament appears to have acted upon principles which may be classified generally under the following heads:—

To save the running company useless expenditure in duplicating lines or terminal accommodation.

To meet an obvious public convenience which could not be left at the mercy of the possible unreasonableness of the company in possession.

To remove the obstruction wilfully offered by a company to the traffic of another company, or where a company has failed to afford proper facilities.

As a statutory confirmation of an agreement entered into between two companies, so that the public advantages so gained should not be at the mercy of future quarrels or divergence of interests between the contracting companies.

In such cases the principle seems to have been conceded that the running company should take no profit on fares earned on the owning company's lines. It pays its own train expenses, and very frequently some charge by the owning company for terminal services and facilities. But there are a few exceptions to this rule of no profits.

It can therefore fairly be stated that the principles regulating running powers are fairly established in most cases in railway legislation and traffic.

I propose to show that there is not the slightest reason why similar principles should not be applied to tramways, whether authorised under the Tramway Act or as tramroads, or under the Light Railways Act, that there are abundant examples of running powers by agreement, mutual running powers and compulsory running powers as between tramways, and to go a little further by showing that while "facilities" generally meet railway conditions, those of tramway traffic make facilities wholly impracticable for the attainment of the much desired public advantage.

The earliest case of running powers that I am able to find as regards tramways was in 1874, when the Swansea Tramway Co. obtained compulsory running powers over the Mumbles Railway, and for many years the curious spectacle was observed of a horse tramcar sandwiched in between the steam cars of the Mumbles Railway, an obviously inconsistent mixture of traffic resulting in inconvenience, which was therefore discontinued a few years ago by agreement, subject to compensation.

In 1882 powers for running into Dudley, by the South Staffordshire and Birmingham and Midland, were obtained.

In 1882 running powers were obtained over the Walsall and Wednesbury and West Bromwich Tramways by the Staffordshire Tramway Co.

In 1884 the London Street Tramways obtained running powers by agreement over the North Metropolitan system in Gray's Inn-road between Holborn and the junction of Theobald's-road with Clerkenwell-road.

Plymouth Corporation over the Stonehouse Co.'s line, 1900.

In 1900 Poole Light Railways and Christchurch and Bournemouth Tramways over the Bournemouth Corporation Tramways.

Glasgow Corporation over Paisley Co., 1901.

In 1901 the Spen Valley Light Railways over a portion of the Batley Tramways.

Salford over Manchester, 1902.

Metropolitan Electric Tramways over Walthamstow, 1902.

South Lancashire over St. Helens, 1903.

Brighton & Hove Co. over Worthing Corporation, 1903.

Tyneside and Newcastle, 1904.

Wakefield Light Railways over Ossett, 1904.

Leyton over Lea Bridge, 1904.

Running powers have been arranged between the Oldham, Ashton & Hyde Co. and the Stockport Corporation over portions of the two systems by agreement.

Dundee and Dundee & Broughty Ferry Co.

Manchester and Ashton, and other outside local authorities.

Wakefield and Leeds.

Aberdeen and Aberdeen Suburban.

East Ham and West Ham.

City of Birmingham Co. and Birmingham Corporation Tramways.

I have made many observations on the effect of a break of service on the traffic of tramway systems. In every case the effect of a break is to reduce the earning capacity on the routes immediately affected from 15 to 50 per cent., whilst there is frequently a much wider spreading of the effect than could be anticipated, and any gain on alternative routes between the same points is far less than the direct loss. Conversely, directly the connection is re-established, the traffic returns to the normal conditions. The favourable effect of a "through" connection established between two systems previously worked with a break of service confirms these cases. As an illustration, I may instance the well-known Newcastle and Tyneside case.

By the courtesy of Mr. McLellan, I am able to quote figures obtained from his statistics of traffic.

The Newcastle tramways terminate in open country about half a mile from Wallsend. The Tyneside Company's line runs up to the same point through Wallsend from North Shields. During the month of April, 1904, when a change of car was necessary to enable passengers to get from the Corporation's system to the company's system, or vice versa, Newcastle brought 48,796 passengers up to the terminus, out of which the company carried on 11,414, leaving 37,382 passengers on the road. Now, from the nature of the country, practically the whole of that number must have been bound for Wallsend and preferred to walk the half mile stage instead of mounting another car. During the month of September both the Corporation's and the company's cars ran through, and 48,409 passengers arrived from Newcastle at the point mentioned, 36,305 of whom went on to Wallsend, thereby reducing the figure of 37,382 passengers walking on to 12,104; and, mark you, this result was obtained immediately upon the through service being run. Similarly, travelling towards Newcastle in April, 16,070 passengers only were carried to the termination of the company's tramways, whereas in September 29,930 availed themselves of the through cars on this stage. Mr. McLellan further informs me that the through service has undoubtedly generally stimulated the tramway traffic. In considering these figures it must be borne in mind that the month of

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* Paper read before the Tramways and Light Railways Association, Thursday, Dec. 1.

April took in the Easter holiday traffic, and that between April and September the electrified service on the North-Eastern Railway came into operation.

Another typical instance I may take is the case of Birmingham and Aston. For a number of years a through service was run from the centre of Birmingham to Aston. During the last six months of this through service 449,858 passengers were carried monthly, and from statistics taken it was found that 72½ per cent. of this number (326,142) crossed the city boundary into the Aston district. Owing to the conversion of the tramways from steam to electric traction a break at the boundary was necessary, and it was then found that the number of passengers carried monthly in the Aston district averaged 178,671, showing a decrease, therefore, so far as Aston section of the tramways is concerned, of about 50 per cent. Now, I know it may be said that the Birmingham section of the line did not suffer at all from this break, but it is necessary for me to point out that the first penny stage on this line from the Birmingham end extended some distance over the boundary. When Birmingham started the electrical service to the boundary, they, of course, charged a penny fare, so their passengers had to pay the same fare for travelling a shorter distance by an improved method of traction, and at the same time had the undoubted inconvenience of walking a portion of their journey. The incident that the gain or loss of traffic may not be equally shared between the two undertakers does not affect the argument of public convenience. It may affect the terms.

Another instance is that of the Leith and Edinburgh Tramways. The break occurred at Pilrig when the Edinburgh section of the line was cabled. The loss entailed here was about equally divided between the two sections, totalling to £6,000 per annum. The length of route between Princes-street, Edinburgh, and the centre of Leith is about a mile and a half, so that the loss in money mentioned is equivalent to £4,000 per mile per annum, which is a good deal more than many tramways get as their rate of gross earnings.

There are marked differences between railway and tramway traffic conditions which materially affect the conditions and terms of running powers. Generally, compulsory running powers are exercised by one company over the line of another in respect to through traffic only, the local traffic being served exclusively by the owning company. Such an arrangement is clearly impracticable on a tramway, the foreign car must be available for the local traffic as well as the through traffic. This also applies on railways with a traffic similar to that of tramways; for example, the several railway companies who run trains on the railways of the District and Metropolitan companies.

Another difference arises in respect to the utility of "facilities" in the railway sense as distinguished from running powers. On a continuous railway journey it makes little or no difference to the convenience of passengers that the locomotive is changed at a particular station, or that the guards of one company are relieved by those of another. But it appears to be found convenient by the companies themselves to employ through guards wherever the traffic is large. The tramway case is quite different. Changing car-crews at a boundary must lead to some waste of men's time, and to delay of the traffic, for clearly there must be a spare or overlapping crew available, or cars in opposite directions must await each other's arrival at the boundary. The fact that the car is also the locomotive, and that the conductor is also the booking-clerk, introduce other objections to the exchange of crews. "Facilities" which only amount to the issue of through-tickets with a change of cars at the meeting points need not be considered, as I have already shown that even where there is no change of ownership, and therefore every endeavour made to minimise inconvenience, a great loss of public advantage and therefore of traffic results.

The justification of compulsory running powers is, of course, the public necessity. It ought not to be tolerated that parties entrusted by Parliament with tramway powers should be permitted by unreasonable conduct to prevent or hinder the full public use and advantage of any means of connection. Experience shows that, unfortunately, reliance cannot always be placed upon the reasonable conduct of the parties. Whether it has been a corporation or a company that has been unreasonable is not to the point, but there does seem a greater tendency on the part of corporations to object to through running on such sentimental grounds as that it is "an intrusion on our tramways," and on such "practical" grounds as that there are difficulties in controlling "foreign" car crews, that the town tramways are already pressed to their full capacity, that there will be ticket and account difficulties, and even, *reductio ad absurdum*, difficulties in apportioning responsibility for accidents.

The only one of these "practical" objections worthy of discussion is that of the full occupation of the city tramways by the local traffic. If this is a fact, it shows that further tramway facilities are necessary, say, for example, by the construction of lines more or less parallel to the through routes, and I would submit that, given the maximum possible number of cars on the city lines, there would be a balance of advantage in having some of them running through, to and from the suburban districts, even though some short distance or local passengers are displaced by long-distance or through passengers.

In the application for running powers into Birmingham the Corporation were prepared to give what they called "facilities," which I have already distinguished from running powers. A few months after the rejection of the bill for running powers, the Birmingham Corporation were fortunate in obtaining the advice and the co-operation of one of the best known and most accomplished tramway managers in this country. The following extract from a speech made by Mr. Alderman Beale, the chairman of the Tramways committee of Birmingham, in May of this year, is far more eloquent and convincing than any words of mine as to the results:—"Going on to explain to what extent the Corporation had given way, Alderman Beale said that when the Corporation went before Parliament it objected to the granting of powers to the company to run through the city. The Corporation rather favoured the Liverpool system of a change of crews at the boundary. The company did not like that, and the committee had given way to the extent of allowing the company's cars to run into Birmingham in charge of the company's servants. Really, on reflection, the objection to this seemed to be sentimental rather than practical, and in some respects the arrangement would be an advantage because they had been able to provide that the whole risk regarding a certain car should be borne by the body to which it belonged."

The only cases where running powers have been settled by reference are those of the Swansea and Mumbles, and the Glasgow and Paisley of this year. The Swansea case, being a very peculiar and ancient one, it is unnecessary here to consider it. It may be interesting, however, to quote the case of Glasgow and Paisley, recently determined by the arbitrator, Lord Balfour of Burleigh, who was appointed by the Board of Trade.

Glasgow in 1901 was granted running powers into the centre of Paisley, and having decided to exercise this power, and not being able to agree with the Paisley Company as to terms and conditions, the matter was referred to arbitration. The distance from Glasgow to Paisley is 7½ miles, 1 mile of which is owned by the Paisley Company. Glasgow proposed to charge a "through" fare of 3½d., and it was suggested that the company was only entitled to receive the proportionate fare in mileage less a sum for working expenses. The company, however, claimed their statutory fare with no deductions, and a sum representing 6 per cent. interest on the cost of constructing a siding that had by the act to be provided for the accommodation of the Glasgow cars.

The company obtained by the award their full statutory fare for local traffic, and inasmuch as they charged for their own "through" traffic 1d. for 1½ miles (being three ½d. stages), they were allowed two-thirds of a penny for each "through" passenger from Glasgow less 8·3d. per car-mile for working expenditure.

Another interesting part of this case is that Glasgow have to pay for the current they use while on the Paisley lines. The principle is, therefore, established that the owning authority is entitled to receive a sum per passenger in excess of the proportionate mileage for the "through" fare; and, in addition, the Corporation have to pay the costs of terminal service and facilities.

The decision appears fairly to represent the views held by railway managers of the past, such as Sir Edward Watkin, who explained to the Railway Companies Amalgamation Commission in 1872 that the owning company was entitled to receive something beyond the ordinary fare on account of the increased traffic receipts accruing to the running company due to the running powers and also a proper sum for terminal accommodation.

It has been already stated that running powers on a railway do not mean profit to the running company. In case of mutual running powers on two systems of tramways this practice should, I think, still prevail; but in cases where there is no mutuality in running powers, like Glasgow and Paisley, it is a very different proposition. Glasgow, by obtaining a through service into the centre of Paisley, with a population of 120,000, instead of having to stop at the boundary, is fructifying some miles of their barren line to the detriment of the Paisley Company; whereas, if Glasgow and Paisley had mutual powers, this one-sided advantage would not exist.

It is clear that in all cases where an outside company desires to gain admittance to the centre of another tramway system it is proper that the local service should not be interrupted, and that, in adjusting terms and conditions, if running powers are granted into the centre of the existing system, the effect of the break at the centre ought to be taken in account as a set-off against any advantage the owning company may be said to secure in extra traffic by the connection.

Having regard to the importance to the public of the advantages I have endeavoured to indicate, which experience shows cannot but result from the working of tramways connecting important districts as a through service free from obstruction, I venture to suggest that this Association will perform a most useful function by making every endeavour to remove the many prevailing and unfounded misapprehensions which exist by the dissemination of information bearing upon the subject, and so abolish what, I think, must be conceded to be a most mischievous obstruction to the better and more useful developments of inter-connection by means of through traffic.

Mr. **A. BAKER**, general manager of the Birmingham Corporation Tramways, in the discussion, said that if compulsory running powers really meant what Mr. Sellon said they meant, there could be no very great objection to them. But the seekers after compulsory running powers had not always been willing to forego all the profits earned on the lines over which they sought to run. Was it ever said in the Birmingham case that the British Electric Traction Co. wished to make no profit out of Birmingham? If so, everybody had been under a most extraordinary misapprehension. Yet Mr. Sellon was one of the principals in that attempt. He congratulated him, however, upon his very definite pronouncement that running powers did not mean profit to the running company. The Birmingham Corporation had been willing that the company's cars should run inside the town by arrangement, but the company had scorned the idea that satisfactory friendly agreements were possible; Parliament, however, took the view of the Corporation with the result that mutual running arrangements had been made. Personally, he believed that there was no better method of dealing with through running than by a change of crews at the boundary where it was possible to do it; for, instance, where the boundary was at some distance from the centre of the town and when there was only an infrequent service. In Birmingham, on the Aston line, the city boundary was 1 mile from the centre of the city. At busy periods on ordinary days the service of the cars, however, was at two minutes' intervals, whilst on Saturday and football match days the cars ran in an almost unbroken stream. Here was a case where a change of crews at the boundary was impossible. Consequently another method of dealing with the matter had to be found. The Corporation insisted on the principle that every penny earned in the city should belong to the city, but they had no desire to take a farthing of the earnings outside the city. The following arrangement was finally entered into between the Corporation and the company. Upon the Aston route, which was 1¾ miles long, it was arranged that the number of cars to be provided by each authority to give an adequate service was to be proportionate to the route mileage. Thus, on the line in question Birmingham found four-fifths of the cars and Aston one-fifth, and the receipts were divided between the two parties in the same proportion, except that 5 per cent. of the total amount was reserved to Birmingham before any division took place, in respect of those passengers riding exclusively in the city. Each party paid its own expenses and was responsible for any accident happening through any of its cars or by reason of its own servants' negligence. No system, of course, could apply to every locality, but he thought, generally, the arrangement at Birmingham could be adopted with safety. The danger of compulsory running lay in the fact that every authority might, sooner or latter, have to guard themselves against unscrupulous persons promoting outside lines not in the public interest, but with a view to exploiting municipal tramways. But, after all, this danger was more apparent than real if Mr. Sellon's policy of no profits to the running company was to apply. He presumed that the author hoped for a general enactment to compel the authorities to agree, but he went so far as to say there was no justification for compulsory running powers, because if there was a legitimate demand, public opinion would be quite strong enough to make those who were inclined to be unreasonable come to terms.

Mr. **J. BARBER GLENN** said he had been secretary to a large company in London now for 30 years, and made an arrangement with a neighbouring company many years ago by which all the receipts were pooled and divided according to the respective number of cars. The arrangement did not work well, however, and another was entered into by which each company kept its own receipts, adjusted the expenses, and balanced up accounts once a fortnight. This arrangement went on for a good many years, and no fault was ever found. Another instance was in connection with the Plymouth Corporation lines and the lines of the Plymouth, Stonehouse & Devonport Co. where there had been reciprocal running powers for three years and not a word of complaint. He agreed with Mr. Baker that a corporation should protect its rights, but he had no sympathy with the so-called sacredness of municipal territory. An instance of arbitrary policy on the part of local authorities was a case he knew of where a corporation ran their cars over a mile of a company's line and paid for it, yet absolutely refused to entertain any discussion as to the company's cars running over the corporation lines. In fact, the corporation desired to run over the whole of the company's system, and still refused to entertain any suggestion of the company running over their lines. Personally he deprecated anything that gave him the power to go to a corporation and demand running powers on the threat of going to Parliament, but he thought there should be some general enactment by which owners of tramways should be compelled to enter into discussion upon the matter, and see what arrangements could be come to.

Mr. **VESEY KNOX** referred Mr. Sellon to one case which had not been mentioned in his list of running powers, namely, the Bexley Urban District Council, which had power to run into Woolwich over the lines of the London County Council, a power which was inserted in the bill by agreement between the two parties. He did not think there was much difference of opinion as to the desirability of through running. It was a different case, however, where a corporation was unreasonable, and he thought there ought to be somebody who had the power to compel them to be reasonable. In the case of railway companies it had long since been found necessary to have a tribunal which had power to grant compulsory facilities, and they had granted such facilities in innumerable cases. If it were necessary in the case of railways then it was all the more necessary in the case of tramways. Only the other day he had a case where tramways in Lancashire were lying derelict because three local authorities had been unable to come to any mutual arrangements although they had been negotiating for three years. It was a scandal to think that there was absolutely nothing in tramway legislation which required facilities to be granted, while such a stage was reached in railway legislation more than half a century ago. If the railway analogy were followed not much harm could be done to anyone.

Mr. **H. E. BLAIN**, manager of the West Ham Corporation Tramways, said he did not look upon this question as one which merely affected companies against corporations, because cases would arise in which company would come into contact with company and corporation with corporation. West Ham was practically in the very heart of what should be an indivisible system of tramway communication, but the difficulty was how to arrange through running of the various systems in order to bring this about. Already difficulties had arisen with East Ham on this point, but an arrangement had been come to in half an hour by the two managers, although a sub-committee had been dealing with the matter for months without result. Only an experimental arrangement was being tried, but it showed what could be done by a little compulsion, because the two Councils were forced to arrange through running by their Acts. In this case each authority retains the whole of the local and through fares paid in its own area.

Alderman **IVEY**, chairman of the West Ham Tramways committee, agreed that the best way to get over the difficulties of through running would be, in many cases, to allow the respective managers to discuss the matter. He agreed with Mr. Vesey Knox that some general enactment was necessary to force all tramway authorities, whether company or municipal, to discuss running powers, with an appeal to the Board of Trade.

Mr. **H. ENGLAND**, general manager of the Wakefield and District Light Railways Co., said that, although a company man, he should object most strongly to compulsory running powers being forced upon him. If a man asked to enter into negotiations, however, he would never refuse. The arrangement between his company and the Leeds Corporation did not take an hour to arrive at. In fact, it was arranged at a game of golf. The Corporation run over the whole of the company's lines, whilst the company ran into the centre of Leeds. They ran to a common timetable, which could be accelerated by telephone wherever it was found necessary. The Wakefield Company issued their own tickets to the Leeds boundary and also a through ticket, whilst when the cars passed the boundary another ticket was issued, which the Corporation sold to the company in bulk, so that every passenger riding in a company's car in Leeds had a Leeds ticket. Thus the whole thing was as easy as ABC. He disagreed with changing crews.

Mr. **STEPHEN SELLON**, in reply, said that the object of the Paper was to show that running powers were absolutely necessary in the public interest. It ought not to be necessary in each case for Parliament to force running powers upon another party. If only some method could be devised of settling whether running powers were desirable, then the respective managers would come to an agreement as to details in a very short time. This was exemplified in the Newcastle case, for within one week of Parliament saying there must be running powers the whole thing was arranged. The Newcastle running powers cost altogether £10,000, an expense which would have been largely avoided had some power of reference existed as had been suggested.

A vote of thanks to the author closed the discussion.

THE USE OF IRON IN ALTERNATE-CURRENT INSTRUMENTS.*

BY DR. W. E. SUMPNER.

(Concluded from page 281.)

Now, in my opinion, no wattmeter should be considered a satisfactory instrument if it has errors like some of those mentioned. However faulty some wattmeters may be when used with transformers, a little attention given to the design of the latter will reduce the resulting errors to a negligible amount. The greatest errors arising in practice in wattmeter readings are neither due to transformers, nor to intrinsic faults in the instruments. They arise from the presence of heavy currents in neighbouring conductors. Some wattmeters are protected from such influences by surrounding the coils with a shield of suitably laminated iron. Iron is used for the transformers, and is used for these surrounding shields. Iron is used anywhere and everywhere, except in the place where it is most efficient—namely, within the coils of the wattmeter itself. In the instrument I have shown you iron has been put in the wattmeter, and has been removed from the transformer coils. The shield may still be needed to protect these coils, but not for the instrument itself, since this will be even less affected by external fields than ordinary permanent magnet voltmeters and ammeter. There is a discrepancy between the flux density in the air-gap of the instrument as calculated (1) from the number of turns, the applied voltage, the frequency and the section of the circuit, and (2) from the number of ampere-turns on the coil, the length of the air-gap and the other particulars of the magnetic circuit. This is possibly caused by undue eddy currents, which reduce the effectiveness of the ampere-turns and increase the copper drop. If so, the use of thinner stampings will improve matters. But as the instrument stands it is as good a wattmeter as many using current

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[*] Chairman's inaugural address to the Birmingham Local Section of the Institution of Electrical Engineers, delivered on Wednesday November 23rd. Slightly abridged.

and voltage transformers, while it possesses greater range and is more sensitive. My main object is to show that the errors arising from using iron magnetic circuits in wattmeters are not necessarily greater than those involved in the use of transformers with such instruments. I consider that the action of the instrument shown justifies this view.

If it be once granted that the errors can be rendered sufficiently small, no one will doubt the great advantage of an iron-cored instrument, or dispute its supremacy in regard to sensitive qualities. It must necessarily be as delicate as a permanent magnet-moving coil instrument, since the magnetic field can easily be made as strong or even stronger. An instrument such as illustrated in Fig. 5 can be utilised for the detection of very small alternating currents or voltages. Of course phase difficulties arise, but these can be overcome by making use of phase-changing devices for applying a voltage of the right phase to the magnetising coil.

The influence of small differences of phase on the action of alternate-current instruments can generally be calculated if the phase differences are known, but these are difficult to determine experimentally. In order to investigate the action of transformers for instrument purposes, I have devised voltmeter methods for measuring small phase differences. I have set forth in Table II. the results of a number of recent measurements. In carrying out these tests I have had the benefit of the able assistance of my colleague, Mr. David Owen. The phase differences measured are given in the column headed θ. The last column shows for the smaller values of θ the number of parts in *one million* by which $\cos\theta$ differs from unity. The first number given relates to a common water resistance, and implies that its power-factor may be taken as 0·999978. This should bring comfort to anyone who has doubted the non-inductiveness of such resistances. The values of θ given for the wire spiral and for the direct current arc are the minimum values I could detect with certainty with the voltmeters I had at disposal when the tests were made; consequently, all that these numbers prove is that the power-factor in these cases does not differ from unity by more than corresponds with the figures given. Then follow a number of tests on voltage transformers of various capacities, with the secondaries, in some cases on open circuit, and in others supplying currents of various magnitudes and power-factors. The last three tests were on current transformers with secondaries closed on the circuits for which they were designed. It will be noticed how exceedingly small the value of θ is for some of the transformers on open circuit. This is of special interest in regard to electromagnets for wattmeters, since such electromagnets are essentially transformers on open circuit, and the phase difference measured is that caused by the copper drop in the magnetising coil. For the 1 unit, equal ratio, transformer this value of θ is only 0·02deg., and $\cos\theta$ differs from unity by less than seven parts in *one hundred million*. On full load θ is only $\frac{1}{3}$deg., and is much the same for a load of power-factor 0·09 as for unity power-factor. The 3-unit transformer shows a lower phase difference for inductive loads than for non-inductive, and it is noteworthy that a very sharply defined minimum value of θ of 0·18deg. occurs at about 80 per cent. of the full load current, with a secondary circuit of power-factor 0·09. The small 10 ampere transformer was supplied by the B.T.-H. Company, to reduce current in the ratio of 20 to 1 for any secondary resistance not absorbing more than 2 volts or 0·5 ampere. The phase difference between the primary and secondary currents at full load is less than $\frac{1}{12}$deg. The 5-ampere current transformer was supplied by a firm of the highest standing for use with one of their own wattmeters. The large phase difference found of 2·3deg. would seem to imply great error in use, yet on fully considering all the conditions of the instrument I find that the error in reading works out to be only 1·7 mm. on the scale, even when the full currents—*i.e.*, such as to produce full deflection on a non-inductive circuit—are flowing in the coils, and the power-factor of the load tested is the lowest for which the instrument is guaranteed—viz., 0·6. For smaller load currents this error is proportionately diminished, and it disappears altogether on high power-factor circuits.

Table II.

Apparatus tested.	Load.		Phase tested of	θ (degs.)	$10^6 \times (1-\cos\theta)$
	Amps.	P.F.			
Lead plates in weak acid	8·0	..	V, A	0·38	22·0
Platinoid wire spiral	7·0	..	,,	0·27	11·0
Direct-current arc	8·0	..	,,	0·17	4·5
0·1 unit Tr. at full voltage	..	..	V_1, V_2	0·34	17·0
1·0 unit Tr. for 50V_1 to 50V_2	..	..	,,	0·021	0·068
,, ,, ,,	21·0	1·0	,,	0·34	17·0
(All tests at 80 cycles and 70 volts)	7·0	0·09	,,	0·115	2·0
,, ,, ,,	23·0	0·09	,,	0·39	23·0
2·0 unit Tr. fully loaded	10·0	1·0	,,	1·04	1,650
3·0 unit Tr. for 100V_1 to 1000V_2	..	,,	,,	0·054	0·4
Two identical Tr. used to step up volts from V_1 to V_2 and down from V_2 to V_3; the value of θ found between V_1 and V_3 being halved. Normal full load 30A	10·0	,,	,,	1·85	..
	20·0	,,	,,	3·4	..
	30·0	,,	,,	4·7	..
	40·0	,,	,,	5·3	..
	50·0	,,	,,	5·8	..
	24·8	0·09	,,	1·08	1,770
	25·4	,,	,,	0·18	5·0
,, ,, ,,	27·0	,,	,,	1·00	1,540
,, ,, ,,	40·0	low	,,	4·3	..
,, ,, ,,	50·0	,,	,,	5·2	..
10A current Tr. for oscillograph	10·0	..	A_1, A_2	0·088	1·2
,, ,, ,,	7·0	..	,,	0·144	3·1
5A current Tr. as supplied commercially for wattmeter	5·7	..	,,	2·32	..

APPENDIX.

Note I.—*The Action of a Rotating Magnetic Field on a coil conveying an Alternating Current, and free to Rotate about the same axis as the Field.*

Assume the axis of rotation perpendicular to the plane of the paper and represented by O in Fig. 7. Let the rotating field be of constant strength F, and of uniform angular velocity p. Let its position be OF_0 initially, and be OF at time t, where $\theta = pt$ is the angle FOF_0. Let the plane of the coil be represented by OC inclined at an angle D to OF_0. Suppose the current in the coil follows the sine law, and that its value at any moment is $A_0 \sin(pt - \phi)$, where ϕ is the phase angle to be measured, then the torque tending to move the coil is at every instant proportional to $A_0 F \sin(pt-\phi)\cos(pt-D)$.

The mean value of this will be zero when $D=\phi$, or the angular deflection D of a pointer attached to the coil will directly measure the phase angle ϕ whatever the frequency of the current. If ϕ is greater than D the coil will move so as to increase D, and vice versa, the turning moment reversing sign with $D-\phi$. It will be readily seen that the turning moment is greatest when D and ϕ differ by 90deg., and that there is an unstable position of equilibrium when these quantities differ by 180deg.

The rotating field will tend to induce a current in the coil as in an induction motor, and there will in consequence be a tendency for it to rotate with the field. This can be made quite negligible by the use of resistances in series with the coil. The more inductive these resistances are the less will be the effect. If the current in the coil is produced, as it would be in practice, by a current transformer, a tendency of this kind would have no effect on the current through the coil, but only on the voltage absorbed by the primary.

If the current does not follow the sine law there will be no direct proportionality between the deflection D and the effective angle of lag of the current. If, however, the rotating field be uniform in strength and angular velocity, D will depend upon, and be a measure of, the time elapsing between the instant at which the field is directed along OF_0 and the instant at which the current passes through its zero value, but D must be measured from some zero position not necessarily coinciding with OF_0. The calibration of the instrument as a power-factor indicator will to a slight extent be dependent on the wave-form of the current. For if F is constant in magnitude and angular velocity, while the current A through the coil has some special wave-form, the torque on the coil is proportional to $A\cos(pt-D)$, and its average value will vanish for a particular relative position of the waves representing the current A and the sine function $\cos(pt-D)$, supposing these waves plotted to a time base. If the wave-form of A remains constant, but its phase (as represented by the instant of reversal) varies, the displacement of the wave A will be proportional to the time representing the phase, while the displacement of the wave $\cos(pt-D)$ will be proportional to D; hence for different phases of A the equilibrium value of D will be a direct measure of this time or phase.

If F is neither uniform in angular velocity nor constant in magnitude, the effect becomes more complicated. The torque is then measured by the average value of $AF\cos(\theta - D)$, where $F = F_0 + f$ and $\theta = pt + \delta$. F_0 is the average strength of the rotating field, and p the average value of its angular velocity. A, f, and δ are alternating periodic functions of the time. D is then no longer proportional to the time representing the phase of A, but is still solely determined by this time for given wave-forms of A, f, and δ.

Note II.—*Wattmeter Errors.*

If owing to self-induction in the pressure coil the current in it lags by an angle θ behind the voltage causing it, the wattmeter will read $VA\cos\theta\cos(\phi-\theta)$, instead of $VA\cos\phi$, where $\cos\phi$ is the power-factor of the load, and ϕ is positive for lagging currents, and negative for leading ones. The factor $\cos\theta$ can be considered unity for the small angles of θ at all likely to occur. Even if θ is 1deg., $\cos\theta = 0{\cdot}99985$. This factor is, moreover, independent of the phase of the load, and is therefore allowed for in the calibration of the instrument. Its variation with frequency is utterly negligible. We can regard the small angle θ as a small decrement of ϕ, so that if the true watts W are given by $W = VA\cos\phi$, we have for the error δW, $\delta W = -\theta dW/d\phi = \theta VA\sin\phi$, or $\delta W/W = \theta\tan\phi$, and $\delta W/VA = \theta\sin\phi$. In these equations, of course, θ must be in radians (1deg. $= 0{\cdot}01745$), so that $\theta\tan\phi$ represents the error in reading as compared with the true power in watts, while $\theta \sin \phi$ is the ratio the error in reading bears to the volt-amperes. These errors are worked out in Table I. for an angle of 1deg. For small angles the errors are proportional to θ. Whether these errors produce an appreciable effect on the instrument reading depends very much on the meaning in watts of the full deflection of the instrument. If this denotes VA numerically, the error as a reading may not be easily detected for lower power-factors, but if it denotes $VA \cos \phi$ or W, the error may be large.

The error increases with the phase-difference ϕ between volts and amperes. In the measurement of power on three-phase mains by the two-wattmeter method there is always a phase difference of 30deg. or more between the currents in the two coils of one of the instruments, and it seems natural to expect appreciable errors in the measurement when the mains carry lagging currents. But on examination it will be found that the error is not greater than would be the case on single-phase mains carrying currents of the same power-factor. For if the instruments are alike, the effect of a small lag θ in the pressure coils is the same as slightly diminishing ϕ. The two wattmeters read respectively:—$W_1 = AV \cos(30+\phi-\theta)$ and $W_2 = AV\cos(30-\phi-\theta)$, where V is the voltage between the mains and A is the line current, assuming balanced loads. So that the watts read are given by $W_1 + W_2 = 2AV \cos 30 \cos(\phi-\theta)$, and the true watts W are obtained from this by putting $\theta=0$. Hence as before, regarding θ as a small decrement of ϕ, we have, if δW is the error in the measurement, $\delta W/W = \theta \tan \phi$.

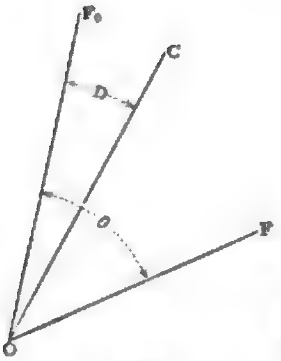


FIG. 7.

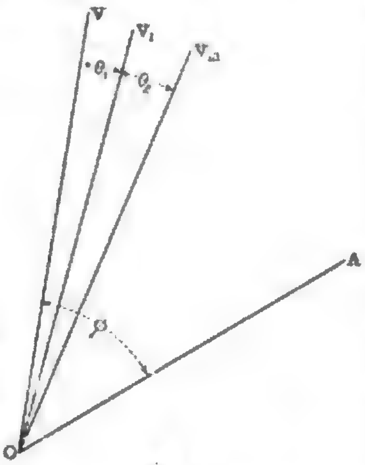


FIG. 8.

NOTE III.—*On Wattmeters having Iron-cored Electromagnets.*

Suppose an instrument such as is illustrated in Fig. 5 have its electromagnet excited by a coil of n_1 turns and resistance r by means of a current, A_m, produced by a voltage, V_1. Let N be the total flux through the coil, the induction density in every part of the air-gap being assumed proportional to N. We have

$$V_1 = rA + (n_1 dN/dt) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Let the load-current A be passed through the primary of an air-core transformer, the secondary of which is connected, through a considerable non-inductive resistance, R, with the moving coil of the instrument. Assume the current c produced in the secondary winding is insufficient to alter the magnetic effect of A. We then have

$$c = \frac{k}{R}\left(\frac{dA}{dt}\right). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where k is some constant.

The torque exerted on the moving coil for any given deflection will be proportional to $\int_0^T cN dt$ where T is the periodic time. This quantity is proportional to $\int_0^T N\frac{dA}{dt}dt$. But since N and A are periodic functions having the same period T, this integral is easily shown to be the same numerically as $\int_0^T A\frac{dN}{dt}dt$, whence by (1) it is proportional to $\int_0^T A(V_1 - rA_m)dt$.

Assuming that the vector representing the copper drop rA_m is negligible in comparison with that representing V_1, it will be seen that the deflection of the instrument is a measure of $\int_0^T AV_1 dt$, or of the watts, if V_1 is the voltage across the mains. This result will be true whatever the wave-form or frequency, whatever the nature of the iron forming the core of the electromagnet, and whatever the phase difference between V_1 and A, provided the copper drop is negligible, and the transformer current c varies as the rate of change of A.

Suppose the self-induced mangetic voltage is denoted by V_m, where $V_m = n_1 dN/dt$, and $V_1 = rA \dotplus V_m$, the deflection of the instrument measures the mean value of the product $V_m A$ in all cases.

Suppose the coil of the electromagnet, instead of being shunted directly to the mains, forms the load of the secondary of an instrument transformer, the primary of which is shunted across the mains at voltage V. The average product of VA then represents the watts to be measured, while the reading of the instrument is a measure of the mean value of $V_m A$.

If Fig. 8 represents the vector diagram of the voltages and currents considered, and if θ_1 and θ_2 represent respectively the phase differences between V_1 and V, and between V_1 and V_m, the error in the wattmeter mainly depends upon the values of these phase differences θ_1 and θ_2. For the ratio of the lengths of the vectors V_m and V is independent of ϕ, the phase of the load-current A in reference to V, and varies only inappreciably with frequency or for different values of V. If θ is the excess of the angle separating V from A, over the angle separating V_m from A, the error of the wattmeter follows the same law as that given in Note II., and we have for small values of θ: $\delta W/W = \theta \tan \phi$. The value of θ must be well within 1deg. if the wattmeter is to work satisfactorily on circuits of different power-factor. θ is the resultant phase error due to (1) the phase difference between V_1 and V_m, (2) the phase difference between the primary and secondary voltage of a pressure transformer if used with the magnetising coil, and (3) any difference between a right angle and the actual phase difference of the currents c and A.

It is to be noted that the inductive effect of the alternating field does not tend to turn the moving coil. The field flux N_1, enclosed by the latter, varies with the position of the coil, but, for a given position, is always proportional to the total flux N produced by the alternating electromagnet. The induced E.M.F. is proportional to the rate of change of N, so that with non-inductive resistances in series with the coil the current produced by this E.M.F. is proportional to, and in phase with, the rate of change of N. The field in which the coil is placed is measured by N, so that the torque on the coil due to this induced current is proportional to $N dN/dt$, the average value of which is zero for all periodic functions.

If it can be shown that the angle between V_1 and V_m introduced by the copper drop in the magnetising coil is no larger than the phase differences caused by the use of current and voltage transformers with wattmeters, it necessarily follows that the use of iron-cored electromagnets in wattmeters need introduce no greater error into the measurement of power than such transformers actually do in practice, while the greater sensitiveness and range of an instrument constructed in this way are obvious advantages.

PHYSICAL SOCIETY.

At a meeting of the Physical Society held November 25, 1904, at the Finsbury Technical College, Dr. R. T. Glazebrook, F.R.S., President, in the chair, a Paper on

"The Measurement of Small Differences of Phase"

was read by Dr. W. E. SUMPNER.

Hitherto, in order to measure the differences of phase between alternating-current quantities, it has been necessary to use some method involving the simultaneous reading of three deflectional instruments, such as the wattmeter method, or the three-voltmeter method either in its original or in some modified form. These methods cannot be successfully applied when the phase-differences to be determined are small. The author describes new voltmeter methods which may be used for the purpose, and gives the results of a number of measurements on alternating-current plant. Difficulties arising in the measurement of very small alternating-current voltages are overcome by rectifying the voltages so as to utilise sensitive direct-current instruments. The Paper gives the result of some tests on two transformers of 3kw. capacity intended to work between voltages of 100 and 1,000, and with currents of 100 cycles per second. One transformer was used to step-up the volts from V_1 to V_2, the other to step-down from V_2 to V_3. It was found that the phase-difference between V_1 and V_3 for a non-inductive load increases regularly with the current. For an inductive load there is a sharply-defined minimum at low power-factor. The author suggested that points on one side of the minimum corresponded to a lag, and points on the other side to a lead of the current on the voltage in the primary circuit.

Dr. A. HAY congratulated the author, and said that the determination of power-factors was a matter of importance. He had found that alternators tested with water resistances gave better results than when tested with lamps. The phase-differences between the volts and the amperes in the water resistances were generally greater than those indicated by Dr. Sumpner. He asked the author what current-density he used, and pointed out that the result would depend upon the current-density at the electrodes. A minimum phase-difference could be obtained by loading up the secondary of an ordinary transformer, and was due to an increase in the power-factor up to a certain point and then a decrease. We were dealing with lag in both cases.

Mr. A. CAMPBELL said that some years ago (Institution of Electrical Engineers, April, 1901) he published a description of the method of measuring a phase-difference, close to 180deg., between two independent voltages by the first method mentioned by Dr. Sumpner—viz., by shunting the larger by a high resistance, picking off from it a part as nearly as possible equal to the other, and measuring the difference resultant. A test on a small transformer gave a phase-difference of about (180–0·15deg.). Dr. Sumpner, however, has considerably improved the method; he ensures the sufficient equality of the components by adjusting until the resultant is a minimum—a simple and beautiful device. In his discussion of the three-voltmeter method Dr. Sumpner assumes that three instruments are necessary. Mr. Campbell has found that in many cases a single instrument with a quick change-over switch is quite sufficient, provided a number of readings are taken in rotation and averages obtained. With respect to Dr. Sumpner's method of measuring small alternating voltages by rectifying them, although it might give good results when the wave-form was known, he thought that in the very cases where such measurements were wanted the wave-form was not known. Small differences of "power" phase may be as much due to small difference in wave-form as to small displacements of similar waves; thus the "difference" resultant is probably nearly always of very uncertain wave-form.

Mr. T. H. BLAKESLEY expressed his interest in the Paper, and said that many years ago he had made use of commutation in order to work with direct-current instruments. He had used a high-resistance galvanometer, and found that not only the self-induction, but also the capacity, of the coils had to be eliminated.

Mr. W. DUDDELL supported Mr. Campbell in his contention that small differences of "power" phase might be due to small differences in wave-form. He had used water resistances in testing large alternators, but had never found any phase-difference between the voltage and the current. He had usually worked with high voltages, so that condenser effects due to polarisation (of the order of 1 volt) would have little effect.

Dr. C. V. DRYSDALE said he had given a good deal of attention to the measurement of small phase differences, and had found it advantageous to measure the sine of the phase-difference instead of the cosine. This could be accomplished by putting a condenser in series with the pressure circuit of a wattmeter so as to produce a phase displacement of nearly 90deg. In these circumstances he had previously shown that with ordinary conditions the watts were equal to the wattmeter reading plus a constant multiplied by the sine of the angle of phase-difference. When, as was usually the case, $\sin \theta$ was nearly equal to unity, it was only necessary to add a constant to the wattmeter reading.

Dr. W. E. SUMPNER, in reply to Prof. Hay, said he had worked with low current-densities, and was unable to say what would happen if the current-density was increased. With regard to rectification, he was aware of the effect of the shape of the wave. He had made experiments with currents of very different wave-forms, and in his opinion only about 20 per cent. of the observed results could be due to any alteration in the form of the wave. His methods were suggested as a means of getting an *approximate* value of very small phase-differences which could not be determined in other ways. The difficulties referred to by Mr. Blakesley were not encountered, as he had worked with a moving coil galvanometer of small capacity and self-induction. He was afraid that the observations of Dr. Drysdale raised questions which it would take too long to discuss at the present meeting.

PROPOSED ELECTRIFICATION OF RAILWAYS IN SOUTH AUSTRALIA.

The Government of South Australia recently invited a report from Mr. F. E. Bradford upon the suggested electrification of the suburban railways of Adelaide, comprising about 50 miles of single track. His report has now been published, and is interesting in that, after giving comparative estimates for direct-current working (with polyphase transmission) and for single-phase working, the latter method is recommended as being the most economical, both in initial cost and in running expenses, the writer stating that though the single-phase motor is a new development, yet it has given such promising results on trials, and differs so little from a standard tramway motor in construction, that there is little fear of its proving a failure in practical operation.

It is considered that the two main suburban lines—Adelaide to Glenelg, and Adelaide to Port Semaphore and Largo Bay, approximating 30 miles of single track—might be converted for single-phase electric working with satisfactory financial results. The cost of the conversion is estimated at £152,000, including all rolling stock, sub-stations and feeders, but exclusive of the power house equipment, this being separately given as £69,000 if for the railways alone, or £83,000 if sufficient to provide, in addition, the energy for the Adelaide tramways, 70 miles of single track, for whose electrification a Government bill is now before the local parliament.

On the basis of present traffic, it is estimated that electrical working would result in an annual saving of £15,000 upon the cost of present steam service. Of this, £6,100 would be absorbed by interest at 4 per cent. upon the cost of conversion, leaving a balance of £8,900, equal to 3·8 per cent. upon the total outlay on both conversion and power house, the interest charges on the latter being included in the cost of electricity debited to the working expenses. It is also pointed out that the more frequent and faster service proposed may be reasonably expected to stimulate traffic to a considerable extent, and that an increase of 10 per cent. in revenue would raise the net profit to £17,700, or 7½ per cent. upon the total cost. The electrification of a short length of line, Adelaide to Mitcham, is also advised, as although the estimated saving will only just pay interest on the cost of conversion, £18,000, yet its convenience as forming a junction between the two lines above mentioned would warrant the outlay. As to the other two suburban lines, the electrification of these, it is stated, would result in savings insufficient to pay interest on their cost; and, moreover, as the districts catered for by these lines are also served, in one case by a tramway likely to be electrified in the near future, and in the other case by one of the lines whose electrification is recommended, the increase of traffic on these two lines could not be very great. Their conversion is therefore ignored in the detailed estimates given for the working of the system.

The cost of the equipment of the two main suburban lines upon the direct-current system with polyphase transmission is given as £269,000, against £235,000 for the single-phase. In addition, working expenses are higher, owing to cost of sub-station attendance and enhanced upkeep of equipment, the saving upon present working expenses being estimated at £13,800, compared with £15,000 given above. This will pay interest at 4 per cent. on the cost of conversion and leave a surplus of £6,300, or 2·35 per cent. on the total outlay. It may be pointed out that the direct-current system is at a disadvantage in that both lines run for a short part of their length through public streets where a low speed is necessitated and where naturally the third-rail construction is inadmissible. The suggested direct-current scheme involves third-rail collection for the greater part, with overhead wires and trolley arm upon public roads, the smaller current requisite at the slow speed allowable here rendering a trolley wire supply feasible at 550 volts, even for motor cars rated at 600 H.P. Upon the single-phase system an overhead wire at 2,000 volts pressure would be used throughout.

The proposed power house would be at Port Adelaide, where condensing water can be obtained, and where sea-borne coal may be transferred to the bunkers without cartage. A steam turbine plant is suggested, and with an output of 10 million units—five million for the railways, and approximately the same for the trams—the total cost of generation including interest at 4 per cent. (but no sinking fund) is put at the abnormally low figure of 0·4d. per unit upon a load-factor of about 30 per cent. The pressure of generation would be 15,000 volts and transmission by means of overhead wires to the sub-stations where the current would be transformed to 2,000 volts alternating in the one case, or to 550/600-volts direct-current by rotary converters in the other.

A high average speed is proposed, about 23 miles per hour, entailing an acceleration of 2·2ft. per second and a maximum speed a little over 40 miles per hour. The multiple unit system of control would be used for ordinary traffic, each train consisting of two or three two-motor coaches and one trailer, while for holiday and special traffic it is recommended that four-motor coaches of 600 H.P. be used, each drawing four carriages of the standard steam service and running as expresses. For both direct and alternating systems details are given as to exact time of journeys, speed, current consumption, &c., the direct current showing slightly the better figures. A 20-minutes' service throughout the day is proposed, the present service in general being half-hourly on the Port line, and somewhat less frequent elsewhere. The equipment estimated for will, however, suffice for a steady 10-minutes' service, which may be necessary on holidays and other special occasions, one line serving the principal racecourse of the State.

Mr. F. E. Bradford is the leading engineer upon the staff of Messrs. Noyes Bros., the Australian agents for the Westinghouse Company, and his report naturally savours of their present-day practice. At the time of his nomination for investigating the matter considerable objection was raised on the ground that he was too closely identified with one particular firm's interests, and it was therefore made clear that this report would in no way commit the Government to Westinghouse plant or system, but was simply to act as a guide in determining whether the time were yet ripe for the matter of electrification to be taken up in a serious manner.

A Proposed Cornish University.—Owing to the distance which separates Cornwall and the great universities, it is proposed that the county should have a university of its own. The suggestion is being publicly supported by Mr. Quiller Couch.

THE CROMPTON-McINTOSH AUTOMATIC REVERSIBLE BOOSTER.

We have received from Messrs. Crompton & Co. some particulars of the Crompton-McIntosh automatic reversible booster, which the firm are building at their Chelmsford works.

The figure shows the arrangement of a tramway station where it is desired to make the 'bus bar volts rise and fall in proportion to the load. This is obtained by the equaliser bar and the series coil D, which are connected up as shown, so that the battery current as well as the generator current flows through the series winding of the generator. In most stations, however, it is desired to keep the voltage constant, say at 500 volts, and in this case the equaliser bar and the series coil D are omitted, and the motor and booster connections are prolonged to the 'bus bar as indicated by the chain-dotted lines. The following detailed description refers to the latter case: The motor, which is directly coupled to the booster, is shunt excited, and the field of the booster is excited by the coil C (in which a current flows proportional to the difference of generator volts and battery volts), and the differential winding A and B. When the battery volts are equal to the 'bus bar volts, there is no current in coil C, and it has no effect. When, however, the battery voltage is lower than the 'bus bar pressure, a current flows in coil C in one direction; and when the battery voltage is higher, in the other direction. So that for every volt the battery falls, the booster voltage rises by one volt, and *vice versâ*. In order that any considerable current may pass out of or into the battery, it is necessary to provide further excitation to compensate for the armature reaction. The differential coils A and B accomplish this: coil A carries the whole (or a definite adjusted proportion) of the feeder current; coil B is a shunt coil across the battery which opposes A.

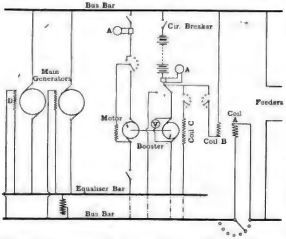


Diagram of Connections of Crompton-McIntosh Reversible Booster.

To take an example: Suppose the 'bus bar voltage is 500, and the mean load is 400 amperes, and that the generator is to supply this current continually. When the feeder current is 400 amperes, coil A will exactly oppose the effect of coil B, and the differential excitation will be nil.

1st case—Now suppose the feeder current rises to 900 amperes, 500 amperes are then required from the battery. Coil A will overpower coil B, and will produce a discharge voltage at the booster terminals just sufficient to compensate for the armature reaction of 500 amperes. A discharge current of that amount, and no more, will therefore flow from the battery. This will cause the battery to fall to, say, 450 volts. But the result of this is to make a current flow in coil C, whose excitation, in these circumstances, conduces to a rise of 50 volts at the booster terminals, so that the battery and the booster volts will be 450 + 50 = 500. As the discharge continues, the battery will fall still lower. But for every volt it falls coil C will add a volt to the booster.

2nd case—Suppose next that the feeder current drops from 900 amperes to 100 amperes: 300 amperes must therefore go from the generator into the battery. With a feeder current of 100, coil A will be only quarter as powerful as coil B, and the differential excitation will be in the opposite direction from what it was in the first case. It will, in fact, be just strong enough to compensate for the armature reaction of a *charging* current of 300 amperes. The battery voltage will quickly go up from, say, 400 to, say, 510. Coil C will reverse its effect, and will give the booster a voltage of – 40. The battery volts + booster volts will therefore again be 500 volts.

When it is desired to run the station on the battery alone, without the assistance of a generator, coil B is cut out. This coil may be varied in strength by a rheostat, according to the size or number of the generators which are running. The operation of switching the battery and booster on to the line is as follows: The three-way switch is put on the middle stud, and the battery circuit-breaker closed. The battery will probably stand at quite a different voltage from the 'bus bars; the booster (which is on open circuit) is then run up and the coils A and B are cut out, coil C being left in. The booster will then be found to give a voltage exactly equal to the difference between the battery and the bars, and the three-way switch may therefore be thrown on to the booster stud, completing the battery circuit without a spark. Finally, coils A and B are put in, and the operation is complete.

A STREET LIGHTING PHOTOMETER.

With the various improvements which have recently been made in gas burners for street lighting it is daily becoming of more importance to be able to determine the relative merits of gas and electricity as an illuminant for streets and open spaces. The Everett-Edgcumbe street photometer, which we illustrate herewith, consists of a neat wooden box, with carrying handle, containing a portable 4-volt accumulator, standard lamp, voltmeter and adjustable photometer. In designing this apparatus, use has been made of the principle first suggested by Mr. A. P. Trotter—viz., balancing the illumination to be measured against that derived from a standard electric lamp, varied according to a well defined law by means of a hinged screen. Various details have been worked out in accordance with the suggestions of Mr. H. T. Harrison, who has carried out a great number of tests on street lamps.

The Everett-Edgcumbe Street Lighting Photometer.

Experience has shown that an extremely reliable standard of light is obtained by means of a 4-volt lamp worked off a small accumulator, the condition of which is at once seen by means of the small voltmeter. The instrument is provided with two scales, and has a total range of from 0·001 to 2 "candle-feet." Besides measurements of illumination, the actual candle power of street lamps in any required direction can also be readily determined by means of this apparatus. It can be used either standing on the ground or on a tripod, as preferred.

THE DOULTON WATER SOFTENER.

Messrs. Doulton & Co., of Lambeth, S.E., have sent us a description of their patent water softener, which is designed for heating with either exhaust or live steam. We give a drawing (Fig. 1) showing the general arrangement of this apparatus. Water enters through the regulating valve M and the ball valve B into the wheel box A, where its force is utilised to drive the motor D actuating the shafting and gearing E and the stirrer at the bottom of the re-agent tank C. This tank, which holds a day's supply of solution, is filled each morning from the stop-cock H, and the softening materials are mixed in it. The water from the wheel box A is delivered into the mixing tank O simultaneously with solution from the tank C. The mixture goes down the pipe R to the bottom of the settling tank P, which is traversed by the exhaust steam pipe K. All the materials are deposited in this tank, and the softened water passes through the standpipes SS contained in the steam compartment X and rises through the filter bed to the outlet. The tanks C and P are provided with sludge cocks J and T for cleaning purposes. When heating with exhaust steam the large pipe K at the bottom of the settling tank should be replaced by two or more similar pipes of smaller size if preferred. When the heating is by live steam only, on the other hand, the pipe K and the steam chamber X are condensers, and a steam jet is introduced into the pipe R. The second illustration (Fig. 2) shows the details of the mixing apparatus with its automatic cut-off. The hard water enters through the pipe M to the regulating box G and passes out through the shoot in front of the latter, in its passage raising the float W and consequently opening the re-agent valve L to an amount proportional to the quantity of water passing through the box G. The re-agent is supplied through the pipe U and the tank Y and the regulator N to L. Thus a definite quantity of re-agent is supplied to a definite quantity of water, the re-agent falling into the mouth shoot Q. The water and re-agent are mixed together by being whirled round the standing outlet V, and the water, mixed with the re-agent, is led by the pipe R to the bottom of the settling tank as already explained. Should the supply of hard water cease the box G will be emptied, thus allowing the float W to drop and close the re-agent valve L. The supply valve above the motors, seen in Fig. 1, is also actuated by a float, in this case placed in the settling tank. These softeners are now in use at the City-road and Wandsworth stations of the County of London Electric Supply Co., at the Erith station of the West Kent Electricity Supply Co., the Avonbank and Temple Back stations at Bristol, the Bath Corporation electricity works, the works of the Hove Electric Lighting Co., and is to be installed at the St. Andrews works of the Electric Supply Corporation. The outputs of the softeners at the Temple Back and Avonbank stations at Bristol are 8,000 and 5,000 gallons per hour respectively.

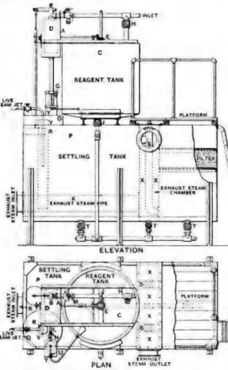


FIG. 1.—PLAN AND ELEVATION OF DOULTON'S WATER SOFTENER FOR HEATING WITH EXHAUST OR LIVE STEAM.

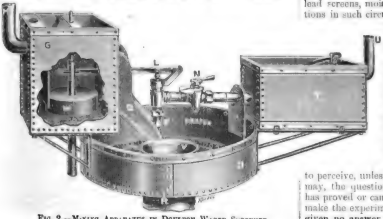


FIG. 2.—MIXING APPARATUS IN DOULTON WATER SOFTENER.

CORRESPONDENCE.

THE BLONDLOT N-RAYS ONCE MORE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is a matter of relief to find that many French physicists are coming round to the opinion that the alleged N-rays are really due to some psychological disturbance, and not to any external or objective cause.

It is desirable, however, that Mons. Blondlot, bearing in mind the many difficulties and troubles which other workers have experienced in the endeavour to repeat his experiments, should give an answer, a clear and definite answer, to a single and a simple question. He has told us repeatedly that most people cannot see the effects which he has described; and no doubt it is well known that the extreme violet-rays, for instance, are visible only to a few specially endowed and gifted individuals. There are, as we know, people who can see into the ultra-violet. Has Mons. Blondlot been able to prove to the satisfaction of others who have not been sufficiently influenced by what may possibly be, and Mons. Blondlott himself will not deny the possibility, an enthusiastic atmosphere which his experiments, his personality, and strong convictions have created all around him, that he can see these phenomena himself? That is the one point, as it seems to me, that ought to be decided and answered in one way or the other. Has he, in other words, been able to see the effects which he has described, when those who have visited his laboratory—assuming that they were competent judges—were allowed to manipulate his lead screens, moist-paper screens, &c., and were his observations in such circumstances consistent and in accordance with the results which he had otherwise obtained when he or his colleagues were the ones who made the tests?

Mons. Blondlot has told us that some English scientists have been in his laboratory, but that they could see nothing, and he attaches little importance to this fact, because as he supposed their vision was not sensitive enough to detect the variations in intensity of his phosphorescent screens, variations which, as he has told us, in some cases amount to 50 per cent. of the original luminosity, and which it is not too much to hope, Celts and Teutons alike should be able to perceive, unless they are partially blind. But be that as it may, the question really is whether Mons. Blondlot himself has proved or can prove that he sees these effects when others make the experiment? That is the question to which he has given no answer, although it is undoubtedly the point upon which, as I take it, the whole difficulty rests, and upon which evidence of the objective or external reality of the effect or effects depends. I have seen one of his photographic plates which shows two different intensities most distinctly, but the record I fear does not prove the required result, because, as has been repeatedly pointed out, the method of alternate exposures with a screen does not eliminate the personal equation, nor the power of suggestion on the one hand, whilst on the other, the presence of a metallic screen close to a very small spark would be sufficient to alter its brightness by the accompanying increase of capacity, if the screens be sufficiently close to the spark. Lastly, the fact that nobody has been able, so far as I am aware, to obtain a satisfactory photographic record—and I, too, I may add, have tried persistently to get the effect, though with negative results—shows that if one could get some independent confirmation of the eye observations, which Mons. Blondlot himself asserts to be the most sensitive test, we should at any rate then feel we had something to go upon and at last reached the solid ground of facts. But until this is done it seems idle to discuss the matter at much greater length.—Yours, &c.,

Cavendish Laboratory, Dec. 2. JOHN BUTLER BURKE.

MAINS CHARGING DEVICE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I think the article on "Electric Power Distribution in South Wales," contained in the current issue of your journal, will lead to a wrong impression as to the action of the mains charging apparatus installed by Ferranti Limited at the Treforest Power House. The metal spiral mentioned as constituting the non-inductive resistance which is inserted in series with the cable to be charged is made of copper. Its resistance is negligible, and its function is to conduct the current from the terminal to the iron electrode which dips into the water. The non-inductive resistance is formed by the columns of water themselves. The dimensions of the tubes have been so chosen that when filled with ordinary water the resistance is sufficiently great to ensure a satisfactory action of the apparatus on any ordinary length of cable.

I would also demur to the statement that the principle of the thing is the same as that introduced by Mr. Partridge and put into practice by him at Willesden and elsewhere. Mr. Partridge's apparatus is something quite different. The simple non-inductive cable charging resistance was first introduced by Ferranti Limited.—Yours, &c.

Manchester, Dec. 2. CHARLES C. GARRARD.

LEGAL INTELLIGENCE.

Tramways Purchase.

In the Court of Appeal (the Master of the Rolls and Lords Justices Stirling and Mathew) on Saturday judgement was delivered in this action. The facts of the case were set out in our last issue.

The MASTER OF THE ROLLS, in giving judgment, said the question for decision arose under Section 43 of the Tramways Act, 1870, and was whether the purchasing authority was liable to take over and purchase a depot situated geographically outside the purchasing authority's district. Sir F. Bramwell, in the special case stated by him, had in a very elaborate manner described exactly the physical conditions of this depot and the purposes for which it was used, and he then formulated certain conclusions with respect to it. In order to bring the depot within the section the company had to show that it was suitable to and used by them for their undertaking within such district. The purchasing authority contended that, having regard to the situation of the depot and of the company's user of it, it could not be held as a matter of law to be suitable to and used for their undertaking. There had been considerable controversy as to whether or not the matter was raised before the arbitrator as a question of law. The company alleged that the question was dealt with by him purely as one of fact, and that, that being so, he having found as a fact that the depot was suitable to and used with the undertaking, that finding was conclusive and binding upon the parties. It seemed to his lordship that the arbitrator, having so minutely set out all the circumstances surrounding the case, treated the question as one of law, and it was open to the Court to now deal with the case on that footing. It was important to notice that in order to get to the depot in question from the Council's district it was necessary to first pass over the main line of the Salford Corporation tramways, and then over a spur line, the depot itself being within the district of Salford Corporation. The Council said that the Company were not in a position to pass to them the right to use either the Salford Corporation's main line or the spur line, and, therefore, as they could not sell that which would enable the depot to be used, the depot was not suitable to and used by them for the undertaking within the meaning of the section. Whether or not the company could pass the right to use the Salford main line was a question upon which he would express no opinion, but it was perfectly clear that whatever rights they possessed with regard to that line those rights did not extend to the spur line. That being so, the depot clearly could not be said to be suitable to the undertaking within the meaning of the section. The company, in his opinion, had failed to show conclusively that there was an obligation on the District Council to pay £24,000 in respect of that depot, and the appeal must be allowed.

The Lords Justices concurred.

Underground Electric Railway Co. of London (Ltd.) and the Commissioners of Inland Revenue.

On Tuesday this case came before the Court of Appeal (the Master of the Rolls and Lords Justices Stirling and Mathew) on the appeal of the commissioners from a judgment of Mr. Justice Channell in favour of the company. The matter was raised in the form of a special case, and the question in issue was as to the amount of stamp duty payable by the company under the agreement by which it acquired control of the Brompton & Piccadilly Circus, the Charing Cross, Euston & Hampstead, the Great Northern & Strand and the Baker Street & Waterloo Railways. The facts of the case were given in our issue of April 22 (p. 29).

At the conclusion of the arguments their lordships reversed the decision of Mr. Justice Channell, and entered judgment for the Crown for the amount claimed.

Mr. ROSKILL, K.C., for the company, asked for a stay of execution with a view to an appeal to the House of Lords.

A stay of execution was granted for one month.

J. Bakewell & Co. (Ltd.).

Mr. Justice Warrington on Tuesday heard a summons asking for the removal of Mr. Joseph Bakewell (who was stated to be the promoter and managing director of the company, and, with his family, the largest shareholder) from the position of liquidator.

After reading the affidavits filed, his lordship, in giving judgment, referred to a report which had been made by an accountant, and said that, to say the least, it was an unfavourable report, and it mentioned matters which required inquiry. The connection of Mr. Bakewell and his family with the company gave rise to a serious consideration as to whether he was a proper person to continue the liquidation. It was not satisfactory that when matters were brought before the liquidator which demanded investigation he should meet them by expressing his willingness that the court should inquire into them. There ought to be a liquidator who was not in such a position that, in order to do his duty, he must come to the court and ask what that duty was. He would grant the application, appointing Mr. Stanley as liquidator.

Milne v. London County Council.

At Westminster (London) County Court on Wednesday plaintiff sought to recover £50 damages for personal injuries through falling from one of the Council's electric cars. Plaintiff stated that she entered an electric car at Camberwell to go to Blackfriars. At Pocock-street two passengers, in the absence of the conductor, who was on the top of the car, rang the bell. The car stopped and they alighted, and witness followed them. When about to step off, the conductor blew his whistle and the car started, and plaintiff was thrown to the ground, sustaining injuries.

Some remarkably contradictory evidence was given, and his Honour said the London County Council were to be congratulated "on the extremely intelligent men they employed on their tramway service."

The jury found for plaintiff, and judgment was entered for £50 and costs.

Irwin v. Dublin United Tramways Co.

At Dublin on Monday, before the Lord Chief Justice and a special jury, plaintiff (Mr. John Irwin, chairman of the Dublin Electric Lighting committee) sought to recover £500 damages for injuries sustained through the alleged negligence of defendants, whereby the horse attached to the vehicle on which plaintiff was driving slipped and fell and plaintiff was violently thrown. Defendants denied negligence or that it was by their negligence that the road became slippery.

Mr. IRWIN said on Feb. 10 he was driving on a vehicle to Westland-row. His driver, a careful man, noticed the setts in the road were glistening. Just as he thought that, the horse came down. As a result of the accident he was unable to attend to his business for three or four weeks, and after that only partially for some time. In cross-examination he said the state of the streets was not as bad as it was on the tram tracks.

The driver of the car also gave evidence. He said the road was very greasy. He said, in answer to a question from the Judge as to his condition on the day of the fall, that he was driving the Lighting committee on that day, and the members were not fond of giving any drink.

After the evidence, his LORDSHIP said he would leave the case to the jury, and the jury found that the accident resulted from the dangerous and unsafe condition of the roadway between the tram rails, and awarded plaintiff £5 damages.

Hampshire v. Bradford Corporation.

At Leeds Assizes on Monday, before Mr. Justice Darling and a jury, plaintiff sought to recover compensation for personal injuries from defendants. Plaintiff was an outside passenger on a tramcar between Manningham and Saltaire. In the course of the journey the cars pass from the Bradford to the Mid-Yorkshire system. The trolley wires in the latter instance being 2ft. higher than on the Bradford system, the trolley pole fell and struck the plaintiff.

After hearing the evidence the jury returned a verdict for £150.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Elland District Council require a working electrical engineer for combined refuse destructor and electric lighting station. Further information from the clerk and solicitor (Mr. James Clarkson), to whom applications by Dec. 17. See also an advertisement.

Belfast Tramways and Electricity committee require an electrical distributing assistant. Salary £200 per annum. Applications to the city electrical engineer (Mr. Victor A. H. McCowen) by Dec. 15. See advertisement.

Walthamstow District Council require an electrical engineer and tramways manager to take charge of their electric lighting and light railway undertakings, salary £400 per annum; also a traffic superindent, salary £200 per annum. Applications to clerk and solicitor (Mr. C. Sidney Watson) by noon Dec. 10.

Worcester Corporation require an electrical engineer. Salary £400, rising to £500 per annum. Applications by 19th inst.

Horsham Council require an assistant engineer. Applications by noon Dec. 13.

A car works superintendent is required for Belfast City tramways. Salary £300. Applications by noon 16th inst.

An assistant, with factory experience, is wanted in the electrical engineering department of the City and Guilds Central Technical College, Exhibition-road, London, S.W. Salary £150. See Advertisement.

Mr. A. J. Beckett, electrical clerk of works at Bridlington, has been appointed borough electrical engineer at £220 per annum, rising by annual increments to £250. Mr. Beckett was formerly assistant electrical engineer at York. It was also decided to appoint an assistant engineer at £100 per annum.

Mr. P. J. Swinney, Burton-on-Trent, has been appointed junior assistant at Hanley electricity works at £100 per annum.

Mr. H. Newcomb, of the South London Electric Supply Corpn., has been appointed shift engineer at Fulham.

Acton.—The Council have accepted the offer of the Metropolitan Electric Supply Co. to advance £25,000 at 3¾ per cent., repayable in 25 years, for electricity supply. At the next meeting the taking up of the balance of the loan required (£29,091) will be considered. Sanction has also been asked for borrowing £10,000 for wiring premises and the supply of electric fittings, &c.

Argentina.—The "Review of the River Plate" states that the Commercial Judge has ordered the Compañia Alemana Transatlantica de Electricidad to pay Buenos Ayres Municipal Council $25,362·57 (gold), being the amount of the arrears of the Council's claim of 5 per cent. tax upon the gross receipts of the company for energy supplied to tramway companies. The company urged, without avail, that they were not liable to pay the tax, as they did not make use of the subsoil, but supplied current to the tramway companies through meters at the power house.

Buenos Ayres Public Works Department recommend that fresh tenders be invited for an electric tramway between Plaza Mayo and Villa Urquiza, Ortuza and Devoto.

Australasia.—The "Australian Mining Standard" states that the North Perth (W. Australia) Municipal Council have consented to the extension of the Perth Electric Tramways (Ltd.) into the Council's area. A portion of the extension has to be completed in two years and the whole in four years.

A bill has been introduced into the Legislative Assembly to give local authorities powers relating to the licensing of cars and drivers, and to permit promoters to agree with local authorities for paying a percentage of receipts in lieu of rates.

The Victorian Government have introduced a bill into the Legislative Assembly to authorise them to construct an electric street railway from St. Kilda (S. Melbourne) to Brighton Beach. The cost of the scheme, including rolling stock, is estimated at £71,372. 5s.

New South Wales Government railway department have decided to adopt the Stone system of train lighting. The introduction of electric fans is also contemplated.

Sydney Electric Lighting committee recommend the City Council to undertake further extensions of the electricity undertaking, and to promote a bill authorising the borrowing of not more than £250,000. The city electrical engineer (Mr. T. Rooke) has presented a report in which he disapproves of the apparent disposition of the Council to confine extensions to the city proper, and advocates the extension of the mains in the immediate future wherever there is a demand for both public and private lighting, as it is desirable to lay mains for both purposes at the same time.

Newtown Council recently approached Sydney Council with a view to the electric lighting of Newtown by the city electricity department, but, the matter having been left in abeyance, an offer has now been submitted by a local syndicate to establish electricity supply and refuse destructor works. At the outset 100 arc and 400 incandescent lamps (aggregating 154,450 c.p.) would be employed for street lighting, superseding the existing 462 incandescent gas lamps, which give only 11,550 c.p. illumination. The street lighting and refuse destruction would be carried out for £2,400 per annum, the estimated capital cost being £24,000, and the promoters stipulate for permission to erect overhead wires for private lighting and power supply, and consent to keep their charges equal to those of Sydney Corporation, the period of the concession to be 10 years, at the expiration of which time the Council would have the right to purchase or renew for a further 10 years. The offer has been referred to a committee.

Ashton-under-Lyne.—The Corporation and the Oldham, Ashton & Hyde Electric Tramway Co. (Ltd.) have renewed the agreement by which the Corporation supply the whole of the energy for working the tramway for 14 years, commencing next July. The company already use over 800,000 units per annum, and we learn that they have recently expressed their entire satisfaction with the supply given by the Corporation during the past six years.

Barking.—The construction of the Council's tramway (authorised by their 1902 provisional order) to link up the East Ham and Ilford Councils' systems is now proceeding. The new bridge over the Roding and the widening of another bridge over Loxford Water have been completed. A bridge has yet to be constructed over the railway at Barking, and until this is done the cars will stop at each end of the level crossing and passengers will transfer.

Bermondsey (London).—The electrical engineer (Mr. W. H. Vincent) submitted a report to the Council on Tuesday respecting the breakdown at the generating station on Oct. 30. Mr. Vincent reported that at 12:15 p.m., when No. 1 balancer starting switch was being open-circuited, on shutting down the balancer, an arc started on breaking the field, causing a short-circuit across the outers of the switch, fusing the switch parts. From the manner in which the switch is fused it would seem that the material which insulates the current-carrying parts from the constructional parts had in some manner become defective, thus diminishing the resistance to leakage from one pole to the other, causing a heavy flow of current to pass momentarily between. Simultaneously the automatic switch of No. 1 dynamo, which was running at the time, opened, but on putting the machine again into circuit two coils of the armature were found to have broken down. This was due to the strain thrown on the armature at the moment of the fusing of the balancer switch.

The committee of the whole Council reported, expressing dissatisfaction at the circumstances under which, although the original contract for supplying and laying cables through the Surrey and Commercial Docks was only £670. 0s. 10d., the actual cost had been £2,644. 8s. 6d.

Birmingham.—On Wednesday the City Council unanimously decided to proceed with their bill for the construction of additional tramways, &c.

Bournemouth.—On Tuesday the Council rejected a motion to run the tramcars on Sundays. It has also been decided not to light the main thoroughfares by electric light on Sundays, as it is alleged that this would entail additional Sunday labour at the Corporation generating station. The streets are, however, to be "illuminated" with gas on those days.

Bradford Technical College.—The distribution of diplomas and prizes was made by Prof. S. P. Thompson last week.

After stating that he was convinced the College was working on right lines, Prof. Thompson delivered an address on "Technical Education." The phrase, he said, whatever it meant in general, meant something different in every trade. He contrasted, for instance, the degree of knowledge and training necessary to a sheet-metal worker against the employee in a chemical factory. Technical education, in a word, was the study of processes of trades in the light of the scientific principles which underlay them, and also of the allied sciences which could be applied to them. In the competition of the world tariffs had absolutely nothing to do; it was brains which must tell. Train the brain, then, to do its thought. The curse of the universities was that they trained men without respect to the future application of their knowledge. He also advised the study of political economy, and dwelt on the need of greater flexibility to enable English manufacturers to change with the changing times. The lecturer instanced the practice of German and American manufacturers breaking up obsolete machinery. In this respect he advised the marking down of the value of machinery and tools at once. As an illustration he quoted the balance-sheets of two allied German firms. The first, a lamp works, contained the items: Site £23,000, buildings £48,000, work in hand £12,000, raw material £12,500, tools and machines £1. The same firm's machine works' balance-sheet showed: Site £160,000, buildings £191,000, work in hand £120,000, raw material £110,000, machines 1s., tools 1s. He concluded with a plea for an all-round education, which should include literature, music, the refinements of life, bodily exercises and good games.

Bridlington.—Last week the Council decided to take up a loan of £26,481 for 25 years at 4 per cent. per annum for electricity supply.

Bury.—On Thursday last a system of parcels delivery in connection with the Corporation electric tramways was inaugurated.

Chelsea (London).—A report is to be obtained from an electrical engineer (at a fee of 15 guineas) as to whether it would be more economical to put down independent generating plant or to take current from Chelsea Electricity Supply Co. for lighting the proposed public baths.

Cheltenham.—At a meeting of the Council on Monday the Lighting committee presented a report containing a series of resolutions passed for their future guidance.

The new chairman (Mr. Ley Wood), in moving the adoption of this report, said it was the intention to follow loyally the recommendations of Mr. James Swinburne, who recently reported on the electricity undertaking, except in regard to the establishment of a depreciation fund.

Ald. Norman, the former chairman of the committee, commented on the fact that Mr. Swinburne had heard the case for the opponents of the electricity undertaking, but had omitted to give either the old committee or the engineer an opportunity of explaining matters, with the result that he had described as "reckless" extensions of mains five of the six instances in which the revenue from them was 50 per cent. upon their outlay. He believed the electricity undertaking would be remunerative in the future.

Devonport.—An inquiry was held last week into the application of the Corporation for sanction to borrow £7,958 for extensions of the electricity works. Technical details were given by the borough electrical engineer, Mr. J. W. Spark.

Dudley.—On Tuesday a long discussion arose on the recommendation of the Tramway and Lighting committee to apply for a loan of £21,000 to cover excess expenditure on the electricity undertaking and to provide additional generating plant, to extend the mains, &c.

In reply to criticisms of the scheme, the chairman of the Committee (Ald. DUNN) said that about £8,000 had already been spent in providing machinery previously agreed to by the Council. The price of 1d. per unit to the local tramway company had been fixed by the Board of Trade, and as the consumption by the company kept the machinery at the power station constantly employed the transaction proved to be the most profitable part of the undertaking.

Mr. H. W. HUGHES said the gross profit last year was equivalent to 8·05 per cent. on the capital outlay, and with the exception of Exeter, Huddersfield, Leeds and one or two other places, that was the best return in the country. When the present arrangement ran out the Board of Trade would consent to an increase in the charge to the tramway company. Their machinery was overloaded. The report was adopted, and a resolution in favour of applying for sanction to the loan was agreed to.

Dumbarton.—It was reported at the County Council meeting last week that negotiations were still proceeding with the Caledonian Water-Power Electricity Co. as to their scheme for generating electricity at Loch Sloy.

Eccles.—Sanction to a loan of £550 for street arc lighting has been obtained by the Council.

Edinburgh.—It was decided at the Council meeting on Tuesday to extent the electricity mains to the Chancelot estate.

The chairman of the Electric Lighting committee (Mr. Stevenson) explained that it was proposed to extend their feeders to the Leith boundary, and that electricity should be supplied by Leith Corporation, who would pay to Edinburgh ¼d. per unit for the use of the mains and services. The result would be that in the first year they would practically pay their way, and in the second year would have a slight profit. The price would be charged at the Leith rate, which was ½d per unit more than the Edinburgh rate.

It has been decided to apply for a further loan of £90,000 for electricity extensions, Mr. Stevenson explaining that the capital was necessary to enable the department to keep pace with the ever-increasing demand for electrical energy, and the success of the undertaking amply warranted it. They had power to borrow £860,000, and their total capital expenditure to May 15 last was £845,336. Their estimated capital expenditure for the current year was £60,820, making the total £906,156, or £46,156 in excess of the amount for which consent to borrow had been obtained. The additional loan would be sufficient to carry them on for probably the next two years, and brought the amount sanctioned up to £950,000. For the past year they had an increase of over 1,000 consumers, upwards of 100,000 8-c.p. lamps had been added, and the output had increased by 1,500,000 units, the largest increases since the undertaking was begun. There had also been effected a further reduction in cost of production, which now stood at 0·89d. per unit, the lowest record of any municipal undertaking of the kind in the kingdom.

Edmonton.—The District Council held another special meeting on Friday to further consider the offers received from the North Metropolitan Electric Power Supply Co., Foote & Milne, the Industrial Engineering Co., and the National Electric Construction Co.:—

To a motion that the offer of the first mentioned company be accepted, an amendment was proposed in favour of the National Construction Company. The amendment was defeated by 11 votes to 10. A further amendment, that the Council should themselves take steps to supply the compulsory area, was under discussion when the meeting stood adjourned.

Electric Power and Lighting at Clydebank Docks—The Works committee of the Clyde Navigation Trust recommends the trustees to erect their own generating plant for the supply of electrical energy for the Clydebank docks, the proposal to take power from the Clyde Valley Electric Power Co. being considered undesirable.

Electricity in Mining.—At the meeting of the Mysore Reefs & General Exploration Co. last week the chairman (Mr. J. Harvey, J.P.) stated that the site chosen for their power house was close to the sea. The electrical machinery would also generate power to be transmitted to the mine to operate the winding engine and air compressor, which had been arranged to work about 10 rock drills.

Electricity in Smelting Works.—In the report of the Cape Copper Co. it is stated that smelting operations at Briton Ferry have proceeded satisfactorily during the past year. Improvements in the electric power plant have been effected with good results; and still further economies will be made when the alterations now in hand are completed.

Electricity in Steel Works.—Pease's Tubular Construction Synd., Darlington, have obtained a contract for the construction of a large electric power station at Bell Bros' steel works, Middlesbrough, which will be entirely composed of patent steel frame plates and galvanised sheets on a foundation of concrete. The power plant, which will, it is stated, be one of the largest in any of the industrial establishments in the kingdom, will comprise three high-speed direct-coupled engines and generators and a combined horizontal engine and dynamo, giving 1,250 I.H.P. In addition to supplying power to Bell Bros.' works, the plant will also supply energy to the adjoining Clarence steel works of Dorman, Long & Co., who have a working arrangement with Bell Bros. in the matter.

Electro-Harmonic Society.—The next smoking concert will be given this (Friday) evening in the King's Hall of the Holborn Restaurant, with Mr. F. H. Nalder in the chair. A new regulation regarding the reserving of chairs at these concerts has been adopted, as follows:—"Chairs may only be reserved up to 10 minutes to eight, after which time any vacant chairs may be occupied."

Erdington.—The Board of Trade have deferred the question of the revocation of the Council's electric lighting order, 1900, for 12 months.

Felixstowe.—The Council, who recently acquired the local electricity works, are threatened with an application for an injunction restraining them from committing an alleged nuisance.

Fulham (London).—On the recommendation of the Lighting committee the Council decided on Wednesday to replace street gas lamps with Nernst lamps at an estimated cost of £70.

Glasgow.—On Wednesday the Tramways committee resolved to recommend that the salary of the new manager of the tramways (Mr. James Dalrymple) be fixed at £850, rising to £1,000 per annum.

The manager (Mr. Dalrymple) has been authorised by the Tramways committee to proceed at once with the construction of the tramway extension from Pollokshaws East to Giffnock.

The first annual dinner of the members of Glasgow Corporation electricity department took place on Wednesday evening.

The Lord Provost (Sir John Ure Primrose) was in the chair. Covers were set for 220. The toast of "The Corporation" was proposed by Mr. H. A. Mavor, and the Lord Provost replied. Mr. W. C. Martin, who proposed the toast of "The Electricity Committee," said that at the end of the first year there were 108 consumers, and last year there were 9,321. The capital expenditure in 1893 was £97,000, and 10 years later it had reached £1,000,000. Councillor Willock responded.

Gloucester.—Last week the City Council resolved to apply for sanction to a further loan of £15,000 for extensions of the electricity undertaking.

Hales Owen.—The District Council have applied for an extension of 12 months for constructing the tramways authorised by their provisional orders of 1901 and 1902. The Council have entered into an arrangement with the Empire Electric Light & Power Co. for a lease of their powers to the company.

Hanley.—It was reported at the Council meeting on Tuesday that the borough electrical engineer (Mr. C. A. Cowell) had tendered his resignation, to take effect at the expiration of three months.

Application has been made to the Local Government Board for an order for the creation and issue of £11,151 Hanley Corporation 3 per cent. redeemable stock for electric lighting.

Hastings.—By 21 votes to 10 the Council have decided not to permit the overhead system on the proposed tramways on the sea front.

Important Railway Agreement.—The Great Western Railway Co. is seeking parliamentary authority to construct a new line from Acton to Shepherd's Bush. In view of the electrification of the Metropolitan Railway, the Great Western Co. wish to provide themselves with an alternative route for their City passengers, and therefore they propose to acquire a site for a large new terminal station immediately adjacent to the Central London Co.'s terminus at Shepherd's Bush, and to construct a connecting link, about 4 miles long, which will enable a through service to be run, not only from all stations on their main line between Acton and Reading, but also from their new Acton and Northolt branch, which connects with the Great Central system. The new scheme will bring Acton, Ealing and the whole of the western suburbs into closer touch with the central parts of the metropolis and the City, and it will also provide all London with a new route to the riverside and other resorts on the Great Western system. It is considered that such an increased traffic would be obtained from the new connection that the Central London Co. feel that the capacity of their line would be unduly taxed thereby, and they have accordingly renewed their proposal for converting the present line into a circle (by the construction of about 7 miles of additional line to embrace Liverpool-street, Cannon-street, Ludgate-hill, the Strand, Charing Cross, Piccadilly and Hammersmith. This scheme would give the Great Western traffic the alternative of finding its way into Central London by travelling in either direction on the circular tube and it would also enable a more frequent service to be given on the Central London line, as the delays incidental to reversing trains at "dead-end" termini would be altogether removed. It is also proposed to construct a new line to Walthamstow and Leyton, under the title of the North-East London Railway, thus completing the chain of communication between the extreme eastern and the extreme western suburbs. These three proposals will be presented as parts of a comprehensive scheme for improving the communications of the Metropolis.

Irvine.—The Council on Tuesday rejected (by eight votes to seven) a motion that a plebiscite of the ratepayers be taken on the question of electric lighting for the town, upon which the Council had already decided by a large majority.

Kilmarnock.—The formal opening of the new electricity station at River Bank of the electric lighting and tramway works of Kilmarnock Corporation takes place to-morrow (Saturday). The opening ceremony will be performed by Lord Howard de Walden.

Leeds.—On Wednesday the Corporation decided to proceed with their application for a provisional order authorising the construction of two additional tramway routes.

Leigh (Lancs.)—For the position of borough electrical engineer at a commencing salary of £250 (increasing by annual increments of £20 to a maximum of £350) there were 147 applicants, and out of this number the Electricity committee have selected the following short list, from whom the appointment will be made:—Mr. W. Ainscough (Leeds), Mr. H. C. Caldwell (Altrincham), Mr. D. A. Hamilton (Lancaster), Mr. D. S. Hornby (Bolton) and Mr. A. T. Smith (Bury).

Leith.—At the Council meeting on Tuesday the consulting engineer for the tramways (Mr. More) submitted an estimate of the cost of reconstruction of the tramway system.

The estimated total cost is £115,945. The details are: Overhead work and feeders, £74,487; 37 cars, one sprinkler car and one light tower waggon, £22,870; car depot, £10,000; contingencies and engineering, £8,588. From the total of £115,945 is deducted the estimated amount (£14,445) to be derived from the sale of old iron, horses, cars, &c.

Littlehampton.—The Council have declined to entertain Mr. L. Alwyn's proposals for the erection of electricity works.

London County Council.—At Tuesday's meeting it was agreed to loan £1,255 to Battersea for street lighting by electricity.

It was agreed to enter into an arrangement with the Southwark Council for supply of current at a flat rate of 4d. per unit for the higher grade school at Mina road, Walworth.

Standardisation of Tramway Rolling Stock.—The Highways committee reported that in view of the great extent of the Council's electrical tramways undertaking it is desirable that the various parts and details of the rolling stock and plant be standardised, and that before further orders for materials were given, standard samples and patterns should be prepared of all the various parts. By possessing its own patterns the Council would be enabled to have castings supplied direct from the makers' foundries and finished in its own workshops. The committee estimated the cost of preparing such drawings, patterns, &c., would be about £350.—Agreed.

Switchboards at Sub-stations.—Sanction was given to a further expenditure of £620 for the supply by the British Westinghouse Co. of high and low-tension and exciter switchboards for Elephant and Castle, New Cross and Camberwell sub-stations of the Council's tramways.

Tramways.—The Highways committee reported that the purchase of the undertaking of the London, Deptford & Greenwich Tramways Co. had involved an expenditure of about £1,000 in excess of the estimate (£95,900).

Lighting Kingsway.—This fine thoroughfare is to be lighted, for its Holborn section, by gas, the L.C.C. having accepted an offer of the Holborn Council to supply gas columns free, gratis and for nothing.

London Power Bills.—At Shoreditch Council meeting on Tuesday it was reported by the Lighting committee that Shoreditch and other metropolitan boroughs had been scheduled by a number of electric power supply companies as part of the area in which they were seeking authority to supply electrical energy in bulk.

The committee advised that these schemes should have the serious consideration of all Borough Councils and that, if possible, joint action should be taken to protect the interests of Municipal Electricity Supply Undertakings.

It was decided to call a conference of the Metropolitan Councils and the London County Council to consider the steps to be taken.

Marylebone.—Mr. Councillor E. R. Debenham has been re-elected chairman of the Electric Supply committee.

The Finance committee, in their report presented to the Council last evening, recommended that sanction be asked from London County Council to permit the first instalment of principal for the repayment of the £483,800 borrowed for electricity supply purposes to be made at the expiration of three years from date of borrowing.

The report of the Electric Supply committee presented last evening called attention to the fact that several companies, including the Metropolitan Electric Supply Co., had given statutory notice by advertisement of their intention to apply for Parliamentary powers to supply electricity in various parts of the metropolis, including the borough of St. Marylebone, and it was recommended that the Council take all necessary steps to oppose all bills presented to Parliament seeking power to supply electric current within the borough.

Marriage.—On Dec. 1, at the parish church, Barnes, London, Mr. Edwin L. Pope, distribution engineer to the L.C.C. tramways, was married to Florence Ada, second daughter of Mr. C. H. Owles, Scarth House, Barnes Common. The beautiful presents included those from the head office and the sub-station staffs.

Metropolitan Electric Tramways.—The Cricklewood-Edgware electric tramways have been opened for traffic.

Middlesborough.—On Wednesday Councillor C. Dorman was re-elected chairman of the Electric Lighting committee for the ensuing year.

The borough electrical engineer (Mr. H. M. Taylor) reported that during November 91,000 units were sold, compared with 66,000 for the corresponding period of last year. The income was £1,258 and the expenses £457, against £919 and £368. The cost per unit was 1·2d., compared with 1·32d. last year.

Municipal Telephony.—Bournemouth Corporation decided on Wednesday not to proceed with their proposed application for a municipal telephone licence.

Musselburgh.—The official inspection of the electric tramways takes place to day (Friday).

Natal Imports.—The value of electrical fittings imported into Natal for the first nine months of 1904 was £25,000, compared with £61,000 for the same period of 1903.

New Cable Steamer.—A new cable steamer was launched from the Low Walker Yard of Messrs. Swan, Hunter and Wigham Richardson, on the 22nd ult. The vessel is built to the order of the Telegraph Construction & Maintenance Co., for whom the same firm constructed the "Colonia." The new vessel has been christened the "Cambria" and is nearly 300ft. in length by 37ft. beam. Her engines are of the twin-screw triple expansion type and are designed to drive the vessel at a speed of 12 knots, and is designed for three large tanks. At the launch Mr. F. R. Lucas represented the owners, the christening ceremony being performed by Mrs. Lucas. There were also present Capt. Cato, Mr. C. Slater and Mr. George Scott, N.A. (designer of the vessel).

New Zealand.—Christchurch City Council started the supply of electricity in Aug. 1903, and serves a population of 42,000 over an area of 1 sq. mile. There are 125 consumers on the mains. A 4-cell refuse destructor plant forms a part of this municipal undertaking.

Christchurch Municipal Tramway Board will commence working the service of tramways, 35 miles in extent, built to a 4ft 8½in. gauge, in April next, the contractors for the electrical equipment of the line being the Electric Construction Co. The service will start with 27 motor-cars and 12 trailers

Water power to the extent of 5,000k.w. is likely to be taken from the Waimakarira Gorge, a project being at present under the consideration of Christchurch municipality. The proposed site for the power house is situate 32 miles from Christchurch.

Paddington (London).—A letter has been received by the Council from the Central Electric Supply Co. notifying that as the Council are not prepared to consent to the granting of a provisional order for the borough the company will not proceed further in the matter.

Parcels Traffic on Tramways.—During the past year about 250,000 parcels were carried on the Bradford Corporation Tramways, which at a uniform charge of 1d. per parcel yielded a gross annual income of over £1,000.

Hitherto no special facilities have been given for dealing with the traffic, but the Tramways committee have now drawn up a very comprehensive scheme for the approval of the City Council. Under this scheme, which will come into force on Jan. 1, not only will tramcars be used for the collection and delivery of the parcels, but it has been decided to purchase three De Dion chassis, which will be fitted with capacious vans. These will accommodate the parcels traffic within a radius of half a mile from the Town Hall, and parcels coming in on the cars from the out-districts for the city will be promptly delivered, and those collected in the city by the motor vans will be transferred. Outside the half-mile area the cars only will be used. There will be central offices and storerooms and 48 sub-offices in various parts of the city. The work of distribution from the sub-offices will be performed by boys, and for their use wicker trucks are to be provided fitted with locks. The Corporation will accept full responsibility for the parcels, subject to certain conditions as to proper packing, and insurance of articles of special value. The boys will collect as well as deliver, their operations extending to half a mile from any tram route. The cars will be met by special messengers, who will convey the parcels to the central depot for immediate delivery. In lieu of the present uniform charge of 1d per parcel, a graduated scale is being prepared fixing the charge according to the weight of the package, large customers being favoured with reduced rates. Arrangements are also being made for the interchange of parcels with tramways in towns and villages having direct connection with Bradford, and it is intended to extend the Bradford operations to Calverley, Bingley and Pudsey.

Express messengers will be also available for the delivery of medicine and other urgent packages at special charges.

The above is but a brief outline of a project which is likely to have wide ramifications.

Patent Amendment.—Notice is given that Mr. Edwin James Preston, director of J. Stone, Son & Co. (Ltd.), engineers, Deptford, seeks leave to amend specification of Letters Patent No. 23,265 of 1898, for "improvements in glow lamps and holders." Particulars of the proposed amendment are given in the "Illustrated Official Journal (Patents)" of Dec. 7, and notice of opposition must be given within one calendar month from that date.

Personal.—Mr. J. Cecil Bull, secretary of the City of London Electric Lighting Co., has been elected a vice president of the Chartered Institute of Secretaries.

Portsmouth.—After considering a report from the tramways manager (Mr. W. B. Spaven), the Tramways committee have decided against the introduction of half-penny fares.

Reading.—At the last meeting of the Town Council an elaborate report on the wages, hours, and conditions of employment of the motormen and conductors on the municipal electric tramways was presented by the engineer and manager (Mr. W. Binns).

The report, which was approved by the Tramways committee, and which recommended that no alteration be made in the terms and conditions of service of the employés, was adopted by the Council. It was also decided not to introduce transfer tickets on the tramway system.

South Africa.—The "British and South African Export Gazette" states that a third destructor plant is being erected for Johannesburg City Council.

Steam from the two already installed is being supplied for the generation of electric energy.

Pretoria Council have got their public works bill through the Legislative Council, which empowers them to raise £1,000,000, including £115,000 for acquiring the electric lighting company's undertaking, which is to be considerably extended.

It has been arranged to construct a broad road from the centre of Boksburg (on the West Rand) to the head offices of the East Rand Proprietary Mines, and the thoroughfare, the company's offices and also various streets in Boksburg are to be lighted electrically.

It is stated that as a result of the refusal of the ratepayers to sanction the expenditure of £100,000 on an extension of the Cape Town electric lighting system only the contracts already begun will be completed. It is thought that this partial suspension of operations will only be temporary.

Amongst the projects recently submitted to the Intercolonial Council was an important scheme for converting the Transvaal railway between Springs and Randfontein to electric traction.

It is stated that Mafeking Council are considering an offer by Harris, Lee & Co. for a concession for electricity supply, the Council to have the right to acquire the undertaking after seven years at valuation plus 15 per cent. It is proposed to charge 1s. 9d. per unit for current for private lighting.

Mr. C. F. Parr has given notice of intention to apply for Parliamentary authority to incorporate a company to construct an electric tramway outside the Durban municipal area and extending from the Umgeni River to a junction with the Corporation lines, and thence to Prospect Hill. Powers are also sought to light electrically the route of the proposed line and an area covering a mile on each side.

Messrs. Gibson Bros. are importing the material required for the equipment of their Kimberley-Beaconsfield tramway on the overhead system. The De Beers Co., who supply current for lighting Beaconsfield, will also supply energy for working the tramways.

East London Municipal Council have decided to extend their tramways at a cost of £4,575 and to spend £3,000 upon the electric lighting of the Quigney and Arcadia districts.

Krugersdorp (Transvaal) Municipality have under consideration electric tramway, electric lighting and water supply schemes estimated to cost £200,000.

It is stated that the Cape Colony Government electrician (Mr. J. Denham) takes exception to some features of the Port Elizabeth municipal electric lighting scheme.

Messrs. Johnson & Phillips have recently installed at the Rezende gold mine, Rhodesia, a pump direct-driven by a 20 B.H.P., two-phase motor at 220 volts. The capacity of the pump is 150,000 gallons per hour, with a head of 400ft.

Durban Corporation have decided to purchase 300 further subscribers' telephone sets, bringing the total number authorised up to 1,000.

The De Beers Co., Kimberley, are purchasing a Westinghouse turbo-generator.

Stepney (London).—On Wednesday the Council decided to offer no objection to the draft regulations of the Home Office with regard to the distribution and use of electricity at factories and other places where the normal working pressure is greater than 250 and less than 650 volts.

Stourbridge.—The Local Government Board have expressed the opinion that the Midland Electric Corpn. for Power Distribution does not possess the necessary powers to supply electricity in bulk to the Council and consequently has refused to sanction a loan for an electricity supply scheme based on an agreement by the Council to take electricity in bulk from the company.

Sunderland.—On Friday Ald. Bruce was re-elected chairman of the Electricity and Lighting committee.

Swansea.—The Tramways committee on Wednesday referred to a sub-committee a claim by the local gas company for £1,772 for work on gas mains said to have been necessitated by the construction of the tramways.

Switzerland.—MM. K. Muller, A. Techan and G. Holliger, of Soleure, have been granted a concession by the Swiss authorities for the construction and working of an electrical funicular railway from Oberdorf to the top of the Weissenstein. The estimated cost of the line is about £28,000.

Tottenham.—At the meeting of the Council on Tuesday it was reported to the Electricity committee that only two tenders had been received in response to the advertisement for offers to undertake the supply of electricity in the district, and the Council were recommended to accept one of the two alternative proposals from the North Metropolitan Electric Power Supply Co. Before, however, entering into an agreement with the company it was deemed advisable to take independent expert opinion. A proposal to refer the matter back for this purpose was approved.

Tramways in West Africa.—A tramway was to have been constructed by the French Colonial authorities at Dahomey, from Adjara to Sakélé (along the Lagos frontier), and a sum of £4,000 was set aside in the Budget of 1904 for this project, with which, however, little progress has so far been made, the engineers being still busily employed preparing the road and filling up the swamp at Adjara.

Another tramway (from Whydah to Lake Ahémé), which was a short time ago under consideration, has been abandoned, as eventually the railway will be continued to the point where the tramway was to have run.

Underground Telegraph Cables.—At the meeting of the Newcastle-on-Tyne Chamber of Commerce on Wednesday a letter was read from the Postmaster-General, which stated that

At present there was an underground telegraph cable from London to Warrington, while between Warrington and Carlisle the drawing in of the cable was approaching completion. There were also underground wires between Manchester and Leeds. The work was very expensive, and the Postmaster-General feared that he might not be able to do more in the next financial year than utilise the pipes now being laid between Carlisle and Glasgow. In deciding on future extensions, Newcastle would be considered among other centres, but the cable to Carlisle, when completed, would strengthen the whole telegraph system in the North.

Wandsworth (London).—Complaints having been made of the insufficient lighting of roads in Tooting, lighted by electricity from the dust destructor, the Council resolved on Wednesday that, pending the consideration of the general question of lighting, the lamp standards in the roads be fitted with Nernst lamps.

Wanstead.—The Council have decided to oppose all applications for electricity supply powers for the district.

Water Power in India.—The acting Viceroy (Lord Ampthill), speaking at a banquet given in his honour on the occasion of his visit to Kashmir, hoped for railway communication with India at an early date, and also that the enormous water power of Kashmir would shortly be utilised in the generation of electrical energy.

Water Power in Italy.—The Chambers of Commerce of the Provinces of Udine and Aquila (Italy) are about to prepare an estimate of the water-power in these two provinces available for industrial purposes. The Florence Chamber of Commerce are moving in the same direction, and have asked the Minister of Public Works to delegate a functionary to specially prepare this data.

Wigan.—The electric tramway between Wigan and Ince Bar has been opened for traffic.

Willesden.—Messrs. Tudor & Jenks have made complaint to the Council that preferential, and, consequently, illegal charges have been made for electric current. The Works committee are satisfied that no such preference has been given and that the scale of charges has been adhered to; 51 accounts, it is allowed, have been amended for proper reasons.

The Electricity committee have been asked by the Council to consider the advisability of adopting the scale of charging now employed in Wimbledon for electric current (4½d., 4d. and 3½d.), on the ground that the present Willesden rates were unattractive to small consumers.

Worcester.—At a special meeting of the Electricity committee recently the city electrical engineer (Mr. C. J. Satherland) tendered his resignation, owing to ill-health. The resignation was accepted with regret and expressions of sympathy. The committee reported on Monday that they had placed Mr. Birrell in charge of the department for the time being, and asked the Corporation to advertise for a successor to Mr. Satherland at £400 per annum, rising by annual increments of £20 to £500. The committee asked for power to make the appointment, but this the Council declined to grant.

Works Lighting.—The London India Rubber Works are to be lighted electrically, and Mr. Frederic H. Taylor has been retained as consulting engineer by the owners, J. G. Ingram & Son.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Directors of the *Great Western Railway Co.* invite tenders for the supply and delivery of the following material required in connection with the electrical equipment of the Hammersmith and City Railway, &c.: Steel conductor rails, cast-iron and steel ramps and fastenings; porcelain insulating supports and their fastenings for conductor rails; copper bonds, insulated cable connections, cable terminals, bonding presses and accessories for connecting up connector rails. Specifications, &c., after to-morrow (Saturday), except between 23rd and 27th inst. inclusive, at the offices of the consulting engineers (Messrs. Kennedy & Jenkin), 17, Victoria-street, London, S.W. Tenders to the Secretary, Great Western Railway, Paddington Station, W., until Tuesday, Jan. 3. See also an advertisement elsewhere.

Bradford Corporation invite tenders for miscellanous stores required by their tramways department during year ending Dec. 31, 1905, including electrical accessories, paints, varnishes, &c., asbestos and insulating materials, armature repairing material, lamp fittings, castings, springs, overhead equipment, cables and wire, hand tools, pinion wheels, transfers, trolley poles and accessories, ironmongery, coal, &c. Forms of tender at the Tramway Offices, 15, Bridge-street, Bradford, and samples may be inspected at Thornbury car depot. Tenders to the town clerk (Mr. Fredk. Stevens) by Dec. 17. See also an advertisement.

Cardiff Corporation invite tenders for the following plant for the extension of their power station on the extra high-tension three-phase system—viz., two 1,600 H.P. slow speed vertical engines, two 1,100kw. three-phase alternators, four Lancashire boilers, with accessories, steam and other piping, switchboard gallery and staircase, extensions to central service gangway, extra high-tension three-phase feeder cables. Specifications, &c., from the borough electrical engineer and manager (Mr. Arthur Ellis), Central Offices, The Hayes, Cardiff. Tenders to the town clerk (Mr. J. L. Wheatley) by Dec. 19. See also an advertisement.

Rochdale Corporation invite tenders for the supply, delivery and erection of high-tension three-phase switch gear and extensions to low-tension continuous-current switchboards. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Sillar & Leigh), 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester, but can be obtained at the former office only. Tenders to the town clerk (Mr. W. H. Hickson), Town Hall, Rochdale, by 27th inst. See also an advertisement.

Southend-on-Sea Corporation invite tenders for additional plant for their generating station, comprising two boilers, one steam dynamo, one fuel economiser, and two electrical feed pumps. Specifications, &c., from the borough electrical engineer (Mr. W. E. J. Heenan). Tenders to the town clerk (Mr. Wm. H. Snow) by Dec. 21. See advertisement.

Fulham (London) Council invite tenders for supply and erection at their generating station, Townmead-road, of a 3,000-volt steam alternator of 1,000kw. capacity coupled to Belliss engine. Specifications, &c., from the borough electrical and consulting engineer (Mr. A. J. Fuller) and tenders to the town clerk (Mr. R. M. Prescott) by noon 20th inst. See an advertisement elsewhere.

Stoke-upon-Trent Guardians invite tenders for the electric lighting of a portion of their workhouse premises. Specifications, &c., from the clerk, Mr. C. Daniel, Union Offices, Stoke-upon-Trent, where tenders are to be sent by Dec. 14. See also advertisement.

The *Manchester Ship Canal Co.* require tenders by 10 a.m. of 22nd inst. for switchboards, mains, feeders, arc lamps, &c., required at the new dock works, Salford. Forms of tender, &c., from Mr. W. H. Hunter, 41, Spring-gardens, Manchester.

Middlesbrough Electricity committee invite tenders by noon Dec. 17 for pipe work and valves.

Edinburgh City Council invite tenders for electric lighting installation at the branch free library, Morningside-road. Tenders to Dr. H. Morrison, Free Library, Edinburgh, by Dec. 14.

Swindon Corporation invite tenders by Dec. 20 for 300kw. (or, alternatively, a 400kw.) steam dynamo.

Tenders are wanted by 9 a.m. of 10th inst. for extensions of the electric light wiring at *Pontefract* new workhouse buildings.

Ilford District Council invite tenders until 19th inst. for telephone fire alarms on the double or metallic principle.

Birkenhead Tramways committee want tenders by 5 p.m. 13th inst. for supply of stores for 12 months.

Leeds Tramways committee require tenders for supply of straight and curved section steel girder rails.

Dublin Cleansing committee invite tenders till noon 20th inst. for refuse destructors, with furnaces, boilers, &c.

The town of *Villanueva y Geltru* (Spain) invites tenders for public lighting on a 10 years' concession. 24 500 c.p. arcs and 240 20 c.p. incandescents will be employed. Power will be granted to the concessionaire to supply current to private consumers without payment of a municipal tax, subject to certain conditions of free supply to the municipal buildings. Tenders will be adjudicated on Dec. 24 at the Casa Consistorial, Villanueva.

Tenders were recently invited for the electric lighting of *Almendralejo* (Spain), but without result. Certain modifications have been made in the conditions of contract, and tenders are again invited up to Dec. 22, to be sent to the Casa Consistorial, Almendralejo.

Tenders are invited for the public lighting of the city of *Valladolid* (Spain), the concession being for a term of seven years. 1,500 17 c.p. incandescents are to be employed. Adjudication of the tenders takes place at 11 a.m., Dec. 26, at the Casa Consistorial, Valladolid.

TENDERS RECEIVED AND ACCEPTED.

Messrs. J. G. White & Co. have secured two important tramway contracts: one for the reconstruction for electric traction of the whole horse tramway system at Belfast, at an inclusive price of £543,404. This work is to be completed within nine months. The second contract is for the reconstruction of the Monte Video tramways at about £450,000.

Queensland Public Works Department (Brisbane) have received the following tenders for three lifts, including two electric passenger lifts for the new Lands and Survey offices:—

Standard Elec. Elevator Co.	£3,800	Sydney Hyd. & Gen. Eng. Co.	£1,867
Waygood Elevator Co.	2,670	Brisbane Electrical Co.	1,875
Brush Co	2,435	Rolley & Padgett	1,775

On Wednesday Liverpool Corporation accepted the tender of the British Westinghouse Co. for two steam turbo-alternators, at £8,035 each; of E. Green & Son, for a fuel economiser, at £657; of Babcock & Wilcox, for four boilers, stokers and superheaters, at £7,200; and of the Wheeler Condensing Co., for condensing plant, at £13,400.

Erith Education committee have accepted the tender of F. A. Glover & Co. at £38 for wiring the pupil teachers' centre. Fourteen tenders were submitted, with alternative figures for wood casing and steel troughing, the lowest for wood casing being £38 and the highest £130. For steel tubing the figures were £43 and £160.

We are informed that the Midland Railway Co. have placed the contract for supply of incandescent lamps for the year ended Dec. 31, 1905, with Cryselco Limited. This company have also received, we are informed, large contracts from the Post Office Telegraph Department and from the Admiralty.

Over 70 tenders were received by the Wolstanton and Burslem Guardians for electric lighting plant, and the following have been accepted:—

Stirling Boiler Co., boilers	£550	0	0
McClure & Whitfield, engines and dynamos	764	7	0
Electric & Ordnance Accessories Co., switchboard	183	19	8
E. M. Evans, wiring	644	5	8
Pfluger Accumulator Works, accumulators	207	2	6
Crompton & Co., arc lamps	148	0	0

The contract for a large storage battery and complete booster equipment has been placed with the Tudor Storage Battery Export Synd., Milton House, Surrey-street, London, W.C., by Durban (South Africa) Corporation. The battery will operate in conjunction with a tramway generating plant, and will consist of 250 cells of a capacity of 770 ampere-hours for one hour. The booster is of the Lancashire Dynamo & Motor Co.'s manufacture.

Hammersmith (London) Guardians have accepted the tender of Scott Anderson & Co., Sheffield, for the wiring, fittings, &c., required for the new workhouse and infirmary buildings at £6,700, and that of Frank Suter & Co. for transforming plant at £2,061. 12s. 6d.

We refer elsewhere to a contract obtained by Pease's Tubular Construction Synd., of Darlington, for the construction of a large power station at Middlesbrough in connection with the extensive steel works in the town.

Durban Municipality have placed orders with W. T. Henley's Telegraph Works for 1 mile of H.T. and with the British Insulated & Helsby Cables (Ltd.) for 5 miles of L.T. cable.

An order has been placed by Johannesburg Corporation with the British Insulated & Helsby Cables (Ltd.) for house-service fuse boxes, meter boards, &c.

We are informed that Messrs. Strong & Moor have secured the contract for the track work of the first section of the Johannesburg municipal tramways. Messrs. Mordey & Dawbarn are the consulting engineers for the scheme.

The Hart Accumulator Co. has received an order for 110 standard lighting type cells to replace an existing battery at Southwold electricity works.

Melbourne (Australia) City Council have accepted the tender of the Austral Otis Eng. Co. for 600,000 plain and 80,000 flame Conradty carbons.

Aberdeen Gas and Electric Lighting committee have accepted the tender of G. & J. Weir for feed-pumps.

Dundee Corporation have accepted the tender of the British Insulated & Helsby Cables (Ltd.) for laying insulated cables in place of the present copper strip feeder mains.

Fulham (London) Guardians have placed an order with Thompson, Ritchie & Co. for an operation table standard with swinging arm for the new operating room, motor transformer, &c., for £49. 12s.

Earsdon Council have accepted the tender of the Northern Counties Electricity Supply Co. for providing and erecting arc lamps, &c., for street lighting at £339. 16s. 3d.

Reading Corporation have accepted the tender of Griffiths & Millington, of Birmingham, for the right of advertising on the tramcars for seven years at £949. 10s., or £26. 7s. 6d. per car per annum.

Messrs. Robson, Robson & Co., Newcastle-on-Tyne, have obtained the contract for the electric lighting of Olympia, Liverpool.

BUSINESS NOTICES.

Owing to Mr. Alfred H. Gibbings having completed his engagement with the Stalybridge, Hyde, Mossley & Dukinfield Tramways & Electricity Board, all communications of a personal nature should, after Dec. 17, be addressed to him at "Lynton," Wellington-road North, Stockport.

Messrs. E. Gaudy and R. H. Dewbery, electrical and general engineers, trading as the Premier Engineering Co. at 71, Parliament-street, Nottingham, have dissolved partnership.

Mr. C. W. Charles notifies us that on Oct. 31 last he was appointed secretary to the London Section of the Electrical Contractors' Association, and all the business of this section will now be transacted at 84 and 85, High Holborn, London, W.C., where all communications should be addressed.

BANKRUPTCIES, LIQUIDATIONS, &c.

At the London Bankruptcy Court on Monday an inquiry was held into the promotion and failure of the Automatic Telephone Co. (1903) (Ltd.), against which a winding-up order was made last March, upon the petition of shareholders.

The statement showed liabilities £1,175, assets £4,185, with a deficiency of £10,051 as regards shareholders.

The late managing director (Max Margowski), in the course of his examination, said that certain plant and machinery were purchased and sent down to premises at Greenwich belonging to his wife, but bearing the name of Margo & Co. The Official Receiver said they had had Margowski, David Benny & Co., and now Margo & Co. Had debtor any more aliases? To which debtor replied that Margo was not very far out. On Oct. 28, 1903, a resolution was passed to purchase (for £950) Mrs. Margowski's share in an improved portable electric fan. The purchase consideration had taken the shape of a mortgage given over the company's machinery, and an action in connection therewith was now pending. The electric fan patent had nothing to do with the automatic telephone patents. The witness was questioned regarding cheques he had received from the company and payments made by him on its behalf, and admitted that he had paid certain cheques into his private banking account, and that his pass-book had been lost in the course of his banking proceedings.

The creditors of Albert Smith, electrical engineer (trading as the Electric Motor Supply Co., 54, Hounds Gate), Nottingham, met on Nov. 30. Gross liabilities £807. 17s. 6d., unsecured debts £744. 18s. 10d., assets £264. 4s. 8d. Debtor attributes his failure to family embarrassments, loss on contracts, &c. Claims against the debtor must be sent by 22nd inst. to Mr. T. Gourlay, 4, Castle-place, Nottingham.

At the O.R.'s, Crypt chambers, Eastgate-row, Chester, first and final dividends are payable at the rate of 2s. 7d. in the failure of Parkes & Sadleir, electrical engineers, The Dingle, Colwyn Bay, and at the rate of 20s. in the separate estate of F. W. Parkes.

In the failure of Harry Cooke, electrical engineer, Buccleuch-road, Normacot, Longton (formerly of Lindhurst-road, Sneinton), the first meeting of creditors and public examination will take place on 19th inst. at the Town Hall, Stoke-on-Trent.

W. C. Bersey, Dacre House, Arundel-street, W.C. (formerly of 34, Queen-street, Cheapside, E.C.), London, has been adjudicated bankrupt.

A final dividend of 3s. will be payable on 12th inst. at 24, Coleman-street, London, E.C., in the liquidation of Harry South & Co. (Ltd.), 10 and 12, Garrick-street, London, W.C.

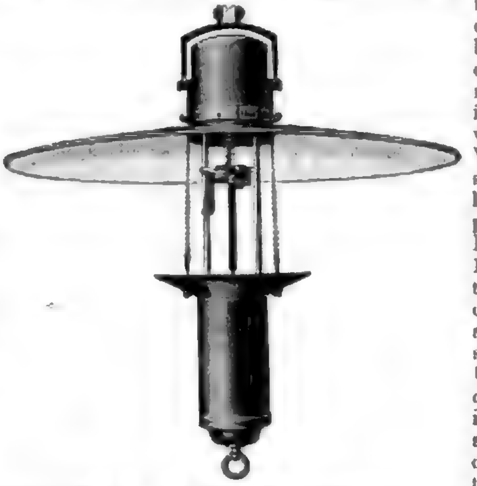
A meeting of the Sheffield Electric Advertisements (Ltd.) will be held on Jan. 15 at 4, York-street, Sheffield, to receive an account of the winding up.

The Cross Electric Engineering & Mfg. Co. (Ltd.) is being wound up voluntarily.

Plant for Sale.—In consequence of the opening of the new borough electricity works, Bridlington Corporation have for sale some electric lighting plant, including a 42 B.H.P. Crossley gas engine, a Thomson-Houston series arc lighting dynamo, 20 Thompson-Rice arc lamps, some B.I.W. cable, &c. Further particulars from the electrical engineer (Mr. J. Lomas). Tenders to the town clerk (Mr. A. E. Matthewman) by 5 p.m. 21st inst. See an advertisement elsewhere.

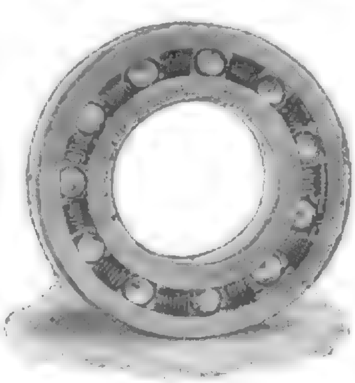
Business for Sale.—Messrs. William Rock & Son, 25, Lord-street, Liverpool, have for sale a small electrical manufacturing business. See advertisement.

Plant Wanted.—An advertiser desires to purchase at once one second-hand or new combined engine and dynamo (or each separate), 300kw. to 500kw. and 500 to 550 volts, direct current; or two smaller engines. See advertisement.



K. & M. Inverted Arc Lamp with Plain Reflector.

"Scotsman" Printing Works Lighting.—In our description last week of the installation of the electrical plant and accessories in the "Scotsman" offices, Edinburgh, we referred to the excellent result of the lighting by K. & M. inverted arc lamps. We omitted to state that these lamps were supplied by the Union Electric Co., of 151, Queen Victoria-street, London, E.C., who are sole representatives for the U.K. and Colonies, of Messrs. Körting and Mathieson, the makers of the lamps. The type of lamp employed in the "Scotsman" offices is shown in the accompanying illustration, and is similar to those in use in many large printing establishments in this country.



Lahmeyer Co.'s Ball Bearing.

Ball Bearings.—In a new type of small motor for continuous-current single-phase, and two-phase and three-phase currents, the Lahmeyer Electrical Co., 109-111, New Oxford-street, London, W.C., have introduced ball bearings of the latest improved pattern. It is claimed that by the introduction of these bearings oil consumption and frictional losses on electric motors have been greatly decreased. A good example of the setting of these ball bearings is shown in the accompanying illustration. It is urged in favour of these bearings that the losses due to friction are considerably reduced, and amount to no more than ½ per cent. of the output of the machine. Little attention is required to be given to these bearings, and any replacement that may be necessary can be effected more easily and quickly than in the case of oil bearings. It will be seen that, instead of filling the whole space between the inner and outer rings with balls, the Lahmeyer Co. have provided the bearing with a smaller number of balls, the space between being fitted with springs, so that if, in consequence of a bend of the shaft, there is a tendency of the outer ring to get out of truth with the inner ring the variation in the speed of the balls is counterbalanced by the action of the springs. The inside of the spring is filled with felt, which forms a rotating lubricating machine.

"Who's Who."—If any doubt existed as to the rapid closing of the year of grace, 1904, the receipt of many annual publications which see the light in the closing days of the year would serve as a reminder. Few of these publications, or groups of publications, receive a heartier welcome than "Who's Who," which issues from the press of Messrs. Adam & Charles Black, of Soho-square, London, W. This bright red, and usually well-read, volume has increased in bulk since its last appearance, and bears evidence of having undergone careful revision. It is published at 7s. 6d. nett, and is the cheapest of the yearly biographical volumes.

The same publishers issue in separate form the "Who's Who Year Book," which contains a mass of tabulated information formerly a popular feature of "Who's Who" itself. This yearbook also grows in bulk, and in importance as a work of reference.

"The Englishwoman's Yearbook," another of Messrs. Adam & Charles Black's annual works, is indispensable to the feminine (and consequently the larger) section of the public, as many subjects treated in this yearbook are to be found in no other publication.

Catalogues, &c.—A new list of enclosed arc lamps of the E.V. and E.V.S. types is sent out by the Union Electric Co., 151, Queen Victoria-street, London, E.C. The E.V. type is both single and double enclosed and of two burning hours (100 and 300). In each case the remains of the positive carbons are used up when trimming as the negative carbons, by which means economy in cost of carbons is secured. With the 300-hour type of lamp a special arrangement has been introduced securing a minimum consumption of carbons and further ensuring little or no deposition on the inner globes. The E.V.S., or traction type of lamp, is specially designed for burning in long series and for remaining unaffected by instantaneous and large changes in voltage.

A pamphlet dealing with the subject of smoke prevention and fuel economy is issued by Erith's Engineering Co., 70, Gracechurch-street, London, E.C. Illustrations of typical plants are given in the pamphlet, as well as details of the claims made in regard to economy of working, &c,

A new list of electrical novelties is issued by F. Darton & Co., 142, St. John-street, London, E.C. The list includes a number of small electric motors, small dynamos and dynamo castings, measuring instruments, bells, batteries, &c. Copies can be obtained on application.

Messrs. Bray, Markham & Reiss, Blackhorse-lane, Walthamstow, have some new sheet lists ready, giving prices and descriptions of shunt regulators and circuit breakers.

A new list of extension ladders, for which Messrs. Heathman & Co., Parson's Green, Fulham, London, are renowned, has been compiled, and is now ready. A large variety of these ladders for all purposes is listed.

"Air-Compressing Machinery" is the title of a pamphlet recently published by Peter Brotherhood, Belvedere-road, Westminster Bridge. Some excellent illustrations of air-compressing machines and apparatus relating thereto are to be found in this publication.

The Otto Electrical Mfg. Co., Longsight, Manchester, issue some particulars regarding the "Otto" arc lamp, in pamphlet form.

Calendars, Diaries, &c.—We have received from Messrs. Clarke, Chapman & Co., Victoria Works, Gateshead-on-Tyne, a copy of their diary for 1905, which, besides being a useful pocket companion, includes an accident insurance coupon for £1,000. The diary thus combines usefulness with providence.

The Gloucester Railway Carriage & Wagon Co. have issued their well-known diary for 1905. Not only will visitors to Gloucester find the book of service, but there is a directors' calendar and other information.

From Wm. Aug's Gibson (Ltd.) we have to acknowledge the receipt of a hanging calendar with date pad attached, the centre being a well-executed lithographic landscape view in colours.

Imports.—The following are official values of imports of electrical machinery, material and apparatus into this country during November :—

Electrical machinery, £44,629 (an increase of £6,999 compared with November, 1903); telegraph cables and apparatus, £8,258 (increase £2,476); other electrical goods, £75,485 (decrease £7,459). The total imports of the three classes during the 11 months ended 30th ult. were respectively £521,590 (increase £16,322), £48,610 (decrease £7,871) and £704,563 (decrease £27,525).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Nov. 30 to Dec. 6, with the ports of destination :—

Africa—Alexandria, £125; Beira, £8; Cape Town, £1,220; Durban, £409; East London, £15; Mombasa, £1,629 (including £78 telegraph insulators and 1,531 cwt. telegraph poles); Mozambique, £264 (telegraph cable); Port Elizabeth, £169; Port Said, £31; Sierra Leone, £10,140 (telegraph cable). *Argentina*—Buenos Ayres, £1,023 (including £186 telegraph apparatus). *Ascension*, £3,030 (telegraph instruments). *Australasia*—Auckland, £59; Brisbane, £34; Fremantle, £64; Melbourne, £58,153 (including £18 telegraph material); Otago, £15; Perth, £45; Sydney, £1,087; Wellington, £536. *Belgium*—Ostend, £86. *Burma*—Rangoon, £17. *Canary Islands*, £28. *Ceylon*—Colombo, £10. *China*—Shanghai, £186; Tientsin, £200. *Denmark*—Copenhagen, £71. *France*—Boulogne, £46; Paris, £1,417; Rouen, £69. *Germany*—Bremen, £85 (telegraph material); Hamburg, £781 (including £160 telegraph material). *Gibraltar*, £5,549 (including £5,190 telegraph cable). *Greece*—Piraeus, £31. *Holland*—Amsterdam, £313; Flushing, £141 (including £128 telegraph material). *India*—Bombay, £89; Calcutta, £2,238 (including £8 telegraph material). *Japan*—Kobe, £146; Yokohama, £1,679. *North Atlantic*—£2,420 (submarine cable). *Portugal*—Lisbon, £12 (telegraph instruments). *Russia*—St. Petersburg, £1,205. *St. Helena*, £23 (telegraph material). *Siam*—Bangkok, £235. *Straits Settlements*—Penang, £78; Singapore, £36. *Sweden*—Gothenburg, £183 (including £12 telegraph gear). *Turkey*—Salonica, £16. *Zanzibar*, £51 (including £33 telegraph material). Total, £94,447 against £139,956 in the corresponding week last year (Dec. 2 to 8).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

November 3, 1904.

23,807 E. L. CALAHAN. Trolley restorers. (Date applied for, Nov. 6th, 1903, date of application in U.S.)*
23,808 A. C. BURNETT and J. RICHMOND. Push button switch.
23,811. G. SCHAULI and G. PETRIDES. Plates and electrodes for storage batteries.
23,816. B.T.-H. Co. (G.E. Co., U.S.). Electric control systems.
23,817. B.T.-H. Co. (G.E. Co., U.S.). Electric motor control.
23,820. G. S. CARSON. Electric choke coils. (Date applied for, March 30, 1904, date of application in U.S.)*
23,828. H. G PRESTED. Terminal for electrical apparatus.*
23,834. L. J. HUNT and SANDYCROFT FOUNDRY Co., Liverpool. Alternating current induction motors.*

November 4, 1904.

23,857 S. SHEPPERD, Jun. Sheffield. Trolley heads.
23,871 P. WATSON. Grimsby. Electrical buoy light.
23,885 R. BRAUN. Magnetic brakes for vehicles.
23,899 A. JUST and F. HANAMANN. Manufacture of incandescent lamps.

November 5, 1904.

23,923 A. W. KENYON. Liverpool. Incandescent lamps and exhausting same.
23,932 D. M. PATON. Trolley wire supports.*
23,952 J. T. ARMSTRONG and A. ORLING. Telegraphic and other transmitting apparatus.
23,960 W. GOULTON. Electric letters, signs and the like.
23,969 H. DIAMANT and A. CHIESA. Arc lamp.
23,971 G. L. ANDERS and M. BYNG. Electric device for circuit closing, indicating power transmitting, &c.
23,972 SIEMENS BROS. & Co. (Siemens & Halske A.G., Germany.)* Electric indicating or measuring instruments having springs to convey current to a movable system.

November 7, 1904.

23,991 A.E.-G. Magnetic suspensions for moving parts of measuring instruments. (Date applied for, Nov. 6, 1903, date of application in Germany.)*
24,030 F. W. E. JONES. Leamington. Electric time switch or contractor
24,056 L. THURNAUER and A. D'ORELI. Switches.
24,078 SOCIÉTÉ INDUSTRIELLE DES TÉLÉPHONES. Conductors. (Date applied for, March 11, 1904, date of application in France.)*
24,083 J. S. RAWORTH. Electric motors and controlling devices for vehicles.
24,093 J. G. BALSILLIE. Receiver for wireless telegraphy.

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1903.

22,090 CORNARO. Manufacture of electrodes and resistances.
22,440A FAIRWEATHER (Kellogg Switchboard & Supply Co.). Telephone switchboards. (Date applied for, Oct. 17, 1903.)
22,758 DALZIEL. Voltage regulated system for lighting railway and other carriages, ventilating, heating, &c.
22,858 CHANDLER and BONNIKSEN. Electrically synchronised clocks.
22,911 CAROLAN (G.E. Co., U.S.). Alternating-current motors.
22,913 CAROLAN (G.E. Co., U.S.). Alternating-current motors and controlling same.
23,355 WARWICK MACHINERY Co. (G.E. Co., U.S.). Electrically operated valves especially applicable to turbines.
23,375 SCHNELLER and KOELEMAN. Electric silent discharge apparatus.
23,531 WHIPP. Loose handle automatic magnetic blow-out circuit breakers.
23,608 TOMLINSON and LOMAX. Switches.
23,652 SOC. ANON. DES ATELIERS DE MÉCANIQUE DE PRECISION DE TERRITET. Electricity meters. (Date applied for, Nov. 10, 1902.)
24,068 AZABOLA. Apparatus for limiting electric currents.
24,680 CRAVEN. Electrical transmission reception, recording and reproduction of sound.
24,798 B.T.-H. Co. (G.E. Co., U.S.). Electric vehicles.
24,799 B.T.-H. Co. (G.E. Co., U.S.). Electric motor systems applicable to electric railways and like purposes.
25,182 MELLER. Apparatus for obtaining variable electrical ignition, applicable to gas engines.
25,527 B.T.-H. Co. (G.E. Co., U.S.). Electric train control systems.
25,591 DELVES, BROUGHTON and COLE. Induction coils and transformers.
25,855 B.T.-H. Co. (G.E. Co., U.S.). Switches.
26,051 FINZI. Voltage regulating devices for alternating-current lines.
26,634 GOBBET. Contact breakers, switches and the like, particularly applicable for internal combustion engines and the like.
26,916 WALKDEN. Advertising on and indicating routes of electric vehicles.
27,267 MILNE. Suspending electroliers.
27,446 REA and REINDORP. Mechanical car for suspending overhead wires.
27,506 WRIGHT and MIDGLEY. Dynamo-electric machinery.
27,892 B.T.-H. Co. (G.E. Co., U.S.). Brush-holders.
27,894 B.T.-H. Co. (G.E. Co., U.S.). Alternating-current machines.
28,453 CROWTHER and HORSFALL. Motor-starting switch.

1904.

461 Benedikt and Macek. Securing wires on insulators.
671 Rees. Connection between brush holders and pillars of dynamos and motors.
786 Sutton and Gregson. Forming joints in conduits for cables.
2,093 Leblanc. Excitation and regulation of induction machines. (Date applied for, Jan. 28, 1903.)
6,716 Babcock. Switches. (Date applied for, March 23, 1903.)
7,208 Westinghouse and Aspinwall. Controlling systems for electric motors. (Date applied for May 1, 1903.)
7,247 Lee. Sealing ends of insulated conductors.
9,340 Morris. Carrying overhead trolley wires of electric tramways.
9,874 Dunn. Switches. (Date applied for, Aug. 25, 1903.)
10,276 Silvene. Electric block signal systems.
11,439 O'Brien. Incandescent lamps. (Date applied for, May 25, 1903.)
11,857 Stevens. Switches.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ALUMINIUM CO. (LTD.)—At an extraordinary meeting on Monday the resolutions passed at the meeting on the 9th ult. were confirmed, on the motion of the chairman (Mr. J. D. Bonner). Subsequently resolutions were passed authorising the funding of the arrears on the 7 per cent. preference shares, the borrowing of £300,000 on debentures, and the creation of £190,000 additional ordinary capital. In reply to questions Mr. Bonner said a business such as the company's could not stand still and unless they greatly increased their output there was no possibility of dividends being continued for any considerable time. About £40,000 had so far been spent on the Loch Leven water power scheme.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—The deputy chairman (Mr. W. I. Buchanan) presided at the meeting on Tuesday, and said that the formation of the company and the erection of the buildings and plant at Trafford Park had doubtless been expensive in every way, while the organisation brought together at the same time, upon the same basis, could not help entailing more than usual expense. It was equally to be borne in mind, however, that during a considerable portion of the past year a large number of their men were still engaged upon what could be properly called "unproductive labour"—namely, the completion and finishing up of the works and grounds in readiness for the large influx of work which they were now fully prepared to handle. The character of some of the work undertaken more than a year ago had also been a factor in the results attained from the year's working, particularly the great turbines now being completed. The first of these were just beginning to do their work of furnishing power for the underground railways in London. That work was so entirely new in every way, and involved such great risks in construction and operation that every precaution that prudence could suggest was demanded of the staff at the works. The development charges thus incurred were of necessity large, covering all the unforeseen expenses incident to such intricate and large engineering and manufacturing problems. He had been asked whether if their sale prices were not too low, and, if so, what effect competition had had upon them, and what steps it was proposed to take to secure better prices for the product of their works. This was in reality the kernel of their business, and the most important matter that could engage the attention of a manufacturing company, since every economy that could be made in expenses could be quickly swallowed up by a drop in selling prices. The depressed condition of trade in this country which applied to British electrical manufacturing trade with more force than to any other was responsible for electrical materials being sold at lower prices than should be the case. But there was another competitive element, far-reaching in its results, that had of late entered into the matter of prices—namely, the competition met with here from manufacturing concerns outside Great Britain. It was not, he thought, so much the amount of business contracted in Great Britain by German and other Continental electrical manufacturing concerns (very large as that was), but rather the influence which the presence of that competition in all important tenders exerted upon prices quoted by British manufacturers, since the logical sequence to be drawn from such a condition was that it became necessary for the sales department of a British company to try in advance to discount that unknown outside price, with the net result that much lower prices were made by British companies under such circumstances than would be the case were the competition they had to meet limited to British competition alone. It was difficult to see how British manufacturing concerns could adjust their business to meet that wider competition, and at the same time satisfactorily uphold even fairly remunerative prices for their products, since they were not able even to take any reprisals, because of the equal fact that the State policy of their competitors' countries protected the latter from similar attacks. It was to the building of such large electrical undertakings as the Clyde Valley Electric Power Co. that electrical manufacturing concerns such as theirs must in considerable measure depend for their success, and he might say that an indication of the extent of interest now being shown in Great Britain in electrical power distribution schemes might be gleaned from the considerable number of bills that will come before the next session of Parliament. Special care had been exercised and thought given to the conservation and upkeep of their buildings at Trafford Park, and he believed they were to-day as valuable as they were a year ago. With regard to the large machine tools and general plant equipment, those had been maintained at a high degree of efficiency. During the year £25,490 had been charged to general expenses in connection with their maintenance, and with improvements made upon them, which had tended to greatly increase their efficiency, and thus reduce the cost of the product turned out. That taken in connection with the fact that many new tools were added during the year, coupled with the proportionately limited amount of work put through the factory, compared to its capacity, which relieved some of the larger tools from much service during the year, appeared to the directors to warrant the view that the £10,500 charged to depreciation thereon was a fair adjustment. In the matter of patterns and dies and small tools, he might say that, quite outside the £19,033 charged against their upkeep and maintenance during the year, the board, at the middle of the fiscal year under review, adopted the policy of charging all dies, patterns, small tools, drawings and blue prints direct to factory expenses, alone or to a particular contract. The sum charged to factory expenses for those things during the six months referred to amounted to £20,346. Realising that the moment was not in sight when the capacity of their works, and of the organisation that had been perfected in connection with them, could be advantageously used, the board, with the hearty encouragement of all the officers, immediately set about reducing general expenses and the cost of manufacturing. Much had been accomplished in that direction. As to the future, it seemed fair to assume that if the development in electric traction in Great Britain kept pace with the outlook now existing in the same direction in the United States there should be, with the gains that seemed likely to take place in the demand for electrical apparatus in the British colonies, sufficient work in the near future for all the electrical manufacturing concerns in Great Britain. Their plant and organisation at Trafford Park were equipped to that end, while the experience of their workmen had brought about a lower cost for their finished products; so that they were to-day much better fitted to profitably tender for and produce electrical equipment than they had been at any previous time.

GENEVA TRAMWAYS CO. (LTD.)—The chairman (the Hon. A. G. Brand) in reviewing the results of the working for 1903, at the meeting last week said those results showed a large improvement in receipts and a large decrease in expenses, giving fair promise of a substantial distributable profit at the end of the year. For the nine months ended Sept. 30 the profit was 354,560fr., compared with 159,494fr. in the corresponding period of 1903.

CRYSTAL PALACE CO.—At the half-yearly meeting last week the chairman (Mr. E. Schenk) said that Croydon Corporation had decided to apply to Parliament for powers to construct a tramway connecting their system by a new line within 250yds. of the main high-level entrance to the Palace, and their negotiations with London County Council as to an extension to their entrance had resulted in the Council deciding to apply to Parliament for powers to make the connection. That left open the even more important question of an extension by London County Council of its South London system to the Palace from the London side, but there was every reason to believe that that was seriously intended as soon as their financial obligations permitted, and with the highly profitable results of the Croydon extension, which might be regarded as assured, there could be no doubt but that the London extensions would shortly follow. The Croydon and Beckenham extension to the Penge entrance, which was already authorised, was, he was assured by the managing director of the British Electric Traction Co., to be commenced this winter and to be in operation by next May. The opening of those important districts was certain to be followed by extensions in the south-east district, until they should ultimately get that large network of feeders which he had always held out as their only hope of a substantial increase in revenue for the Palace.

POWER GAS CORPN. (LTD.)—The chairman (Sir Henry Fowler, M.P.), in moving the adoption of the report at the meeting on Wednesday, stated that the progress and profits made during the past year had been adversely affected by the depression in the engineering trades. He read a long report, prepared by the managing director (Mr. Schweich), on the position of the company. Mr. Schweich said that, after the depression of trade, the most important question was the degree of perfection now attained in the construction of large gas engines. On the Continent, especially in Germany, the builders of large gas engines had been far better supported by manufacturers than they found to be the case in this country, and no doubt, by reason of their wider range of experience, Continental gas engine builders had succeeded more rapidly in producing reliable gas engines of large sizes than had been the case hitherto in this country. It was, however, satisfactory to note that some of the most important engine builders in this country had now completed arrangements for securing the advantage of the Continental experience, and were now manufacturing large gas engines of some of the best of the foreign types—for instance, the Oechelhaeuser, Korting and Cockerill engines. Electricity could be produced cheaper by Mond gas driven generators than in any other way; but engineers of electricity stations in this country had not yet made up their minds as to the feasibility of running large gas engines in parallel in generating alternating current, although many such installations could be seen running in parallel abroad, particularly in Germany. They hoped that the North-Western Electricity and Power-Gas Co. would soon place itself on a working basis, and proceed with the erection of their first generating station, which was to be driven by power-gas and large gas engines, and would thereby furnish an object lesson, the importance of which to the development of their business could not be over-estimated. The range of industries employing their patent processes was being gradually extended, and perhaps the most important new ground broken was in the direction of electric tramway work. Their work at the South Staffordshire Mond Gas Co.'s first station was now practically finished, and no doubt they would proceed to distribute gas as soon as the laying of mains would permit.

NEW COMPANIES, LIENS REGISTERED, &c.

NEW COMPANIES.

BRYNAMMAN & DISTRICT ELECTRIC SUPPLY CO. (LTD.) (82,705).—Reg. Nov. 29, capital £2,000 in £1 shares, to carry on the business of suppliers of electricity, electrical and mechanical engineers, manufacturers of and dealers in electric, telegraphic, telephonic and other apparatus, &c. Reg. office, Brynamman, Carmarthenshire.

GOSPORT & ALVERSTOKE ELECTRIC LIGHTING CO. (LTD.) (82,693).—Reg. Nov. 28, capital £5,000 in £10 shares, to supply electrical energy for lighting towns, streets, markets, theatres, and other public or private places, and to carry on the business of electricians, manufacturers of and dealers in all apparatus used in connection with the generation, distribution, supply and employment of electricity, &c.

SUPPLIES LIMITED. (82,737).—Reg. Dec. 1, capital £5,000 in £1 shares, to carry on the business of electricians, mechanical engineers, producers and suppliers of electricity, &c. The subscribers are:—J. Atherton, manufacturer, J. B. Atherton, manufacturer, S. A. Atherton, H. A. Atherton, C. E. Buckley, D. L. Chalmers, D. Hogg. Reg. office, 12, St. John's-lane, Liverpool.

MORTGAGES AND CHARGES.

INDUSTRIAL STORAGE BATTERY SYND. (LTD.)—Issue on Nov. 14 of debenture for £1,000, part of series created Sept. 6, 1904, to secure £3,000, charged on company's undertaking and property, present and future, including uncalled capital, subject to prior charge for £3,000. No trustees. No previous issue of same series.

MILFORD ON SEA ELECTRIC SUPPLY CO. (LTD.)—Issue on Nov. 12 of £850 debentures, part of series created Sept. 3, 1904, to secure £2,000, charged on company's whole property, present and future. No trustees. No previous issue of same series.

MUIRHEAD & CO. (LTD.)—Issue on Nov. 16 of £16,000 debentures, part of series created same date to secure £20,000. Property charged, company's undertaking and property, present and future, including uncalled capital. Holders, Dr. A. Muirhead and F. L. Muirhead, M.A.

PERTH ELECTRIC TRAMWAYS (LTD.)—Issue on Nov. 24 of £500 debentures, part of series created Dec. 22, 1903, to secure £50,000, charged on benefit of certain agreements, deposit, provisional order and Acts of Parliament, tramways, tramway undertaking, plant and machinery, &c., in Perth, W. Australia. Trustees, Lord Arthur Butler and J. S. Austen. Previously issued of same series, £35,500.

UNITED ELECTRIC LIGHT & POWER SUPPLY CO. (LTD.)—Issue on Nov. 22 of £450 first mortgage debentures, part of series created March 17, 1903, to secure £3,000, charged on the company's undertaking and property, present and future, including uncalled capital and buildings, machinery and other property at Guimaraes, Portugal. No trustees. Previously issued of same series, £2,375.

CITY NOTES.

MEMORANDA (Dec. 8).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 27⅛d. per oz. Consols 87¹¹⁄₁₆—87¹³⁄₁₆ for money, 87⅞—88 for account; 2½ per cent. annuities 87¾—88¼. Consols Pay Day, Jan. 5. Stocks and Shares Continuation Days, Dec. 13 and 28; Ticket Days, Dec. 14 and 29; Pay Days, Dec. 15 and 30; Mining Share Carry-over Days, Dec. 12 and 27.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—The directors have declared an interim dividend on the 6 per cent. preference shares for the six months ended 31st inst., and an interim dividend at the rate of 10 per cent. per annum on the capital paid up on the ordinary shares.

GENERAL ELECTRIC CO. (LTD.)—The transfer books of the 5 per cent. preference shares will be closed from 19th to 31st inst. inclusive.

ISLE OF THANET ELECTRIC TRAMWAYS & LIGHTING CO.—The receipts for the year ended Sept. 30 were £37,620, and the net profit £13,493. In order to pay interest, preference dividend, &c., an additional £2,454 was required, and has been taken from the unappropriated balance, which now stands at £1,558. Owing to objections raised by the Board of Trade to the double truck cars it became necessary to alter them, and to mount them on single trucks at a cost of £1,833, and the balance of the special account for improvement and reconstruction of cars (£1,800) will be written off revenue in six annual instalments.

RAND CENTRAL ELECTRIC WORKS (LTD.)—The result of working for November was 795,000 units generated, yielding a gross revenue of £7,450, against 659,855 units and £5,877 for the corresponding period of last year.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Dec. 14 a special settling day in £60,000 4½ per cent. debenture stock of the *Telephone Co. of Egypt (Ltd.)*, and have ordered same to be quoted in the official list. The committee have been asked to allow a further issue of £85,100 5 per cent. redeemable first mortgage debenture stock of the *Auckland Electric Tramways Co. (Ltd.)* to be quoted.

UNITED WIRE WORKS (LTD.)—In the report for year ended Sept. 30 the directors recommend a dividend of 2½ per cent., leaving £2,041 to be carried forward to meet dividend accrued on preference shares to Sept. 30 (£1,228), and a free balance of £812.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Dec. 3	1,009	+ 32	47	33,538	+ 5,771
Airdrie	Nov. 25	188	...	47	8,468	...
Ayr Corporation	Dec. 3	174	+ 6	29	10,131	+ 404
Barnsley	Nov. 25	150	− 15	47	7,967	− 549
Barrow	" 25	180	...	42	8,531	...
Bath Electric Trams, Ltd.	" 30	450	...	43	30,677	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	Dec. 4	953	+ 26	...	...	...
Birmingham Corporation	" 3	337	...	35	11,181	...
Birmingham Tramways Co.	" 3	5,411	+ 531	22	119,741	+ 5,589
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	" 1	758	− 8	35	42,153	+ 5,902
Blackpool and Fleetwood	" 3	182	− 1	47	20,400	+ 890
Blackp'l, St. Anne's & Lytham	" 1	114	− 19	¶14	605	134
Bolton Corporation	" 4	1,719	+ 152	36	65,664	+ 522
Bournemouth Corporation	Nov. 30	706	− 29	‡35	39,758	+ 2,045
Bradford Corporation	Dec. 3	5,107	+ 249	34	162,147	+ 20,438
Brighton Corporation	" 4	750	+ 24	35	37,815	+ 3,232
Brisbane Tramways	Oct. 19	2,607	+ 191	16	37,940	+ 882
Bristol Trams & Carriage	Dec. 2	4,175	− 99	17	144,586	+ 1,345
Buenos Ayres & Belgrano	Nov. 6	3,306	+ 8	3	9,917	+ 283
Burnley Corporation	Dec. 3	983	+ 169	9	9,161	+ 1,965
Burton Corporation	" 4	274	+ 6	¶35	12,427	...
Calcutta Tramways Co.	" 3	R89,349	+ R5,583	28	R8,6,620	+ R37,802
Camborne-Redruth	" 3	98	− 6	6	12,451	− 117
Cardiff Corporation	" 3	1,816	+ 118	35	73,818	− 1,654
Carlisle Tramways Co.	" 3	161	+ 7	46	9,504	+ 216
Central London Railway	" 3	6,957	− 154	23	139,084	− 2.9
Chatham & Dist. Lt. Rys.	" 1	434	− 45	48	25,105	+ 2,121
City & South London Rly.	" 4	2,807	− 290	23	69,036	− 2,160
Colchester Corporation	" 1	131	...	18	4,995	...
Cork Electric Trams Co.	" 1	354	+ 27	49	27,518	− 2,513
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	Nov. 25	604	− 27	47	25,102	+ 3,253
Dover Corporation	Dec. 3	153	− 13	36	5,269	− 185
Dublin & Lucan Railway	" 2	58	− 2	22	2,944	− 82
Dublin Southern District	" 2	762	+ 112	22	118,309	− 2,716
Dublin United	" 3	3,858	+ 166			
Dudley—Stourbridge	Nov. 25	717	− 46	47	42,978	+ 1,857
Dundee Corporation	" 30	776	+ 1	...	...	...
East Ham Council	Dec. 3	572	+ 48	36	26,846	+ 1,465
Gateshead & Dist. Trams	Nov. 25	853	− 7	47	47,868	+ 1,846
Glasgow Corporation	Dec. 3	18,612	+ 490	†27	885,743	+ 20,277
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	Nov. 25	178	− 35	47	11,900	+ 44
Gt. Northern & City Rly.	Dec. 3	1,367	...	44	63,139	...
Greenock & Port Glasgow	Nov. 25	510	+ 7	47	27,219	+ 1,374
*Halifax Corporation	" 30	2,157	+ 19	35	51,084	+ 3,801
Hartlepool Tramways	" 25	233	− 9	47	13,565	+ 1,010
Huddersfield	...	...	...	...	...	...
Hull Corporation	Dec. 3	2,066	+ 221	35	77,507	+ 10,015
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	Nov. 30	81	− 37	9	1,077	− 141
Ipswich Corporation	Dec. 3	299	+ 10	35	17,650	...
Isle of Thanet Co.	" 3	255	+ 12	9	3,074	− 184
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	Nov. 25	90	− 6	47	6,078	+ 18
Kirkcaldy Corporation	" 30	501	− 5	48	10,990	...
Lanarkshire Trams Co.	Dec. 1	570	+ 46	48	81,859	+ 19,100
Leeds Corporation	" 3	5,120	+ 345	35	249,910	+ 12,103
*Leicester Corporation	" 3	1,402	...	29	42,533	...
Liverpool Corporation	Nov. 26	9,278	− 302	45	427,179	+ 13,731
Liverpool Overhead Rly.	Dec. 4	1,449	− 75	†28	86,286	− 1,974
London County Council	Nov. 26	11,177	+ 2,048	‡34	410,511	+ 94,260
*Lowestoft	Dec. 3	147	+ 8	...	...	...
Maidstone Corporation	" 1	60	...	37	3,094	...
Manchester Corporation	" 3	11,034	+ 529	35	485,545	+ 19,291
Mersey Railway	" 3	1,659	+ 188	22	32,531	+ 2,041
Merthyr	Nov. 25	180	− 10	47	9,485	+ 55
Metropolitan Elec. Trams	Dec. 2	1,339	+ 582	24	44,194	+ 11,508
Middleton	Nov. 25	241	+ 8	47	15,385	+ 847
Nelson Corporation	Dec. 3	142	+ 10	36	4,804	+ 1,274
Newcastle-on-Tyne Corp.	" 3	4,482	+ 141	24	81,116	+ 3,971
Newport (Mon.)	...	...	...	...	...	...
Oldham, Ashton & Hyde	Nov. 25	471	− 82	47	25,861	− 1,059
Oldham Corporation	" 30 " 27	1,812 1,379	+ 203 + 145	35	42,709	+ 160
Perth (W. A.) Elec. Trams	Dec. 2	1,359	+ 107	48	61,467	+ 6,214
Peterborough	Nov. 25	94	− 19	47	7,046	− 246
Poole and District	" 25	211	− 15	47	14,431	+ 41
Portsmouth Corporation	Dec. 3	1,272	+ 71	§35	71,674	+ 5,083
Potteries	Nov. 25	1,515	+ 150	47	80,978	+ 5,943
Reading Corporation	Dec. 1	512	+ 21	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	Nov. 25	22	− 4	47	6,822	− 5
Salford Corporation	Dec. 5	3,773	+ 300	36	145,903	+ 7,869
Sheerness	Nov. 25	51	+ 4	47	8,098	− 477
Sheffield Corporation	Dec. 4	4,357	+ 330	§36	164,049	+ 8,443
Southampton Corp'ation	" 1	738	− 74	35	35,310	− 2,271
Southend Corporation	Nov. 30	193	+ 11	35	10,651	+ 1,381
Southport Tramways	" 25	210	− 37	47	16,645	+ 462
S. Staffordshire Trams	" 25	610	− 406	47	36,137	− 7,329
Stockport Corporation	Dec. 2	871	+ 16	35	30,470	+ 7,831
Sunderland Corporation	" 4	1,054	+ 86	35	45,620	+ 979
Swansea Trams	Nov. 25	447	− 8	47	25,550	+ 952
Taunton Trams	" 25	89	− 8	47	2,516	− 295
Tynemouth and District	" 25	161	− 32	47	18,902	− 927
Tyneside Trams Co.	" 30	305	+ 62	44	19,696	+ 3,121
Wallasey District Council	Dec. 6	614	+ 45	§35	27,146	+ 1,725
Walsall	" 3	453	...	46	23,127	...
Warrington Corporation	" 1	270	− 6	35	14,352	+ 364
West Ham Corporation	" 1	930	...	40	37,727	...
Weston-super-Mare	Nov. 25	26	− 2	47	6,189	+ 501
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	" 25	385	− 20	47	18,406	− 87
Worcester	" 25	241	+ 182	42	13,871	+ 6,661
Wrexham	" 25	77	− 34	47	5,162	− 231
Yorkshire Woollen District	" 25	434	− 55	47	27,516	+ 8,200

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

** Fortnight

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Dec. 7.	Rate per Cent. Yielded.			Dividend Due.	Business, Week to Dec. 7.	
				£	s.	d.		Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.							
5	3/0	Anglo-Argentine Ordinary Shares	7¼—7½	4	9	0	April, Oct	7⅛	7⅛
5	2/6	Do. 6% Cum. Pref.	5¾—6¼	4	9	0	..	5⅞	5¾
St.	6%	Do. Permanent 6% Deb. Stock	143—146	4	2	9	—	145	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	106—107	4	15	8	—	106½	..
10	6%	Barcelona Tramways Ord.	10½—11	5	14	6	—	10⅝	10½
10	5/0	Do. 5% Cum. Pref.	9—10	5	0	0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91—96	4	14	0	—	..	..
100	5%	Do. 5 per Cent. Debs.	98—101	4	19	6	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	½—¾		..		..	..	..
1	..	Do. 5% Cum. Pref.	¾—1⅛		..		..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½		..		..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5	17	8	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96—100	4	11	9	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19—20	4	0	0	Feb, Aug	..	..
10	6%	Do. Cum. Pref. (fully paid)	10—10½	5	16	2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107—109	3	13	4	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100—103	5	10	6	—	102	..
St.	5%	† Do. Pref. Ord. Stock	102—105	4	15	8	—	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10¾	4	18	0	—	10⅝	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103%—106%	4	6	0	..	..	..
100	4½%	Do. Vancouver Power Debs.	98—101	4	11	0	..	100	..
10	6/0	British Electric Traction Ord.	9¾—10½	5	17	3	..	9⅞	9¾
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾—11	5	9	1	Feb, Aug	11	10¾
St.	6/0	Do. 5 per Cent. Perpetual Debs	117—119	4	4	3	—	119	118
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	93—97	4	12	10	..	96½	95¾
5	1/6	Buenos Ayres and Belgrano Ord.	1½—3½	6	16	8	—	3½	3⅛
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5½—5¾	5	2	8	—	5⅞	5½
5	3/0	Do. "B"	5½—5¾	5	11	6	—	5⅝	..
St.	5%	Do. 5 per Cent. Debs.	108—109	4	12	8	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	103—106	4	16	0	—	105	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. 5% Deb. Stk.	96—99	5	2	6	..	..	..
5	3/0	Calcutta Tramways	7½—8½	3	13	11	—	8	7¾
100	4½%	Do 4½% 1st Deb. Stock (red.)	107—109	4	3	6	—	108½	108½
1	1/0	Cape Electric Tram Shares	1⅛—1⅜	6	8	0	..	1½	1½
St.	4%	Central London Ordinary Stock	91—93	4	6	0	June, Dec	92½	..
St.	4%	Do. 4 per Cent. Pref. Stock	101—103	3	17	9	..	101½	101
St.	4%	Do. Deferred Stock	84—86	4	13	6	—	84½	..
100	4%	Do. 4 per Cent. Debs.	108—110	3	13	4	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—5½	4	17	6	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98—101	3	19	3	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	46—47	4	15	8	Feb, Aug	47	46½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122—125	4	0	3	Feb, Aug	..	..
St.	5%	Do. (1896)	117—120	4	3	6	..	..	..
St.	5%	Do. (1901)	116—118	4	4	6	..	116½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104—107	3	14	9	May, Nov	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	101—104	4	16	3	..	103½	101½
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13—14	4	5	5	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15—16	3	15	0	..	..	..
10	3/0½	Gt. Northern & City Rly. Prf. Ord. (4%)	5½—6		..		—	5⅞	5½
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8½—9½		..		..	..	..
10	10%	‡ Imperial Tramways Ord	19—20	4	0	0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—15½	3	18	4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	110—112	4	0	0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 6% Pf.	3½—4½	5	17	8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90—93	4	7	3	..	..	..
10	1½%	Liverpool Overhead Railway Ord	3½—3¾	3	13	0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10—10½	4	15	3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—101	3	19	3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10¼—10½	4	12	0	..	10⅜	10¼
St.	4%	Do. 4% 1st Mort. Deb. Stock	103—105	3	17	4	..	104½	104
St.	..	Madras Elec. Trams 5% Deb. Stk.	103—105		..		Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6—9		..		..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10—13		..		..	..	..
1	..	Metropolitan Electric Trams Def	¼—½		..		—	½	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5	0	0	—	..	..
St.	18/7	Do. 4½ Deb. Stock	103—106		..		—	104½	..
100	5%	Montreal St. Ry. St'g 5% Mrt. Dbs. (1908)	100—103	4	17	3	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103—105	4	6	9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—1½		..		May	..	..
St.	5%	Perth (W.A.) Elec. Trams 1st Mt. Db. Stk.	103—105	4	16	9	..	..	..
10	10/0	Potteries Electric Traction Ord.	8—9	5	11	2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½—9½	5	5	3	Feb, Aug	9¼	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99—102	4	8	3	—	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—		..		..	..	..
1	..	Do. 6% Pref. (£1 paid)	..		..		April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..		..		Jan, July	..	..
St.	3%	Waterloo and City Ord.	88—90	3	7	0	June, Dec	..	..
		ELECTRIC MANUFACTURING, &c.							
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	¾—1	5	14	2	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	½—⅞		..		..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5½—6½	6	13	2	July, Feb	6⅛	..
5	3/0	Do. 6 per Cent. Pref.	5½—5¾	5	4	4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102—105	4	6	3	..	..	..
St.	4½%	British Thomson-Houston 4½% 1st Mt. Db.	100—102	4	8	6	..	..	..
5	3/0	British Westinghouse 6% Pref.	2½—3½		..		—	3	2¾
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	88—90	4	10	3	..	87	..
2	..	Brush Electrical Engineering	½—¾		..		March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½—1¾	8	0	0	Mar, Sept	1½	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	93—96	4	14	6	Mar, Sept	96	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	69—73	6	6	8	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	9½—10	5	5	0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¾—6⅛	4	18	0	Jan, July	6⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104—106	4	6	7	Nov, May	106	104½
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1⅛—1¼	4	18	9	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	95—98	4	13	4	..	..	..
1	0/9½	Chadburn's (Ship) Telegraph Ord.	½—1½	8	17	6	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 56,000)	1½—1¾	4	5	2	Jan, July	1⅝	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	93—96	5	4	3	Jan, July	90	..
5	10/0	Dick, Kerr & Co. Ord.	7½—7¾	6	8	8	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	5½—5¾	5	6	8	Sept	5⅝	..
St.	4½%	Do. 4½% Deb. Stock	106—107	4	5	7	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾		..		Feb, Aug	..	..
5	..	Do. (£5 paid)	1—1½		..		Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	75—83	4	17	9	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79—84	6	0	8	..	..	..
5	4/0	Edmundson's Elec. Corp. Ord.	6—6½	6	12	0	H'lf-yearly	6	..
5	3/0	Do. 6 per Cent. Cum. Pref.	6—6½	4	16	0	..	6½	6
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103—105	4	4	3	..	107½	106
2	1/7½	Electric Construction Co.	1½—1¾	6	8	0	July	..	..
2	2/0½	Do. 7 per Cent. Cum. Pref.	2½—2¾	5	12	0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98—100	4	0	0	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90—95	5	5	3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10	5	0	0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91—96	4	3	4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½—11	6	7	3	Feb, Aug	11½	10½
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4	3	9	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	110—112	4	0	10	Feb, Aug	112	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	19—19½	5	2	6	Feb, Aug	19¼	19¼
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99—102	3	18	6	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11½	4	8	10	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	35—40	3	15	6	Mar, July	39	38½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	103—103	3	17	0	Jan, July	..	..
3	..	Willans and Robinson Ord.	1—2		..		Apr, Oct	..	..
2	..	Do. 6 per Cent. Cum. Pref.	2—3		—		Apr, Oct	..	..
	4%	† Do. 4 per Cent. 1st Mort. Debs	74—78	5	1	3	May Nov	75½	..

Share.	Last Dividend	Name.	Price Wed., Dec. 7.	Rate per Cent. Yielded.			Dividend Due.	Business, Week to Dec. 7.	
				£	s.	d.		Highest.	Lowest.
		ELECTRICITY SUPPLY.							
..	..	Blackheath & Greenwich Dist. El. Lt. See South Metropolitan Elec. Lt. & Power Co. below	..		..		..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12—13	6	3	1	..	12½	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10	4	10	0	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11—12	5	0	0	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104—106	4	5	9	—	..	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5½—5¾	3	9	7	..	..	..
St.	4½%	Do. Do. 1st Debs	101—104	4	7	0	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4	10	11	..	10¾	..
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3	5	1	Mar, Sept	..	..
5	3/0	Calcutta Electric Supply Ord.	7½—8	4	7	6	..	7¾	7⅝
St.	4%	†Central Elec. Sup. Co. 4% Guar. Db. Stock	104—107	3	14	9	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8½—8¾	4	11	6	Feb, Aug	8¾	..
5	2/3	Do. 4½ per Cent. Pref.	5½—6½	3	18	3	Feb, Aug	6⅛	6⅛
St.	4%	Do. 4% Deb. Stock (red.)	103—106	3	17	8	..	104½	104½
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4	10	0	—	4⅞	4¾
5	2/3	Do. Do. (1903)	4½—5		..		..	4⅞	..
5	2/3	Chelsea Electric Supply Ord.	6½—6¾	4	5	2	March	6⅝	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109—111	4	1	9	Jn, Dec	..	..
10	6/0	City of London Electric Lighting Ord.	10½—11	4	10	11	Feb, Aug	10⅞	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12½—14	4	5	9	Jan, July	12¾	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123—127	4	0	0	Jn, Dec	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	104—106	4	5	9	..	103	..
10	4/0	County of London Elec. Supply Ord.	9½—9¾	4	2	1	..	9½	9
10	6/0	Do. 6 per Cent. Cum. Pref.	12—12½	4	18	0	Mar, Sept	12¼	12
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107—110	4	3	3	..	108½	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101—103	4	7	6	..	102	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88—93	5	7	6	..	..	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5½—6	4	11	9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	102—105	4	7	0	—	..	..
10	..	Havana Electricity Co. Shares	9½—10½		..		..	..	..
5	3/6	Hove Electric Lighting Ord.	7½—8	5	6	3	..	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	100—103	4	5	9	..	101	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	½—1½		..		—	½	..
5	5/0	Kensingtn & Knghtsbdge Ord.	12½—13½	4	8	11	..	12¾	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4	5	9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102—104	3	17	3	—	..	..
3	..	London Electric Supply Ord.	2—2½		..		..	..	..
5	6/0	Do. 6 per Cent. Pref.	5½—6½	5	2	1	..	5⅞	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	97—99	4	2	0	Mr, Jn, S, D	98½	..
10	9/0	Metropolitan Electric Sup. Ord.	16½—16¾	5	7	0	April, Oct	16⅝	16½
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½—5¾	4	0	10	Jan, July	5⅝	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	112—117	3	18	8	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97—99	3	11	6	..	97	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	93—96	4	14	9	..	95½	..
10	6/0	Notting Hill Electric Ord.	14½—15	4	0	0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	101—103	3	15	3	..	..	..
5	2/6	Oxford Electric Ord.	6½—6¾	5	2	2	March	6½	..
St.	4%	Do. 4% Deb. Stock	99—101	4	0	0	..	..	..
1	..	Rand Electric	1—1½		..		..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mt. Deb	100—102	4	8	9	April, Oct	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	14—14½	5	0	0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	8½—9	3	17	9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	99—101	3	10	0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2½—3½	6	3	1	—	3⅛	..
St.	4%	Do. 4 per Cent. Deb. Stock	83—87	4	12	6	..	..	..
5	2/0	South London Electric Supply Ord.	4½—4¾	3	8	8	—	4⅝	4½
1	..	South Metrop'n Elec. Lt. & Power Ord.	½—1		..		—	..	..
1	0/8¾	Do. 7% Cum. Pref.	1⅛—1¼	4	16	9	—	1⅛	..
St.	4½	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. Accn.)	107—110	4	2	3	—	..	..
5	2/6	Urban Electric Supply Ord.	4⅞—5⅛	4	18	9	..	5	..
5	2/6	Do. 6% Cum. Pref.	5—5½	4	17	7	..	5¼	5⅛
St.	..	Do. 4½ 1st Mort. Deb.	104—105		—		..	104½	104½
5	6/6	Westminster Electric Supply Ord.	12½—13	5	5	10	Mar, Sept	12⅝	12½
5	2/6	Do. 5 per Cent. Cum. Pref.	6½—7	3	11	5	—	6¾	..
		TELEGRAPHS.							
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	100—103	3	19	2	Jan, July	..	..
10	..	Amazon Telegraph	1—1½		..		Jn, Dec	..	..
St.	12/6	Anglo-American	55—58	4	17	0	F, My, Ag, N	56	..
St.	25/0	Do. Preferred	102—104	5	5	6	F, My, Ag, N	103	102
St.	2/0	Do. Deferred	11½—11¾	0	15	7	F, My, Ag, N	12⅛	11½
100	$2	Commercial Cable Capital Stock	170—190	4	4	2	Ja, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	92—95	4	4	9	Jn Ap, Jy, O	94½	93½
10	5/0	Cuba Submarine Ord.	8½—9½	5	3	0	Feb, Aug	9	8¾
10	10/0	Do. Preference 10 per Cent.	16½—17½	5	14	3	Feb Aug	17	15½
5	2/0	Direct Spanish Ord.	2½—3½	6	3	1	April, Oct	2¾	..
5	6/0	Do. 10 per Cent. Cum. Pref.	7½—8	6	6	0	April Oct	7⅞	..
50	4½%	Do. 4½ per Cent. Deb.	101%—103%	4	8	3	Jan, July	100½	..
20	8/0	Direct United States Cable	10½—11	5	3	1	Ja, Ap, Jy, O	11	10¾
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	101—103	4	3	3	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	123—126	5	4	7	Ja, Ap, Jy, O	124½	123
St.	17/6	Do. 3½ per Cent. Pref. Stock	88—90	3	18	0	Ja Ap, Jy, O	89½	88
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105—107	3	14	9	May, Nov	106½	106
10	2/6	Eastern Extension	13½—13¾	5	1	9	Ja, Ap, Jy, O	13⅝	13½
St.	4%	Do. 4 per Cent. Deb. Stock	106—108	3	14	3	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	101—103	3	18	6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3	18	5	May, Nov	..	..
10	5/0	Gt. Nrthn. (of Copenhagen)	29—29½	6	1	6	Jan, July	29¼	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	101—103	4	3	2	June, Dec	..	..
25	12/6	Indo-European	44½—46½	5	7	6	May, Nov	45	44
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	98—100	4	0	0	June, Dec	..	..
10	4/0	† West African Telegraph Shares	7½—7¾	5	3	2	..	..	..
2½	..	West Coast of America	½—¾		..		..	..	..
100	4%	Do. 4 per Cent. Debs.	98—100	4	0	6	Jan, July	..	..
10	..	West India and Panama	½—¾		..		May, Nov	¾	¾
10	6/0	Do. 6 per Cent. 1st Pref.	7½—8	7	10	0	May, Nov	8	7⅞
10	..	Do. 6 per Cent. 2nd Pref.	6½—7½		..		May, Nov	6¾	6½
100	5%	* Do. 5 per Cent. Debs.	104½—105½	4	13	11	Jan, July	104½	..
10	5/0	Western Telegraph	13½—13¾	5	1	9	Mr, Jn, O, D	13⅝	13½
100	5%	* Do. 5% Debs. (2nd Series, 1908)	104—105	4	17	9	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101½—103½	3	18	0	—	103	..
		TELEPHONES.							
5	4/0	Chili Telephone (fully paid)	5½—6	5	16	8	August	5⅞	..
1	0/7½	Monte Video Telephone Ord.	¾—1		..		..	..	..
St.	6%	National Co. Pref. Stock	108—109	5	10	10	—	108½	107½
St.	6%	Do. Def. Stock	96½—97½	6	2	6	..	97½	96½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13—14	4	5	8	Feb, Aug	13⅞	13½
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12—13	4	12	4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5¾	4	18	0	Feb, Aug	5⅝	5½
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98—99	3	11	10	June, Dec	99½	98
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104½—105½	3	17	2	..	105½	104½
..	6/3	Do. Do. Prov. Certs, 35% to be pd.	67½—68½		..		..	68⅛	67¾
1	0/7½	Oriental	1⅛—1⅜	6	6	8	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1½—1¾	4	16	0	..	..	..
5	5/0	United River Plate	6½—6¾	5	15	7	July	6¼	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4	14	5	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	105—107	4	13	9	June, Dec	106½	106
		FINANCIAL, INVESTMENT, &c.							
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5—5½	5	9	1	—	..	..
10	2/0	Globe Telegraph and Trust	10—10½	5	7	3	Ja Ap, Jy O	10¼	10⅛
10	3/0	Do. 6 per Cent. Pref.	13½—14	4	6	9	Ja Ap, Jy, O	13⅝	..
100	6%	Submarine Cables Trust (Cert.)	119—122	4	18	0	April, Oct	..	..
..	6%	†Underground Elec. Rys. Co. of London 6% Profit Sharing Secured Notes	96½—97½	6	3	9	—	97½	—

In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

THE report of the serious breakdown at Bradford last week which we publish on another page will awaken in all electrical engineers a feeling of regret and of sympathy with the Electricity Committee of the Bradford Corporation and their electrical engineering staff. Their energy and resource has been taxed to the utmost during the past week, and they have worked unsparingly to restore the electric lighting of the city, which was completely interrupted by a breakdown of the cable network. Yet it is necessary that there should be a complete and searching inquiry into all the circumstances of the case, and that it should be ascertained with whom the responsibility for the disaster rests. Here we have not a case of the sudden failure of a particular machine or piece of apparatus or the result of a pure and unavoidable accident; it is evident that the failure is attributable to a gradual deterioration of the cables in the Bradford streets, and that no adequate steps had been taken to arrest its progress. The condition of the cable network must have been extremely bad to cause a disaster which necessitated the cessation of the whole supply for a day and night, and as this condition has been the result of a gradual deterioration it should have been detected and remedied one, two or even three years ago.

◆

WE have repeatedly urged the necessity of systematic tests of the networks used for electricity supply. The mere observation of the out-of-balance leakage recorded on the ammeter between the middle wire and earth is not a sufficient check,—it would be as reasonable to pretend to measure the current flowing through the feeders by the current supplied by the balancing transformer. There is no difficulty in measuring the actual insulation resistance of the entire network of mains day by day without interrupting the supply, and if this is done the supply-station engineer cannot fail to detect a constant increase in the leakage from the system.

◆

BUT apart from any matters of testing and inspection, it is evident that serious fault may be found with the design of the network. The City Electrical Engineer had apparently drawn the attention of his Committee to this in a report that was to have been considered on the very day that the breakdown occurred, but there can be little doubt that the fault in design should have been rectified long ago. We can hardly credit that it escaped the attention of the present Chief Engineer's predecessors, for it must have existed five or six years ago, and that he himself has only discovered it after having been a year in office. Many of the joint-boxes are of an old pattern and are not properly bonded, although there is a large system of electric tramways in the town; the distributing network is all connected up without fuses; and short lengths of live armoured cable were discovered, whose very existence was unknown to those who are now in charge. Moreover, from the fact that no part of the network could be saved from total disconnection for a day, it would appear that no proper districting of the system can have been employed, and the entire absence of fuses has added to the many difficulties experienced in setting matters right. Such a large and dense network as at Bradford should preferably be divided up into a number of main districts entirely independent from one another and fed by independent feeders, the connection between them being only through the station 'bus bars. These districts should be divided again into sub-districts inter-connected through fuses in the proper places, and each with its own feeder or feeders. If this is systematically carried out, a general disaster such as has occurred at Bradford should be impossible.

◆

In a Paper on "Means for electrifying the atmosphere on a large scale," read before the Physical Society a year ago (*The Electrician*, Vol. LII., p. 173), Sir Oliver Lodge pointed out the difficulties attending the use, on a practical scale, of delicate electro-static machinery for producing extra high voltages for fog-dispelling purposes. In experiments conducted on the roof of the University College in Liverpool he had successfully dispelled fog from a space some 50 to 60 yds. in radius, using a Wimshurst machine, yet he felt reluctant to approach the Liverpool dock authorities for applying the method for clearing the river Mersey of fog because electro-static machinery was hardly more than laboratory apparatus. In the same lecture Sir O. Lodge described and demonstrated means for producing the high voltages required with more robust machinery. A detailed description of these means will be found in the abstract of Sir O. Lodge's patent specification No. 24,305 of 1903, which we publish elsewhere in this issue. The high-tension unidirectional current is produced by a combination of a battery or dynamo with a high-tension transformer and mercury rectifiers. If a continuous-current source is used, the current is given a pulsating character by a suitable mechanical or electrolytic interrupter. The rectifiers are so connected that both half-waves of the alternating current from the transformer are used. This method of connection is similar to that employed for a like purpose by those who have experimented with the aluminium electrolytic "valve." Actual experiments on a more extensive scale are now wanted. We should like to know the cost of a given installation and the power required to drive it. It is conceivable that the power required may be considerable. The particles of matter suspended in the atmosphere have to be drawn together in clusters of particles, which have sufficient density to fall to the ground. Thus, in dispelling fog by electrical means, a certain weight of particles has to be moved through space, and by a very inefficient method probably. There is little doubt, however, that the dissipation of a London fog would be worth the value of many thousands of kilowatt-hours to the City of London; but it has still to be determined whether we have practical means at our disposal for utilising this power with efficiency for the particular purpose, and that these means are not too costly. Sir Oliver Lodge's line of research is promising, however, and we trust that it will be continued and that the method will eventually be tried on a practical scale.

◆

The brief note which we published last week announcing that the Local Government Board has refused sanction to the Stourbridge Urban District Council for an electric lighting loan comes as a corollary to the recent decision of Mr. Justice Farwell in the dispute between the Willesden Urban District Council and the Metropolitan Electric Supply Co. The Stourbridge Council have been rather badly treated at the hands of the Board. Last spring the Council sought sanction for a loan to enable them to build an electricity works in combination with their dust destructor which was practically completed. It was shown at the Local Government Board inquiry that it would be more economical for the Council to take power "in bulk" from the Midland Electric Corporation for Power Distribution than to generate it themselves, and the inspector stopped the inquiry so that they might consider more carefully this company's offer. The Council followed this advice, and have now sought sanction for a loan for a distributing network which would take power from the Midland Corporation. This sanction has now been refused on the ground that the Midland Corporation has no power to supply in Stourbridge. Contrary to other power companies, this company works under Provisional Orders and not under a special Act, and as recently decided in the case above referred to, a company has no power to supply outside the area covered by its Provisional Orders. As it is now purely a technical legal difficulty, the matter can easily be remedied by the Midland Corporation bringing in a late Bill before this Session of Parliament authorising it to supply power "in bulk" to the Stourbridge Urban District Council.

◆

In our Correspondence Columns will be found a letter from Mr. Justus Eck, in which he makes an appeal to the well-to-do and charitably-inclined to earmark some of their Christmas-gift moneys for a benevolent fund now in process of being organised for the electrical industry. We gladly give publicity to this appeal, but must admit that at first sight it would seem as if the electrical industry were in some danger of being burdened with an unnecessary multiplicity of such funds. To begin with, there is the Benevolent Fund of the Institution, and this, if properly supported and worked, should be able to deal with nine-tenths of the "deserving cases" to be found among electrical engineers.

◆

But electrical engineers, properly so called, constitute but a small fraction of the Grand Army which subsists, directly or indirectly, upon the electrical industry. There are mechanics and factory hands, engine drivers, stokers, dynamo tenders switchboard attendants, motormen and conductors, clerks and miscellaneous labourers. What of these and the hard cases which are not unknown amongst them? Is not a benevolent fund on a broader basis than that of the Institution Fund necessary for these? We are far from wishing to assert dogmatically that it is wholly unneeded, but we feel that there is a more excellent way, which would cover all cases except a few exceptionally hard ones, and these would, in our opinion, be better dealt with by the private and personal charity of friends, relations and employers.

◆

For the old age of clerks and the like there exists at the present moment the British Electrical Superannuation Fund, to which we have often directed attention, which is on broadest possible lines, and to which every electrical firm without a fund of its own would do well to belong. Then, again, there is a fund for electric tramway employees called the British Electrical Friendly Society. This society is now some three years old and some 2,000 strong. It gives sick pay to men when ill, death grants to cover funeral expenses, and on New Year's Day there will be inaugurated a promising scheme of old-age pensions. But the most laudable feature of both these funds is this: The companies concerned do not guarantee the funds or support them in a spasmodic manner as deficits arise, either of which courses would be distinctly demoralising. On the contrary, the companies regularly contribute every week or month a fixed sum proportionate to that contributed by the men, and this proportion, in the case of the pension scheme for tramway employees, increases as the individual employee's years of service increase. Quite recently a little paper dealing with the British Electric Friendly Society's affairs has been started, and it is intended to devote all profits arising from sales to the building up of a small fund to deal with hard cases among the society's own members.

◆

WE cannot help thinking that it is on these lines salvation must come. Charitable donations, falling, as it were, out of the clouds have a most marked tendency to sap the springs of effort. The community in the long run *must* rely upon the energy, integrity and self-help of its members. Therefore let employers encourage the growth of these valuable social assets by every means in their power.

◆

TRANSFORMERS for very high potentials—dangerous toys to-day but maybe commercial realities to-morrow—were built and experimented with by Prof. H. B. Smith and some of his students at the Worcester Polytechnic Institute, and their achievements are briefly recorded on another page of this issue. Most interest, from a designer's point of view, attaches to the construction of the secondary winding. It certainly speaks well for the general design that the Professor and his students were able to construct the secondary of this successful 500,000-volt transformer with No. 32 B. & S. wire, double cotton-covered only and wound "anyhow" on spools, which each developed some 8,000 to 9,000 volts. Of not less interest is the 200kw. 300,000-volt transformer, and it can only be regretted that the technical data given with regard to it are so scant.

Wireless Telegraphy to the Scilly Islands.—The submarine cable between Penzance and the Scilly Islands has broken down, and a system of wireless telegraphy is being employed by the Post Office authorities to continue the service.

McMillan Memorial Fund.—We have much pleasure in announcing that in consequence of the vigorous appeal by Mr. W. H. Patchell after the annual dinner of the Institution of Electrical Engineers on December 1st the subscriptions received towards the above fund have now brought it up to the full amount of £2,000 which it was always hoped by the committee to realise. The committee have reason to congratulate themselves on the generous response of the members on behalf of their late secretary.

Gift to Edinburgh University.—Sir Donald Currie has given £25,000 to the University of Edinburgh in response to an appeal for better provision for an extension of the teaching staff and for the promotion of research work. The donor has given his consent to the application of £5,000 out of the £25,000 to the purchase of a site for proposed new laboratories, if such an expenditure should be necessary. In response to the appeal £15,000 has now been received in addition to the sum given by Sir Donald Currie.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne—Pinheiros	Aug. 18, 1902	—
Boissi-Issa (Yemen)—Camaran	Oct. 23, 1902	—
Tarifa—Tangier	Jan. 16, 1904	—
Cayenne—Paramaribo	July 18, 1904	—
Jupiter Julets (Florida)—Nassau (Bahamas)	Oct. 20, 1904	Dec. 10, 1904
Sitka—Valdez (Alaska)	Nov. 11, 1904	—
Falmouth—Bilbao	Dec. 14, 1904	—

Snowstorm in West Fife.—A severe snowstorm, followed by a gale and much rain, was experienced in West Fife on Tuesday. In the morning snow lay on the streets to a thickness of 6in. in many places, but a thaw set in accompanied by torrents of rain and a gale of wind. The result was that the majority of the telegraph and telephone lines were damaged and the service disorganised. By the evening of Wednesday, however, things had assumed their normal conditions. The damage was greatest in Dunfermline.

Institution of Civil Engineers.—At the ordinary meeting of the Institution of Civil Engineers on January 10th, 1905, an address on "The Recent Visit to the United States and Canada" will be delivered by Sir William H. White, at 8 p.m. This lecture will be repeated on the following day at 3:30 p.m. for the benefit of members and their friends. On Friday, January 13th, Mr. James Swinburne will deliver a lecture at 8 p.m. to the students of the Institution of Civil Engineers on "Theory of Electricity and Magnetism."

The Nobel Prizes.—The awards of the Nobel prizes have now been published. That for Physics has been awarded to the Right Hon. Lord Rayleigh, F.R.S., and that for Chemistry to Sir William Ramsay. The distribution of the prizes took place on Saturday, December 10th, in the Great Hall of the Academy of Music, Stockholm, in the presence of King Oscar. A banquet followed, at which nearly 200 guests were present. It was stated in *The Times* on Tuesday that Lord Rayleigh intends to present the value of his prize to Cambridge University. The sum of money attaching to each Nobel prize is about £7,825.

Flooding of the New York Subway.—On Wednesday morning a water main which burst in Eighty-sixth-street, New York, was the cause of an unpleasant experience upon the recently opened electric subway railway in New York. The water overtook several trains and flooded them to a height of several inches above the floor of the carriages. The passengers had to stand upon the seats, and something approaching a panic resulted. Fortunately the water did not rise any higher before the trains were withdrawn, but a portion of the subway wall in Seventy-second-street, being loosened by the water, caved in and blocked the line.

Paris Automobile Show.—President Loubet opened the seventh international automobile show at Paris last Friday in presence of great crowds of visitors, who unanimously agreed that the latest show surpassed the former ones not only in size, but also in the quality and luxuriousness of the cars exhibited. It was also noticed that the present show was much more international in character than was previously the case. There are a number of electric vehicles exhibited, and some of the petrol cars are lighted by electricity. A heavy Krieger lorry, intended for military purposes, is fitted with an electric searchlight.

"The Central."—The fourth number of "The Central," the journal of the Central Technical College Old Students' Association, has just been issued. It contains a short illustrated article on the Manhattan Railway power station by W. A. del Mar; the second instalment of Prof. H. E. Armstrong's article on "Mechanism of Combustion"; an illustrated description of the transmission and distribution system on the North-Eastern Railway, by S. B. Price; an article on "The Vacuum Cleaner Machine," by H. C. Booth; notes on an Australian Sugar Refining Company and on Egypt, by Dr. G. Harker and C. Collingwood respectively; and the usual article on the College Session, as well as notes on what some of the old students have been doing recently. These latter notes are now arranged under the headings of the various years, so that readers may find the names of their old fellow students without reading through all the notes.

Royal Commission on London Traffic.—Two private sittings of the Royal Commission on London Traffic were held at the Westminster Palace Hotel on Thursday and Friday last week for the purpose of considering the preliminary report of the technical advisory board, which consists of Sir John Wolfe Barry, Sir Benjamin Baker and Mr. W. Barclay Parsons. This report deals with the engineering and other technical considerations involved in the numerous proposals put before the Commission, but it is understood that it does not comment upon any specific schemes which have at any time been presented to Parliament. No decision as to further public sittings of the Commission has yet been arrived at.

Electric Power at the "Scotsman" Offices.—In our article dealing with this subject, which appeared on p. 279 of *The Electrician* for December 2nd, the following list of contractors was inadvertently omitted :—

Messrs. Aitken & Allan (Edinburgh), Shafting, gearing, &c.
Messrs. Anderson & Munro (Edinburgh), Lighting and power mains.
Messrs. Wm. Barton & Sons (Edinburgh), Branch wiring and fitting connected with the lighting.
Messrs. Bergtheil & Young (London), Bullock "teaser" equipments.
British Electric Plant Co. (Alloa), Motors.
Messrs. Bruce Peebles & Co. (Edinburgh), Motors.
Brush Electrical Engineering Co. (Loughborough), Motors.
Messrs Ernest Scott & Mountain (Newcastle), Motors.
Union Electric Co. (London), K. & M. arc lamps.

Retirement of Mr. H. A. C. Saunders.—Mr. H. A. C. Saunders, electrician-in-chief of the Eastern and Associated Telegraph Companies, having decided to retire at the end of the current year from active service, his colleagues and friends have arranged to recognise this event suitably and at the same time to commemorate his 50 years' connection with submarine cable enterprise by presenting him with a testimonial at a dinner (to be held at the Trocadero Restaurant on Wednesday, January 18th next) at which Sir John Denison-Pender, K.C.M.G., has kindly consented to preside. Subscriptions to the testimonial can be forwarded to Mr. A. R. Hardie (Electra House, Finsbury-pavement, E.C.). The cost of the dinner tickets, including wines, will be 25s. each.

Speed Limits.—The secretary of the Tramways and Light Railways Association has addressed a letter to the President of the Board of Trade on the question of tramway speed limits. In this a strong appeal is made that speed limits on tramways should not be more stringent than the limit for motor cars, and especially for motor omnibuses on the same road. Under sec. 9 of the Motor Car Act, 1903, the limit for motor cars is 20 miles an hour, unless a lower limit is enforced, (*a*) on the petition of the local authority, or (*b*) by the order of the Local Government Board, and this limit can never be less than 10 miles an hour. There is no scientific reason, the letter points out, why tramcars should not safely be allowed to run as fast as motor cars, except on very sharp gradients. The matter is recommended to the attention of the Board of Trade, and interests both of the travelling public and of private or municipal capital embarked in tramways.

Society of Engineers.—The fiftieth annual general meeting of the Society of Engineers was held on Monday, December 12th, at the offices of the Society, 17, Victoria street, Westminster. The chair was occupied by Mr. D. B. Butler, president. The following gentlemen were duly elected as the council and officers for 1905 :—

President, Mr. Nicholas James West ; vice-presidents, Messrs. Maurice Wilson, Richard St. George Moore, and Joseph William Wilson ; ordinary members of council, Messrs. Joseph Bernays, George Abraham Goodwin, George Green, William Henry Holttum, Edward John Silcock, Diogo Andrew Symons, John Aird, and Alexander Graham Drury ; honorary secretary and treasurer, Mr. George Burt ; honorary auditor, Mr. Samuel Wood.

The president announced that the following premiums amongst others had been awarded by the council for Papers read during the past session—viz., the president's gold medal to Mr. William Edward Storey for his Paper on "Condensing Machinery," a Society's premium of books to Mr. A. S. E. Ackermann for his Paper on "British and American Coal-cutting Machines."

Technical Education.—On Monday a deputation from the Association of Chambers of Commerce waited upon Lord Londonderry, President of the Board of Education, with the object of securing increased Government aid to higher technical and higher commercial education. Sir William Holland, M.P., introduced the deputation, which included Sir Albert Rollit, Lord Shaftesbury, Lord Brassey and representatives from 12 Chambers of Commerce, in addition to London. After several speeches Lord Londonderry said it seemed that the deputation was of the opinion that the Board of Education could accomplish a good deal more than it was really capable of doing. With regard to technical education he referred the deputation to a letter written by Mr. Morant to the London Chamber of Commerce on Sept. 26, and devoted his speech to the question of commercial education. In this connection they could rely upon the Board of Education to give aid commensurate with the requirements.

Train Resistance.—In concluding a very interesting article on "Train Resistance" in the *Street Railway Journal* of New York, Mr. W. J. Davis suggests the following formula for computing the total resistance offered to a moving train :—

$$R = b + cV + \frac{dAV^2}{T}[1 + m(n-1)].$$

Where n = number of cars in train, including leading motor car, all of which are assumed to be of equal cross-section ; R = friction in pounds per ton ; V = velocity in miles per hour ; T = weight of train in tons of 2,000lb. ; A = cross section of train in square feet ; c = combined journal and rolling friction coefficient ; d = wind pressure coefficient ; m = coefficient showing proportional section of trailing car considered as affecting total windage. Based upon tests on the Buffalo and Lockport Railway and other data available, the following values are offered for the various coefficients : $b = 3{\cdot}5$ for heavy loaded freight cars ; $b = 4$ for standard passenger coaches or large electric interurban cars ; $b = 5$ to 6 for light electric cars with grease lubrication ; $c = 0{\cdot}11$ for heavy track construction ; $c = 0{\cdot}13$ for medium track construction ; $d = 0{\cdot}0035$ for open platform cars ; $d = 0{\cdot}0024$ to $0{\cdot}0030$ for vestibuled electric cars ; $m = 0{\cdot}10$. The cross-section of the car includes the space bounded by the wheels between the top of rails and body.

King's College Engineering Society's Dinner.—The eleventh annual dinner of King's College Engineering Society was held at the Hotel Cecil on Saturday evening, Prof. J. M. Thomson, LL.D., F.R.S., being in the chair. After the usual loyal toasts had been duly proposed and honoured, the vice-president, Mr. G. R. Kinder, proposed "Our Guest." In his reply Sir Wm. White modestly said that he was tired of hearing of his shipbuilding achievements, although he had been responsible for the design of about 250 battleships, and he had made a greater demand on the public purse of this country than any living man. The next toast was that of "The College and Staff," ably proposed by Mr. R. A. Helps, hon. treasurer of the Society, who referred to King's College as the oldest technical institution in the country. Prof. Capper, in replying to this toast, said it behoved them to keep up their classics and sports and not narrow their sympathies and education. He deprecated the centralisation of teaching which was being pushed forward by the London University, as it tended to produce narrow-minded men. In proposing "The Engineering Society" the chairman said that although he was not an engineer, yet he had taught engineering students for 33 years, and had absorbed a certain amount of engineering himself in the process. The president, Mr. A. M. Finlayson, then replied, and said that the existing membership of the Society constituted a record. There were not enough Papers read by students and he urged his hearers to remedy this defect. With regard to the athletic achievements of the Society, he was not able to say much, but he was very glad that they had secured the shield in the shooting competition, and this was chiefly owing to the fact that no other faculty had competed. The speeches were interspersed with musical selections by Profs. Wilson and Waynforth and Mr. G. A. P. Thomas. The dinner secretaries, Messrs. B. G. Cooke and F. W. Cramer-Roberts are to be congratulated on the success which attended their labours.

Electric Light and Power in South America.—In an article in the *Electrical World* of New York, Mr. Victor M. Arana affirms that few are aware of the rapid progress made in the introduction of electric power in South America. Ten years ago there was not an electric railway system, few of the capital cities boasted of electric lighting plants, and the use of electricity for industrial purposes was not dreamed of. Now, however, a veritable transformation is taking place in the southern continent. Every town of some importance wishes to be up-to-date, and importers, contractors and engineers have more than they can do in introducing and installing electric railway, lighting and power plants. The latest electric labour-saving devices and power appliances are being introduced in regions where formerly the use of mechanical power in any form was hardly known, and where even the steam engine was a rare luxury. About three-fourths of South America is composed of deep valleys, high plateaux and chains of mountains. This peculiar configuration of the territory, which is everywhere lined with streams, varying in size from gigantic rivers of the Amazon type to shallow six-month streams, affords innumerable waterfalls, some of which could certainly rival Niagara in volume of water and the Californian mountain streams in abruptness of fall. If to this be added the unusual facilities afforded by governments to industrial enterprises, and the prosperous condition of the majority of those countries, the magnitude of the movement is at once apparent. Buenos Aires, the progressive capital of Argentina, is the most important seat of electrical industries in South America, and has six large railway, lighting and power companies. The power stations are in the outlying districts of the city and current is generated and distributed at voltages ranging between 1,000 and 6,000 volts, which is stepped down for use by means of transformers placed in sub-stations and cellars. The cost of power varies from 2 to 15 cents. per kw. hour, depending on the quantity, voltage of supply and location of the consumer. The generating stations use, to a great extent, American machinery and supplies, and the street car lines, American motors and other railway apparatus exclusively. Although the promoters and capitalists are from different countries, the control and management are mostly under Argentines or native Europeans who have become naturalised citizens.

University of Birmingham.—A new Chair of Electrical Engineering has been established in the University of Birmingham as a supplement to the Lectureship in the same subject so admirably held by Dr. D. K. Morris. The first occupant of the Chair will be Mr. Gisbert Kapp, now lecturer at Charlottenburg. He is not expected, however, to return to this country until the autumn of next year, and his appointment will not take effect till October, 1905. Meanwhile, and subsequently, Dr. Morris and his staff will continue their work as before. The new and large buildings for the Department will be ready by that time. Prof. Burstall will continue to occupy his Chair, the title of which will be changed to "Mechanical Engineering," and he will have control over a great engineering block and the power station. It is not improbable that a special Chair of Civil Engineering in the narrower sense will be established. It is certain that a competent assistant will have to be elected to assist Prof. Kapp in the drawing office for dynamo and central station design. Mr. Kapp, who was born in Vienna, has spent a large portion of his life in England. His first employment here was with Messrs. Gwynne & Co., in 1875. He relinquished this and after a few years' absence he returned to take up the appointment of engineer to the Chelmsford works of Messrs. Crompton & Co. in 1882. In 1885 he severed his connection with this firm and later on commenced practice as a consulting engineer. During this period he was a frequent contributor to *The Electrician* and other technical journals, and also read many Papers before the various scientific societies including the Society of Telegraph Engineers and Electricians, the Institution of Civil Engineers and the Society of Arts. In 1894 he accepted an appointment in Berlin as secretary of the Verband Deutscher Elektrotechniker, and at the same time the editorship of the *Elektrotechnische Zeitschrift*. Since then he has also been appointed a lecturer on electrical engineering at the Technical High School, Charlottenburg. The appointment at Birmingham, by which Mr. Kapp returns once more to England, carries with it the right to undertake a certain amount of consulting work. Thus Mr. Kapp will be able once more to come into close touch with the industry here, and his presence in England will doubtless lead to a welcome re-appearance at the meetings of the Institution of Electrical Engineers.

Northampton Institute.—The annual prize distribution and conversazione took place at the Northampton Institute, St. John's-street-road, Clerkenwell, on Friday and Saturday last. Mr. L. B. Sebastian, chairman of the governing body, was in the chair, and the prizes were distributed by Lord Reay. There was a large attendance. Dr. R. Mullineux Walmesley, in presenting his report for the season 1903-4, said that the number of student hours worked during the year was 107,000, an increase of 13 per cent. on the corresponding figures for the preceding session. This increase would have been larger had it not been found necessary to stop the enrolment of students in certain of the classes in the electrical engineering department owing to lack of space. This same feature was very much accentuated during the present session, several of the important classes being immediately filled and numbers of students being turned away. The effect of this condition of things was serious, for besides being unable to accommodate the number of students wishing to attend, want of space prevented the further development and improvement of the teaching in these classes. Another matter to which prominence was given in the report was the change brought about by the London Education Act of last year, and to which was ascribed another cause of the arrest of the educational work of the Institute. The enormous amount of detail work involved in the merging of the Technical Educational Board of the London County Council in the new education authority had led to the postponement of the further consideration of carefully thought out plans which had reached the stage of being submitted to the old Technical Education Board, these plans having already been favourably considered by that Board. Dr. Walmesley expressed the hope that this postponement would only be temporary. The work of the Institute generally, however, has maintained its usual high standard. Mr. L. B. Sebastian, in introducing Lord Reay, pointed out that another disadvantage which the Institute had suffered in consequence of the change of the educational authority in London was that no equipment grant had been received this year. He could only hope that they would receive an increased grant next year. Lord Reay, before distributing the prizes and certificates, reviewed in detail the work of the various departments of the Institute. He then dealt with the question of the place of polytechnics in the educational system. The time had come, he said, when their position should be clearly defined. With good organisation there should be no overlapping, for it was his opinion that polytechnics should take no part in secondary education of any kind.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, December 16th.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER STUDENTS' SECTION.

7:30 p.m. Meeting at the Municipal School of Technology. Paper to be read: "Battery and Booster Working," by E. D. S. Shelmerdine.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:30 p.m. Meeting in the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Included in the business of the evening will be the discussion on Mr. W. R. Cummins' Paper on "A Comparison of Vertical and Horizontal Tubes in Water-tube Boilers."

MONDAY, December 19th.

FARADAY SOCIETY.

8 p.m. Ordinary Meeting at the Institution of Electrical Engineers, 92, Victoria-street, Westminster. The following Papers will be read: (1) "The Electric Furnace: its Origin, Transformation and Applications" (Part II.), by Adolphe Minet; (2) "Electrolytic Analysis of Cobalt and Nickel," by F. Mollwo Perkin and W. C. Prebble; (3) "The Electrolytic Preparation of Tin Paste," by F. Gelstharp; (4) "Note on the Electrolytic Recovery of Tin," by F. Gelstharp.

THE METROPOLITAN RAILWAY.

The opening of the newly "electrified" Metropolitan Railway took place on Tuesday with a marked absence of the ceremonial which usually accompanies such functions—not that the event was any the less important, but simply because the directors desired to do the deed as quietly as possible. Prior to the running of a special train to Uxbridge and back, a luncheon was given at the Hotel Great Central, at which Sir Charles McLaren, Bart. M.P., chairman of the company, presided. At the conclusion of the luncheon, the chairman said that the Metropolitan was, to a certain extent, in the hands of the District Company, but a satisfactory arrangement had been arrived at between the two, whereby there would be an interchange of electrical energy at suitable points. When the line had been properly cleaned up—as it certainly would be—he thought it would be second to none in London. A special feature was the great width of tunnels, these having been built originally for the old broad gauge rolling stock of the Great Western Railway. He was quite convinced that they must give the public the most up-to-date facilities in order to capture the traffic, but he also mentioned incidentally that they had been compelled to "electrify" by force of public opinion and the Board of Trade. An adjournment was then made to Baker-street Station where a special train was awaiting the guests to convey them to Uxbridge. The run was a complete success in every respect, there being no comparison between the new electric rolling stock and that of the old steam days.

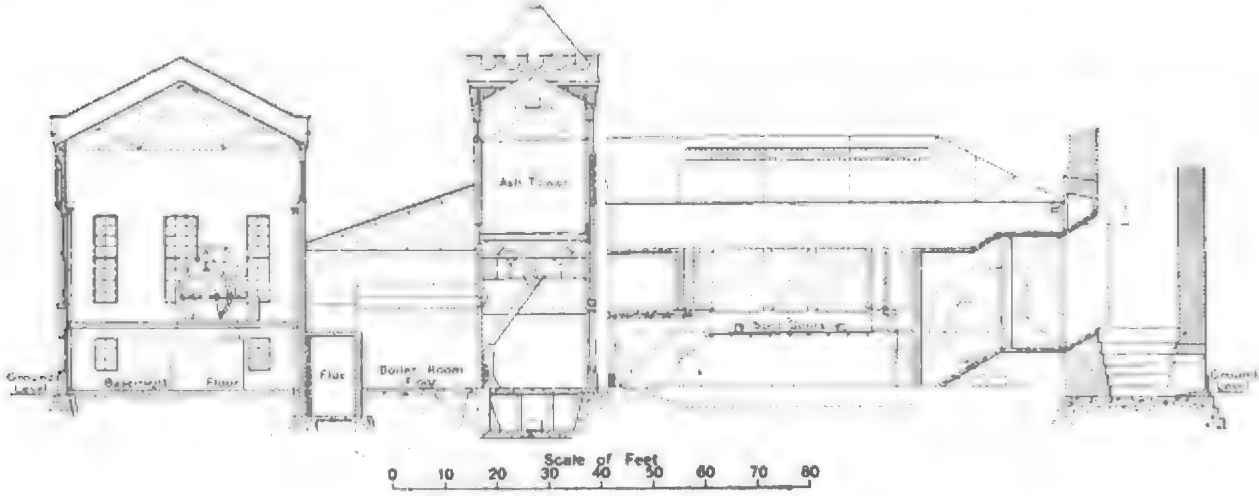

FIG. 1.—CROSS-SECTION OF POWER STATION.

Situated at the northern extremity of the Metropolitan Railway Co.'s Neasden works and yard is the particularly fine power house which has been erected for supplying electrical energy to the entire system. Referring to Fig. 2, which is a plan of the station, showing pipework, &c., it will be observed that the building has been designed to accommodate four turbo-generators. As a matter of fact, two of these are running on load, the third is being put down and the fourth is already on order. On entering the engine room one is struck by its great length compared with its width. This feature may be gathered from the illustrations, and it may be mentioned that the entire building covers an area of 32,130 sq. ft., its length being 318ft. and its width 101ft. There is, of course, plenty of room for extensions when these are required.

Coal is brought in by rail in the company's own trucks, to the coal-crushing, elevating and conveying plant (Fig. 4), and there emptied into a receiving hopper capable of holding the contents of a standard British waggon. Beneath this receiving hopper there is placed an automatic feeder of the jigging type, which keeps the crusher (fixed immediately underneath the feeder) supplied with coal. This feeder also acts as a screen, which enables the small coal to pass by the crusher instead of passing through, the small going direct to the automatic filler of the conveyor. The large coal, which falls over the end of the jigging feeder or screen, passes into the crusher, and, after being crushed or broken to the required size, rejoins the small by-pass coal in the filler of the conveyor. The filler is so constructed as to fill each bucket of the conveyor without spilling any coal outside the buckets, which are of the tilting or gravity type. Fourteen sets of tilting gear of a substantial design are provided and fixed to the longitudinal channels carrying the conveyor rails over the bunkers. One set of tilting gear is fixed over the ash bin, and all tilting gears are arranged so that they can be easily shifted to enable the coal or ashes to be delivered at any desired point.

The conveyor is driven by a 15 B.H.P. motor manufactured by the British Westinghouse Co. This motor has a speed of 525 revs. per min., and on the shaft there is fitted a raw hide pinion which in its turn drives the train of wheels, thereby reducing the speed down to that required by the driving shaft of the conveyor. The receiving hopper has a capacity of 8½ tons, is 14ft. long, 7ft. wide, approximately 9ft. deep, and is located over the crusher pit at one side of the coal track. One of the bottom plates of the hopper is provided with a door consisting of a $\frac{5}{16}$in. wrought-iron plate working in slides. The door is regulated by means of a pinion on a spindle turned by a large hand-wheel, the pinion engaging with a rack on the door. It is arranged with set screws so that it can be adjusted in any desired position to regulate the flow of coal into the jigger feeder. The crusher is of Messrs. Graham, Morton's standard four-roll design, and has a capacity of 40 tons per hour which is also the capacity of the conveyor. Power required for driving the crusher is provided by a 15 B.H.P. motor fixed in a convenient position close to the crusher and connected to the same by means of a train of wheels and the necessary countershaft, then from the countershaft to the crusher by means of leather belting.

This conveyor carries the coal up and empties it into the coal bunkers, which have a capacity of 2,000 tons. From the bunkers coal gravitates through travelling shoots to the boiler furnaces. Each shoot is in the form of an inverted Y, each of the branches delivering coal to one side of the grate. As the coal falls it is automatically weighed by Avery weighing machines and the weight registered. It may be mentioned that it has not yet been definitely decided exactly what coal will be used, but it will probably be nuts, having a calorific value of 12,000 B.Th.U. per pound and costing about 6s. at the pit's mouth. The boilers, of which there are at present 10, are of the Babcock & Wilcox water-tube type. Each is capable of evaporating 20,000lb. of water per hour, to steam at a pressure of 180lb. per sq. in., and superheated by 100°F., the final temperature of the steam being about 520°F. in

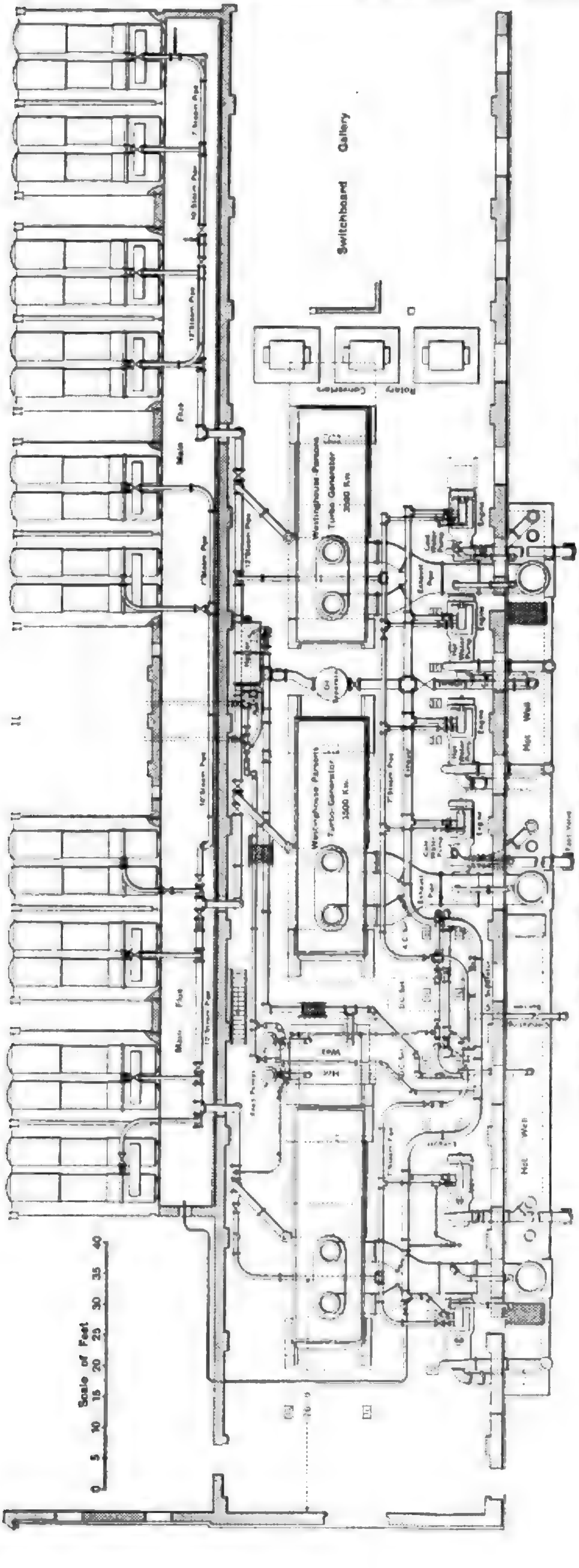

FIG. 2.—PLAN OF POWER STATION, SHOWING GENERAL ARRANGEMENT OF PLANT AND STEAM PIPING.

the main steam header. Each boiler has a heating surface of 5,730 sq. ft. and is equipped with a type of grate and stoker which is somewhat uncommon in this country, although largely used in America. This is of the Roney pattern (*The Electrician*, Vol. LI., p. 154), in which the grate itself consists of a large number of short fire bars capable of partial rotation about their longitudinal axes. The degree through which the bars rotate may be varied from the boiler front, by the adjustment of a screw and the periodic turning movement to which they are subjected is effected automatically by means of shafting driven by spur gearing from a 5 H.P. Westinghouse steam engine. Each one of these engines works three stokers. The effect of rocking the bars in the manner described is to cause the coal to travel from the top to the bottom of the grate, which slopes at an angle of about 45deg., at any predetermined velocity; this velocity depends, of course, on the number of times per minute the bars are rocked and on the angle through which they are caused to oscillate. When the coal has reached the bottom of the grate it—or rather the ash—is dumped into the ash pit through dumping plates swung at the lower end of the grate, and opened and closed by means of long handles worked from the front of the boilers. As a matter of fact, combustion is very complete with this type of grate and stoker, as is evidenced by the appearance and nature of the ash. Both forced and induced draught plant is installed, but on light loads natural draught is found to be quite sufficient. On heavier loads forced draught is employed, and sometimes induced draught. After the ashes fall into the ash pit they are sprinkled by hand and shovelled on to the conveyor which travels down to the other end of the boiler house and comes back under the firing floor after having deposited coal in the bunkers. The ashes are carried along and dumped in the ash tower, Fig. 1, from whence they gravitate to the railway waggons and are then suitably disposed of. Thus, a waggon coming in laden with coal, may be unloaded and filled with ashes, being sent off again immediately. The main flue is 8ft. 7½in. in width, but as shown in Fig. 2, it is divided in the middle opposite the chimney. A brick wall keeps the two parts separate until the chimney itself is reached. This, of course, involves the placing of the economisers in two separate compartments and an induced draught fan is installed in each compartment. Green's economisers, having 1,760 tubes 10ft. in length and 4in. in internal diameter, are arranged in four banks. Three-phase motors are employed for driving the scrapers. The chimney is 200ft. in height and 15ft. in diameter.

One very excellent feature in connection with the station is its splendid water supply. Two artesian wells 400ft. in depth have been bored, and all make-up water is obtained from these by means of air-lift pumps manufactured and supplied by Messrs. Davey, Paxman & Co. These pumps are worked by a pair of horizontal simple girder steam engines, whose cylinders have a diameter of 12in., the stroke being 24in. Each engine is fitted with a flywheel of 8ft. 6in. diameter and 12in. in width. They run at a speed of 80 revs. per min., and the working steam pressure is 150lb. per square inch. The piston and valve rod glands are fitted with United States metallic packing. Paxman's patent automatic expansion gear is fitted on the engines. In each case the air cylinder is placed behind the steam cylinder, and is mounted on an extension of the engine bedplate. It is driven directly from an extension of the steam piston rod, to which the air-pump rod is connected by means of a suitable cottered coupling. The diameter of the air cylinder is 14in. and the stroke 24in.; it is capable of compressing air up to a pressure of 80lb. per square inch. An air receiver, 10ft. in length by 4ft. in diameter, is provided with each engine, and is constructed for 150lb. to the square inch working pressure.

Two vertical direct-acting pumps (Fig. 5) for feeding the boilers have been supplied by Messrs. G. & J. Weir. These are of the tandem compound type, the high-pressure cylinder being set above the low-pressure cylinder. The steam is used expansively in each steam cylinder, the object being to slow down the speed of the piston towards the end of the stroke. This latter is a most important factor in the working of a direct-acting pump, avoiding the sharp return or shock at the end of the stroke, which is usually attended with the loosening of screws, breaking of joints and injury to the material. The water cylinders of the pumps are 12¾in. diameter, with 14¼in. high-pressure and 25in. low-pressure cylinders, the stroke being 27in. Each pump, when working under normal conditions of piston speed and steam pressure, is capable of delivering 15,900 gallons per hour against a boiler pressure of 170lb. per square inch when working with steam at 160lb. The pump ends are of cast iron, lined with gunmetal, and the pump rods are of cold-rolled manganese bronze. Weir group type water valves are employed, and the valve seats are of gunmetal. The water pistons are of gunmetal, fitted with special ebonite packing rings. All parts of the pump are readily accessible.

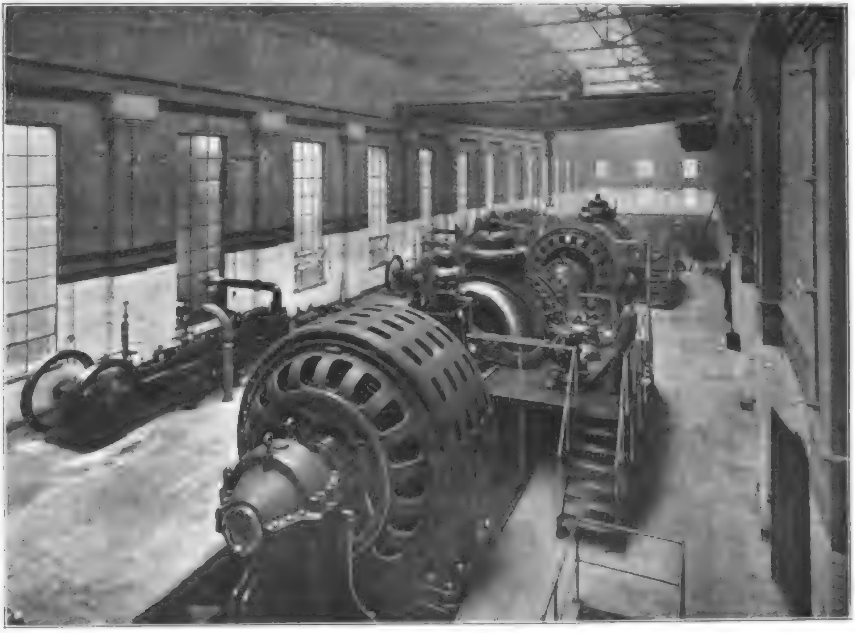

Fig. 3.—General View of Engine Room.

All well water is passed through an automatic water softener (Fig. 6) before being allowed to enter the boilers. This softener was supplied by the Harris Patent Feed Water Filter Co., and is capable of softening 13,000 gallons per hour of well water. The cold lime process is employed, and the principle of the softener was fully described in *The Electrician*, Vol. XLIX., p. 782. Briefly, the apparatus consists of a distributor, by which the correct proportion of water is diverted to two lime tanks, in which the lime water is prepared continuously from milk of lime by the aid of an automatic air agitator. By ingenious mixing arrangements, and two pairs of treatment and settling tanks, the necessary reaction and the deposition of the resulting sludge is effected. The water is finally filtered before being conducted away for use. The boiler feed arrangements are in duplicate, and the feed water may be heated either by means of a feed-water heater supplied with steam from the exhaust of the steam driven auxiliaries, or by passing it through the economisers. On the other hand, it may, by means of suitably arranged valves, be caused to pass through both the heater and the economisers, or may be fed directly to the boilers.

Coming now to the turbines, it will be seen, from Fig. 1, that the steam piping to them from the boilers is quite simple. There are four turbines of the Westinghouse-Parsons single-cylinder, double flow, four-stage type, the steam pressure at the stop valve being 165lb. and the superheat 100°F. The permissible overload is 50 per cent., and is dealt with by an automatic by-pass. It is claimed by the makers that the use of superheated steam effects a reduction of close upon 2½lb. of steam per electrical-horse-power hour at full-load, and proportionate reductions at other loads. Steam enters at the centre of the cylinder, and passes through a series of nozzles and impulse blades, this operation being repeated until the steam has expanded to about atmospheric pressure. After this it passes through a series of pressure blades on the Parsons principle until the exhaust is reached. As the steam enters at the centre and flows both ways, the shaft is kept in perfect equilibrium; thus, all end thrusts are eliminated, and the necessity for balance pistons, &c., to take up the same is done away with. A thrust block, however, is fitted at the extreme end of the cylinder, but this is only for the longitudinal adjustment of the moving part. The rotating portion consists of a rolled steel drum, a forged steel umbrella-shaped disc being shrunk into each end. The high carbon steel spindle ends are pressed into these discs at the same time, with the result that the whole makes an extremely light though strong construction. As each part can be machined all over, the balancing difficulties met with in cast steel and other unhomogeneous materials are virtually eliminated. The first series of blades are let into the dovetailed grooves of the cylinder and spindle. All low-pressure blades are of special metal, this material preventing any corrosion due

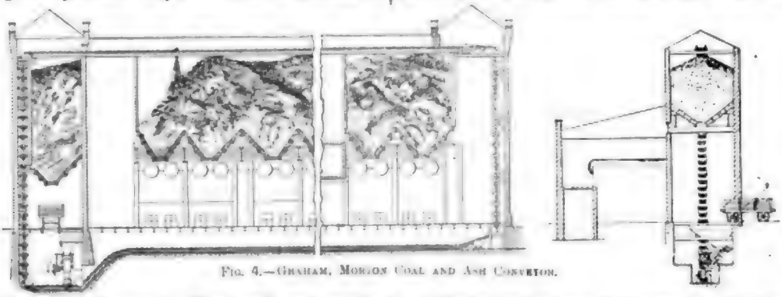

Fig. 4.—Graham, Morton Coal and Ash Conveyor.

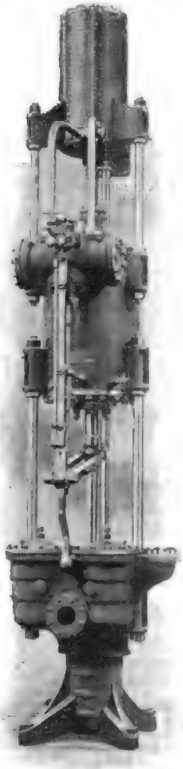

Fig. 5.
Weir Direct-Acting Feed Pump.

to wetness of the expanded steam. The bearings are of cast iron, with babbitt metal linings, and have spherical seats, the latter being water-jacketed. Keys, liners, &c., are provided to admit of the finest adjustment. The forged steel coupling connecting the turbine and generator is of the flexible claw type, and runs in oil. It transmits the full power of the shaft, and at the same time has sufficient latitude to allow the generator and turbine shaft to revolve about independent centres, so that any want of exact alignment is immaterial. The arrangement of valves is as follows: Steam enters through a main disc-type stop valve, which is connected through gear wheels, with a hand wheel on the platform. It then passes through an emergency shut-down valve, steam strainer, and governor valve of the double-seat poppet type into the cylinder. A centrifugal governor (Fig. 7) directly driven through gearing from the turbine shaft, operates the poppet valve C through a small steam relay E, the points A A being fixed so that this admission valve is directly controlled by the speed of the turbine. Continuous reciprocatory motion is given to the relay valve through the rod F, and steam is thus delivered to the turbine in puffs, the duration of which depends upon the load. At the end of the turbine shaft opposite to that at which the centrifugal governor is attached is fitted an emergency governor. The latter is set so that should anything happen to the centrifugal governor, and the speed of the turbine reach a predetermined maximum, the emergency governor will come into operation and open a small valve, which in its turn will close the emergency throttle valve above referred to. A central lubrication system is provided, oil being supplied under pressure to each machine, a small oil pipe leading up from the main to the centre of each bearing. An oil reservoir is situated over the coal bunkers, and the oil gravitates from this to the piping system. A pressure of from 7lb. to 15lb. per square inch above atmospheric pressure is obtained, and after passing through the bearings, the oil is led to a filtering tank, whence it is pumped back to the reservoir to be used over again. Electric regulation of the turbine from the switchboard is provided, the device consisting of a small motor, which causes a weight to traverse a lever. The normal speed is 1,000 revs. per min., and it is interesting to observe that although only the low-pressure blades are laced in the two sets at present installed, it is intended to lace all the blades in the third set. There are no fewer than 100,000 blades in each turbine and their lengths are 1⅞, 2⅞, 3⅞ and 5⅜in. After passing through the turbine steam leaves at both ends, the exhaust pipes being carried under the floor and subsequently merged into one. The condensers are of the barometric ejector type, the hot and cold water pumps being situated in the basement of the building. Each condenser has its own pumps, and forms, with a turbine, one complete unit. The condensed steam and circulating water fall by gravity into the hot well, which extends along the entire length of the station. From here the requisite amount of feed water for the boilers is obtained, the remainder, which, of course, constitutes the bulk, being pumped up to the top of the cooling towers.

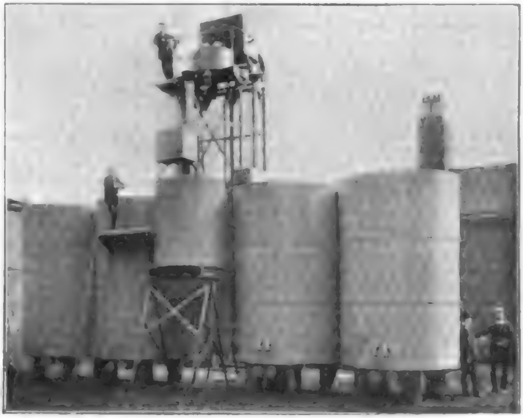

Fig. 6.—Harris-Anderson Feed Water Softener.

The cooling tower installation (Fig. 8) consists of six "Duplex" towers forming altogether 12 single units. They are sub-divided into three sets, each set consisting of two "Duplex" towers constructed in such a manner that by means of a suitable arrangement of pipes and valves any one section can be worked independently of either of the other two. Each section corresponds to a condensing set, and for the sake of illustration may be numbered 1, 2 and 3 respectively, and with the aid of the pipe and valve arrangement above mentioned they can be so adjusted that No. 1 condensing set could work in conjunction with either 1, 2 or 3 of the cooling tower installation or, if necessary, all of them, and the same with Nos. 2 and 3 of the condensers. Each tower is capable of dealing with 205,000 gallons of water per hour and each section double this quantity, the combined capacity of the three sections when working at maximum load consequently being 1,230,000 gallons of water per hour. Under average conditions of climate these towers will cool the water from 110°F. to 80°F. when passing the full volume of water.

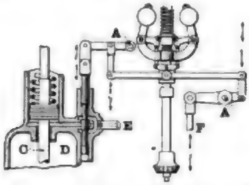

Fig. 7.—Westinghouse–Parsons' Steam-Turbine Governor.

Each tower is 105ft. long by 26ft. 6in. wide by 75ft. high, the water being admitted at three different points at a height of 25ft. above the foundation level. The hot water from the condensers is conveyed in a riveted steel main pipe of 28in. diameter, a similarly constructed pipe of 20in. bore feeding into this from each of the three condensing sets, suitable connections being taken from the main pipe to each section of the cooling tower installation, and the three inlets to each tower are eventually reduced to 10in. diameter. A shallow tank constructed of concrete is situated beneath the towers for the purpose of collecting the water, the ground having been excavated for this purpose, so that the top of the tank is practically level with the surrounding ground. This tank is sub-divided by means of walls into three sections to correspond with the sections of the cooling towers, and the three tanks thus become separate and independent of each other or can be worked as a whole. This is accomplished by means of a suitable arrangement of penstocks. At each side of the tank a culvert is constructed about 9ft. in width, and into these the cooled water from the tank is discharged by means of the penstocks, the water then being conducted into a large lake some considerable distance beyond the towers. If necessary, however, the plant can be worked independently of the lake, but as a rule the water will be caused to circulate through the towers and into the culvert at the side furthest from the power house and from thence into the lake, returning by the other side. Branches are taken from the culvert which conduct the water into wells from which the circulating pumps for the condensers take their supply. The towers are of the natural draught chimney type, there being no spray, the hot air and steam being carried to such a height as to prevent any nuisance arising from this source. Zschocke's patent hurdles and well-known water-distributing system are provided. The hurdles themselves consist of a number of wooden laths laid at a suitable angle, the edge of each being serrated in such a manner as to cause the water to distribute itself in a very thorough manner and to fall through the tower in the form of an evenly divided shower, thus ensuring the highest possible efficiency. The chimney portion of the tower—that is to say, that part above the water inlet—is specially constructed to cause the up-draught to be increased, and the velocity of the draught is further accelerated by the aid of the cornice fixed at the top of the chimney on the outside. Air passing underneath it in an upward direction naturally induces a draught and so acts somewhat in the nature of an injector. The necessary gangways, ladders and other conveniences are provided to facilitate manipulation of the valves and to give ready access to the towers. This installation, we are informed by Messrs. Donat & Co., who put it down, is the largest cooling tower installation in the world, and it presents a very striking appearance.

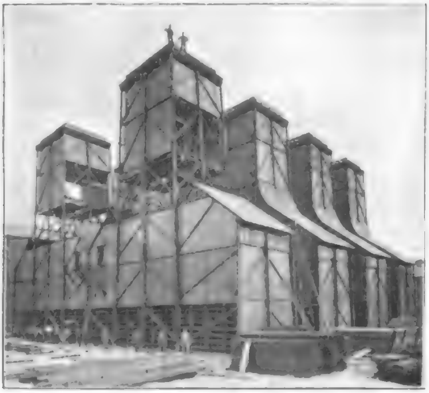

Fig. 8.—Cooling Towers.

Messrs. Donat & Co., who are sole British agents for Zschocke's Engineering Co., also secured the contract for the whole of the concrete foundations and tank, together with the penstocks, pipe connections and valves.

(To be continued.)

SERIOUS MAINS BREAKDOWN AT BRADFORD.

A most serious interruption in electricity, comparable in extent only with the disastrous fire at the Bristol Electricity Works a year ago, took place at Bradford on Thursday last week, the whole private lighting supply being interrupted for a day. A succession of serious short-circuits, fires and explosions took place on the mains early on Thursday morning, and it became necessary to shut down the whole network. Owing to the damage which had been done it was impossible to restore matters by peak time on that day, and it was not until after midnight that the supply could be reinstated, although Mr. Blackman, the city electrical engineer and manager, and his assistants worked with untiring energy to restore matters to their normal condition. We append a detailed account of the occurrences :—

A short-circuit occurred upon the negative side of the system on Thursday morning at 6:10, developing into a heavy short across the outers 10 minutes later, and upon investigation a fault was located to a feeder laid across the iron bridge which passes over the main line of the Midland Railway in School-street. The feeder was disconnected at both ends, but a heavy fault still remained. The pavement upon the railway bridge was opened up, when it was found that the arcing had burned a hole in the iron plates forming the bottom of the bridge. The cable was cut upon each side of this, and tested bad in both directions.

At 8:30 the pavement opposite the Midland station, about a quarter of a mile distant from the bridge, was displaced by an explosion, and the ground was immediately opened up to expose the cables, which at this point are laid in two parallel brick and stone culverts, which contain the cables supplying current to the four most important feeding points in the centre of the town. While this work was proceeding, violent explosions occurred, and the pavement was displaced at other points in the immediate vicinity. The explosions became so serious that at 9:55 the works were shut down in order that the faulty cables might be cut clear.

There are at each feeding point three pavement boxes arranged side by side, and the links in all except the centre boxes were removed at the four feeding points and at the works, but the explosions continued after the current was cut off with increasing violence, so that it was not considered advisable to commence running again until the ground had been opened up, and the culverts ventilated in places by the removal of the cover stones, which are 6in. thick and consequently heavy to handle. Observation at this time showed that nearly all the 15 cables in the two culverts were burned asunder

The works were started up again at 12:35, when smoke commenced to re-issue from the ground, the mains being at the time fed by 1,800kw. of plant across the outers and 320kw. of steam balancers on each side. The ground was accordingly opened up below the bottom of the culverts and short lengths of armoured cable—which, by the way, no one upon the job knew were located there—pulled out in a very heated condition, and it was difficult at the moment to account for the cable being alive, as the whole of the cables had, so far as could be ascertained, been disconnected at both ends upon the positive and negative poles. The bottom of the culvert, which also consisted of stone slabs 6in. thick, was removed for some yards and arcs exposed, which were, however, kept down by recovering them with earth, and the works and feeding-point boxes again visited to confirm that all the links in the outside boxes and at the works had been removed. This proving to be the case, and as the arcing continued with unabated vigour in close proximity to a large gas main, the works were shut down a second time at 2:35, as the feeders remaining were not in any event nearly adequate to carry the evening load. It was subsequently found that pieces were fused out of the gas main which was not cut off, and it is, therefore, probable that the damage would have assumed very serious proportions had the arcing continued.

The whole of the cables upon each side of the fault were now cut, and every available man set trimming back the ends, as it was necessary to test the cables to ascertain which were usable as they had been very considerably heated carrying the heavy currents to the faults, and the terminal points of the individual cables in each direction were unknown, owing to the cables having been massed in the culvert.

While this work was proceeding new cable was got on to the job, and pulled in to bridge the gap, which was 160yds. in length. Several of the cables to different parts of the town were found to have dead earths upon them, which so reduced the capacity of the mains between the fault and the feeding points that the supply could not be reinstated until such time at night as the load fell to the capacity of the available mains

The supply to practically the whole of the town was reinstated at midnight, but while the main fault was being dealt with another developed in quite another part of the town, and this was taken in hand, and the supply recommenced here soon after six next morning. During the night the faults upon the more important of the defective cables were located, and the following day additional temporary cables were got in to augment those bridging the gap caused by the destroyed cables.

The cables that were the cause of the mishap, and those burned out thereby, were laid between 8½ and 16 years ago, and were burned through in many places at old-fashioned cast-iron straight-through joint boxes fitted with rubber glands, the cables having lead sheaths and hygroscopic insulation. The Bradford system of mains has until the last few months consisted wholly of single-core cables, and there are no fuses upon these.

The mystery of the live cables beneath the culverts was cleared up in tracing the cables out, and found to be caused by a set of three single-pole disconnecting boxes being arranged with the negative between the positive and neutral, instead of the neutral box being in the centre, as in all other parts of the town. The trouble is attributed to stray currents upon the cable sheaths causing a fault at the point where a cable entered a rubber gland joint-box, and thus raising the potential of the lead sheath; the lead sheaths are not electrically continuous across the joint boxes.

The distribution to the tramways was unaffected.

It appears that the city electrical engineer and manager had submitted a report on the bad condition of the network to the Electricity committee a short time ago, and that it was down for consideration by the committee on the very day that the breakdown occurred.

THE NEW YORK RAPID TRANSIT SUBWAY.

(Concluded from page 211.)

The trucks (Fig. 14) which will be used for the steel cars are identical with those previously ordered for use under the wooden cars. As may be seen from the illustration, the truck resembles in general design the usual standard designs which have been used successfully in heavy high-speed electric railroading. The trucks were built to the designs of Mr. Gibbs and Mr. Thomson, of the Interborough Company, by the Baldwin Locomotive Works, Philadelphia, the motor trucks being designed in part for the Westinghouse No. 86 railway motors, and the remainder for the General Electric No. 69 railway motors. They are all arranged for nose suspension. The wheels and axles were furnished by the Standard Steel Works, the wheels being of the steel-tyred type, with 2⅜in. steel tyres held in place by retaining rings. The bearings are of Damascus bronze, while the brake shoes are the "Diamond S" type, made by the American Brake Shoe & Foundry Co. The table in the next column gives the chief dimensions of the motor and the trail trucks.

The entire under faming is covered with a sheathing of No. 22 galvanised corrugated sheet-iron, which is laid across the longitudinal sills and secured to the floor angles which are especially arranged for this purpose, by rivets and special clips of 1in band iron. This corrugated sheathing serves as a base upon which the "Monolith" flooring is laid. This is a cement-like material, made up in the following proportions: 5¼ gallons monolith; ¾lb. raw senna; ½lb. burnt umber; ¼lb. Tuscan red; and 37½lb. Monolith cement. These constituents are mixed with a sufficient quantity of hardwood sawdust to give the material the constituency of mortar, and it is spread evenly upon the corrugated flooring and finished smooth on top. The special clips used in riveting the flooring assist in securing the monolith to the corrugated metal and holding it in place. When finished, hardwood strips are laid upon the floor along the aisles of the car to provide the necessary wearing surface. It was found that these strips could be easily fastened to the Monolith cement by wood screws after first boring small leading holes, without cracking it. The floors of the platform are of ¼in. steel plate riveted to the platform frame. They are covered with pebbled rubber matting, which is cemented upon the steel plate. Special threshold metal treads are provided at the passage ways between car and platform. The outside finish of the car is applied by the steel plate of the side-frame girder construction, upon which the paint finish of Tuscan red is applied. Similar sheathing of special rolled steel plate is applied to the car ends and platform framing. The window posts are covered with extruded metal, of which the inside and outside window stops and also the eaves moulding are formed. The roof covering is of fire-proof composite board, fastened to the roof framing and furring, as above stated, and, after receiving a heavy coat of white lead, is covered with cotton duck. The principal constituent of the fire-proof board, which is used for the roof sheathing, is asbestos. The side windows have a double sash of mahogany, the lower being stationary and the upper arranged to drop. Aluminium ratchet racks are provided, in which the window locks may be caught in any position; the ratchet provision allows the upper sash to be closed without manipulation of the window catch or lock, while in lowering the catch must be opened.

—	Motor truck.	Trailer truck.
	Ft. in.	Ft. in.
Gauge of track	4 8½	4 8½
Distance between backs of wheel flanges	4 5⅝	4 5⅝
Height of truck centre plate above rail, car body loaded with 15,000lb.	2 6	2 6
Height of truck side bearings above rail, car body loaded	2 10	2 10
Wheel base of truck	6 8	5 6
Weight on centre plate with car body loaded, abt	27,000lb.	..
Side frames, wrought-iron forged	2½ by 4in.	1½ by 3in.
Truck bolster	cast steel	wood & iron
Spring plank, wrought-iron	1 by 3in.	..
Bolster springs, elliptic, length	2 6	white oak
Equalising springs, double coil, outside dimen.	4½ by 7⅛in.	2 8
Wheels, cast-steel spoke-centre, steel-tyred, dia.	2 9½	3⅜ by 6in.
Tyres, tread M C. B. standard	2⅜ by 5¼in.	2 6
Axles, diameter at centre	0 6½	2⅜ by 5¼in.
" " at gear seat	0 7$\frac{11}{16}$	..
" " at wheel seat	0 7¾	0 4¾
Journals	5in. by 9in.	0 5⅞

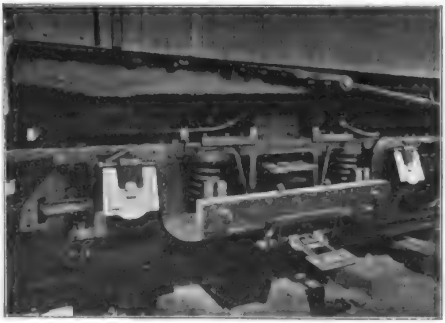

FIG. 14.—CURRENT-COLLECTING DEVICE ON MOTOR CARS.

Sheet aluminium is mostly used for the interior finish of the car. The wainscoting surface between longitudinal seats, all the end interior panels and the window panels are covered with No. 14 gauge sheet aluminium, being fastened in place over the inner sheathings of the "transite" (asbestos) board by nickel-plated round head screws; the headlinings are also similarly faced with No. 14 sheet aluminium. All mouldings used throughout the car are of aluminium, pressed to shape. The result is a very light and cheerful interior appearance, and, from a practical standpoint, it is a finish that will remain bright and clean with a minimum of deterioration.

Hand rails of 1¼in. aluminium tubing are provided for carrying the hand straps. This rail is carried upon aluminium brackets fastened to the deck, and is equipped with 88 hand straps. In accordance with the latest practice in lighting, three rows of lamps are used, one of six lamps under the upper roof, and the others, each having 10 lamps, under the side roofs. The wiring mouldings are also of aluminium, thus blending with the general interior finish of the car. Instead of having gates, the platforms have doors, which are arranged to slide into pockets in the side framing, thereby giving up the entire platform to the passengers. These doors are closed and opened by an overhead lever system. The sliding doors of the motor cars may be partly opened and secured in that position by a bar, and thus serve as an arm-rest for the motorman when used as the motorman's compartment. Rubber door steps of tubular shape are provided to cushion the shock of closing the sliding side door and, furthermore, to prevent catching the clothing of passengers when the door is closed. The end doors between vestibules and bodies of cars are of the double type, hung on nickel-plated sheaths with hard fibre anti-friction rollers, and also provided with steel tracks enclosed over the doors. These doors are provided with rubber stop cushions, and, like the side doors, with anti-rattlers consisting of rubber rolls. These end doors are also provided with horizontal curtains, for use when the vestibule is occupied by the motorman; the curtains are automatically raised or lowered as the door is opened or closed, to shut the light away from the motorman. Another interesting attachment is the improved handle on the sliding door. This door is made to latch so that it cannot slide open with the swaying of the car, but the handle is so constructed that when pressure is applied upon it to open the door the same movement will unlatch it.

A novel feature in the construction of these cars is the motorman's compartment and vestibule, which differs essentially from that used heretofore. The cab is located on the platform, so that no space within the car is required; at the same time the entire platform space is available for ingress and egress, except that on the front platform on the first car, on which the passengers would not be allowed in any case. The side of the cab is formed by a door, which can be placed in three positions. When in its mid-position it encloses a part of the platform, and this would be its position on the rear platform of the rear car. In the third position the door is swung around to an arc of 180deg., when it can be locked in position against the corner vestibule post enclosing the master controller. This would be in its position on all platforms except on the front of the front car or the rear of the rear car of the train.

The multiple-unit system of control has been adopted for operating the trains. In an eight-car multiple-unit express train the first, third, fifth, sixth and eighth cars will be motor cars, while the second, fourth and seventh will be trail cars. An eight-car train can be reduced, therefore, to a six-car train by uncoupling two cars from either end, to a five-car train by uncoupling three cars from the rear end, or to a three-car train by uncoupling five cars from either end. In each case a motor car will remain at each end of the reduced train. In like manner a five-car local train may be reduced to three cars, still leaving a motor car at each end, by uncoupling two cars from either end, since in the normal five-car local train the first, third and fifth cars will be motor cars.

The motors are of the continuous-current series type, rated at 200 H.P. each at 570 volts. They were supplied by the General Electric and Westinghouse Co.'s. The weight of one make complete, with gear and gearcase, is 5,900lb. The corresponding weight of the other is 5,750lb. The ratio of gear reduction used with one motor is 19 to 68, and with the other motor 20 to 68.

In wiring the cars unusual precautions have been adopted to guard against risk of fire. The floors of all motor cars are protected by sheet steel and a material composed of asbestos and silicate of soda, which possesses great heat-resisting properties. In addition to this, all of the important power wires beneath the car are placed in conduits of fire-proof material, of which asbestos is the principal constituent. Furthermore, the vulcanised rubber insulation of the wires themselves is covered with a special braid of asbestos, and in order to diminish the amount of combustible insulating material, the highest grade of vulcanised rubber has been used, and the thickness of the insulation correspondingly reduced. The motors and car wiring are protected by a carefully-planned system of fuses.

Express trains and local trains alike are provided with a 'bus line, which interconnects the supply of current to all cars and prevents interruption of the delivery of current to motors in case the collector shoes attached to any given car should momentarily fail to make contact with the third rail. At certain crossovers this operates to prevent extinguishing the lamps in successive cars as the train passes from one track to another. The controller is so constructed that when the train is in motion the motorman is compelled to keep his hand upon it, otherwise the power is automatically cut off and the brakes are applied. All cars are heated and lighted by electricity, the heaters being placed beneath the seats. The conductor used for the heater circuits is carried upon porcelain insulators clear of all woodwork, while the wiring for lights is carried in metallic conduit. All lamp sockets are separated from the woodwork of the car by air spaces and by asbestos. The interior of each car is lighted by 26 10-c.p. lamps, in addition to four lamps provided for platforms and markers.

We conclude our articles by a brief description of the car and inspection shed, occupying an area of approximately 336ft. by 240ft. It is divided into three bays, of which the north bay is equipped with four tracks running its entire length, and the middle bay with five tracks. The south bay contains the machine tool equipment, consisting of 18 electrically-driven machines, locker and wash rooms, heating boilers, &c. The building is a steel structure made up of four rows of centre columns, which consist of 21 bays of 16ft. each, supporting the roof trusses. The foundations for these centre columns are concrete piers mounted on piles. After the erection of the steel skeleton, the sides of the building and the interior walls were constructed by the use of $\frac{3}{4}$in. furring channels, located 16in. apart, on which are fastened a series of expanded metal laths. The concrete is then applied to these laths in six coats, three on each side, and termed respectively the scratch coat, the rough coat and the fining coat. In the latter the concrete is made with white sand, to give a finished appearance to the building.

Since the third-rail is not carried into the shops, the cars will be moved about by means of a special trolley. In the middle bay this trolley consists of a four-wheeled light frame carriage, which will be run on a conductor located in the pit. A flexible wire is attached to the carriage, which can be connected to the shoe hanger of the truck or to the end plug of the car, so that the cars can be moved around in the shops by means of their own motors. In the north bay, where the pits are very shallow, the conductor is carried overhead and consists of an 8lb. T-rail supported from the roof girders.

The middle bay is provided with a 50 ton electric crane, which spans all of the tracks in this shop and is so arranged that it can serve any one of the 80 cars on the five tracks, and can deliver trucks, wheels, motors and repair parts at either end of the shops, where they can be transferred to the telpherage system, which is one of the features of the shops. It runs the entire length of the north and south bays, crossing the middle bay or erection shop at each end, and extending across the transfer table pit at the west end of the shops and into the storehouse and blacksmith shop at the Seventh Avenue end of the grounds.

The travelling telpher hoist has a capacity of 6,000lb. It runs upon girders which consist of 12in. I-beams, hung from the roof trusses. The car has a weight of one ton, and is supported by and runs on the I-beam girders by means of four 9in. wheels. The hoist is equipped with two motors. While the 2 H.P. driving motor transmits its power through a double reduction gearing to the driving wheels at one end of the hoist, the 8 H.P. hoist motor is connected by worm gearing and then by triple reduction gearing to the hoist drum. The motors are controlled by rheostatic controllers, one for each motor, and the hoist motor is also fitted with an automatic electric brake. There is also an automatic cutout, consisting of a lever operated by a nut, which travels on the threaded extension of the hoisting drum shaft, and by which the current on the motor is cut off and the brake applied if the chain hook is wound up too close to the hoist.

The buildings are heated throughout with steam on the Warren-Webster principle, with vacuum system of return. Steam is supplied by two 100 H.P. return tubular boilers, located at the south-eastern corner of the building and provided with a 28in. stack 60ft. high. Steam is distributed at 15lb. pressure throughout the three bays by means of coil radiators, which are placed vertically against the side walls of the shop and store room. In addition, heating pipes are carried through the pits as already described. The shops are well lighted by large windows and skylights, and at night by enclosed arc lights.

The general store room, oil room and blacksmith shop occupy a building 199ft by 22ft. This building is of the same general construction as that of the inspection shops. The general store room, which is that fronting on 148th-street, is below the street grade, so that supplies can be loaded directly on to the telpherage hoist at the time of their receipt, and can be carried to any part of the works, or transferred to the proper compartments in the store room. Adjoining the general room is the oil and paint store room, which is separated from the rest of the building by fire walls. This room is fitted with a set of eight tanks, each with a capacity of 200 gallons. As the barrels filled with oil and other combustible material are brought into this room by the telpherage system they are deposited on elevated platforms, from which their contents can be tapped directly into the tank. The final division of the west shops is that in the north-eastern corner, which is devoted to a blacksmith shop, This shop contains six down-draft forges and one drop hammer, and is also served by the telpherage system.

Connecting the main shops with the storeroom and blacksmith or west shops is a rotary transfer table 46ft. 16$\frac{3}{4}$in. long and with a run of 219ft. The transfer table is driven by a large electric motor, the current being supplied through a conductor rail and sliding contact shoe. The transfer table runs on two tracks and is mounted on 33in. standard car wheels.

POWER DISTRIBUTION PLANT AT AN IRISH COTTON WORKS.

The history of the development of many industries has demonstrated the fact that a material reduction of the cost of any manufactured article has almost invariably been attended by an increased demand. This is most strikingly exemplified in the case of several of the world's largest industrial concerns, which by the adoption of electric power have secured both a greater output, a reduction in their cost of production, and consequently a readier market for their goods. Owing, however, to conservatism and extreme caution on the part of mill owners, electricity has not made the progress—so far as the textile industry is concerned—to which its undoubted superiority over all other motive powers entitles it. One of its most important advantages undoubtedly lies in the fact that with electricity it is possible to concentrate the whole of the power necessary for operating all the various machinery of an extensive mill or group of mills into one central power plant, thus effecting consequent saving in working costs, maintenance and staff. Moreover, it is not necessary to use the power required for the operation of all the machinery in the building to run a single machine; each machine being a unit, only the power essential for the efficient driving of the same is used when operating singly. Great economies are thus effected when sections of works are being run overtime. Lighting can also be obtained from the same plant. It is needless to mention the advantages accruing from this; suffice it to say that with arc lighting colour values can be readily determined and purer atmospheric conditions obtained.

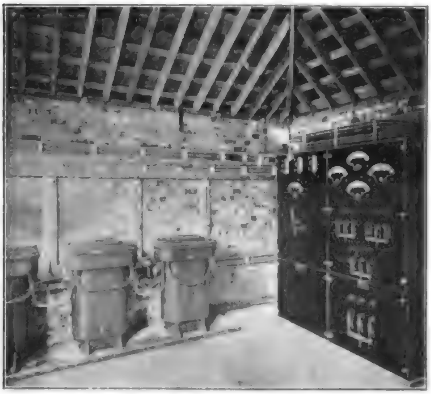

Fig. 1.—Oil-cooled Transformers and Switchboard.

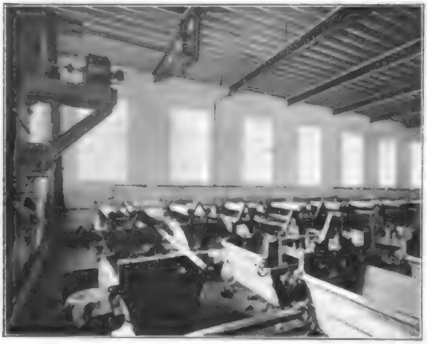

Fig. 2.—Motor-driven Dye Jigs.

In these days of keen competition only by adopting the most modern and efficient methods of production can commercial prosperity be assured. That electric power is of first importance among these methods there is no room for doubt. The only objection that can be urged against the change from old and imperfect systems of driving to electric driving is the initial outlay required, but that such an expenditure would rapidly show a handsome return has been amply demonstrated by the history of some of the largest manufacturing concerns in the world.

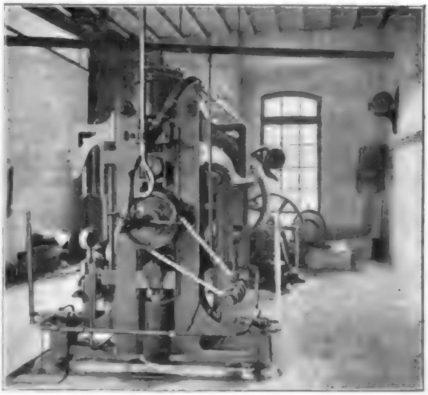

Fig. 3.—Motor-driven Hydraulic Calendering Machine.

As an indication of the advantages to be obtained in this direction, the Maine Bleaching & Finishing Co. (Ltd.) is an excellent case in point. Though situated in a remote part of the North of Ireland, and penalised to the extent of £1 per ton for carriage on all cotton they bleach or finish, they are, nevertheless, able to compete successfully with more favourably situated firms in and around the Manchester district. The works are situated on the River Maine at Cullybackey in the County of Antrim. Owing to the fall at this place being insufficient to give enough power for all their needs, the company have built their power station at a fall about 1½ miles lower down the river. The plant installed consists of a B.T.-H. three-phase rope-driven generator having a capacity of 60 kilovolt amperes at 750 revs. per min., which generates current at a voltage of 1,100 and a frequency of 50 ∼ per second. This generator is driven by a water turbine, and the exciter is coupled directly to its shaft.

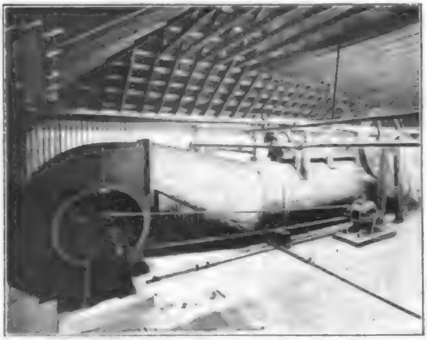

Fig. 4.—Motor-driven Fan for Supplying Hot Air to Stenter Frames.

Power is transmitted to the works, 1½ miles distant, by means of bare overhead copper conductors having a diameter of 0·25in. At the works there are three oil-cooled transformers which reduce the voltage to 200. These transformers, which are shown together with the switchboard in Fig. 1, are of the British Thomson-Houston

Co.'s make, and are insulated to withstand, without oil, a 10,000-volt test between primary and secondary. They are of the core type, and each has a capacity of 25kw. The switch gear consists of a generator panel at the waterfall end of the line, a receiving panel at the works end of the line, and a low-tension distributing panel for the various circuits in and around the works. To ensure safe control, all the high-tension switch gear is fitted with B.T.-H. oil-break switches and high-tension fuses. The motors used for operating the various machinery in the works are all of the British Thomson-Houston Co.'s three-phase induction type. They are fitted with slip rings, by means of which speed regulation can be obtained when required.

Chiefly on account of the very low load-factor obtaining in bleach and print works, the application of the electric drive has shown particularly satisfactory results. So low indeed is the load-factor, that prior to the introduction of electric driving, it was found economical to drive all the larger machines, such as Callender and Stenter fans, &c., with separate steam engines, each with its long and wasteful line of steam piping and consequent large steam consumption. The plant at the Maine Works has been in operation for the past 12 months, and has in every way proved itself to be most satisfactory and efficient. It has been said that the adoption of the most modern and efficient systems of production is a sure sign of commercial prosperity. In view of this, it is pleasing to note that textile manufacturers in Great Britain are at last becoming alive to the necessity of adopting electric power as one of the means to be employed to cope successfully with foreign competition.

THE COMBINATION OF DUST DESTRUCTORS AND ELECTRICITY WORKS ECONOMICALLY CONSIDERED.[*]

BY W. P. ADAMS.

Any attempt to enter upon a general description of the various makes of destructors would be out of place in a Paper dealing more particularly with results obtained, yet a brief description of the more generally known types will be useful in showing the difficulties to be contended with in securing good steam-raising results and the problems that still await solution before the perfect destructor is evolved.

The type of combined destructor furnaces and boilers employed by Messrs. Manlove, Alliott & Co., is well illustrated in the Shoreditch installation. Two furnaces are placed one on either side of a water-tube boiler erected in the customary manner, and the gases from the destructor pass sideways into the boiler furnaces and thence between the tubes to the flues. The ordinary boiler grate is available for burning coal both when the destructors are in use and when shut down. Dampers are provided between the destructor and boiler furnaces to cut off the former when not in use, and the boiler front is made as far as possible airtight. These precautions are taken to prevent the access of volumes of cold air to the boiler and flues. The destructor ashpits are closed, and forced draught is provided by fans driven either by independent steam engines or by electric motors.

The refuse is admitted from the top on to an inclined hearth at the back of the furnace, whence it is raked forward on to the grate. The refuse is partially dried on the hearth, and all gases therefrom have to pass over the hottest part of the fire to the side openings into the boiler furnaces. This system of top feed on to an inclined drying hearth is common to nearly all modern destructors.

The Horsfall destructor consists of a number of independent cells with independent ashpits placed side by side, and where the number is large, back to back. The refuse is fed in the same manner as in the Manlove Alliott cells, and the gases pass from the furnace into side exhaust flues arranged between the cells, and thence into the main flue at the back of the cells. This main flue plays the important part of a combustion chamber where all the products of combustion are raised to high incandescence. The boilers are placed in the main flue as near as possible to the cells. An ingenious device to prevent burning away of the firebrick lining of the furnace immediately above the bars has been adopted in the shape of cast-iron boxes arranged on either side of the grate into which the air blast is drawn by steam jet blowers, the outlet from the boxes being beneath the furnace bars; by this means a hot blast is secured while the boxes remain comparatively cool.

The Meldrum Simplex destructor is arranged as one furnace with several independent grates with separate ashpits, one long firebrick arch covers the several grates, and clinkering doors are provided to each cell. Hand-feeding through the clinkering doors is preferred, but top feed is arranged when desired. At one end of the furnace, or at the back, is a combustion chamber in which all gases are mixed, and with the shortest possible length of flue this chamber is connected to the boilers. The grates are fed and clinkered alternately, so that the temperature in the combustion chamber and flues is maintained so far as possible at a constant point. Forced draught is provided in each ashpit with independent control, so that as each grate is fed or clinkered the blast can be stopped. Steam blast is preferred, but fans are provided when desired; in both cases a regenerator in the flues behind the boiler is provided to raise the temperature of the air to some 300°F. or 400°F.

Another type of the furnace made by Messrs. Meldrum Bros. is the Beamen & Deas, which consists of a pair of cells with independent grates and ashpits, but with a common combustion chamber behind. The forced draught is provided by either steam blast or fan, as in the Simplex. The feed is from the top on to an inclined hearth, the grate is horizontal, and clinkering is carried out through side doors. Each pair of cells is generally provided with one water-tube boiler placed immediately beyond the combustion chamber; the usual boiler coal-firing grate is provided with firing doors at the side instead of in front. To secure some uniformity of temperature in the combustion chamber, charging and clinkering should be done in each cell alternately.

The Heenan & Froude destructor has some features in common with the Simplex, several cells are placed side by side to form a continuous furnace ending in a combustion chamber, the ashpits are independent, and closed and hot-air blast is provided by fans which draw cold air through a generator placed in the flues behind the boiler. During clinkering the blast is shut off below the grate and admitted above: this is said to prevent the inrush of cold air through the open doors and the consequent cooling of the furnace and flues generally, which is a fault in some other types of destructor. A feature of this furnace is the building of the roof in a series of parallel arches, one over each cell; by this means incandescent gases from one cell are deflected on to the top of the refuse in the next, thus securing combustion of the refuse from above as well as from below. The boiler, generally a water-tube, is placed by preference immediately above the combustion chamber. The undermining of the walls in the furnace above the grate bars by blowpipe action is prevented by the provision of shelves of firebrick.

The Hughes & Stirling destructor has, in common with several other types, the top feed, sloping hearth and grate and closed ashpit. Forced draught is provided by fans, and the gases from the fires are brought into a common flue between each pair, or double pair, of cells; this flue serves as a combustion chamber and opens out into a main flue which conducts the gases to the boiler. Water-tube boilers are preferred, and one is usually provided for each pair of cells.

The points in common with all modern high-temperature destructors are, forced draught, preferably heated, means of drying the refuse in part before placing on the grate, and a combustion chamber in which all gases are mixed and brought to a state of high incandescence and their temperature equalised so far as possible.

Steam blast for producing forced draught is claimed to have advantages over simple air blast in that it produces water gas in passing through the incandescent fuel, which materially aids combustion; it also tends to keep the fire bars cool, thus giving them an appreciably longer life and clinkering is rendered easier. These claims have been sufficiently verified, but it is to be doubted whether the large percentage of steam used in practice secures an adequate return. The Horsfall Company claim that their system of hot steam blast requires 5 to 10 per cent. of the total steam raised, but no figures, test or otherwise, have come into my hands showing anything approaching such results. Messrs. Meldrum Bros. will guarantee that the percentage of steam with hot-air blast provided through a re-generator shall not exceed 15 per cent. of the total steam generated, and they claim that it is often as low as 12 per cent. It is an extremely difficult matter to measure the steam blast except on specially arranged tests, but it is a very simple matter to measure the power used by electrically-driven fans.[*] However, it is a question that does not turn entirely on the relative consumption of power, as the improved combustion with fuel of high calorific value may outweigh the extra percentage of steam used with steam blast. This is one of the interesting points upon which additional information would be of value, but I venture to think that it will be a hard matter to justify the application in the blast of 20–40 per cent. of the total steam generated. Economy in the blast is of considerable importance, as the absorption of power is continuous, and if a wasteful form be used a large percentage of the power available i swholly lost.

The prevention of air leakage is another important matter, and long and badly-arranged flues are also a prolific source of lost power. A principle never to be lost sight of in the construction of destructors is that, after the perfect cremation of the refuse has been secured, the heated gases should be applied directly to the boiler without having to pass through long flues. Again, the charging arrangements are sometimes crude and not designed or constructed with a full appreciation of the problem involved; the furnaces of the boilers are often a source of trouble through air leakage and unsatisfactory combustion effects, and not a few combined works show poor results through careless and indifferent handling of the refuse and management of the burning.

The composition of refuse varies largely in different parts of the country; in the neighbourhood of coal mines it is often rich in carbon. In towns having a staple industry, where much waste material from the factories is sent to the destructor, the calorific value of the refuse may be high or low, according to the carbon in such waste material. Suburban residents generally provide quantities of garden stuff to feed the destructor, and although the percentage of carbon in this stuff is large, so also is the percentage of moisture, and it is therefore not regarded with favour by destructor managers. It is a strange fact that some of the richest refuse comes from poor localities. Mr. Vincent, the electrical engineer of Bermondsey, claims that his refuse has an unusually high value because the neighbourhood is poor, and this, I have observed, is also the case in another London borough where good refuse is collected in a poor district near the destructor, and refuse of only average value is obtained from a wealthy residential district a little distance away. This anomaly is due to the more extravagant habits of the working classes, who, unlike the middle classes, rarely sift the ashes from their fires before consigning them to the dustbin. It has recently been stated that where coal is expensive, there refuse will be poor and the utilisation of steam therefrom of doubtful value; but I hold that the exact contrary is the case. The quantity of coal and ashes is probably less, but the fuel value of what coal there is and of the other carbon in the refuse is of proportionately greater value.

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[*] Abstract of a Paper read before the Institution of Electrical Engineers last night.

[*] In one of the tables in the original Paper this is given as a percentage of total steam generated. It varies from 6 in the Hughes & Stirling destructor at Bermondsey to 20 in the Heenan & Froude destructor at Gloucester.

Some of the finest samples of refuse which have come to my notice are those from Warrington and King's Norton, near Birmingham. At the former place the electrical engineer states that his Beamen & Deas furnaces generate 8lb. of steam per pound of refuse all the year round, and as an explanation he gives the proportion of cinder in the refuse as from 60 to 70 per cent.; this, doubtless, includes a quantity of ash. This result is of some value, as it has, I understand, been arrived at over a lengthy test under working conditions. At King's Norton the refuse for several days was sampled, and the samples submitted to an analyst—Dr. Frankland, of Birmingham—who gave, as the result of his investigations, 36·8 per cent. of carbon, 7·8 per cent. of oxygen, 12·12 per cent. moisture. It will be observed that the samples were comparatively dry, but, nevertheless, an available 4,500 B.Th.U. per pound is a fine figure. Some 2,500 B.Th.U. per pound of refuse may be taken as a fairly representative average of English town refuse in winter; this would be sufficient to evaporate 2lb. of water from 50°F. to steam at 140lb. pressure, neglecting the evaporation of moisture in the refuse itself, and the heat absorbed in raising the clinker to some 2,000°F.; under varying conditions of moisture these two items would absorb from 500 to 1,000 B.Th.U.

In some places refuse of unusually low value is collected. At Llandudno, where the bulk of the refuse is collected in summer during the season, when fires are in little use, and therefore the percentage of carbon small, the evaporation on test was as low as 0·7lb. water per pound of refuse. At Royton, in Lancashire, where a careful calorimeter test was made, only 997 B.Th.U. were obtained per pound. Such figures as these point very forcibly to the desirability of a careful and independent examination of refuse before combined schemes are entered upon. This is all the more necessary if the scheme be for a town outside the limits of this kingdom, for astonishingly poor refuse is collected in some Continental towns where destructors have been erected, a residue of some 60 to 70 per cent. of combustible matter being left after cremation in a high-temperature furnace.

There is often a considerable difference between the value of winter and summer refuse in a given town, and also a variation in the quantity collected; but it is worthy of note that these variations correspond very fairly with the fall and rise of the summer and winter output of electricity, the winter refuse generally being of the highest value (see Fig. 1).

Some of the difficulties to be met with in the utilisation of refuse-raised steam for electrical purposes are—uncertain delivery of the refuse, the varying value of the refuse from day to day and hour to hour, and the varying percentage of moisture contained; also in winter snow may prevent collection for many days, fog sometimes greatly hampers collection, and holidays occasionally prevent collection for days. By careful management and forethought some of these difficulties may be largely neutralised, but it is merely sufficient to call attention to them to demonstrate that only under favourable conditions may a combined plant be expected to run for any length of time on refuse alone.

To equalise to some extent the varying quantities collected, and also to adapt the quantity burnt to the varying demand for electricity, some system of storage is desirable; this is especially so where the electricity works has a small day load. The refuse itself may be stored and burnt as the demand requires, or, when direct-current plant is used, a battery may be employed with advantage. Large destructor plant is best run steadily throughout the 24 hours, and no great difference in the rate of burning during the day and on the peak is admissible. With a 12-cell plant, eight cells might be run during the day and 12 at night. This represents a maximum variation, and it will, therefore, be seen that where the day load is small, a peak load some five times greater could not be coped with in this manner. Personally, I am a strong advocate of the use of batteries, for they not only serve for storage during the day, but with a suitably arranged reversible booster they equalise the load when the steam generation varies, as it does very rapidly sometimes. To secure the best results such a battery need not be abnormally large. A combined station burning some 30,000 tons per annum would require a battery of about 1,000 to 1,500kw.-hours capacity, assuming a simple lighting load with a day demand about one-fifth of the peak load.

Before I pass on to consider the commercial results achieved with joint schemes, I will deal briefly with the financial aspect of combined plants from the point of view of capital expenditure. It is fairly obvious that in an undertaking of moderate size the combination of electricity works and destructor on the same site should result in several economies. These are embraced under site, building, chimney and plant.

Site.—As a rough approximation, it will generally be found that one-third of the land space required for the separate undertakings is saved by combination.

Buildings.—An entire boiler house is sometimes saved; on the other hand, the destructor with boilers will cover more space than one without. Sundry offices, mess-room, lavatories, weigh house, and weigh bridge would all require to be duplicate in separate works, and often no inconsiderable saving is effected in boundary wall and street paving.

Chimney.—In separate works separate chimneys would be erected and a saving of a complete stack is therefore effected by combination.

Plant.—Some boilers are saved to the electricity works, together with steam and feed piping, pumps, &c. In large works a generator to supply motors, and perhaps fans and lighting, are saved to the destructor; on the other hand, an unusual length of steam main may be necessary.

So many different methods of apportioning capital outlay are in vogue that I would venture to suggest the following as a basis of arrangement in new works. Opinions will probably differ on this point, but I will give my suggestions for what they are worth in the hope that the already heavy labours of electricity and sanitary committees may in one or two cases be somewhat lightened when the burning question of apportionment of capital expenditure arises.

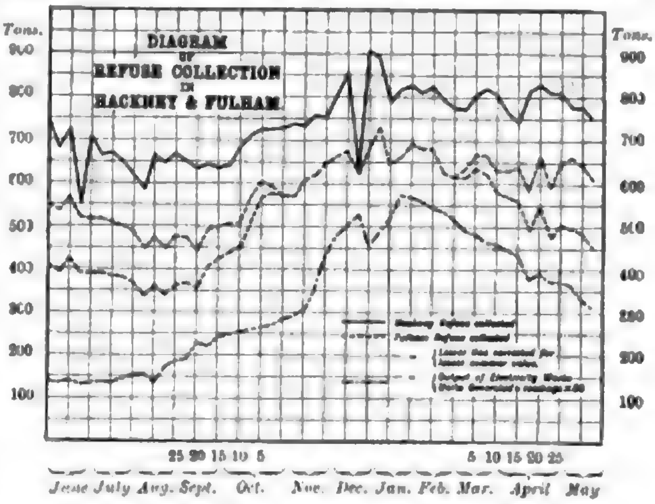


Fig. 1.

Site.—Actual value of ground space covered by the joint undertaking to be equally divided; spare land available for extensions to be debited to each undertaking in accordance with probable future requirements.

Buildings and Chimney.—An estimate of the cost of buildings for each undertaking erected separately should be got out, and the actual cost to be divided in the proportion of the estimate.

Plant.—All boilers save one should be debited to the electricity works, together with steam and feed piping, pumps, &c. The entire saving in piping and pumps to the destructor would be a fair set-off against additional flues required by the additional boilers. The saving of an electric generator and the cost of its upkeep and attendance can best be dealt with by the electricity works making a small charge to the destructor for electricity supplied.

The cost of maintaining the buildings and chimney would be apportioned on the basis of the original estimate until extensions took place, and then the additional outlay would be debited to the department extended, and the cost of upkeep apportioned accordingly. I do not pretend that this by any means a perfect adjustment, but there must of necessity be a certain amount of give and take in partnership of any description. With regard to repairs and maintenance, the destructor department should bear all expenditure on furnaces and other destructor plant, one boiler, and all flues and brickwork; even in maintenance a saving should be effected in joint works, as the fierce heat from the furnace is absorbed by the boilers and not turned loose into the flues and chimney to do damage to linings and brickwork. The supply of electricity and light and power to the destructor is a possible bone of contention between

Table A.—*Fuel and Wages Costs at Electricity Works combined with Destructors.*

	Name of town.	Year.	Units sold.			Fuel costs.		Total fuel costs per unit sold.	Wages per unit sold.	Management per unit sold.	Total costs per unit sold.
			Coal generated.	Refuse generated.	Total.	Per coal-generated unit sold.	Per refuse-generated unit sold.				
						d.	d.	d.	d.	d.	d.
London.	Shoreditch Coronet-street works only ..	1898-9	312,200	719,148	1,031,348	1·0	1·0	1·0	0·37	..	2·05
	Stepney	1902-3	664,349	1,095,000	1,759,349	0·885	0·446	0·65	0·16	0·[illegible]	1·[illegible]
	Fulham	1902-3	297,677	512,000	809,677	1·0	0·78	0·86	0·54	0·43	2·74
	Hackney	1902-3	469,000	1,146,000	1,615,000	0·48	0·48	0·48	0·19	0·24	1·03
	Bermondsey	1902-3	Nil	401,000	401,000	..	..	..	..	..	..
	Average of six municipal uncombined works	1902-3	2,057,500	..	2,057,500	..	..	0·93	0·33	0·38	2·21
Provincial.	Shipley	1902-3	218,369	83,000	301,369	0·515	0·62	0·54	0·22	0·34	1·48
	Beckenham.....................	1901-2	129,461	70,000	199,461	2·02	1·28	1·75	0·56	0·59	3·53
	Partick	1902-3	41,924	301,000	342,924	0·51	0·375	0·39	0·35	0·32	1·44
	Nelson	1902-3	..	..	320,463	..	..	0·45	0·1	0·41	1·54
	Mexborough	1903	12,000	120,000	130,000	1·5	0·75	0·82	..	..	..
	Gloucester	1902-3	171,000	142,895	313,875	0·82	..	0·45	0·4	0·41	1·89
	Grays	1902-3	69,200	39,269	108,469	1·04	1·34	1·15	0·86	0·45	2·71
	St. Helens	1900-1	588,736	322,000	910,736	..	..	0·35	0·19	0·25	1·18
	"	1902-3	..	..	1,514,745	..	..	0·21	0·139	0·25	0·95
	Wimbledon.....................	1902-3	..	..	1,011,998	..	..	0·92	0·22	0·34	1·78
	Accrington	1902-3	81,884	94,000	175,884	0·42	0·414	0·42	0·47	0·59	2·04
	Bangor	1902-3	66,200	31,500	97,700	1·68	0·95	1·46	..	..	..

committees. By obtaining current from the electricity works some outlay on plant is saved to the destructor and also some running expense; on the other hand, the electricity used is generated from refuse steam and, apart from running costs, it ought to be supplied to the destructor free. The system adopted at Hackney seems fair: all electricity generated from the refuse is credited to the destructor at 0·39d. per unit generated, its ascertained coal value, and a charge of 1d. is made per unit supplied to the destructor; anything over 1d. is, I think, extravagant unless the credit to the destructor exceeds ½d. per unit.

Revenue earned by a destructor combined with electricity works will be chiefly from the sale of current generated, and in addition there will be the sale of steam for other purposes; sale of clinker, flue dust, and other residuals; the destruction of trade refuse—which is paid for—and besides these items, which are more or less common to all combined undertakings, receipts are sometimes obtained from other sources. Fulham seems especially favoured in the matter of miscellaneous receipts, for no less than £300 per annum is received for the privilege of picking over the refuse as it is turned out of the carts.

In some undertakings not the remotest idea is held by those in charge as to what proportion of electricity generated is due to the refuse-raised steam, and while such a condition of things holds it is not surprising that the clumsiest of systems of crediting the destructor are devised. In every undertaking the average coal consumption can be ascertained from time to time when the destructor is out of use, or is purposely shut down, and then such average figure could be taken as a basis for ascertaining the units generated by each undertaking. In the larger works there really ought to be no excuse for not ascertaining what electricity should be credited, as the feed of the destructor boilers can with small cost be measured, and the average pounds of water per unit generated would form the basis of the adjustment; this method is less simple, perhaps, where steam blast is used in the furnaces, but a fair percentage of this could be agreed upon and deducted. The steam meter recently introduced by Mr. Bamber, of the Manchester Electricity Works, should prove most valuable in conjunction with combined works.

The cash credit to the destructor for electricity generated should be on the basis of the actual coal cost; personally, I can see no reason why the full ascertained coal value should not be credited as in the case at Hackney. It is often suggested that owing to variations in steam pressure and other causes, refuse-raised steam is of less value than coal-raised steam, but on a large output surely this cannot be a matter of moment. Then, again, it is suggested that the dust and general nuisance from the destructor causes extra work and increased repairs; judging from my own observations this would appear to need demonstrating.

The sale of steam for other purposes is a most difficult item to adjust in the absence—to the present time—of any means of measuring the quantity delivered to baths, laundries, disinfectors, &c. Here again I think the Bamber steam meter may be of great value; the need of some such apparatus will be readily appreciated when I am dealing with the London combined works.

In some towns all the destructor costs are borne by the Health or Sanitary Department, and the electricity works gets the benefit of all the steam generated; in others an arbitrary allowance is made, and the difference between that and the actual cost of disposal is debited to the electricity works for steam; this debit is sometimes largely in excess of the coal value of steam. The fairest method is that in use at Fulham and Hackney, where the actual destructor revenue is deducted from the total costs and the balance is made up by the Health Department. As the utilisation of the steam and clinker increases the credit will diminish, and I have every hope that not a few of the large destructors combined with electricity works will become self-supporting in course of time. It is important to bear in mind that every penny earned by a destructor is direct saving or profit to the ratepayers, for a destructor is provided in the first instance as a sanitary appliance, and not as a commercial concern like electricity works; it is for this reason that I would urge that proper balance-sheets be provided for every destructor showing all costs and every item of revenue. It is very usual in the annual reports of local authorities to find brief statements made giving the net cost of disposal "after deducting value of electricity and sale of clinker," without stating what the various values are. I trust this system will soon fall into disuse, and that carefully kept destructor accounts will lead to the same emulation between the managers of combined works in the securing of records in costs that have been so important and valuable a feature in the development of electricity works and the reduction of the costs of generation.

Before leaving the financial aspect of combined works I must devote a few moments to Table A, in which I have set out particulars of units sold, with values of coal and refuse generated electricity for comparison. Beside fuel costs I have included wages and management, both items which might reasonably be expected to be favourably influenced by combination; and, for the purpose of comparing the London combined undertakings with the uncombined, I have given the average of six uncombined municipal undertakings. While not laying too much stress upon the fact, I will ask you to notice that the wages and management costs at Shoreditch, Stepney and Hackney are the lowest on the list, thus tending to confirm my belief that in combined stations there is actually a substantial saving on both of these items. These remarks do not apply in the case of Fulham, but here the records given are for the first year, and I have reason to believe that Mr. Fuller, the new engineer, will show much better results for the next financial year.

(*To be continued.*)

HYDRODYNAMICAL AND ELECTROMAGNETIC INVESTIGATIONS REGARDING THE MAGNETIC-FLUX DISTRIBUTION IN TOOTHED-CORE ARMATURES.

BY PROF. H. S. HELE-SHAW, F.R.S., LL.D., ALFRED HAY, D.SC., AND P. H. POWELL, M.SC., M.ENG.

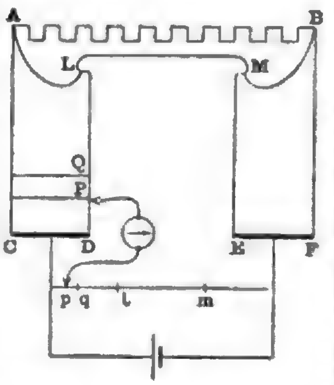
The following is an abstract of the discussion on the above Paper which took place before the Institution of Electrical Engineers on Thursday, November 24th and Thursday, December 8th. The Paper itself was published in *The Electrician* for November 25th, p. 213, and December 9th, p. 307.

Thursday, November 24th.

Prof. **SILVANUS P. THOMPSON**, having congratulated Prof. Hele-Shaw on his Paper and the beautiful experiments he had shown, desired to add a word of caution as to taking these analogies too far. Although magnetic lines did behave very much like the stream lines of a flowing liquid, they were not quite the same thing—they were not flowing.

Neither did they do what some of the stream lines appeared to do. At the moment when the coloured liquid was turned on there were apparently a number of magnetic lines, with ends to them, picking their way through. Magnetic lines did not move endways at all. When dealing with substances having a permeability of the order of thousands—and not as in many of the diagrams shown of the order of 20 or so—it must be remembered that such magnetic lines passing from air to iron or iron to air underwent a kind of refraction, such that they always entered from the air into the iron at right angles. If the permeability were lower, they would not enter at right angles. In calculating the distribution of the magnetic flux from the pole shoe of a dynamo to the armature various assumptions might be made as to the path of the lines of force, but of all these assumptions the only correct one would be that which gave the least magnetic reluctance. Since the lines of force left and entered the iron at right angles, it followed at once that the lines of force were always curved, except when traversing a parallel gap. It was no doubt well known that when a magnetic line, coming along through iron at any angle, came out into the air the law of refraction for the magnetic lines somewhat resembled the law for light. There was this difference, however, that while for light the refractive index was the ratio of the sines of the angles of refraction, the corresponding index for the magnetic phenomenon was the ratio of the tangents of the angles. Another point was this: With a slotted core armature they knew that the conductors lying in the slots were somehow protected by the teeth from the drag due to the magnetic flux. But if the Faraday principle was true—*i.e.*, that an E.M.F. is induced by the wire cutting the magnetic lines—how could it be explained that an E.M.F. was actually generated in the moving conductors, although these themselves were shielded from the drag due to the magnetic flux? The answer was that the wires lay in a space where there were comparatively few magnetic lines, but that the mass of the magnetic lines, as the teeth moved round, snapped across quickly from tooth to tooth. Mr. Swinburne had already pointed out that this had a kind of analogy with certain optical phenomena. He hoped that the authors of the Paper had not yet exhausted the resources of their laboratory and that they would show later on, not only the stream lines from pole to tooth, but also how the stream lines snapped from tooth to tooth as the teeth passed by. Prof. Thompson then showed, by means of animatograph pictures on the screen, how the magnetic lines of force behave and arrange themselves in various cases. In one of the cases shown, the armature of a horse-shoe magnet was seen to advance to and recede from the magnet, and the shifting of the lines of force during this process could be easily followed. In another case, the snapping over of the magnetic lines from tooth to tooth of a rotating armature was depicted. The pictures had been reproduced from diagrams calculated by Prof. Thompson, these having been photographed on to animatograph films by Mr. R. W. Paul.

Mr. ALEXANDER RUSSELL said that solutions obtained by the hydrodynamical method of mapping stream lines would be useful not only in magnetic theory, but also in the theories of heat, electrostatics and the flow of electricity in a plane. In particular, they might be used for finding the stresses in the dielectric of a three-core cable—*i.e.*, the potential gradient at various points in the dielectric, a problem which did not lend itself easily to mathematical treatment. The useful table which the authors gave for the fringing coefficient c when the armature was smooth and the poles were not too narrow, would be more instructive if they had tabulated c for values of r less than 4. For example, c vanished when r was nearly 1·1 and became negative for smaller values of r. The formula given to enable a correction to be applied to the formula for the air-gap reluctance so as to take account of the slots in the armature was really only applicable to the case of a single slot of infinite depth. It could be seen by examining the figures 1—9 that very few of the stream lines penetrated far into the slot, and so the formula applied with considerable accuracy to the hydrodynamical cases considered. The formula could easily be deduced from the formula given by Prof. J. J. Thomson in "Recent Researches in Electricity and Magnetism" for the case of the analogous electrostatic problem. The agreement between theory and experiment in this case was exceedingly satisfactory. The following extension of an electrical method, suggested by Mr. F. W. Carter,* gave the complete solution of the problem of finding the reluctance of the air-gap of a dynamo, when the problem could be regarded as being in two dimensions. To this end a sheet of tinfoil should be cut out to the shape shown in the figure. Then DLME would represent to scale the outline of the pole and pole-piece, AB the armature and CD and EF half the distance between adjacent poles. This piece of tinfoil should then be pasted on a plate of glass. The position of the armature has been so chosen that the lines of force on each side of the pole are symmetrical. Copper strips, connected with an accumulator (see Fig.), are then placed over CD and EF. The equi-potential lines on the tinfoil could be easily plotted out by Kirchhoff's method. AL and BM are the equi-potential lines through A and B. It followed at once from the general mathematical equations that the equi-potential lines in the current problem were the lines of force in the magnetic problem and the lines of equal magnetic potential in the magnetic problem were the stream lines of current in the electrical problem. The equi-potential lines at P and Q were practically parallel to CD. The number of equi-potential lines between P and Q was proportional to the difference of potential between P and Q and this might be found by the potentiometer method indicated in the figure. This method was described in the classical Paper by Prof. G. Carey Foster and Sir Oliver Lodge which was read to the Physical Society nearly 30 years ago.† The points p, q, l and m were at the same potential as the points P, Q, L and M. The reluctance $\mathcal{R}$ of the air-gap, per unit thickness of pole, parallel to the axis of rotation could then be found from the formula $\mathcal{R} = (c/a) \times pq/lm$ where a = the length of PQ, c = CD—that is, half the distance between adjacent poles—and pq and lm denoted the lengths of the potentiometer wire between the points p and q, and l and m respectively. If the breadth of the pole parallel to the axis of rotation be b, then the reluctance would be $\mathcal{R}/b$. It was to be noted that the size of the piece of tinfoil was immaterial. It had, however, to be made accurately to scale. In this manner it was easy to find the effect on the reluctance of slight alterations in the shape of the pole-piece. The flux-density at every point could also be found at once, not only on the surfaces of the pole-piece and the armature, but also at every point in the air-gap. Thus, in alternators, the armatures of which had a simple bar winding the form-factor of the wave of E.M.F. could be found and the effective voltage predetermined in certain cases. By a slight extension of the method—namely, by cutting out in tinfoil a representation of the complete air-gap of a machine—the variations of the reluctance of the air-gaps due to differences in the relative positions of the stator and rotor could be ascertained. The proof of the formula for the reluctance depended on the reciprocal relations between equipotential lines and stream lines. If R_1 were the resistance to electrical flow from AL to BM and R_2 be the resistance to electrical flow from LM to AB when LM and AB were lines of equal potential and AL and BM were stream lines, then we had $R_1 R_2 = \rho^2$, where ρ is the resistivity of the tinfoil. Again, we had



$$\mathcal{R} = \Sigma l/\mu s \text{ and } R_2 = \Sigma \rho l/s.$$

Therefore, the reluctance could be deduced from R_2 by merely writing $1/\mu$ for ρ, and thus, since μ equalled unity in our case, and R_1 could easily be found by Ohm's law, it was found that $\mathcal{R} = (c/a) \times pq/lm$.

Thursday, December 8th.

Dr. E. W. MARCHANT pointed out that when the distance between the pole-pieces became great the lines of force would leak not simply from the tips of the poles themselves, but would leak from points further up the poles on to the surface of the armature. Consequently, in dealing with continuous-current machines where the commutation was effected nearly under the pole tips, the effect of these lines in producing E.M.Fs. would be negative. The very beautiful stream-line diagrams exhibited at the previous meeting were particularly valuable in showing the distribution of flux through teeth of rather extraordinary shapes. Unfortunately there was one point of difficulty which occurred, and which had been referred to in the Paper. When dealing with the very high flux densities of 140,000 to 150,000 lines per square inch the variation in the permeability came into play, and this was difficult to take into account with the stream line method. In his laboratory during the last six months two students had obtained very interesting results with regard to the non-uniformity of the distribution of the flux over the pole tips due to the presence of the teeth, and they had found extraordinary values for the E.M.F.s induced in stationary wires fixed to the pole-pieces as compared with the E.M.F.s induced in corresponding wires placed on the surface of the armature of an alternating current machine. The actual value of the E.M.F. induced in a coil fixed to the pole was of the order of 20 per cent. of that in a coil placed on the moving armature. The actual value of this E.M.F. depended very largely on the current that was flowing in the armature. It was very largely increased when the alternating current in the armature was in phase with the applied pressure. It was reduced, however, when the current lagged and increased still more when the current led. He hoped these results would be communicated to the Institution in the form of an original communication.

Mr. C. C. HAWKINS said that in Mr. Carter's Paper mentioned by the authors (Vol. XXIX. of the Institution *Proceedings*) a comparison had been made between the rough approximation which Mr. Wightman himself had given for the fringing from the edge of the pole and the more correct mathematical expression contained in Mr. Carter's Paper. But he thought this was hardly a fair comparison. In a particular case Mr. Carter stated that the fringing coefficient was 1·76 on Mr. Hawkins' basis as against 1·07 obtained by Mr. Carter's method. Mr. Carter's example, however, referred to a case where the face of the pole was at right angles to the armature core, whereas his (Mr. Hawkins') example was for a sloping edge. This would bring his own figure to 1·96. But the real point which he wished to bring out was that the fringing which Mr. Carter had compared with his ought to be multiplied by 2, because his (Mr. Carter's) figure took account of both fringes. Therefore, the true comparison would be 2·14 against 1·96. Figures 16 to 20 were of very great interest but he thought they would be of greater value if the ordinates had been plotted in terms of the induction instead of the total magnetic flux. It would then be possible to compare the mean air-gap induction with the induction in the teeth. From the mean air-gap induction the apparent induction could also be found on the assumption that all the lines passed through the tops of the teeth. In working out the armature turns necessary for the teeth of an ordinary dynamo armature, the basis was usually a curve connecting apparent induction with real induction. This was based on a particular assumption that the lines all passed down the teeth in parallel straight lines and that on each side there was a certain fringe of lines also passing down parallel to those in the teeth. When this was done various curves were obtained for different ratios of width of tooth and width of slot. This assumption was quite wrong, however, and could only be regarded as a makeshift. It was not even a close approximation.

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* *Electrical World and Engineer* of New York, Vol. XXXVIII., p. 884.

† "On the Flow of Electricity in a Uniform Plane-Conducting Surface." Part II. Feb. 27, 1875.

Prof. HAY, in reply, said that, in connection with the remarks made by Prof. Thompson, he would like to emphasise the fact that the diagrams which were generally given of the magnetic flux distribution in most text books appeared to indicate that the authors were either ignorant of the law of tangent refraction for magnetic lines or else deliberately ignored it. In a number of text books published during the course of the present year a large number of diagrams were given in which no attempt had been made to show the refraction lines as they passed from air into the mass of soft iron. With regard to Mr. Russell's method, it was the opinion of the authors that it was an extremely laborious way, and anyone who had attempted the plotting of equi-potential lines by this method would agree with this view. Prof. Marchant's remarks with regard to the difference in the E.M.F.s induced in a coil which was placed on the surface of a rotating armature, and those induced in a coil placed against a pole-piece were most interesting, because they showed the wide differences in the armature reaction of the machine experimented upon. The effects mentioned were precisely what might be expected, if it was considered that when the armature current was in phase with the E.M.F. the greatest cross-magnetising effect was obtained. The E.M.Fs. induced in the armature conductor depended mainly on the cross-magnetising effect, due to the fact that the lines were crowded under the lagging tip of the pole-piece and swing back, as the current diminished, to the leading tip. If, on the other hand, the current was lagging considerably, then the effect was really a demagnetising effect, and if the machine was provided with very heavy pole-pieces, then a considerable damping effect would be produced, and, consequently, the E.M.F.s induced in a coil placed at the ends of a pole-piece would not probably be so large as it was in the case where the effect was a cross-magnetising one. Referring to Mr. Hawkins' remarks, he said there would be no difficulty in plotting the curves so as to connect the apparent induction through the tooth with the mean induction. It was hoped to extend the stream-line method to the regular shapes of teeth which were employed in induction motors. In this case, an exact knowledge of the air-gap reluctance was of particular importance because, as was well known, the behaviour of an induction motor was largely determined by the reluctance of its air-gap. The stream-line method appeared to be one very well adapted to the solution of this particular problem. No matter how irregular the shapes of the teeth in the stator and rotor of the machine might be, it was possible to determine the exact distribution and calculate the corresponding coefficient.

Prof. HELE SHAW said he wished to say a few words in order to correct a misunderstanding which had apparently arisen. The mathematical verification of the stream-line method by the late Prof. Stokes was contributed simultaneously with a Paper by himself to the British Association meeting at Bristol. In this case, as in many other cases, experiments were made first, and then the mathematician demonstrated that the results were what might have been expected. He believed it was not anticipated, however, that it would ever be possible to produce perfect stream-line motion with a viscous fluid, and that the more viscous the fluid the more perfect the motion. In order to obtain good results it needed the preparation of a certain thickness of paraffin free from air bubbles. This had been obtained by boiling the sheet of glass together with its layer of paraffin. Prof. Thompson had suggested that it might be possible to demonstrate by the stream-line method the actual working of an armature, and so demonstrate to students what was actually going on. He hoped this would be done. It was quite possible, because they had already got as far as this in another direction, not electrical, however. He hoped that every technical school would be able to have a very simple form of this apparatus to demonstrate to the students the various problems of this kind. Mr. Paul was going to make a cheap form of the apparatus. In conclusion, he pointed out that although his name was down as one of the authors of the Paper, the largest part of the work had been done by the other two authors. In fact, he was in Africa when his name was put to the Paper and this was only done by virtue of his early work in this direction.

FOG-DISPELLING APPARATUS.

Sir Oliver J. Lodge has been granted a patent (No. 24,305 of 1903) entitled "Improvements in means for the production of continuous high potential electrical discharges applicable for the deposition of dust, fume, smoke, fog and mist, for the production of rain and for other purposes," of which the following is an abstract:—

The property of the electric discharge of causing the coalescent deposit of matters suspended in a gaseous medium has not come into practical use on account of the difficulties attendant on the use of the statical electrical apparatus, this class of apparatus being too delicate and easily upset for use on an extensive scale. Sir Oliver Lodge's invention consists in a combination of high potential rectifiers, arranged in quadrilateral groups of four or multiples of four in such a way that instead of the reverse pulses of the alternating-current supply being suppressed or non-existent as at present they are redressed to form the positive and negative discharging streams required for the deposit purposes.

Referring to the accompanying drawings: Fig 1 is a diagrammatic view showing one method of carrying the invention into effect; Fig. 2 shows diagrammatically another method in which an alternating-current dynamo is used; Fig. 3 is a view of a rectifier suitable for use in carrying out the invention; while Figs. 4 and 5 show some of the means of insulation which may be employed.

In the arrangement shown in Fig. 1, *a* is a battery in circuit with an intermitter, *b*, and the primary *d*, of a large Ruhmkorff induction coil; a condenser, *c*, may be placed in parallel with the intermitter *b*. The secondary *e* of the Ruhmkorff coil is connected through two series of high potential rectifiers, *f g*, preferably of the form hereinafter described, to the terminals *k m* of the insulated coatings of a pair of Leyden jars, whose outer coatings, *j l*, are in electrical connection. To the terminals *k m* are also attached the leads for discharging wires, *o p*, which are supported by insulators, *n*. A dynamo may be employed in place of the battery. The leads or discharging wires must be well insulated (see Figs. 4 and 5). The dischargers may be points, flames or other means whereby a free discharge can be obtained; parallel rows of barbed wire or of barbed-wire fencing or other metallic areas may be used, one of which areas may be insulated while the other is earthed, or both may be insulated and placed facing each other beyond sparking distance in the place where the discharge is wanted. When the apparatus is used for the removal of smoke or the like, it is preferable to insulate both dischargers; when electrification of clouds is the object, one set of dischargers would usually be earthed, and the other set arranged so as to be discharged skywards by well-insulated conductors.

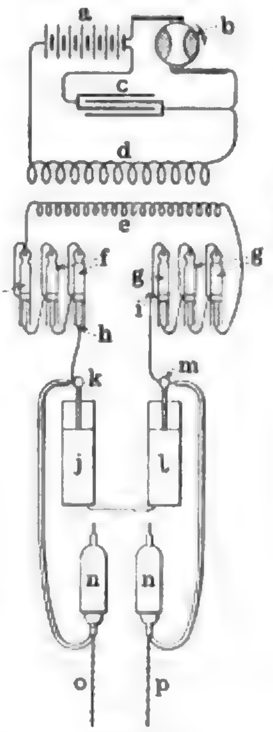

FIG. 1.

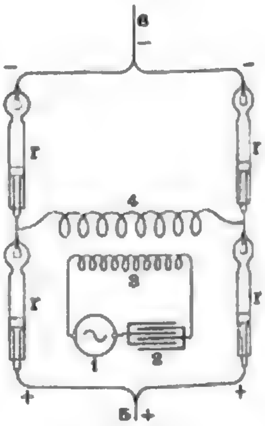

FIG. 2.

In the operation of the apparatus the current generated in the battery or dynamo is interrupted by the intermitter and induces intermittent pulses of violently high potential in the secondary coil of the Ruhmkorff coil; these pulses are transmitted through the rectifiers, positive pulses through the series *f* and negative pulses through the series *g*, to the insulated coats of the two Leyden jars. The object of each series of rectifiers is to transmit a current easily in one direction and to strongly oppose a passage of current in the opposite direction; by this means the intermittent supply from the induction coil is enabled to maintain the jar or jars steadily charged. The higher the potential desired the more numerous are the rectifiers required in each series, and it has been found that three in each series is a convenient number to use where it is required to keep up a practically continuous discharge, between the dischargers, at a potential of about a quarter of a million volts.

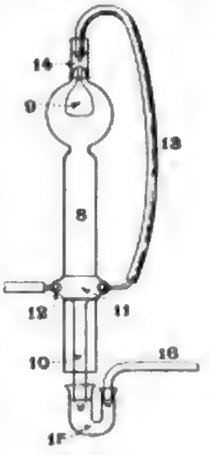

FIG. 3.

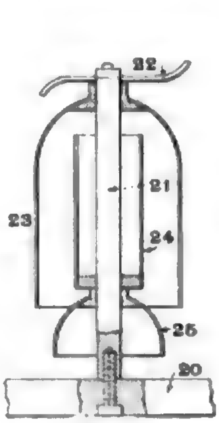

FIG. 4.

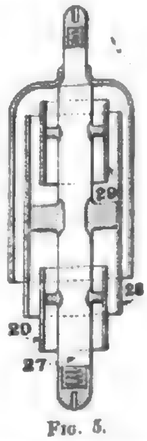

FIG. 5.

Fig. 2 shows an arrangement in which the source of current is an alternating-current dynamo; the dynamo 1 is placed in circuit with a condenser, 2, and the primary 3 of an alternating-current transformer which may in this case have a closed magnetic circuit. The high-potential rectifiers *r*, arranged in a quadrilateral, are combined in four groups, each of which contains one or more rectifiers in series, the number depending on the potential required. Two of the groups of rectifiers similarly directed are connected between the terminals of the secondary coil 4, and the positive discharging means 5 and the other two both directed in the opposite direction, are connected between the terminals of the coil 4 and the negative discharging means 6. In this arrangement an alternating-current dynamo may be used, having an excessively high frequency, say, 3,000 to 4,000 alternations per second, or the alternating discharge of condensers such as Leyden jars may be employed.

In this case, as in the arrangement shown in Fig. 1, Leyden jars may be connected between the rectifiers and discharging means thereby obtaining a more continuous discharge.

The rectifier shown in Fig. 3 is similar to the Cooper-Hewitt mercury-vapour lamps, and is formed from thick glass tube, 8, having an iron anode, 9, at the top and provided at the bottom with a mercury-pool cathode, 10, surrounded by an outside metallic band, 11; the positive terminal 12 is formed on this band which is connected to the anode, 9, by an insulated wire, 13, the contact being made by placing the end of the wire 13 in a vessel, 14, containing mercury formed at the top of the tube 8. A U-tube 15 containing mercury is placed so that the contact leading from the mercury pool is under the surface of the mercury in the U-tube as is also the end of the wire 16 leading from the cathode. The object of the mercury contacts 14 and 15 is to avoid the loss which would otherwise occur at the exposed points on the conductors, when used to convey electricity at the high potential necessary. In some cases the rectifiers may be submerged in oil in order to lessen the liability to loss and spitting off, but this is not usually found to be necessary.

In Fig. 4 the conductor 22 is supported on an ebonite or glass or earthenware rod or other suitable insulator, 21, from a supporting beam, 20; the rod is protected by two umbrella-shaped inverted covers 23 and 25, and a cylindrical vessel 24 open at the top, all of which are constructed of ebonite, earthenware, glass, mica or other suitable material. Fig. 5 shows a modification in which the conductor is suspended from a rod, 27, protected by cylindrical vessels, 28, 29, all being constructed of suitable insulating material.

The apparatus described may also be used for causing the deposit of lead fume in the manufacture of white lead by furnace processes or for depositing valuable factory dust.

The principal claims are :—

(1) The method of causing small particles to coalesce into larger ones by the use of a high potential discharge, the supply of electricity being obtained from a dynamo or battery or from the alternating discharge of condensers. (2) The method of causing small particles to coalesce into larger ones by the use of a high potential discharge obtained by the use of high potential mercury rectifiers and a high potential intermittent or alternating electric current. (3) The method of producing a continuous high potential discharge of electricity in one direction by the use of high potential mercury rectifiers so arranged as to transmit pulses always in one direction and so to charge and keep charged condensers which are connected to the discharging means, substantially as described.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Microscopic Resonators.—Photographic plates developed in Lippman's process show a change in the tint of the transmitted light when the gelatine film dries up. A similar phenomenon is seen in slightly gelatinised solutions of colloidal gold as prepared by Szigmondy. Both phenomena have been explained on the supposition that the distances between the absorbing particles is diminished on drying, and that consequently the pitch of the molecular resonators is altered. This matter has now been investigated by F. Kirchner and R. Szigmondy, with a view to determining the constitution of the resonators themselves. They applied Planck's theory of electrical resonance, being enabled to determine the necessary data by Siedentopf and Szigmondy's ultra-microscopic apparatus already described. That apparatus enabled them to count the number of ultra-microscopic particles in a cubic centimetre of the emulsion, and thus from the known quantity of gold in the emulsion to determine the mass of one particle. This mass came out as 7×10^{-14} megohms. The emulsion showed a blue coloration in the dry state and a high red colour in the wet state. The real resonators are not these particles but the smaller gold particles which form the larger aggregates by combining with each other and with a certain amount of gelatine. The absorbing layer is represented by the sum of all aggregates contained in the emulsion, and is independent of their mutual distance. The selective absorption cannot be accounted for by interference or diffraction, since the particles are too small and too close together. And something else is required besides simple molecular resonance. The latter could only explain the change of colour if the molecules could be individually separated from each other, as in a gas under varying pressure. According to Faraday, gold particles of very different masses produce the same coloration of a solution. The gold particles must be assumed to be flat leaves, and then the application of Planck's theory leads to a displacement of the maximum of absorption in the observed sense.

[KIRCHNER and SZIGMONDY, *Annalen der Physik*, No. 13, 1904.]

Life of Radium.—A. Voller claims to have obtained evidence that the life of radium varies according to its concentration, and that when it is very finely divided it dies off in a few days. He prepared aqueous solutions of radium bromide having concentrations of 0·1, 0·01, &c., and spread them on glass plates, which were then allowed to dry. The thin radio-active layer thus prepared was found to adhere very tenaciously to the surface of the glass. The radio-activity was measured by the electrometer method, but for the detection of the last remnant of radio-activity the spintharoscope was used. The author obtained two results. One of these is that the concentration of the salt increases the intensity of the radio-activity. The other result is that it also increases the life of the radium salt. A 0·00001 solution of radium bromide spread on a square centimetre of glass loses all perceptible radio-activity in about 126 days. A 10^{-9} solution lasts only a fortnight. In no case did the author notice a revival of the radio-activity, at least none that could be detected with the electrometer. A very long exposure still yielded a photographic impression, but it was only slight, and appeared to be due exclusively to α-rays of feeble penetrative power. Discussing these results, J. Stark pointed out that the composition of the substance on the plate is somewhat doubtful, and it may consist of secondary radium rays or of emanation. The transformation of the emanation into the further products of the decomposition of radium might give rise to the impression that the radium itself was decaying. Nernst recalled the analogy of a very thin film of gold deposited upon silver. The deposit after a time loses its characteristic colour and other optical properties, but cannot be said to have disappeared.

[A. VOLLER, *Physikalische Zeitschrift*, December 1, 1904. Paper read at the Breslau Scientific Congress.]

Electric Theory of Gravitation and Terrestrial Magnetism.—The conception that the inertia of matter and that of electricity must be identical makes it probable that gravitation has an electric origin. W. Sutherland, who recently showed that cohesion and rigidity are essentially electric properties of matter, now investigates gravitation from a similar point of view. Matter may be regarded as composed of electrons in the form of doublets, whose inertia constitutes the inertia of matter. The author determines the attraction between two such doublets by the law of inverse squares. He finds that the gravitational constant may be formulated as follows in the C. G. S. system :—

$$G = 9\,(b + c)\,a^2\,V^4/16\,e^2,$$

where a is the radius of the electron, e its charge, V the velocity of light, and b and c are small fractions representing the deviation of the attraction or repulsion from the strict law of inverse squares. If this formula is to account for gravitational attraction we must have

$$b + c = 32 \times 10^{-44}.$$

Gravitation then can be traced to an electrical origin if between two electric doublets there is an outstanding electric attraction which is of the order 10^{-40} times the force between two of the electrons, one in each doublet. Ordinary experimental evidence of a difference of this order of magnitude has hitherto been out of the question, but turning to phenomena on the same large scale as universal gravitation in astronomy, terrestrial magnetism holds out the greatest promise. The author has already shown that the earth's primary magnetic field can be accounted for by spherical distributions of positive and negative electricity within the earth and revolving with it, the negative being on the whole nearer to the surface, but by an amount which need not exceed the diameter of a molecule. The author works out a theory which leads up to the old hydrodynamical analogy of sources and sinks. The only difficulty which results is how to account for the absence of a strong electric field resembling the earth's magnetic field.

[W. SUTHERLAND, *Philosophical Magazine*, December, 1904.]

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"ELECTRIFICATION" OF THE METROPOLITAN RAILWAY.

For nearly 42 years the famous Metropolitan Railway of London has been worked by steam locomotives, and within a month of its 42nd birthday the deposition of that class of machinery has been commenced. Obviously, it would be impossible to make the change from steam to electric traction suddenly, but the withdrawal of the old rolling stock and the introduction of the new commenced on Tuesday, and the replacement will now proceed gradually but continuously. The history of this railway is interesting, the line having been owned originally by the Great Western Railway Co. When first opened it was only 3¾ miles in length. Its object was to act as a feeder to the Great Western Railway, and it ran from Farringdon Street to Bishop's Road. Long before electric traction was thought of, so early, indeed, as the first year of the life of the line, a third rail was laid, its function being not to convey electrical energy, but to enable the tract to accommodate both broad and standard gauge trains. Originally the line was built to the old broad gauge, so as to permit the Great Western rolling stock to run over it, but on the formation of the Metropolitan Railway Co., who took over the working, a third rail was laid down to standard gauge, and rolling stock of both gauges ran in the tunnels. In 1869 the broad gauge was abolished. Previously to this date, however, an extension had been constructed to Moorgate-street and another to Hammersmith. The St. John's Wood branch to the "Swiss Cottage" was also opened in 1868, and at the present day the line serves a very extensive area in the north-west of London. It is not proposed to adopt electric traction on the entire system forthwith, but there will, nevertheless, be approximately 26 route miles electrically equipped in the immediate future, most of which is nearly completed. This figure includes the entire northern half of the familiar Inner Circle, the branch from Baker-street to Harrow and thence to Uxbridge, and the Hammersmith line from Westbourne Park. The power required will, naturally, be very considerable, and although the power house at Neasden is not so large as that of the Metropolitan-District Railway at Lot's-road, yet it is the largest in the United Kingdom owned by a single railway company.

It was the unpleasant atmospheric conditions upon the Inner Circle that first led to the consideration of the question of adopting electric traction. In consequence of numerous complaints, a Committee was appointed by the Board of Trade in February, 1897, "to inquire into the existing system of ventilation of the tunnels on the Metropolitan Railway and to report whether any, and if so what, steps could be taken to add to its efficiency in the interest of the public." The report of this Committee was published in October, 1897, and after making certain recommendations, as a temporary expedient to mitigate the existing nuisance, the Committee stated that "by far the most satisfactory mode of dealing with the ventilation on Metropolitan tunnels would be by the adoption of electric traction." Now the Inner Circle is owned by two separate companies,—viz., the Metropolitan Railway Co. and the Metropolitan District Railway Co. (frequently called simply the "District Co.")—which are two independent concerns with different directorates, in spite of the similarity of their names and the physical connection between the two lines. In 1898, after negotiations between the two companies, Sir JOHN WOLFE BARRY and Sir WILLIAM PREECE were appointed to report on the possibilities of electric traction. Upon the presentation of this report, a sum of £20,000 was voted for the purpose of experiments, and in due course the section of the Inner Circle between Earl's Court and High-street, Kensington, was equipped for working electrically. The total length of this line was 5,000ft., a third and fourth rail being added and low-tension continuous current being supplied from a temporary power station erected close at hand. The line was opened in May, 1900, and a full illustrated description appeared in *The Electrician*, Vol. XLV., p. 163.

Following the advice of the old Italian proverb, "Chi va piano, va sano e anche lontano" the directors of the two companies next determined to ascertain whether any other system than the experimental one would be more advantageous. In August, 1900, therefore, it was agreed between the two companies to ask eminent firms of electric traction engineers to submit plans and specifications for the equipment of the Inner Circle for electrical working. Amongst the names mentioned as good firms to apply to were the British Westinghouse Co., Messrs. Mather & Platt, Messrs. Siemens Brothers & Co. and the "American Companies," and a committee of three members from each of the railway companies was appointed to deal with this matter.

At first there had been no circumstances, beyond public convenience, to induce the directors to hasten matters unduly, but the Central London Railway, which was opened in June, 1900, immediately caused an adverse effect upon the traffic of the Inner Circle. In fact, during the last 20 weeks of the year 1900 it was estimated that the loss in revenue, as compared with previous years, amounted to £1,390 per week. In consequence of this, the electrification of the Inner Circle was regarded, practically for the first time, as being of extreme urgency, and in January, 1901, nine tenders were received from various firms for the complete equipment of the Inner Circle, whilst the District Company, at a special meeting, received sanction for the creation of £500,000 new share capital and £166,000 in new debenture stock in view of the expense which the new system of traction would involve. The nine tenders were immediately referred to Sir WILLIAM PREECE and Mr. THOMAS PARKER for report. The choice of these two gentlemen ultimately fell upon a tender from Messrs. Ganz & Co. of Budapest, which proposed the use of high-tension three-phase current in which a pressure of 3,000 volts was applied directly to the trains. A saving in cost of many thousands of pounds was claimed for this system as compared with the low-tension continuous current system. This recommendation had been adopted by the Metropolitan Railway Co. and was under consideration by the District Company when a hitch in the negotiations was introduced mainly owing to the financial condition of the District Company, and matters were made more acute by the resignation of Mr. J. STAATS FORBES from the chairmanship of the company. It had always been admitted that the Metropolitan Company was in the better position financially, but the position of the District Company was such that Mr. R. W. PERKS, when elected chairman of the company in succession to Mr. FORBES, found it advantageous to carry on negotiations with certain American financiers with Mr. C. T. YERKES at the head. During the course of his investigations into the prospects of the District Company, Mr. YERKES and his engineers paid a visit to Messrs. Ganz & Co.'s works at Budapest to inspect the system proposed in this firm's tender; but returned firmly convinced that such a system should not be adopted if he were to continue any relationship with the District Company. Consequently, a complete deadlock arose between the two companies, and the matter came before the Board of Trade for arbitration. The Hon. ALFRED LYTTELTON, K.C. (now Colonial Secretary) was appointed umpire, Mr. H. F. PARSHALL representing the District Company and Mr. T. PARKER the Metropolitan Company. A first meeting was held on October 7, 1901, but only formal business was transacted, and an adjournment was made until October 29th, when the case for the District Company was opened by Mr. FLETCHER MOULTON, K.C. The District Company advocated the ordinary continuous-current system at 500 or 600 volts so far as the working current was concerned, with high-tension three-phase generation and distribution to sub-stations. Their witnesses included Mr. R. W. Perks, Mr. C. T. Yerkes, Mr. J. R. Chapman, Mr. E. W. Rice (Vice-President of the American General Electric Co.), Mr. James Swinburne and Mr. Philip Dawson. The case for the Metropolitan Company was entered upon on Tuesday, November 5th, Mr. C. A. Cripps, K.C., contending that if the Ganz system were adopted a saving of £15,000 per year would be effected in addition to £150,000 in initial cost. Herr O. T. Blathy, manager to the electrical department of Messrs. Ganz & Co., explained the system proposed in great detail. As stated before, it was proposed to introduce a pressure of 3,000 volts directly to the motors on the train from overhead equipment. The adoption of the system was supported by Prof. J. A. Ewing, F.R.S., Prof. S. P. Thompson, F.R.S. and Major P. Cardew. The proceedings, which terminated on November 15, 1901, were specially reported in our columns at considerable length. The Award, in favour of the continuous-current system, was issued within a month.

Both companies have loyally acted upon the terms of the Award, and now that the Baker-street extension has been completed we may look forward to the conclusion of the work on the Inner Circle before the end of next year. There is no doubt that the change from steam to electric traction is one that will be given a most hearty welcome by the public. The run to Uxbridge, mentioned on another page, which took place on Tuesday, and really marked the inauguration of electric traction, was an unqualified success.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

The Cultivation and Preparation of Para Rubber. By W. H. JOHNSON, F.L.S., F.R.H.S. (London: Crosby Lockwood & Son.) 7s. 6d. net.

Three or four books relating to indiarubber from a scientific or a manufacturing point of view have appeared of late years to swell the very small library previously existing for those interested in the subject. The small volume under notice is the first, we believe, to minister specially to the wants of the rubber planter, who, as a class, will undoubtedly increase as time goes on. Mr. Johnson has strong qualifications for his self-imposed task, having held Government posts in connection with the furtherance of Para rubber planting in the Colonies. As a botanist, and on his own ground, he writes lucidly, and has managed to crystallise into a small space matter hitherto available only in trade journals and Government publications.

It is where he gets off his own ground in the brief *resumé* of the manufacture in the introductory chapter that he comes in for our criticism. A little judicious editing (say, in the office of the *Indiarubber Journal* so often quoted in the book) might have resulted in something more understandable by the uninformed reader. Of course, the difficulties in the way of treating the matter in the short space allotted to it must not be overlooked, but at any rate the dates might be correctly given. The vulcanisation of rubber was first effected by Hancock and Goodyear much nearer 1844 than 1874, and though the rate of progress has certainly been increased in later years, yet the great fillip that the trade received must be dated from 1845. With regard to the increasing demand for rubber and its undoubted shortage of supply we think that rather too much is made of the effects of the tyre and electrical industries. In the latter case paper and other fibrous material has largely ousted rubber, while as regards the tyre industry, we think that if careful enquiries could be made, its progress is not responsible for the increased use of rubber to anything like the extent claimed for it by general writers. This use of rubber, of course, looms largely before the public eye, while its application in engineering, and more especially in modern shipbuilding are altogether ignored because they do not come under general observation.

Though the cultivation of Para rubber is certainly to be commended where found feasible as likely to prove a remunerative departure in economic botany, it must not be overlooked that the shortage of supply from natural sources in South America is largely due to the amount of acclimatised labour being so limited. Were the climate less deadly, it is certain that the large areas of untapped forest would soon minister to present wants. With regard to the market quotations given for the Ceylon rubber and for that from untended Nature, we are not aware of any preference being given to the former by manufacturers except in the one particular of freedom from moisture. The South American product always loses somewhere about 15 per cent. in washing and sheeting, while the Ceylon rubber comes to the market practically dry, for this reason fetching a higher price, due directly to its higher content of rubber, and not, to the best of our knowledge, to any intrinsic superiority. That the Para rubber tree can be successfully cultivated in Ceylon and the Malay Archipelago is now a matter of fact, and the result of the efforts to acclimatise it in West Africa will be watched with interest, all the more since the diminution in the yield from the Landolphia trees due to reckless gathering has become accentuated.

With the present volume at hand the prospective planter will have a valuable aid in his work, and he will be well advised if he keeps himself up to date by perusing the issues of the *Indiarubber World* of New York, a journal in which rubber planting interests receive close and regular attention.

Higher Text-Book of Magnetism and Electricity. By R. WALLACE STEWART, D.Sc. (London: W. B. Clive.) 6s. 6d.

As explained by the author, the basis of this work is his "Text-Book of Magnetism and Electricity." The new work takes the student up to the standard necessary for final degree work, and although the treatment is mainly of an elementary character, the author has made use of higher mathematics, including the calculus, to a certain extent. Part I. deals with electrostatics, part II. magnetism, and part III. current electricity. One great advantage of the book is the way in which it deals with the numerical work. Instead of giving an example of each formula as it occurs, a brief summary of the most important quantitative relations is given at the end of every few chapters, and after illustrating one or two calculations by examples, a number of questions are set and their answers printed at the end of the book. Candidates for London University degrees will find this work a valuable aid, although for practical engineers it is, of course, less useful.

A Pocket-book of Electrical Rules for the Use of Electricians and Engineers. By JOHN MUNRO and ANDREW JAMIESON. 17th edition. (London: Chs. Griffin & Co.) 8s. 6d.

A few revisions have been made in this pocket-book, but it still retains its character and offers its patrons the dear familiar mixture of old and—nearly new. In each new edition some of the suggestions of the reviewers of the previous edition are adopted, but this still leaves the amended portions about 18 months behind the times. Moreover, this method of revision assumes that the reviewer laboriously and conscientiously wades through the book from cover to cover, and then publishes the result of his labour in his notice of the book. Even were the available space in our review columns ample enough for the purpose, we should be loth to do this; for it would be almost vandalism to remove or to renovate some of the ancient and historic pages that are still left of the Munro and Jamieson of our student days. Let us still preserve the charm of old associations if we can, and do nothing to assist in the replacement of monuments of antiquarian interest by the unsuccessful efforts of those who have endeavoured to keep up with the rapid pace of electrical engineering progress and have been left behind in the race.

First Stage Magnetism and Electricity. By R. H. JUDE, M.A., D.Sc. Revised edition. (London: W. B. Clive.) 2s.

This elementary text-book is intended for students reading for the South Kensington Board of Education examinations, and has recently been revised and re-written. It consists of three parts, the first of which deals with electrostatics from the "potential" point of view, the "free and bound charge" aspect having been abandoned as a basis. The second part deals with phenomena of magnetism, while the third embraces "voltaic electricity." Although the number of elementary text-books of this kind is legion, yet it cannot be said that the one before us is superfluous; the methodical arrangement of the matter and its general treatment are distinctly in its favour.

THE DIELECTRIC STRENGTH OF CERTAIN SPECIMENS OF MICA.

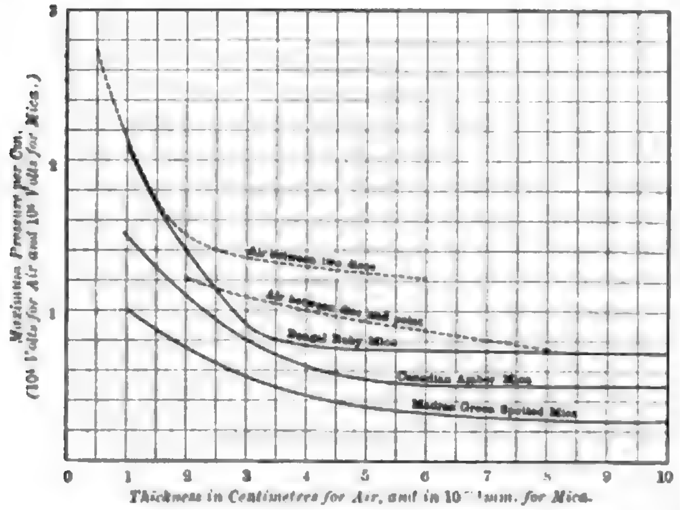
BY ERNEST WILSON AND W. H. WILSON.

About a year ago Messrs. F. Wiggins & Sons supplied one of us with a series of mica specimens upon which we conducted a number of experiments, our object being to find their dielectric strength. We publish the results as they may perhaps prove useful to engineers.

The method of test was to place each sheet between two circular bronze electrodes each 1in. in diameter and $\frac{1}{8}$in. thick and to raise the difference of potential between them by aid of an alternate-current transformer until the specimen broke down. The frequency was 55 and the P.D. was raised by increasing the exciting current of the alternate-current generator. Each test was completed as rapidly as possible, but in the case of the micas having the higher dielectric strength (for example, some of the Bengal micas) there was slight local heating due to the electric discharge at the edge of the discs consequent upon the increased density of the electric force produced there by the presence of the mica. In some cases as many as eight or nine specimens of one kind of mica were broken down.

The P.D. in volts per centimetre of the thickness was plotted in terms of the thickness and a mean curve drawn through the points. From these curves the figures given in the accompanying table have been obtained. In three cases only have we figures obtained from sheets about 1mm. thick, which had to be of much larger size to render the tests possible. These specimens are Nos. 14, 15 and 3, placing them in the order of their dielectric strengths, and as these micas are most in use for electrical purposes the curves are plotted in the accompanying diagram. The inference is that at about 1mm. thickness the total dielectric strength of mica between 1in. discs becomes approximately proportional to its thickness. The ruby micas are largely used for condensers. The amber (Canadian) and green (Madras) micas are largely employed for insulation purposes generally.

It is noteworthy that those micas which have the highest dielectric strength when thin are not necessarily the best when thicker layers are compared. The time taken to break down most of the sheets varied from ¼ minute to 1 minute, but in the case of the ruby mica when 1mm. thick its temperature would have been raised unfairly high on account of excessive sparking if we had broken it down with 1in. discs. A blunt point, having an angle of 25 deg. on a rod ⅛in. diameter, was used instead of one of the circular electrodes. In all other cases the circular electrodes were used, and in no case was the temperature more than one could bear by placing the hand on the specimen.



In order to get a comparison between the dielectric strength of air and these micas we show two dotted curves in the diagram. The upper one gives the strength of air between the discs which were used with the micas. The lower one gives the strength when one of the discs was replaced by the blunt point used for breaking down specimen No. 14 when it was 1mm. thick. The difference between the strength of air of a given thickness in the two cases hardly justifies us in plotting the point obtained with specimen No. 14 when it was 1mm. thick on the same curve with those obtained when it was thin. The strength of this mica between the 1in. discs would probably have been greater than $0{\cdot}72 \times 10^6$ volts per centimetre, but the sheet was not large enough to break down with sufficient rapidity to keep down its temperature. We chose discs for the tests as they more nearly represent engineering practice, but with flat mica sheets of moderate size a difficulty is naturally encountered by the different conductivities for electric flow in the insulator and the surrounding air producing electric discharge through the air.

It must not be inferred from the above experiments that the *specific* dielectric strength of an insulator is a variable dependent upon its thickness. The P.D. required to puncture a given specimen when surrounded by air is a function of the shape, relative size, distance apart, and nature of the electrodes. The following experiment is interesting in this connection. Suppose two sheets of ruby mica (No. 14) each 0·07mm. thick be placed side by side between two circular disc electrodes, each 1in. diameter. It will be found that the P.D. required to puncture these sheets in a given time is less than when two sheets of the same kind of mica each 0·05mm. thick have placed between them a sheet of tinfoil of larger area than the electrodes, the total distance between the electrodes being the same as before. An examination of the brush discharge shows that the greater area of the tinfoil accounts for this since it reduces the density of the electric force at the edge of the discs. This increased density at points along the edge of the discs suggests that the slots in which high-tension coils are embedded should be rounded off at the ends, or special shields used there to relieve it. In special cases an intermediate sheet might prove beneficial.

No. of specimen.	Description and place where found.	Maximum volts in 10^6 required to puncture.			
		Thickness in millimetres.			
		0·1	0·2	0·8	1
1	Madras, brown spotted	1·6	1·2	0·9	..
2	„ green „ A.	1·3	1·1	0·9	..
3	„ „ „ B.	1·0	0·75	0·5	0·27
4	„ „ „ C.	1·3	1·1	0·94	..
5	„ „ stained	1·6	1·2	0·95	..
6	„ „ much stained ..	1·9	1·3	1·0	..
7	„ green clear. B.	1·7	1·2	0·95	..
8	„ „ „ C.	1·7	1·2	0·90	..
9	„ „ „ D.	2·0	1·3	0·8	..
10	Bengal, spotted	1·1	0·6	0·2	..
11	„ ruby, much stained ..	1·6	1·4	1·2	..
12	„ white	2·5	1·3	0·4	..
13	„ yellow	2·1	1·4	0·9	..
14	„ ruby, clear	2·1	1·4	0·9	0·72
15	Canada, amber	1·5	1·1	0·8	0·5
16	South America, spotted	1·0	0·6	0·4	..
17	„ „ ruby, clear....	2·1	1·4	0·9	..

GAS ENGINES IN CENTRAL STATIONS.

The following is an abstract of the discussion which took place in connection with the Paper on the above subject read by Mr. H. Campbell before the Leeds Local Section of the Institution of Electrical Engineers on November 17th. The Paper itself was published in abstract in *The Electrician* of November 25th, p. 211 :—

Mr. McLAREN asked whether the note, "No condenser, no power load," appended to the tabulated results of the steam-driven plant at Guernsey applied to October only or right through. He had had some experience in putting engines into central stations, and found that the more economical the engines the worse were the results, and this would also apply to the gas engines. In his Paper before the Institution of Mechanical Engineers in July, 1903, he had mentioned that none of the gas engine stations showed an economy equal to the steam engine stations. Referring to Walthamstow, Redditch, &c., Mr. Campbell had made comparisons without having all the facts. It was impossible to compare one station with another, because of the different working conditions. That was the reason why he (Mr. McLaren) took the whole of the stations throughout Great Britain; he obtained the whole of the different prices of fuels and struck a rough average, so that the lighting stations were not confused with the tramway stations, &c. The author had taken his figures for London at 1d. per unit, condensing. But there were in London alone five steam engine stations lower in works cost than Walthamstow, and two of these stations were lower in fuel cost, so that it was evident that comparisons could not be made unless everything was taken into account. As regards the comparison of fuel costs, it was hardly right to mention engines using a cheaper fuel and compare them with engines using a dearer fuel. The ordinary oil engine had to use an expensive oil, and the economy of the "Diesel" engine lay in the fact that it could use a cheap oil. He admitted that the results of the gas engines at Guernsey were excellent, but he could not congratulate them on the steam engine results, which seemed to him to be very bad, the fuel cost being on an average 0·7d. Of all the small stations there were very few which had such a high fuel cost. He also thought there must be some error in the exceedingly high load-factor of 70 or 80 per cent. which was mentioned. There was a difference in the price of coal used at Walthamstow and Guernsey respectively of 88 per cent., and there was only 34 per cent. difference in the cost per unit, showing that Walthamstow was really more economical than Guernsey. Regarding the units generated at Guernsey, the fuel cost was 0·5 for the steam engines and 0·242 for the gas engines. That was a very great difference in favour of the gas engines, on which the author was to be congratulated; but he believed that he worked on a wrong basis; he should not place the best gas engines against the worst steam engines. The steam engines seemed to be running very badly, according to the tables, and with the gas engines it was just the reverse. However, it very much depended upon the man who was looking after the machines. When it came to works cost the difference was only 28 per cent. in favour of the gas engines, the reason being that more attention was required by gas engines. The coal used by the boiler for making the gas was 15 per cent. of the total required for the plant. They were, therefore, using the most economical plant with the worst boiler imaginable.

Mr. A. B. MOUNTAIN said that it would be a good thing to use gas engines just to tide over the peaks during the period from October to March. Mr. Mountain thought that the author would agree with him that an engine governed by throttling was not as economical as the old "hit and miss" engine.

Mr. WOODHOUSE asked whether the cranks were actually at right angles or only approximately so. If the engine was balanced, the cranks could not be at right angles, as it was impossible to balance an engine with four cranks set like this.

Mr. J. W. DAWSON inquired whether there was any increase in efficiency by introducing water into the exhaust. With regard to the proposal of using gas engines in addition to steam engines, taking gas from a gas company, he pointed out that the gas engines would then be taking gas at the same time that the mximum of gas was used for other purposes.

Mr. S. D. SCHOFIELD, speaking with regard to the gas engines at Hebden Bridge, said that the sound of the engine when working and its external appearance was very similar to the standard high-speed central station type of steam engine. There did not seem to be much more attention required than what would be given to a steam engine of similar size. In connection with the question of overload capacity, he mentioned that he had put down several steam sets and on the last one erected found that the engine would give its normal output for 24 hours continuously; would carry 25 per cent. overload for two hours, 50 per cent. overload for 30 minutes, and 100 per cent. overload for one minute without dropping speed or volts more than 10 per cent. Such an overload capacity was very comforting to an engineer when the peak load came on in the winter time. While fuel costs would appear to show in favour of the gas plants, it must be remembered that fuel costs were not the whole of the running costs. The cost in wages for the two sets given in the Paper, did not seem to show any decided advantage in favour of gas or steam. He thought that the cost of repairs and renewals would be heavier with gas than with steam. The valve gear and other parts of the engine would require refitting, adjusting and renewing oftener than similar parts in the steam set.

Mr. H. E. YERBURY asked if the author had any figures with regard to the relative efficiencies of gas engines and engines fed with common petroleum with a modern type of carburetter.

Mr. P. ROSLING was of the opinion that a 250 H.P. engine was not of much use to large stations. With regard to the power-factor at the Guernsey station, the two months chosen—viz., September and October, were the particular months in which the load-factors were 11 and 20 per cent., respectively, less for the steam engines than for the gas engine. If July and August had been taken when the load-factors were approximately the same, the balance was only very slightly in favour of the gas engine. He had seen recently two 250 H.P. gas engines, running on gas from coke ovens, but in less than 12 months they had to take the whole thing to pieces to remove the tar; and he supposed that gas from coke ovens was somewhat similar to that from a producer plant. The author had shown these engines with flywheels at both ends of the crankshaft, and he (Mr. Rosling) would like to know if any trouble had been experienced with engines built that way, because steam engine makers had had great trouble with two flywheels one at either end of the same crankshaft.

Mr. ROGERSON drew attention to the Hebden Bridge results and mentioned that the fuel cost was as high as 0·462d. and this, he thought, would have to be considerably lowered before the results could compete with steam engines. In one of the tables the momentary variation in speed on the maximum load being thrown off, was given as 9 per cent. and this was extremely high, especially in cases of stations using alternators in parallel for traction work.

Mr SEATON alluded to the costs obtained in a 500kw. steam-driven station which Messrs. Willans & Robinson had erected in Scotland about three years ago. The coal cost came out at 0·148d., oil and waste 0·013d., wages 0·022d., repairs 0·022d., total works cost 0·205d.; 5 per cent. interest on £10,000 came out at 0·014d., and 10 per cent. depreciation on £10,000 came out at 0·038d.; the total cost, including interest and depreciation, was therefore 0·337d. He had a letter from Scotland only the other day to the effect that these figures were being very well maintained, the figures for this year coming out at 0·334d. It was a factory plant, and the boilers were working at 250lb. pressure, engines running condensing. As far as he knew, these figures constituted a record in electrical generation.

Mr. H. DICKINSON thought that the results obtained with gas engines so far were not very good. He understood that at Redditch there had been very considerable trouble, and believed that the engines there were out of use for many months and a steam plant running.

Mr. W. EMMOTT said that his final report on the Hebden Bridge engines showed that the efficiency obtained was really 6 per cent better than had been stated in the author's Paper. As to the comparative cost of a 250 B.H.P. suction plant, and a water-tube boiler of the same power, it could be stated that a water-tube boiler would cost 2¼ times as much as the suction plant. Regarding the space, a water-tube boiler would take twice as much as the suction plant. Where anthracite could be obtained at a prohibitive price only coke could be used, and he knew of an instance where it was cheaper to burn coke at 13s. per ton than anthracite at 26s per ton. The cost of banking up a fire in a suction plant of 250 B.H.P. for 12 hours was less than 1s. Several engines could be run with one producer. An engine could be started up from a banked fire in 15 minutes without difficulty, and an engine could be started in one minute when the producer was going.

Mr. H. CAMPBELL, in reply, agreed that the boiler of the gas plant was not a very good one. Unfortunately, gas-plant makers did not much trouble about the fuel consumption in these boilers. With reference to gas engines for alternating-current machines, he was sorry he could not give much information on that point His firm was now making an engine of 400 H.P. intended to drive alternating-current machinery. The engines at Guernsey were quite capable of carrying continuously the load at which they were rated. The St Sampson's engines ran at top load, not all the time, of course, owing to the varying power load; but they had to take an overload of 20 per cent. at any time. One feature about the four-cylinder engines was that they had never been able to pull them up, no matter what load had been on. They had slowed them down but not pulled them up. The engines at St. Sampson's started at seven in the morning and stopped at eight at night. In September the steam-engine plant ran 480 hours and the gas-engine plant 412 hours. So far as the author's experience went, there was neither a loss nor a gain due to the cooling of the exhaust gas by the water; the sole object of which was to reduce the noise. With reference to Mr. Schofield's remarks as to the wages cost, they were given in the table. With reference to Mr. Rogerson's remarks about the fuel cost at Hebden Bridge, Mr. Campbell pointed out that the engine was running at half load at the time the figures were taken. As to the variation of speed between no load and full load, at the time his firm made this engine this matter was not thought of being of great importance. He did not see any difficulty in cutting down that figure of 9 per cent. to something like 6 or even 5 per cent; it all depended upon the range of the governor in working the throttle valve. The description which Mr. Seaton had given of the Willans set and the total cost per unit of 0·334d. was remarkable indeed, but it must be said that it was working in very favourable conditions. Engine slack was suitable for gas-making plants, but he was not an enthusiast about using ordinary coal for gas making. There were a few gas plants which used a common coal, but the first cost was out of all proportion to the advantages gained. He himself preferred to pin his faith to a plant where the first cost was low and the efficiency higher. He believed that the plant using anthracite and coke was the plant which would survive the others. In answer to a question by Mr. Rosling, he might tell him that the steam engines at Guernsey had been working for three years, so that they were not very ancient engines. Another question which had been asked was about the two flywheels on the engine shaft. When his firm designed the engines they were not aware of the trouble which Messrs. Willans & Robinson had had, and so far they had not had the slightest trouble with two flywheels; neither with hot bearings or creaking crankshafts. Mr. Dickinson spoke about the bad results at Leyton and King's Lynn, and he also asked what was wrong with Belfast. He (Mr. Campbell) thought the answer was that they had got hold of bad gas engines. Taking the Belfast experience first, the difficulty there was first of all in getting the engines to run in parallel; they had the old hit-and-miss type of governor. Then they had difficulties in getting the engines to run at top load. In addition to that they were using town lighting gas at 2s. 3d. per 1,000 cubic ft., and they were also using the old system of ignition tubes, the cost of which was given as 0·223d. per unit, including, of course, waste, &c. With regard to King's Lynn, he understood they had a great deal of trouble with vibration and noise. With regard to Leyton he did not know the details. He agreed with Mr. Dickinson that high speeds were necessary, but he feared that we should never be able to get the high speeds of steam engines. The gearing would not be able to stand the 400 or 450 revs. per min. Occasionally the water jackets on the gas engines and the exhaust valves and pistons had to be cleaned out, but that was after several years' time. At Guernsey salt water is used for cooling the engines and for the gas plant, and as long as the water was circulated fast enough and was not allowed to increase in temperature too much, there was no salt deposit. The note "No condenser, no power-load," referred to by Mr. McLaren, referred to the month of October only.

NOTES ON EXPERIMENTS WITH TRANSFORMERS FOR VERY HIGH POTENTIALS.*

BY PROF. HAROLD B. SMITH.

During the college year 1900-1, four graduate students in electrical engineering at the Worcester Polytechnic Institute undertook the design and construction of a 500,000-volt transformer at the suggestion and under the direction of the writer. This transformer was in operation early in May, 1901, and at that time developed a secondary potential, at 60 cycles per second, which was capable of disrupting a 48in. (1·22-metre) air-gap between sharp needle points.

The design of this transformer called for a ratio of transformation of 1 to 2,520, at 60 cycles, and a maximum core density of 8,000 gausses, when at a secondary potential of 500,000 effective volts. The primary winding consisted of 46 turns of heavy stranded conductor—23 turns on each core—in series for a primary potential of 200 volts, 60 cycles, giving a maximum magnetic flux of about 1,600,000 maxwells at full rated voltage. The secondary winding was sub-divided into 66 coils, each of which was further sub-divided by cotton tape into four sections. There was a total of 115,920 turns of number 32 B. and S. double cotton-covered wire in the secondary winding. Each coil was wound in a spool turned from thoroughly-seasoned white pine of the very best quality and carefully selected stock. The cross-section of the spool is shown in Fig. 1, and the outside diameters of the spools ranged regularly from 16in. up to 32in.

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* Abstract of a Paper read before Section B of the International Electrical Congress of St. Louis.

The middle of the secondary winding was connected to the core and to the primary winding, and carefully earthed in most of the work which has been done with this transformer, although it has been operated on a number of occasions without earthing the secondary circuit. The primary circuit, supplied with current from a generator which may be regulated as desired, was always earthed for the protection of the operator.

This transformer has been used for three years upon work of investigation connected with various thesis subjects upon which students at the Institute have been engaged, together with some work carried out personally by the writer upon the dielectric properties of air and oils. During this time it has been found necessary upon two or three occasions to cut out a few faulty coils of the secondary winding; but when it is stated that this winding contains about 125 miles of No. 32 B. and S. wire, which was not wound in layers, although each coil may develop from 8,000 to 9,000 volts, this is not surprising. Tests made with this transformer indicate that, with the substitution of a modification of the secondary winding which has been introduced by the writer in transformers of more recent design, a potential of not less than 750,000 volts effective, or over a million volts maximum, can be secured from this transformer. As soon as suitable opportunity presents itself, it is proposed to make this change. The transformer is located in a separate transformer house on the campus of the Institute, at some distance from other buildings on account of the fire risk occasioned by over a thousand gallons of oil required for insulating the secondary winding.

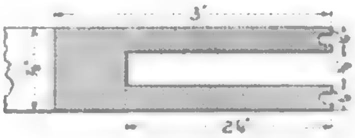

Fig. 1.

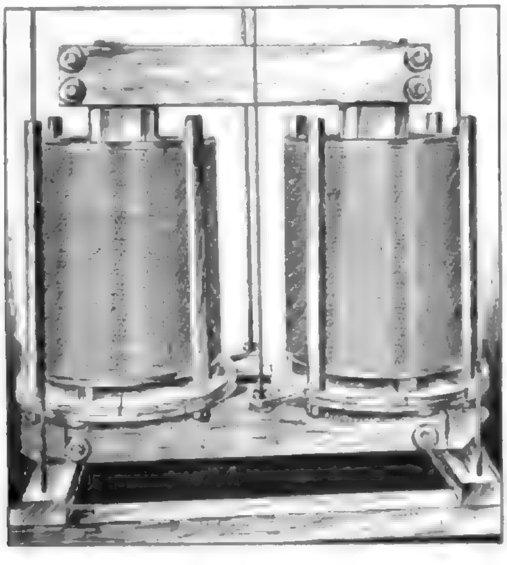

Fig. 2.—Side View of 200kw. 300,000-volt Transformer, 1904.

On May 27th of this year, an order was placed with the writer for a 200kw. 300,000-volt transformer, which was shipped to its destination July 18th, and has recently been placed in operation and accepted by the purchaser. As this transformer was designed along lines which will permit its operation at considerably more than its rated voltage and power output, and probably constitutes the largest transformer yet built for very high potentials, the writer has been permitted to give the following brief description:—

Fig. 2 shows an assembled view of the transformer core and secondary winding ready to be immersed in the oil contained in the transformer tank. The connections to the primary and secondary circuits are so arranged as to permit full rated power output at secondary potentials of either 75,000, 150,000 or 300,000 volts, 60 cycles. The maximum ratio of primary and secondary turns is 316, as the primary is designed to be supplied from a 1,040-volt generator. The secondary contains about 33,000 turns of about 42 miles length of conductor.

STUDIES IN MAGNETIC TESTING.*

BY G. F. C. SEARLE, M.A.

(Cavendish Laboratory, Cambridge.)

(Continued from page 316.)

Effects of many Reversals of a Force X upon the Apparent Permeability for a Smaller Force H.

§ 18. To illustrate in a systematic manner the effect of a magnetic history of many reversals of a magnetic force upon the apparent induction subsequently found for a smaller magnetic force, the following experiments were made upon 16 strips of "Tagger Plate."

The iron, after demagnetisation by reversals, was subjected to 50 reversals of a force X, for the purpose of giving it a magnetic history; it was then subjected to 200 reversals of a force H, and at the end of this series of reversals the apparent induction B′ for the force H was found. This constituted one observation. The operation, including the demagnetisation, was then repeated with other values of H ranging from zero to X, the force X remaining fixed. A new value was then taken for X, and the process of finding the apparent induction for a series of values of H was repeated, the values assumed by X being 8·0, 4·0, 2·5 and 1·0 gausses. To obtain a standard for comparison the normal induction B_0 was found for each value of H employed.

The maximum value of the magnetic force used in the demagnetisation was found to be about 4·8 gausses. This exceeded considerably the critical magnetic force—1·6 gausses—and was found to be sufficient for effective demagnetisation.

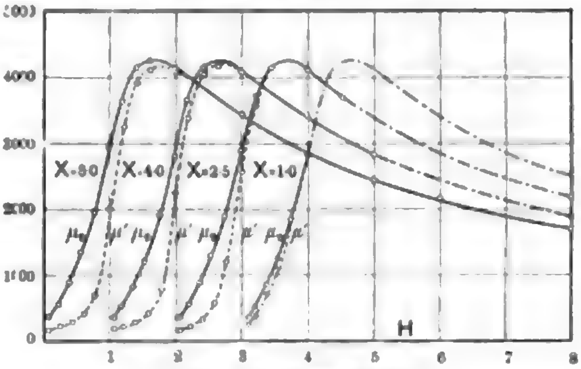

Fig. 3.—"Tagger Plate."

The results of the experiments are recorded in Fig. 3, which shows how the values of the normal permeability μ_0 and of the apparent permeability μ' depend upon H. In order to show all the results on a single diagram a fresh origin has been taken for each fresh value of X, the step from one origin to the next one being 1·0 gauss. To make the diagram more complete, the curve for each of the smaller values of X has been continued beyond the point H = X by the data obtained for the normal permeability in the experiments with X = 8; the continuations of the curves are shown as broken lines, thus:

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It will be seen that in each case the apparent permeability after the action of the force X is, for small magnetic forces, less than the normal permeability for the same forces, the effect being the more marked the greater the force X which gave the magnetic history. The greatest proportional reduction of permeability occurs for H = 0·5 after the action of X = 8, when the value of μ'/μ_0 is as small as 0·28.

But even for the largest value of X there is very little difference between μ' and μ_0 when H exceeds 1·6, the critical force for which μ_0 attains its maximum value; for H = 3·0 and for larger forces up to H = 8·0, I could detect no difference between μ' and μ_0. The value of H, for which the two curves begin to be identical, diminishes as X diminishes, and in each case the two curves begin to coincide before H reaches X.

In the curves for X = 8·0, X = 4·0, and X = 2·5 it will be seen that the maximum of μ' occurs at nearly the same value of H as the maximum of μ_0. In this circumstance is found a justification of the statement made in § 7—viz., "The magnetic force corresponding to the maximum of μ', has a nearly definite value for a given specimen, for it is found that its value is but little affected by the magnetic treatment experienced by the specimen before this series of permeability tes's."

§ 19. In another set of experiments the force H, for which I found the apparent induction, was kept at the *constant* value of 1·0 gauss, and the effects of a continuously varying magnetic history upon the value of B for H = 1·0 were observed. The 16 strips of "Tagger Plate" used in §§ 13, 18 were used in these experiments.

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* Paper read before the Institution of Electrical Engineers on Dec 8th. Specially abridged for *The Electrician* by the author.

After the iron had been demagnetised by reversals, it was subjected to 50 reversals of a force X. After the 50 reversals of X, the circuit was broken, and the batteries and resistances were rearranged in such a manner (ascertained before the demagnetisation) that on completing the circuit the magnetic force should be 1·0 gauss. The force of 1·0 gauss was now reversed 200 times, and then the ballistic effects of a pair of reversals were noted; from them the apparent induction B' was deduced. This completed the observations for the particular value of X. The whole process, including the demagnetisation, was repeated for each fresh value of X.

The value of D was about 4·8 gausses; this gave satisfactory demagnetisation.

The results are shown in Fig. 4, where the abscissa is the value of X employed to give the magnetic history, while the ordinate is the value of the apparent induction B' subsequently found for the standard magnetic force of 1·0 gauss. It will be seen that, until X reaches 1·5 gausses, the 50 reversals of X have no appreciable effect upon the value of B' for $H = 1{\cdot}0$. As X increases from 1·5, the value of B' for $H = 1{\cdot}0$ diminishes, at first very rapidly, but afterwards more slowly, and when high values of X are reached the value of B' appears to be nearly constant. The highest value of X used in these experiments was 24 gausses.

The normal induction, B_0, for $H = 1$, was about 2,860, and the apparent induction, B', for $H = 1$, continued at this value till reached 1·5, but when X was 24 the value of B' was reduced to 1,812—*i.e.*, to a little less than two-thirds of B_0. Notable as is this reduction in the value of B', the curves of Fig. 3 show that, had the experiment been tried with $H = 0{\cdot}6$ instead of $H = 1{\cdot}0$, much more striking results would have been obtained, for in the experiments of §18 upon the same specimen, the normal induction for $H = 0{\cdot}6$ was 789, while the apparent induction for $H = 0{\cdot}6$ after 50 reversals of a force of 8·0 was only 232—*i.e.*, less than one-third of B_0.

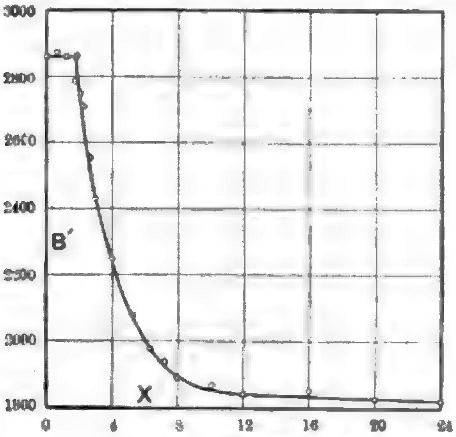

FIG. 4.—"TAGGER PLATE."

On the other hand, if H had been as great as 2·0, Fig. 3 shows that the effect of 50 reversals of X would have had no sensible effect upon the apparent induction for $H = 2{\cdot}0$.

INFLUENCE OF PARTIAL DEMAGNETISATION ON THE AFTER-EFFECTS OF A LARGE FORCE.

§20. In all the preceding experiments the maximum magnetic force D used in the demagnetisation exceeded considerably the critical magnetic force M_0, and the demagnetisation was thoroughly effective, so that when the process was carried out after many reversals of a large force it completely wiped out the effect of the large force in reducing the apparent induction subsequently found for a small force.

I now turn to some experiments in which the iron was first subjected to 50 reversals of a force of 8·0 gausses and was then demagnetised by reversals, but not always effectively, the maximum magnetic force employed in the process being D. After this partial demagnetisation, the iron was subjected to 200 reversals of a force of 0·4 gauss, and then the apparent induction for $H = 0{\cdot}4$ was found. These operations were repeated for each of a series of values of D ranging from zero to 4·78.

In these experiments the 16 strips used in §13 were tested in the magnetic square, and the force 0·4 was chosen because the experiments described in §18 showed that for this specimen the effect of 50 reversals of a large force upon the apparent induction for a force H is most strongly marked when H is about 0·5 gauss.

The iron was first *effectively* demagnetised by reversals, D being 4·78. It was then subjected to 50 reversals of a force of 8·0 in order to give it a magnetic history, and next it was more or less effectively demagnetised by reversals, the maximum force D used in the process being calculated from the maximum "effective" current. Then, fter 200 reversals of the force of 0·4, the apparent induction B' for $H = 0{\cdot}4$ was found.

The results of the experiments are shown in Fig. 5, where the abscissa represents D, the maximum force employed in the more or less effective demagnetisation, and the ordinate represents B', the apparent induction for $H = 0{\cdot}4$ gauss.

The iron was certainly effectively demagnetised by $D = 4{\cdot}78$ and the *apparent* induction subsequently found for $H = 0{\cdot}4$ was therefore he *normal* induction for $H = 0{\cdot}4$; its value was 348·2 maxwells per square cm. When the demagnetisation was totally ineffective, *i.e.*, when D was zero, so that the 50 reversals of the force of 8·0 were immediately followed by the 200 reversals of the force of 0·4, which were made before the apparent induction B' for $H = 0{\cdot}4$ was found, the value of B' was only 102·0. The value of 102·0/348·2 is 0·293, which is practically identical with the value 0·291 found for μ/μ_0, when H was 0·4 and X was 8·0, in the experiments of §18.

The figure shows that the course of the phenomenon may be divided into three well-defined stages, the points of transition being approximately $D = 0{\cdot}45$ and $D = 1{\cdot}60$.

In the first stage, from $D = 0$ to $D = 0{\cdot}45$, B' is independent of D, and is equal to the apparent induction found immediately after 50 reversals of the force of 8·0.

In the second stage, from $D = 0{\cdot}45$ to $D = 1{\cdot}60$, the restoring effect of the demagnetisation increases rapidly as D increases; the relation between B' and D in this stage is represented by an approximately straight line.

In the third stage, from $D = 1{\cdot}60$ to $D = 4{\cdot}78$, B' is again independent of D, and is equal to the normal induction. We thus see that *any* value of D greater than 1·60 gives effective demagnetisation, and completely wipes out the effects of a history of 50 reversals of the large force 8·0.

On account of the roughness of the measurement of D, we may perhaps identify the value 1·60 with 1·60, the critical force for this specimen, and the value 0·45 with 0·40, the force for which B' was found. If this be allowed, we see, on the one hand, that demagnetisation by reversals is fully effective so soon as D, the maximum magnetic force used in the process, exceeds the critical force M_0, and, on the other hand, that demagnetisation by reversals produces no restoring effect at all and is practically useless unless D exceeds the magnetic force for which the apparent induction is to be found.

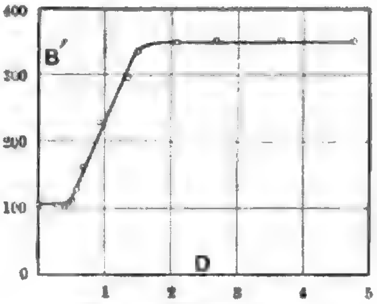

FIG. 5.—"TAGGER PLATE."

It is here supposed that the apparent induction B' is to be found for some force H *less* than the critical force, M_0. When H somewhat exceeds the critical force, the experiments of § 18 show that a history of 50 reversals of a stronger force have no effect in reducing the value of B' below the normal value B_0.

EXPERIMENTS ON VIRGIN IRON.

§ 21. In all the experiments hitherto described in this paper, the effects could be reproduced, as often as was desired, by effectively demagnetising the iron before subjecting it to the magnetic process, the effects of which I wished to study. I now come to some experiments which can be made only *once* upon a given specimen, for the reason that they require that the iron should never have been magnetised—at least not since its annealing.* This is the theoretical specification; in dealing with specimens cut from transformer sheets in their commercial condition, we must be satisfied to specify that the iron has not been subjected, since its annealing, to any magnetic force exceeding that due to the terrestrial magnetism.

These experiments show that the normal permeability for a piece of iron, found (as the definition of "normal" requires) after effective demagnetisation, is, for low values of H, much higher than the permeability which is found when the iron has never since its annealing been exposed to any magnetic force greater than H.

When the iron has never, since its annealing, been subjected to any magnetic force greater than the force H for which it is being tested, I shall, for the sake of brevity, speak of it as being in a virgin state, and shall call the value of the apparent induction, found after *many* reversals of H, the *virgin induction* for H, and shall denote it by B_r. It *is* necessary, in order to secure definiteness, to specify that there shall be *many* reversals, for, when H is small, the ballistic effect of a reversal of H diminishes rapidly during the first few reversals. Thus, with a specimen of soft iron wire, Mr. T. G. Bedford and I found that for $H=2{\cdot}5$ the average change of induction for the first pair of reversals was 2,220 and for the forty-first pair 1,840, a diminution of 17 per cent.*

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* Both the late Prof. Rowland and also Prof. Ewing noticed long ago that virgin iron is in a peculiar magnetic state, which is altered as soon as the iron has once been magnetised. But I have not found any record of any systematic examination of the question.

Ballistic Study of the Action of Effective Demagnetisation on Virgin Iron.

§ 22. A set of ballistic experiments was made upon four strips of Schultz iron.

Preliminary tests were made to find the batteries and resistances required for definite magnetic forces such as 0·25, 0·50 . . . gausses.

The strips, which had never been magnetised by any force exceeding the earth's force, were fitted into the magnetic square, the circuit being broken. The resistances, &c., were then so arranged that a force of 0·25 gauss was applied on completing the circuit. After this force has been reversed 200 times, the ballistic effects of a pair of reversals were observed, and from them the virgin induction B_r and the virgin permeability μ_r for $H=0{\cdot}25$ were found. The force was then increased to 0·50 and, after 200 reversals, B_r and μ_r for $H=0{\cdot}5$ were found. This process was continued step by step up to $H=8{\cdot}0$, care being taken never to expose the iron to any force greater than that for which B_r was to be found. The resulting virgin permeability curve is shown in Fig. 6, where it is shown by the dotted line marked "μ_r."

The iron was now demagnetised by reversals, the maximum force used in the process being 7·75 gausses; this considerably exceeded 8·60, the critical force for this specimen, and so caused effective demagnetisation. The normal induction B_n, was then found for a series of values of H in the manner described in § 11. The resulting normal permeability curve is shown in Fig. 6, where it is marked "μ_0." The curve for the demagnetised iron lies above that for the virgin iron for small values of H. To illustrate the relation between the two curves I have plotted a third curve, in which the ordinate represents 1,000 μ_0/μ_r.

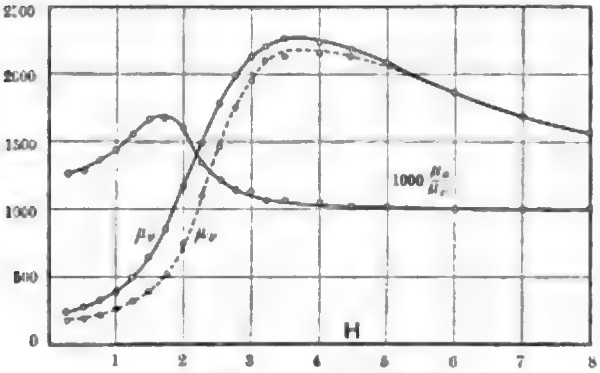

Fig. 6.—Schultz Iron.

The value of μ_0/μ_r reaches a maximum of 1·65 when H is about 1·65 gausses, and afterwards falls off as H increases. The quantity begins to reach the constant value 1·0 when H is about 5·5, a value somewhat greater than the critical force 8·60. Thus, when H is greater than 5·5, there is no advantage in demagnetising the iron, for we obtain the same value for the induction whether the iron is in the virgin state or whether it has been demagnetised.

We have already seen that, when H exceeds the critical force M_0, the apparent induction is independent of the magnetic history of the specimen and is equal to the normal induction. The present experiments serve to show still more plainly than before that the behaviour of iron under the action of the forces greater than M_0 differs widely from its behaviour under the action of forces less than M_0. When H exceeds M_0, B' seems to depend only on H, but when H is less than this value, B' is greatly influenced by many circumstances.

(To be concluded.)

New York Subway.—The New York Subway finished its first month of operation on November 26th, having carried about 6,000,000 passengers. The daily average of traffic, not counting the Lenox Avenue branch, which opened only a few days ago, was 201,318, showing daily average receipts of $10,065.90.

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* *Phil. Trans. R S.*, Vol. CXCVIII., A., p. 71, 1902.

SOME NOTES ON HIGH-SPEED ELECTRIC RAILWAY WORK.*

BY F. W. CARTER.

Train resistance depends on the weight moved, on the type, external shape, size and number of the vehicles, on the vibration, the parallelism of axles, lubrication of journals, condition of wheels, &c., as well as on circumstances external to the train, such as quality and condition of track, amount and direction of wind and steepness of grade. In so far as it depends on the weight, train resistance is probably approximately proportional to it, and nearly independent of the velocity; at any rate, these are the best assumptions that our present knowledge will admit of. This portion of the resistance is about 3lb. per ton for oil-lubricated journals (see Figs. 1 and 2); for grease lubrication the resistance may be taken as 4lb. per ton. This only applies when the train is in motion, for the initial resistance at starting is much greater, having been found to be about 17lb. per ton in the L. & Y. Railway tests of Fig. 1. As the train resistance depends on the configuration, size and number of the coaches, it is much more complicated than the foregoing, and varies greatly with the velocity. The resultant effect can nevertheless, from the nature of the case, be approximately analysed and separated into two components—one associated with the two ends of the train, and the other with the intermediate portion—and this separation will enable us to determine the resistance for any length of train as long as it is not so short that the air current regions about the two ends encroach upon one another. For when the train is sufficiently long the centre coaches are similarly involved in air currents, and the

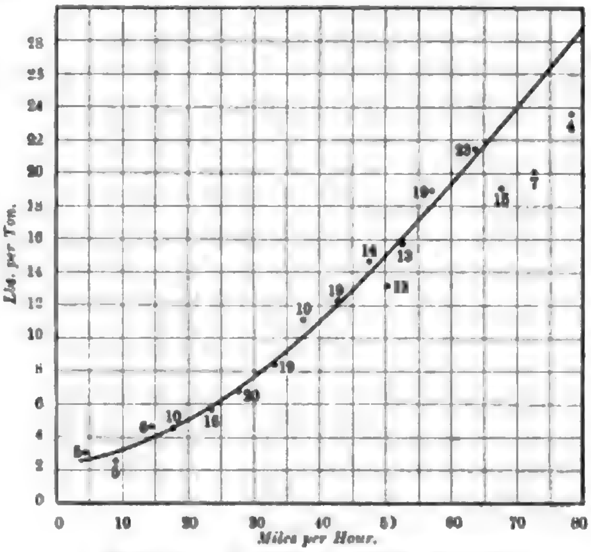

Fig. 1.—L. & Y. Railway. Train Resistance.

For a 5-coach train: Total weight, 115 tons 4 cwt. 1 qr.; total length of train, 294ft. 10in. Cross-section, approximately: 85 sq. ft. For 10-coach train: Total weight, 218 tons 14 cwt. 1 qr.; total length, 542ft. 2in. Each point is the mean of the number of readings indicated by the figures near the point.

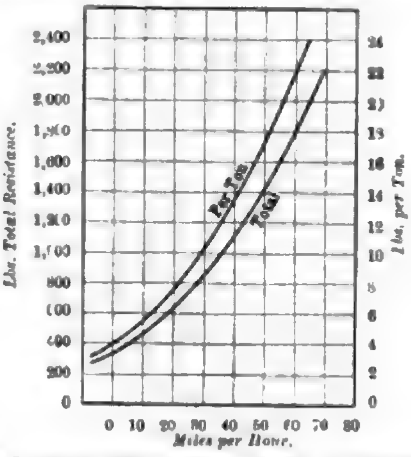

Fig. 2.—Marienfelde-Zossen Tests. Train Resistance.

One car: 72ft. over buffer beams, 76ft. over buffers, 93 tons, 110 sq. ft. cross-section.

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* Abstract of a Paper read before the Rugby Engineering Society.

increase in train resistance due to adding, say, two coaches to the middle of the train, will be just double that due to adding one. As we have not tests on all types of coach, we prefer to express the former of the above components per unit length of train instead of per coach (Fig. 3, lower curve), and the latter per unit area of cross section (Fig. 3, upper curve), instead of a total sum, expecting in this way to obtain an approximately correct result for types of coach not exactly similar to those which formed the subject of the tests on which the curves are based. The total train resistance is therefore made up of a constant amount per ton, a variable amount per foot length, and a variable amount per square foot cross section (Fig. 3).

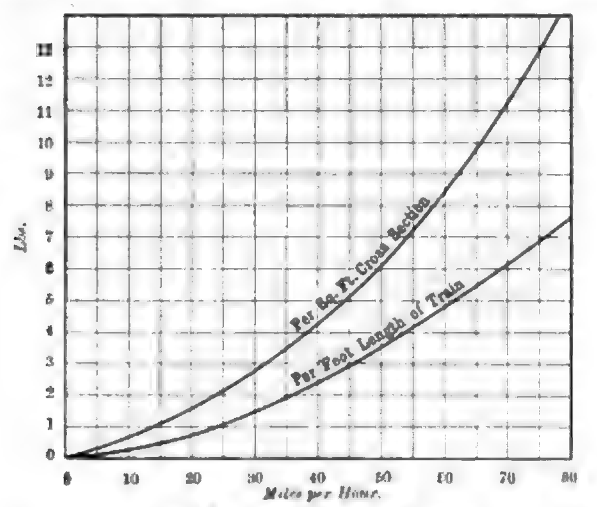

FIG. 3.—TRAIN RESISTANCE CURVES.

Total train resistance—amounts given by the curves+3lbs. per ton for oil-lubricated journals or 4lbs. per ton for grease-lubricated journals.

Very complete results for a particular type of what may be taken as typical English bogie stock were given in J. A. F. Aspinall's Paper on "Train Resistance."* The train consisted of five Lancashire and Yorkshire bogie coaches and a dynamometer car, and upwards of 200 readings were taken to obtain the curve, which is given in Fig. 1. Unfortunately, the measurements were made behind an engine and tender, and therefore do not include the head resistance. A few readings were taken with longer trains, and from these the point shown on Fig. 1 for a 10-coach train (10 bogie coaches and a dynamometer car) was obtained. If this point be accurate, we deduce that at this speed, the total amount to be charged to the length of the train is 0·7 of the total air resistance of the five-coach train. Assuming, in default of further information, that this ratio holds for all speeds, we deduce the lower curve of Fig. 3 as the amount to be charged per unit length of train. We have no information enabling us to obtain the resistance component due to the ends of this or any similar type of train, and the upper curve in Fig. 3 is taken to accord with the results of the Marienfelde-Zossen tests* given in Fig. 2. It is far from satisfactory to have to deduce this component from so different a type of train as one composed of a single coach, running on six-wheeled bogie trucks, weighing 83 tons, and measuring 72ft. over buffer beams, but, until more suitable information is available, it is the best that we can do. The coach appears to have a cross-sectional area, through motors of at least 110 sq. ft., but, as it is well rounded at the ends, we have taken the equivalent area as 100 sq. ft. in obtaining the curve of Fig. 3, this being the best estimate we can give to obtain a result applicable to flat-ended English coaches.

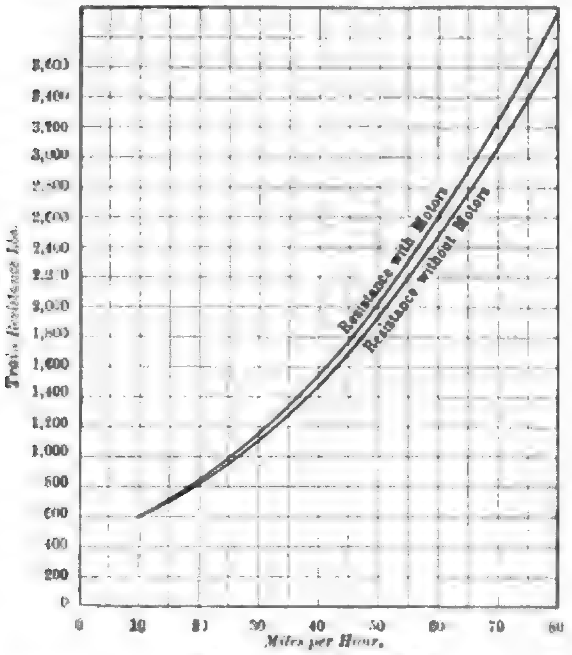

FIG. 4.—TRAIN RESISTANCE.

Five-coach train: 125 tons coaches and passengers only, 252ft. long, 90 sq. ft. cross-section. Resistance due to addition of motors taken as 4lbs. per ton additional weight.

A continuous-current equipment of considerable power, such as is used on our suburban railways, weighs approximately 40lb. per rated horse-power—this figure, of course, including all controlling apparatus and accessories. Based on continuous rating, which we must use in comparing the ordinary type of motor with that specially suited for high-speed long-distance service, we may take the weight as 160lb. per horse-power. Motors for the class of service we have in view, should show less variation in horse-power with variation in speed than is usual with the present railway motors.

We will now show the result of the foregoing by investigating the particular case of a five-coach train similar to that used in Aspinall's tests. The train consists of bogie coaches, and when carrying its passenger load weighs about 125 tons, exclusive of electrical equipment. The total train resistance, deduced from the curves of Fig. 3, is shown in Fig. 4, for the train both without and with electrical equipment. From resistance and speed we deduce the horse-power and from this we deduce the weight of the motor equipment, which amounts to upwards of 50 tons for instance for a train speed of 75 miles per hour.

Our conclusions as regards main line express work are these: We must design motors to suit the service and carry them on vehicles specially constructed to suit the motors. In other words, we shall use locomotives rather than mount the motors on the train axles. This implies the abandonment of the multiple-unit train control system, but as the advantages of this system are needed chiefly in suburban service, this point is of small importance for the class of service we are considering. The motors will be large and powerful units, probably open on the cab side to aid the dissipation of wasted energy, but closed to the weather. The usual method of rating which was developed to suit the needs of tramway motors will probably be abandoned in favour of some method more suited to the service that these motors will be called upon to perform. The tramway type of motor, in conquering the suburban railway field, has probably reached the limit of its usefulness in railway work, and for main-line service we should expect motors differing largely from those we are accustomed to. A considerable portion of the superstructure of the locomotive may be occupied by the motors, and in general the complete locomotive will be the designer's unit, all parts being adapted to the exigencies of the service and of the type of machinery necessary for electrical driving.

LOADED TELEPHONE LINES IN PRACTICE.†

BY DR. HAMMOND VINTON HAYES.

The mathematical discussion of the theory of loaded telephone lines has been fully given in the writings of Prof. M. I. Pupin‡ and Dr. G. A. Campbell.§ In the present Paper it is intended to state briefly the results which have been obtained by the use of loading coils on many of the telephone circuits of the Bell companies. In every problem affecting the transmission of telephone waves, over a line, there are two factors to be considered—the attenuation and the distortion of the waves. The loss of energy of the waves upon the line must be kept at a minimum and the several component waves of the telephone or voice waves must be transmitted without unequal relative impairment.

DISTORTION.

The introduction of lumped inductance in the form of loading coils upon a telephone line tends to increase the distortion by the possible unequal reflection of the component waves of different periodicities, and by the possible unequal attenuation of the several waves in passing through the coils.

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* *Minutes of the Proceedings* of the Institution of Civil Engineers, Vol. CXLVII., May, 1902.

* See "High-speed Electric Railway Experiments on the Marienfelde-Zossen Line," by Alex. Siemens, *Proceedings* of Institution of Electrical Engineers, Vol. XXXIII, May 26, 1904, and *The Electrician*, Vol. LIII. p. 346.

† Paper read before Section G of the St. Louis International Electrical Congress.

‡ *Trans.* Am. Math. Soc., July, 1900; *Trans.* Amer. Inst. Elec. Eng., Vol. XVII., May, 1900.

§ *Phil. Mag.*, March, 1903.

Reflection Losses.

The mathematical work of both Pupin and Campbell showed conclusively that if several loading coils lay within a wave length on any particular loaded circuit, and the coils themselves were theoretically perfect, the circuit was distortionless. The spacing of the coils upon a circuit in practice therefore depends simply upon a determination of the highest periodicity that should be retained in the telephone waves in order to maintain the character of the voice waves unimpaired. It has been found convenient in studying the spacing of loading coils to consider the number of coils which would be passed by a wave front on each particular circuit in the unit of time, or a second. As the velocity of all waves upon a given circuit is the same, and as the wave-length for any periodicity can be readily determined from the velocity, this convention makes it possible to readily determine the number of coils lying within any particular wave-length.

A large number of long telephone circuits have been equipped with loading coils, the spacing of the coils upon the several circuits being such as to produce a range of the number of coils per second between 13,000 and 7,000. A comparison of the transmission over these several circuits has shown that the quality of transmission is not appreciably impaired even with the lower number of coils per second. This seems to indicate the lack of importance of the overtones of very high periodicity in the successful transmission of speech.

It can be said, therefore, with considerable certainty, that the distortion due to reflection losses in a loaded telephone circuit can be neglected, provided the coils are so spaced upon the line as to give at least 7,000 coils per second, and that this spacing of the coils is substantially uniform throughout the line.

Distortion in Coil.

To entirely eliminate distortion in a loading coil, it is necessary to have it so designed that the effective resistance of the coil to all the essential periodicities of the telephone waves shall be the same. Such a coil is theoretical, and cannot be obtained in practice. A loading coil is primarily one so designed as to provide a required amount of inductance, and must, of necessity, consist of several turns of wire. Moreover, to prevent attenuation, it is imperative that the resistance of the coil be kept as low as possible. To make the resistance of the coil low, the wire employed should be of copper of large size, and the number of turns of wire in the coil should be kept small. A reduction in the turns can, other things being equal, be most easily obtained by the use of iron for the core of the coil. If the coil is made entirely of copper, the effective resistance of the coil with the frequencies within the range of telephone periodicities will differ from the resistance by an amount corresponding to the losses due to eddy currents in the copper. If iron forms a portion of the coil, there will be, in addition to the eddy-current losses in the copper, eddy-current losses in the core, as well as hysteresis losses in the iron, which will augment the difference between the resistance and the effective resistance. As it is impossible to eliminate the eddy-current and hysteresis losses entirely, the effective resistance of a loading coil will vary with different periodicities, and thereby tend to produce distortional losses in the transmitted telephone waves. The difference between the resistance and the effective resistance, at telephonic periodicities, can be made much smaller in a coil composed entirely of copper than in one having an iron core.

Practical and commercial reasons demand an iron-cored loading coil, provided that such a coil can be so designed that its use in a telephone circuit will not be productive of appreciable distortion. To determine whether, in practice, there was appreciably more distortion introduced by loading coils having iron cores, as compared with those made entirely of copper, the two circuits first loaded were equipped, one with iron-cored coils, and the other with copper inductance coils. The circuits were each about 1,000 miles in length. The coils used on these two circuits were spaced alike, and had the same inductance and approximately the same resistance. The effective resistance of the coil having an iron core was about 15·5 ohms at a periodicity of 2,000 per second, and that of the copper coil 11·8 ohms at the same periodicity. These circuits thus loaded were compared with each other with the greatest care, and no difference was apparent either in the character, or quality, of the telephone transmission. These tests are again confirmatory of the fact that the suppression or reduction of the waves of the highest periodicities of the voice waves does not appreciably affect the quality or intelligibility of transmitted speech. This experiment was considered as demonstrating conclusively the possibility of the commercial use of loading coils having cores of iron.

Loading Coil.

A discussion of the theoretical dimensions of loading coils for different classes of circuits may be found in Dr. Campbell's Paper, to which reference is above made. In practice the size and cost of the coil are factors requiring serious consideration. For aerial circuits, where the size of the line wire is large, and consequently the resistance of the circuit small, it is of the utmost importance that the effective time-constant L'/R' of the coil should be made as large as is consistent with reasonable cost. Except so far as the cost is affected, the size of the aerial loading coil is of no special moment, as the coils can be mounted singly upon the poles. The time-constant of a coil can be increased by enlarging its size, but such increase in size increases its cost. The best commercial loading coil is, therefore, the smallest coil that will give the required inductance and the largest effective time-constant.

Following the theoretical considerations as deduced by Dr. Campbell*, the resistance of the coils which have been used on aerial circuits has been made 2·4 ohms. The design of the core, the permeability of the iron, the subdivision of the iron and the copper have been made such that a loading coil has been produced having an inductance of 0·25 of a henry, a time-constant of 0·048 second, at a periodicity of 1,000 periods per second, and a bulk of approximately 314 cubic in. This coil is toroidal in shape, 10in. in diameter and 4in. high. It has an effective resistance of 15·5 ohms at 2,000 periods per second.

Coils designed to be used on cable circuits in which the size of wire employed is much smaller do not require to be made of as low resistance as the coil above described; consequently their size and time-constant may be made much smaller. Large numbers of cable loading coils have been placed in service, their design varying with the character of the circuit upon which they are to be used.

Reflection.

In the terminal apparatus at present used in telephony, or where there is a condition of non-uniformity in the character of the line, the telephone waves suffer a reflection, which, in many cases, is effective in materially increasing the attenuation. This reflection is particularly pronounced at the point where an unloaded section of line is connected to a loaded section. The amount of reflection is greater the greater the divergence from homogeneity. Thus a section having large inductance per mile, when connected with a non-loaded section, exerts a larger reflective action than one having a small inductance per mile.

In practice the effect of reflection is of very considerable importance, particularly when the loaded section is not relatively long. Theoretically, these reflection losses may be eliminated by the use of a perfect transformer introduced at every point of non-uniformity in the line. Even could such a perfect transformer be made, its introduction on commercial circuits is open to practical objections, and, as a substitute, its equivalent, in the shape of a series of coils of varying inductance, has been employed. This arrangement of coils of varied inductance is known as a "terminal taper." The arrangement of the several coils constituting the taper is such that a coil having an inductance somewhat less than that of the coils used on the loaded section is placed nearest the loaded line, a coil of inductance somewhat less than the first taper coil is placed next in order, and a coil of small inductance is placed nearest the non-loaded section or the terminal apparatus. The spacing of the coils in the taper corresponds with that of the coils of the line of which it is to form the terminal.

Results Obtained on Commercial Circuits.

The following figures illustrate the results which have been obtained on several typical commercial circuits. In what follows, all comparisons are made on the basis of relative attenuation between similar circuits loaded and unloaded, without reference in any way to distortion or quality of the transmitted speech. The curves shown in these figures are the results of actual tests, made on commercial loaded circuits, using standard terminal apparatus at the transmitting and receiving stations.

Loaded Cable.

In Fig. 1 are shown the results obtained in tests of a heavily loaded standard telephone cable. In this cable the wires are 0·03589 of an inch in diameter, having a resistance of about 96 ohms per mile of circuit. The mutual capacity between the two wires of the circuit is 0·068 of a microfarad per mile. The inductance added to the circuit by the loading coils amounted to about 0·6 of a henry per mile. In this figure the abscissæ represent lengths of cable and the ordinates the relative strengths of current. Curve 1 is that representing the attenuation of current on an unloaded circuit as the length of cable is increased.

It will be seen that the attenuation increases very rapidly as the length of cable is increased. Curve 2 represents the attenuation on a similar circuit, but loaded as above described, the terminal telephone apparatus being placed directly at the ends of the loaded cable, thereby obtaining the full effects of reflection. It will be noticed that the initial current on the loaded circuit is about one-quarter of what it is on the unloaded circuit. Moreover, the transmission on shorter lengths of the loaded circuit under these conditions is much poorer than the transmission over similar lengths of the same cable circuit unloaded. But the rate of attenuation per unit of distance is much less on the loaded than on the unloaded circuit; so that for the longer lengths of circuit the transmission is superior on the loaded circuit to that on the same lengths of unloaded circuit. Curve 2 shows the attenuation when no terminal tapers are employed and the reflection is a maximum. If terminal tapers are employed at the two ends of the loaded circuit and the telephone transmitting and receiving apparatus is connected directly to the tapers, the attenuation on the loaded circuit is represented by Curve 3. Here again it is seen that the initial current is considerably less than that on the unloaded circuit and that the transmission on short lengths of circuit is better on the unloaded than on the loaded conductors, but the introduction of the tapers on the loaded circuit has more than doubled the initial current and has shortened by about one-half the length of circuit which showed the unloaded circuit superior. A comparison of Curves 2 and 3 shows how great a factor the reflection losses are between the terminal apparatus and a loaded circuit and the importance of the taper in reducing these losses. In practice it has been found that reflection losses can be still further reduced and under special conditions almost, if not entirely, eliminated.

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* *Phil. Mag.*, G. A. Campbell, March, 1903.

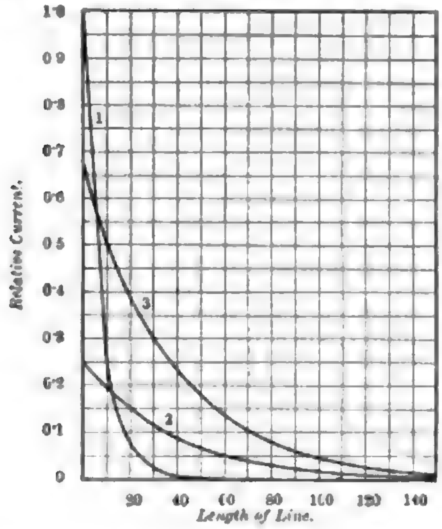


Fig. 1.

In the case above described a large amount of inductance has been added to the circuit. The results which have been obtained upon cables where less inductance has been added are shown in Fig. 2. In this case the cable is substantially similar to that previously described. Upon it loading coils are placed so as to bring the inductance of the circuits up to approximately 0·17 of a henry per mile. In other words the inductance is less than one-third of that in the case just described.

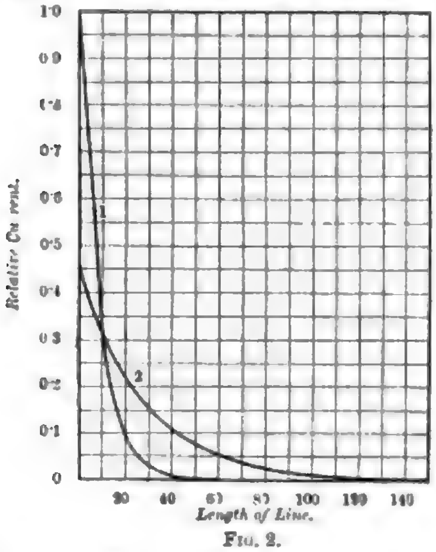


Fig. 2.

In Fig. 2, Curve 1 is similar to that in Fig. 1 and represents the attenuation of the telephone current in an unloaded circuit in the cable. Curve 2 represents the attenuation in the lightly loaded circuit when no tapers are employed and the telephone transmitting and receiving apparatus are placed at the terminals of the loaded cable. It is to be noted that the reflection losses are much less in the case of the lightly loaded cable than is the case in that having the heavier loading. In fact for shorter lengths of cable the lighter loading is more effective in transmitting the telephone wave than the heavier. For longer lengths, however, the heavier loading gives better results. With proper apparatus at the terminals of the loaded cable to reduce reflection losses, much less attenuation would result than is indicated by Curve 2.

Loaded Aerial Circuits.

In Fig. 3 are shown the results which have been obtained on open-wire circuits composed of copper wire weighing 435lb. to the mile. On these circuits loading coils were so placed as to make an inductance of about $\frac{1}{10}$th of a henry to the mile. Curve 1 shows the attenuation with various lengths of line upon a similar unloaded circuit, and Curve 2 shows the attenuation on the loaded circuit when the telephone transmitting and receiving apparatus are placed directly at the ends of the line without tapers. Curve 3 shows the attenuation under similar conditions when tapers are employed. The results resemble those obtained with loaded and unloaded cable. There is a large reflection loss which is considerably reduced when tapers are employed. Even with tapers the loaded line for shorter distances is inferior to the unloaded. The point particularly to be noticed is the relative slope of the curves in the two cases indicating that the benefits to be obtained from loading open-wire circuits are less than with cable circuits.

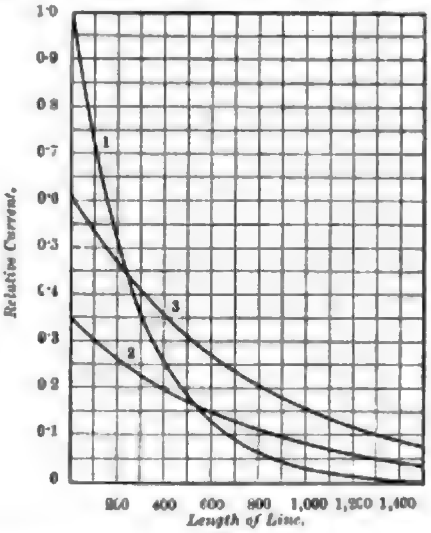


Fig. 3.

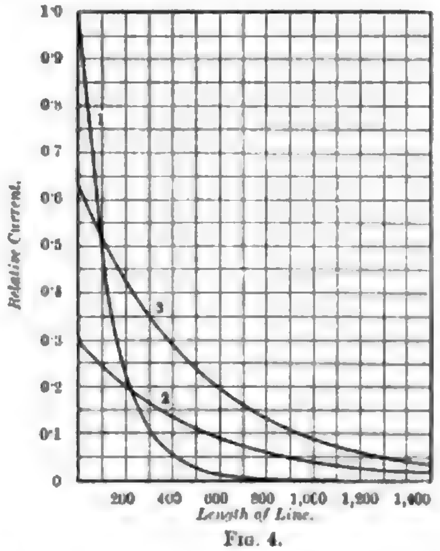


Fig. 4.

Fig. 4 illustrates the results which have been obtained from loading open-wire circuits using a conductor weighing 176lb. to the mile and having an added inductance equal to about 0·1 of a henry to the mile. As before, Curve 1 represents the attenuation on a similar unloaded circuit; Curve 2, the loaded circuit without tapers, and Curve 3, the loaded circuit with tapers.

General Considerations.

The above curves show the results which have been obtained by the use of coils of considerable inductance added to open-wire and cable-telephone circuits and may be considered as typical of the results obtained on similar circuits of different capacity or composed of wire of different size. As before stated the curves illustrate simply the relative volumes of transmission under the various conditions described.

In the case of cables there is a distinct improvement in the quality of the transmission produced by the introduction of the loading coils, the voice of the speaker being received more distinctly. The high insulation which can be maintained at all times on cable circuits renders it possible to introduce loading coils upon the circuits without danger of materially augmenting leakage losses. The marked diminution in attenuation, the improvement in quality of transmission and the ease with which inductance coils can be placed on cable circuits without introducing other injurious factors, such as leakage or cross-talk with other circuits, renders the use of loaded cable circuits especially attractive.

The reduction of attenuation that can be obtained by the introduction of loading coils on air-line circuits, even under theoretically perfect conditions, is less than can be obtained on cable circuits. This difference in the effectiveness of loading between the two classes of circuits, as far as attenuation is concerned, can be explained by the fact that on a cable circuit the capacity is large and the inductance of the circuit itself is practically negligible, due to the proximity of the two wires of the pair. On aerial circuits, on the other hand, the distance between the outgoing and return wire is such as to make the capacity of the circuit much less, and its inductance much greater. This larger self-induction of the open-wire circuit operates to decrease the attenuation, and, as it were, to rob the loading coils of part of their usefulness. Again, the insulation of an aerial circuit cannot be maintained as high as that of a cable circuit, so that the added inductance due to the introduction of loading coils upon the line tends to increase the losses due to leakage.

Moreover, there is not the same improvement in the quality of transmission on a loaded aerial circuit as compared with a similar circuit unloaded, as is found between loaded and unloaded cables. Initially, open-wire circuits are practically free from distortion, whereas the distortion on cable circuits of long length is considerable. The addition, therefore, of loading coils to aerial circuits cannot be expected to effect any improvement in the quality of transmission. whereas in the case of cables the introduction of the additional inductance renders the circuits practically distortionless and effects a marked improvement in the clearness of the transmitted speech.

In presenting this brief summary of the operation of loaded telephone circuits, it is desired to make acknowledgment to Mr. H. S. Warren and Mr. E. H. Colpitts for the solution of the many problems involved in the design of suitable coils for use in carrying out this invention, and to Mr. W. L. Richards and Mr. A. N. Mansfield for the careful tests upon which the curves above shown are based.

CORRESPONDENCE.

A CHRISTMAS APPEAL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It having been pointed out in many quarters that the Electrical Industry, although very wide reaching and giving employment and occupation to many thousands of individuals in all grades of life, has in connection with it no means of supporting any of those unfortunate members who fall into temporary or permanent need, an influential committee of gentlemen actively connected with various branches of electrical work has been constituted to organise a Benevolent Fund for the industry.

This committee has authorised me to announce to you that insufficient time has elapsed to prepare a full scheme of operation, but that, as we are approaching the Christmas season, when, doubtless many connected both directly and indirectly with the industry are giving gifts in kind and cash, I would ask you to make a preliminary notice in your esteemed journal so that they may earmark or retain some important percentage of these gifts for the Fund.

As soon as a sufficient sum is available, this Fund will eventually be used for the purpose of providing pensions and donations for deserving cases in the Electrical Industry, voted for by the subscribers.

Further details will shortly be announced, but in the interval the organisation is being rapidly proceeded with.—Yours, &c.,

London, Dec. 10. JUSTUS ECK.

LEGAL INTELLIGENCE.

Harrop v. Ramsden.

At the Leeds (West Riding) Assizes last week (before Mr. Justice Darling and a jury), plaintiff, a journeyman painter, sought to recover from Mr. N. Ramsden, painter, Dewsbury, damages for personal injuries. It appeared that defendant had contracted to paint the Dewsbury tramway poles and plaintiff had been engaged on the work from February to June last year. According to plaintiff, he had been told by Mr. Ramsden that there could be no danger unless the trams caught the ladder. One day as he was reaching over the tramway arm with his left hand, his right holding the ladder, he accidentally touched the wire, and received an electric shock. He fell from the ladder and sustained a compound fracture of both arms and was rendered permanently deaf. He believed if his employer had supplied him with indiarubber gloves the accident would not have happened.

For the defence, Mr. RAMSDEN denied that plaintiff had asked him if there was any danger in the work. Each morning as plaintiff and the other men left the shop he warned them to be careful not to touch the wires. He had never heard of indiarubber gloves being necessary until after the accident, and then he provided them.

The jury found that the injury occurred by reason of want of proper care on the part of plaintiff, and that defendant neglected to supply plaintiff with appliances proper to the work; that defendant did not know it was dangerous for a careful workman to do such work without gloves; and that it was negligent of defendant not to have made himself aware that it was dangerous to do the work without wearing gloves, and found for plaintiff £75 as damages.

Upon the findings, however, his LORDSHIP first entered judgment for defendant, but on the following day he said he had since considered the position, and he would like to hear counsel for defendant on the point. There was no dispute (said the judge) that if plaintiff had been supplied with rubber gloves the accident would not have happened. The jury found that defendant was negligent in not supplying such gloves That would have entitled plaintiff to judgment, but it was contended that the accident was due to the contributory negligence of plaintiff, since the accident would not have happened if plaintiff had not taken hold of the live wire or of the ear to which it was attached.

Defendant's counsel now submitted that his lordship's judgment was quite in order. When the plaintiff put his hand on the wire nothing that the defendant could have then done could have prevented plaintiff from being injured. He maintained that plaintiff had been guilty of that want of care which brought about the injury to himself.

His LORDSHIP said he thought there was a difficulty in the case, and he still thought there was an argument for plaintiff. But on the whole he thought that the case came within the rule. If plaintiff had not taken hold of the wire the fact that he had no gloves on would not have mattered, and that obliged him to enter judgment for defendants, but he stayed execution pending an appeal.

Aspden v. Steam Engine Makers' Society.

At Liverpool Assizes on Saturday, before Mr. Justice Walton and a special jury, a case was tried which involved a question as to the liability of trade unions. Plaintiff, an engine fitter, met with an accident to his left hand whilst employed by Messrs. Yates & Thoms at the works of Messrs. Vickers, Son & Maxim at Barrow. He received compensation from his employers under the Workmen's Compensation Act, 1897, and also drew sick pay from the defendant society and was still in receipt of such pay. In April, 1903, it was discovered that the plaintiff's injury was more serious than at first supposed and that he would probably be permanently incapacitated. He gave notice of total disablement to the society and claimed £100 under its rules as having been a member for over five years. His claim was refused unless he refunded certain sums received from the society as sick pay.

Mr. HORRIDGE, K.C., submitted that the Court had no jurisdiction. The society was essentially a trade union, and existed for restricting trade. If the action had been brought before the Trade Union Act, 1871, it could not have been maintained, as it was illegal.

For plaintiff it was argued that the rules of the society were severable. A great part of them were those of a benefit society, and such rules as related to the restraint of trade could not make the benevolent department illegal.

His LORDSHIP held that one of the main objects of the society was restraint of trade, and that although that object no longer made the society illegal or its rules void, the old law still remained to the extent that an action could not be brought now any more than it could have been brought before the Trade Union Act, 1871, was passed. Judgment would be for defendants, with costs.

City Churches Arbitration.

Yesterday, in the House of Lords, before the Lord Chancellor and Lords Macnaghten, Lindley and Robertson, this appeal, arising out of the arbitration proceedings between the City & South London Railway Co. and the rector and churchwardens of the united parishes of St. Mary Woolnoth and St. Mary Woolchurch Haw, London, E.C., was heard.

The company appealed from a judgment (reported in *The Electrician* for April 3, 1903) of the Court of Appeal, affirming a decision of Mr. Justice Wright as to the basis upon which compensation by the company was to be paid on certain findings of the arbitrator. In 1893 the company obtained an act empowering them to purchase (for their undertaking) the site upon which the church of St. Mary Woolnoth stands, and in March, 1896, they served a notice to treat upon the rector and churchwardens for the purchase of the church and adjoining lands. The same year they deposited a bill for an extension of time to construct the railway. The bill was passed with the insertion of clauses designed to preserve the fabric of the church. By the terms of the act, "the amount of purchase money or compensation to be paid by the company for the portion of so much of the surface as was not occupied by the church as shall be required by them, and for the subsoil and crypt, and for the temporary occupation of the church and all other matters of differences" were to be determined by arbitration. In 1900, Mr. R. Vigers was appointed arbitrator, and the most important questions he left for the court were whether the compensation payable by the company was to be assessed (1) upon the basis that all the lands taken were the site of the church of St. Mary Woolnoth, and that the same could never be used for any other purpose; or (2) upon the basis that although the lands were at present *extra commercium*, they might by Act of Parliament at some future time become available for building, and that the arbitrator might draw his own conclusion as to when that time, if ever, would be likely to arrive; or (3) upon the basis that the site of the church and the rest of the land could immediately be made available for buildings other than a church. On basis (1) the sum payable was assessed at £90,628, on basis (2) at £136,421 and on basis (3) at £143,548. Mr. Justice Wright decided that basis (2) was the true basis, and that decision was affirmed by the Court of Appeal. The company now appealed to their Lordships' House.

At the conclusion of the arguments,

The LORD CHANCELLOR said he agreed with the judgments given in the Courts below, and he came to the conclusion, and for the reasons there stated, that the view taken by Mr. Justice Wright that the true basis of compensation was that stated in finding (2) of the award. The appeal must, therefore, be dismissed.

The other noble and learned lords having concurred, the appeal was, accordingly, dismissed with costs.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

"The Electrical Transmission of Energy." By A. V. Abbott. 4th edition. (London: Crosby Lockwood & Son.) 30s.

"The Dynamical Theory of Gases." By J. H. Jeans. (Cambridge: University Press.) 15s.

"Petrol Motors and Motor Cars." By T. Hyler White. (Longmans, Green & Co.) 4s. 6d.

"Electricity Control; a Treatise on Electric Switchgear and Systems of Electric Transmission. By L. Andrews. (London: C. Griffin & Co.)

"Fowler's Mechanical Engineers' Pocket Book, 1905." Edited by W. H. Fowler. (Manchester: Scientific Publishing Co.). 1s. 6d.

"Small Electrical Measuring Instruments." (London: Percival Marshall & Co.) 6d.

Calvert's Mechanic's Almanac for 1905. By William Calvert. (London and Manchester: John Heywood.) 4d.

"Proceedings of the Royal Society." No. 502. Vol. LXXIV. (London: Harrison & Sons.) 2s.

"Theorie der Elektrizität." Edited by Dr. M. Abraham and Dr. A. Föppl. Vol. "Einführung in die Maxwellsche Theorie der Elektrizität." (Leipzig: B. G. Teubner.) 12m.

LIGHT RAILWAYS.

During the past month 18 applications were lodged for Light Railway Orders (against eight in May, 1904), and in 10 of these electric traction was scheduled. Five of the latter are, however, for orders for extensions of time or amendment of powers, &c. Particulars of the electrical projects are set out below :—

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Rhodes Electrical Mfg. Co., 70-71, Bishopsgate-street Within, London, E.C., require a capable commercial engineer to start a branch office in Manchester. See also an advertisement.

Worcester Corporation require an electrical engineer. Salary £400, rising to £500 per annum. Applications by 19th inst.

A general manager is required for Newcastle-upon-Tyne Corporation's electric tramways. Salary £700, with increases of £50 per annum to £800. Applications by Jan. 7.

Elland District Council require a working electrical engineer for combined refuse destructor and electric lighting station. Applications to Mr. James Clarkson by Dec. 17.

Blackburn Corporation require a car shed superintendent. Applications by 22nd inst.

Croydon Corporation require a head for their publicity department. Salary £150. Applications by 27th inst.

A lecturer in electrical engineering is required at Queen's College, Galway, early in January, 1905. Salary £125, with class fees. Applications to the registrar, Mr. Edward Townsend, M.A., by 31st inst. See advertisement.

An assistant, with factory experience, is wanted in the electrical engineering department of the City and Guilds Central Technical College, Exhibition-road, London, S.W. Salary £150. See advertisement.

The Council of Victoria University, Manchester, propose to appoint a professor of engineering. Total income not less than £1,000 per annum during the first three years. Applications by Feb. 15.

A chief assistant is required in the mechanical engineering department of Northampton Institute, St. John Street-road, London, E.C. Applications to principal by Jan. 3.

Battersea (London) Council have appointed Mr. J. H. Fooks Bale, resident engineer of the Mersey Railway Co. (for the British Westinghouse Co.), to the position of borough electrical engineer, at a commencing salary of £400. There were 109 candidates.

Mr. J. Galbraith Westlake, of Peterborough, has been appointed shift engineer at Battersea out of 131 candidates.

Mr. W. F. Endean, chief inspector of Devonport and District Tramways has been appointed manager of the Middleton tramways.

Mr. Percival Herbert Powell, of Stafford, has been appointed lecturer and demonstrator in electrical engineering at Canterbury College, Christchurch, New Zealand.

EDUCATIONAL NOTICES.

The annual distribution of prizes and certificates to the students of the engineering and architectural sections of the Regent-street Polytechnic took place on Tuesday.

Mr. A. H. Gilkes, M.A., headmaster of Dulwich College, distributed the prizes to the students at the South-Western Polytechnic (London) on Saturday.

American Railways and Telegraphs.—It is announced that the Supreme Court has given judgment for the Pennsylvania Railroad in a case involving the right of that company to remove the telegraph poles of the Western Union Telegraph Co. from its right of way.

Argentina.—The "Review of the River Plate" says the electricity supply at San Martin was recently inaugurated.

The Rosario Electric Co.'s electricity supply undertaking, which was established in 1890, has now a total connection to the mains of the equivalent of 51,260 8 c.p. lamps, taken by 983 consumers, including 260 H.P. for motors. Electric tramways will probably be in operation in Rosario in 1905.

Extensions of the lines of the Buenos Ayres Electric Tramway Co. were opened on Nov. 14.

Title.	Promoters.	Engineers.	Mileage.	Motive power.	Agents.
Ackworth & Lindsey (W.R. Yorks. & Lincs.)	R. E. C. Shann, W. F. Tempest and others	F. H. E. Shipton & M. N. Ridley	53¾	Electric or steam	Allen, Tennant & Co.
Bath Elec. Trams (Lt. Rail. Extensions) (Somerset)	Bath Electric Tramways ..	G. Hopkins & Sons	1⅞	Electric	Paines, Blyth & Huxtable.
County of Middlesex (amendment and lands—extension of time, &c.)	County Council	H. T. Wakelam ..	..	Electric	Sir Richard Nicholson.
Knutsford & Warrington (Cheshire)...............	Cheshire Lt. Railways (Ltd.)	H. H. Scotter	10¼	Electric	Baker & Co.
Maidstone Corporation (Extension) (Kent)........	Maidstone Corporation....	S. Sellon	4½	Electric	Sharpe & Co.
Mansfield & District (Extensions) (Notts.)...........	Mansfield & Dist. Lt. Rly. Co.	Bramwell & Harris	4¾	Electric	W. & W. M. Bell.
Newark & District (Notts.)	H. R. Holland, G. L. Addenbrooke & H. Rüfler	Bramwell & Harris	5	Electric	W. & W. M. Bell.
New Quay (Cardigan)	J. C. Harford, E. J. Davies and others	S. W. & A. L. Yockney	8	Electric or steam	Young, Jones & Co.
Portmadoc, Beddgelert & S. Snowdon Railway (to construct and work as light railway)	Portmadoc, Beddgelert & S. Snowdon Railway Co.	..	..	..	Paines, Blyth & Huxtable.
Welshpool & Llanfair (further capital powers) (Montgomery)	Welshpool & Llanfair Light Railway Co.	..	..	Electric	Bircham & Co.

The total mileage of the whole of the schemes is 140¾ and the estimated cost £1,307,994.

We referred in our last issue to a decision in the local courts ordering the Compañia Alemana Transatlantica de Electricidad to pay the Municipal Council $25,363·57 (gold), representing arrears of a tax of 5 per cent. on the company's gross receipts from the tramways. The municipal director of public lighting has followed up this victory by a discovery that 5 per cent. is inordinately low, as he calculates that the gas companies pay 9·5 per cent. of their gross receipts, and he now proposes an increase to the latter figure of the tax on the electricity supply company as an equitable way to put the matter right. The "Review" points out that the public are the ultimate victims.

According to a Buenos Ayres municipal decree of 1899 the tramway companies are bound to light the routes of their lines where the lighting is defective, and the public lighting department now recommends that this obligation be enforced in regard to a large number of streets.

Messrs. Lacroze Bros. are about to convert to electric traction their tramways in the centre of Buenos Ayres, and also the steam tramway which runs to San Martin.

Buenos Ayres Municipality have entered into a two years contract with the Cia. Alemaña Transatlantica to take current, for purposes other than street lighting, at 9c. (gold) per unit for lighting and 4½c. for power.

Barrow-in-Furness.—From April 1 the period for which electricity for lighting, other than dwelling-houses, is charged 6d. per unit, and for motive power at 3d. per unit, will be reduced from 1½ hours to 1 hour, and places of worship will be supplied at a flat rate of 4½d. per unit.

Battersea (London).—It was reported to the Council on Wednesday that the model prepayment electricity meter submitted by the British Thomson-Houston Co. had been thoroughly tested and found satisfactory. It was decided that all meters for the town hall and the workmen's dwellings on the Latchmere estate should be of this type.

Bethnal Green (London).—The Council are applying for a loan of £75,000 for electricity works and £8,200 for arc lamps. The total cost of the site taken at Marion-square is £25,000 and it is intended to allocate £10,518. 12s. 2d. of this to the lighting undertaking.

Birmingham Electric Club.—Mr. J. Inniss presided at the meeting of the members of this club on Saturday last.

Mr. Inniss said that as the club membership included all departments of the electrical industry he hoped the papers to be read at their meetings would be as practical as possible. Like other professions, that of the electrical engineer was somewhat crowded in some of its departments, but there were satisfactory openings for good men, such as designers of machines. In this connection he stated that he knew of more than one electrical firm which had to go abroad for their chief designers. There were also great possibilities in other directions, and in support of this, Mr. Inniss pointed with satisfaction to the remarkable development of electricity during the past decade, to the electrification of railways, to the cheap, reliable, and moderately rapid means of locomotion in and around large cities; and to the improved facilities for lighting by electricity and for distribution of power.

Bridlington.—The Council have decided to supply electric current for private lighting at 5d. per unit, with a reduction to 4½d. if 500 units are taken per quarter and to 4d. if 1,000 units are consumed.

Burgess Hill.—The Council recently decided to ask the Board of Trade to extend the period for complying with the terms of the provisional order, 1901, as tenders had been obtained for the works, but the Council has not so far been prepared to meet the capital expenditure.

Burslem.—The Town Council have received sanction to loans of £21,000 for electric lighting and £9,984 for a refuse destructor. Tunstall Council have decided to support the Council's application for a provisional order to supply electrical energy in Tunstall on the same terms as in Burslem, subject to the insertion of a clause providing for the purchase by Tunstall Council of such part of the undertaking as might be within their own area at any time on giving Burslem six months' notice.

Chesterfield.—On Tuesday the Council declined to take a poll of the ratepayers on the Sunday tramway question, as they are satisfied a limited Sunday service is necessary.

City of London.—The Charing Cross & Strand Electricity Supply Corpn. intend to apply to the Corporation for approval to alter the standard pressure of supply to consumers from 100 to 200 volts in the company's distributing mains.

Colonial Preference.—For many years past we have devoted a section of "The Electrician" Electrical Trades' Directory and Handbook to a list of Colonial firms and persons engaged in electrical occupations and in the manufacture and sale of electrical goods. This section has been a costly one, but has been kept well up to date with a view to placing manufacturers and dealers at home in close touch with buyers and users of such goods, actual and potential, in the Colonies. This year we have dealt with the matter as usual, and have despatched our printed circulars for correction, &c., in the regular way. We find, however, that the Government of the Commonwealth of Australia, which we are told in the political papers is crying aloud for preferential treatment from the Motherland with regard to their produce, &c., has put a spoke in our wheel by imposing a tax which subjects each 2oz. of printed matter sent from Britain to Australia to a charge of ½d. This the addressee in the Commonwealth, very naturally we think, declines to pay, not perhaps on the score of the amount of the surtax, but on principle. It is therefore, we fear, probable that the Colonial Division of the "Big Blue Book" (so far as it relates to the Commonwealth) will, in common with similar matter in other publications, be less complete and reliable than in former years. At a time when the question of "Colonial Preference" looms large in the political world, when we are invited to look to Britain beyond the seas for assistance in matters commercial against the prohibitionists of foreign countries, the imposition of such a vexatious and self-stultifying tax will, we think, strike the commercial community at home as a singularly inopportune example of how not to impress the British public with the merits of a policy of "Colonial Preference." If our own kith and kin, who can send practically just what they please to this country without tax or impost of any kind, treat us in this way, we may reasonably say "Save us from our relations and friends." Even the benighted trades unionists of the Commonwealth cannot urge that Australian trade can be injuriously affected by such printed matter as we send in, for it has to be returned to us, and so the Commonwealth is pecuniarily benefited through its postal department.

Customs Decisions.—The Customs Department of the Australian Commonwealth has recently decided that electric chain mining machines, with self-propelling trucks, shall be classed as electrical machines and appliances, and bear a 12½ per cent. ad val. duty.

Dunfermline.—At the Council meeting on Thursday last Mr. Harley urged that the Fife Electric Power Co. should not be allowed to lay mains in the streets until the Corporation had had advice from an electrical engineer, and it was decided to consult Mr. W. B. Sayers.

Dungannon.—The Council have asked for an extension of time to carry out the provisions of their electric lighting order, 1901.

East Barnet.—The revised terms of the North Metropolitan Electrical Power Distribution Co. for the supply of electricity in this district have been submitted to the Council, and after discussion it was decided to apply to the Board of Trade for an extension of time to comply with the terms of the Council's provisional order, 1899.

Electricity on Battleships.—The "Britannia," which has a length of 454ft. overall, and will be ready for launching from Portsmouth Dockyard early in 1906, is to be equipped with wireless telegraph apparatus, the gaff for the aerial wire being carried at the mainmast head, where a semaphore for long distance signalling will also be fitted. Electrical generating plant will be installed on board consisting of four dynamos capable of giving 600 amps. at 105 volts. Electricity will be used for lighting and for driving the ventilating fans, motors for ammunition hoist winches, coal hoist winches, and the after capstan. A complete installation of electric bells will also be provided.

Epsom.—It has been decided to reduce the charge from Jan. 1 for electric current for private lighting from 6½d. to 5½d. per unit. For current supplied to arc lamps for outside lighting the charge will be reduced to 4d.

Exhibition.—Under the auspices of the Edinburgh Merchants' Association a meeting was held at Edinburgh last week, and a proposal to hold an exhibition at Edinburgh in 1907 was approved. The opinion was expressed that, although foreign exhibits would be eligible, the exhibition should be illustrative of the progress made by Scotland since the Union. Further meetings are to be held and Edinburgh Town Council are to be asked to give the project financial aid.

Fiji.—Telephonic communication exists between Suva and Lautoka, a distance of 125 miles, via Nausori and Ba.

Glasgow.—The Corporation approved on Thursday last the draft tramways provisional order, which provides for the construction of extensions of the tramways from Maryhill to Canniesburn Toll, from Barrachnie to Baillieston, from Toll Cross to Uddingston and from Spiers Bridge to Barrhead.

Gorton.—The Council last week considered an offer from Manchester electricity department to supply arc lamps, standards, &c., for lighting Hyde-road and to supply current for same and include the cost of the lamps, &c., in the charge for current. A deputation was appointed to interview Manchester Electricity committee and report.

Guatemala.—It is stated that a line of electric street tramways is to be established here, current being obtained from water-power plant. The power station is to be situate about 80 miles from Guatemala. The 7 miles of single-track line which now exist are of a primitive character and the cars are mule-drawn. Senor Ricardo Echeveirra is general manager of the tramway company in this city.

Hammersmith (London).—The borough surveyor has been instructed to carry out by direct labour, at an estimated cost of £100, the excavations for the foundations of the boiler house extension of the electricity works.

Hornsey.—The Council will oppose the power bill of the Char Cross & Strand Electricity Supply Corpn.

Hove.—Last week the Council resolved to oppose any application for an electric lighting order for any portion of the borough.

Islington (London).—The Finance committee have approved estimates for £4,000 for providing and laying high-tension distributing mains in the Newington Green district, £1,050 for extending lighting and power mains principally to supply current for lighting tube stations in York-road and Gillespie-road, and £220 for main extensions in Highbury-crescent and Caledonian-road.

Highgate public library is to be wired for the electric light.

Kilmarnock.—On Saturday last the electric lighting and electric tramway undertakings of the Corporation were inaugurated, the ceremony being performed by Lord Howard de Walden. It is over five years since movement was first made in the direction of supplying electric light and power in Kilmarnock. The Town Council in 1898 were asked to give their consent to a private company's application for powers to supply the burgh with electrical energy. After consulation with Mr. Wm. Arnot, of Glasgow, the Corporation decided themselves to undertake the supply of current, and a committee was formed to take the matter in hand. Mr. W. A. Bryson was subsequently appointed engineer to the Corporation, and plans and specifications were prepared; but in consequence of the outlay involved the scheme did not find favour at the time. A proposal for combined electric lighting and tramways subsequently came under discussion by the Corporation, and Dr. A. B. W. Kennedy was called in to advise. After full consideration the joint undertaking was proceeded with, in spite of much local opposition. Public electric lighting was actually inaugurated at Kilmarnock on Nov. 5, and now that the electric tramways are in operation the Corporation's project may be said to be complete. Mr. A. H. Burbidge was appointed by Messrs. Kennedy & Jenkin, the consulting engineers to the Corporation, as resident engineer for the work, and he has been eminently successful in pushing matters forward and securing the completion of the contracts in record time. Early in the progress of the works Mr. Burbidge was appointed by the Corporation to the post of burgh electrical engineer and manager of the tramways, and continues in that position. The combined lighting and power station and tramcar sheds are situate at Riccarton, on the river Irvine, and have been erected from the plans of Mr. Stanley Peach, who has been responsible for many similar groups of electricity buildings in various parts of the kingdom. Associated with Mr. Burbidge in the engineering portion of the works on Messrs. Kennedy & Jenkin's behalf were Mr. B. Raikes and Mr. B. Pugh, the latter acting as permanent way inspector. The contractors for the works include:—

Buildings: Mr. C. Fairweather, jun., Kilmarnock, with Mr. C. Stewart as clerk of the works.

Track work: Dick, Kerr & Co., with Mr. J. E. Tarling in charge.

Overhead equipment: R. W. Blackwell & Co., with Mr. H. L. Davis as representative engineer.

Cables (both lighting and traction): Callender's Co., with Mr. A. O. St. John Dixon as representative engineer.

Station and car-shed lighting: Cox-Walkers, Darlington and Edinburgh.

The total cost of the electric lighting portion of the scheme is estimated at about £37,000, and of the tramways at £42,000. The plant comprises Belliss engines coupled to dynamos of Dick, Kerr & Co.'s make, the condensing plant being of the Mirrlees Watson Co.'s manufacture. A battery of Tudor accumulators, comprising 254 cells of a total of 360 ampere-hours' capacity, is installed, and the plant includes a 192-tube Green economiser, and two Weir direct-acting pumps. The pipe work has been supplied by Aiton & Co. (London), the cars by Hurst, Nelson & Co. (Motherwell), and the motor equipment for the cars by Witting, Eborall & Co. (London). 11 out of 12 of these cars on order have been delivered. The inauguration was carried out without hitch of any kind.

Kirkcaldy.—On Monday the Town Council agreed to increase the salary of the burgh electrical engineer (Mr. O. F. Francis) to £300 per annum, with permission to take pupils. The recommendation of the Tramways committee was that the salary be increased to £400 per annum and that the premiums paid by pupils be paid to the town treasury.

A portion of the tramway in Wemyssfield is to be doubled. The agreement with Mr. Wemyss for the construction of tramways from Leven to Kirkcaldy has been adjusted with the exception of two minor matters.

Liverpool.—A special meeting of the City Council was held on Monday to consider the general powers bill to be presented to Parliament next session. Among the clauses is one dealing with repayment of moneys borrowed for tramway purposes, and providing for the application of the sinking fund principle, already adopted for the Corporation electric lighting undertaking.

The tramways bill for the construction of electric tramways in Walton-on-the-Hill, West Derby, Bootle, Fazakerley, &c., was approved.

Logrono (Spain).—An interesting plant for lighting and power distribution is being constructed in Logroño by Messrs. Jackson & Phillips, and will be ready for opening about February next. The works are owned by the Electra Recajo Logroño, and are on the alternating-current system with three-phase generation. The new three-phase plant now being erected 22 kilometres distant from the supply station in Logroño, is turbine-driven, the head of water available being 165ft.

London County Council.—At Tuesday's meeting, on the recommendation of the Education committee, an expenditure of £494 was sanctioned in respect of the installation of electric light and the provision of electrical fans for Shoreditch Technical Institute.

Tramways.—The Highways committee submitted a lengthy report dealing with the contracts for continuous-current and three-phase electrical plant. The committee stated that under the terms of the specifications for the engines supplied the contractors were entitled to a bonus at the rate of £300 per lb. for every pound or fraction of a pound by which the steam consumption of each engine fell short of 24lb. per kw.-hour. It had been found that the engines supplied by Messrs. Dick, Kerr & Co. consumed 22·35lb. per kw.-hour at full load, and the contractors were therefore entitled to a bonus of £495 on each of the four engines, making a total of £1,980. A small unexpended balance was available for paying part of the bonus, and the Council agreed to the payment of the bonus.

Roof Covers for Cars.—The Highways committee recommended the expenditure of £8,500 on 100 "Mengarini" roof covers to the tramway cars from Milnes, Voss & Co., owners of the patents. A royalty of £4. 10s. for each cover would have to be paid to that firm, the actual work of construction being done by the Council's own staff.—Consideration adjourned for a week.

London Electric Lighting Areas Act, 1904.—A report of the Board of Trade upon the agreement under this act made between Battersea Council and the County of London Electric Lighting Co. was submitted by the Highways committee. The Board of Trade had confirmed the agreement.

Louth.—On Tuesday the Electric Lighting committee recommended the Council to acquire the James-street site for electricity works, and to put down steam-driven plant. The matter is, however, to be dealt with by the Council in committee.

Ludlow.—The Town Council will consent to the grant of a provisional order to a company provided the Corporation have the option of purchasing the undertaking in 20 years, that the opening of the streets be done by the borough surveyor at a fixed charge, that the company consult the Corporation as to the position of the cables, &c., and not to erect any overhead wires without first obtaining permission of the Corporation; the price to the Corporation for electric current for public lighting to be 4d. per unit, but should the price be reduced to 5d. for the general public, then the price to the Corporation to be reduced in proportion.

Metropolitan Asylums Board.—On Saturday the Board decided to adopt for lighting the Eastern Hospital and Ambulance Station the alternative system of charging offered from Jan. 1, 1905, by Hackney Council—viz., 7d. per unit for first hour's supply per day at the maximum demand, and 1d. after. The engineer-in-chief reported that the adoption of this scale would save 40 per cent. on the amount spent at present for current at a flat rate of 4d. per unit, subject to 10 per cent. discount.

It was resolved to invite tenders from six selected firms for wiring Belmont Asylum.

Mexico.—Señor T. E. Ramos, who has obtained a concession for the construction and working of a narrow-gauge railroad from Hunucma (Yucatan) to Sisal, has also, under the same concession, been granted public telegraph and telephone privileges.

Municipal Telephony.—At Glasgow City Council meeting on Thursday last,

Mr. Gray moved approval of clause 78 of the Corporation's draft provisional order, 1905, which reads as follows:—

The annual value of all underground or overhead lines, pipes, cables, or apparatus belonging to the Corporation for the supply of telephonic communication or electrical energy in the City, and in any burgh in or through which the Corporation have laid, or may be entitled to lay, such lines, pipes, cables, or apparatus shall, for the purposes of all assessments leviable in the City or such burghs, be held to be one-fourth of the annual value thereof as entered on the valuation roll for the City or such burghs.

Bailie Murray opposed, on the ground that the clause subsidised from the rates the telephone and electricity departments to the extent of three-fourths of their proper taxation.

Mr. Gray's motion was, however, carried by a large majority.

Musselburgh.—The local electric tramways and electricity works were opened for traffic on Monday. The electricity supply station and the tramways have been erected and equipped by the National Electric Construction Co.

New Malden.—A resolution of the Council, passed on Nov. 1, directing the Electric Lighting committee not to further consider the subject of electricity supply until the Council should have decided upon its policy in regard to the matter has now been rescinded. At the last meeting of the Council Mr. Glenn, on whose motion the former resolution was rescinded, said that several electric lighting companies were interesting themselves in the district, and it was time the subject should be taken into serious consideration by the committee.

Newcastle-on-Tyne.—For the half-year ended Sept. 29 the Corporation auditor (Mr. T. Bowden) states that the balance of tramway income over expenditure was £3,414. 5s. 5d., subject to adjustments.

Rolling stock should be adjusted by writing off to revenue such expenditure under that head as could not reasonably be considered to have increased the value of the asset, and in regard to depreciation no provision has been made. The total receipts were £102,239. 3s. 1d., and after paying all expenses the balance was £34,814. 17s. 1d. Interest absorbed £16,805. 13s. 1d. and sinking fund £14,595. 18s. 7d., leaving £3,414. 5s. 5d.

Northampton Institute.—We give elsewhere a report of the proceedings at the annual conversazione and distribution of prizes at the Northampton Institute on Friday last. Amongst other interesting items on the programme on the occasion was a demonstration in the swimming baths of the Middleton system of submarine navigation, the salient feature of which is that vessels are propelled, impelled, directed, controlled and governed by fins connected by prime movers (engines or motors) in such fashion that they can move in any way in the fluid in which they are immersed. The fins are a new instrument of impulsion, invented for the purpose of enabling a vessel to be navigated in tri-dimensional space, the screw being only fitted for motion in two dimensions. It is claimed for the Middleton system that vessels constructed on this principle are completely navigable under water, can move in any direction, and can be of any required size. Other particulars were available on the occasion, and the demonstration proved extremely interesting.

Obituary.—Mr. Wm. Ashmore, who 40 years ago founded the firm of Ashmore, Benson, Pease & Co. (Ltd.), electrical and mechanical engineers, of Stockton-on-Tees, died on Dec. 8 at the age of 78 years.

The death occurred on Saturday of Mr. Robert Watson, National Telephone Co.'s inspector for Blackpool district, who was formerly manager of the Lytham Exchange.

The death is announced of Mr. Norman E. Bowtell, M.Sc., on the technical staff of the Castner-Kellner Electrolytic Alkali Co. Deceased was only 26 years of age.

The death is also announced of Mr. J. M. Irvine, telegraph engineer at Inverness since 1896.

"Pall Mall Magazine."—This famous publication has now joined the list of 6d. magazines, and will commence the new series with the January, 1905, issue, which will contain, amongst other valuable contents, a contribution from Mr. F. Lees on "M. Marcelin Berthelot, Scientist and Philosopher."

Police.—At Marlborough-street (London) on Wednesday the St. James' and Pall Mall Electric Light Co. was summoned for permitting water heated to 170 F. to flow into the public sewer.

Mr. Morse, who defended, did not dispute the facts, but urged that as the company had now arranged to prevent any recurrence of the trouble a very small fine should be inflicted. Fines amounting to £5. 19s. (on 20 summonses), with 20 guineas costs, were imposed.

Presentation.—The members of the staff and employés of the Cardiff electricity and tramways departments have presented the deputy electrical engineer (Mr. J. E. Teasdel) with a gold watch, a case of cutlery, &c., on his departure to take up the position of chief engineer and manager of the electricity supply and tramways departments at Pontypridd.

Rubber Substitute.—Several of the Mexican journals refer to the value of a plant called "guayule" for producing a substitute for rubber, and Señor L. C. Aguirre states that the company with which he is connected (La Anglo Mexicana S.A.) have made numerous experiments in extracting the gummy substance which this plant contains and in transforming it into rubber. Patents have been obtained and a small factory established at Jimulco (Coahuila). The erection of other similar factories in some of the frontier states of Mexico is under consideration. Considerable capital is said to have been invested in this enterprise, and large contracts for the supply of the product from guayule have been entered into.

Sevenoaks.—At the last meeting of the Council the chairman (Mr. A. Laurie, J.P.) announced that the local electric lighting company required about £7,000 to make a start, and he and another citizen had guaranteed £1,000 each, provided two others would guarantee a like amount. He was sure electric lighting must come. The Board of Trade have extended the time for making of the deposit prescribed by sec. 8 of the Sevenoaks (1903) order, for six months.

Sheffield.—The Tramways committee have decided, as an experiment for one year, to treat the Accident sub-committee as an insurance company in matters of accidents to employés, 6s. per cent. being paid by the committee on the department's total wages account. It has also been decided to meet all claims by third darties out of tramways revenue.

At Wednesday's meeting of the Corporation, on the presentation of the minutes of the Tramways committee, Councillor Whiteley moved an amendment that a conductor be paid on joining the service 5d. per hour, and after 12 months' satisfactory service 5½d. per hour. The recommendations of the committee were that on joining the service the amount should be 4½d. per hour, after six months' satisfactory service 5d. and after a further 12 months' satisfactory service 5½d. per hour.

Ald. Clegg said there was a point beyond which the tramway undertaking could not go in the matter of wages if it was to be a commercial success, and they had now got to the straining point. If increased financial responsibility were placed upon the department they must consider their position. In Sheffield passengers were carried longer distances than anywhere in the country for the same money. The amendment was rejected.

Councillor Bennett has been elected chairman of the Electric Light committee in place of Ald. Styring, who has been chairman for a number of years.

St. Pancras (London).—The special committee appointed to deal with matters arising out of the action "Calwell and others v. St. Pancras Council" have reported that they are unable to acquire outstanding interests of property in Great College-street abutting on the electricity works, as the owners ask excessive prices.

Salford.—The Heaton Park extension of the Corporation's electric tramways was opened for traffic on Friday last.

South Africa.—Pietermaritzburg electric tramways were formally opened for traffic last month.

South Shields.—The Town Council have resolved to municipalise the local tramways, and will commence the work of reconstruction at an early date. Tenders are to be invited.

Straits Settlements.—In a report on the trade of the year for 1903 of the Straits Settlements, the Governor (Sir John Anderson) states that all telephone materials used in Singapore are imported from Belgium, the service being the property of the Oriental Electric & Telephone Co. The telephone service in Penang (167 miles in length) and in Malacca (186 miles) is owned and worked by the Government.

Tramway rails and tramway materials in use in Singapore are of German manufacture. The value of the imported metal manufactured goods for 1903 was nearly £1,000,000 sterling, an increase of £272,000 for 1902.

The Singapore Tramways (Ltd.) have constructed a considerable portion of their track. Standards have been erected in many of the principal thoroughfares, and the work of erection of the power station is proceeding.

Penang Municipality has made good progress with a scheme for the lighting of George Town by electricity.

Stratford-on-Avon.—The Birmingham Installation Co. have completed an agreement with Stratford-on-Avon Corporation for the transfer of their provisional order and powers to the company, and this now only awaits confirmation by the Board of Trade, which was applied for in November. Mr. C. D. Falcke will be in residence in Stratford-on-Avon for carrying out the undertaking, and the company will have offices in Stratford-on-Avon. It is not expected that the specifications for the plant required will be ready before March.

Swansea.—At the end of November there were 589 customers of the electricity department and the equivalent of 58,860 8 c.p. lamps was connected. Motors represented 473½ H.P. The specifications for lighting Morriston district are completed, and supply will be given on the high-tension single-phase system.

At a special meeting of the Council on Tuesday the Corporation approved the General Powers Bill which is being promoted for the acquisition of the local tramways, &c.

Switzerland.—In a report on the trade of Switzerland for 1903 a list of articles is given in which it is considered by the British commercial agent in that country (Mr. J. C. Milligan) that greater scope exists for British trade. Amongst these articles are electrical apparatus, glassware and domestic machinery. There has been a stationary demand for electrical apparatus from the United Kingdom for the past five years in Switzerland.

Train Lighting in India.—At a meeting of the Great Indian Peninsula Railway Co. on Monday, the chairman (Sir Andrew Scoble) said the company had at last succeeded in obtaining the sanction of the Government for a trial of the electric light on some of the mail trains. They also had on the stocks a motor car, which they intended to try experimentally on some of their feeder lines.

Tramways in the City of London.—The Streets committee of the City Corporation have decided to adjourn until the New Year the further consideration of the application of London County Council for sanction to their proposal for connecting the present tramway termini in Blackfriars road and Westminster Bridge-road by the construction of double track tramways over Blackfriars and Westminster Bridges and along the Victoria Embankment

Upton.—On Wednesday the chairman of the Birkenhead Electricity committee (Mr. M'Gaul) announced that the cables had been laid to Upton and the equivalent of 812 8 c.p. lamps were connected. The following scale of charges has been fixed for electric current:—

Oct. 1 to March 31, 8d. for first 1½ hours, 6d. for second 1½ hours, and 2½d. after. April 1 to Sept. 30, 8d. for first ½ hour, 6d. for second ½ hour and 2½d. after.

Village Lighting.—Electricity supply was inaugurated at Broxburn and Uphall (N.B.) on Tuesday.

Waipori Falls (N.Z.) Electric Power Scheme.—We announced some time ago that the Waipori Falls Electric Power Co. had secured the support of all the local authorities, except Dunedin City Council, in the districts which they proposed to serve.

These districts include counties of Taleri, Bruce, Tuapeka and Waikouaiti, the boroughs of Milton, Mosgiel, Green Island, Caversham, South Dunedin, St. Kilda, Mornington, Roslyn, Maori Hill, North East Valley, West Harbour and Port Chalmers, and the road districts of Peninsula, Tomahawk and Portobello.

Dunedin Corporation opposed the company's bill in Parliament, but the parties have now provisionally agreed upon the transfer of the company's rights and obligations to the Corporation for £31,000 and about £18,500 to cover the company's expenditure (exclusive of amount paid for water rights and £5,500 for promotion of the company's bill).

Mr. R. Hay, consulting engineer for the Corporation, has submitted a report, in which he estimates the cost of the Waipori scheme for the supply of 2,000 H.P. to Dunedin at £94,237. Mr. Hay's estimate of the cost of the Lee Stream scheme is £104,000, so that, even after paying the company's demands, adoption of the Waipori project will save the Corporation £9,763.

Wednesbury.—Application has been made for sanction to a loan of £1,000 for extensions of the electric lighting mains.

West Ham.—A return showing that electric current is now being taken for 51 different classes of buildings in the borough was presented at the Council meeting on Tuesday.

35 public buildings were the largest consumers (222,343 units used during the year), 38 public houses came next (196,036 units), followed by 70 drapers (150,694), two theatres and music halls (80,065), 49 butchers (76,294), seven co-operative society buildings (71,561), 113 private houses (62,682), 39 grocers (62,428), 12 restaurants (41,396), 23 bootmakers (37,729), 14 pawnbrokers (36,731), 22 tailors (35,980), 17 bakers (23,059), 20 tobacconists (21,368), five oil and colour shops (20,828), 14 watchmakers (20,397), 12 factories (18,295), two public halls (16,830), and six clubs and institutes (16,531).

The electrical engineer (Mr. W. J. W. Bullock) reported that although under the scale of 7d. and 2d. per unit the average price received was not excessive, there was an outcry against the maximum demand system, and he believed a large number of consumers would prefer to be charged a fixed rate. It was resolved (*a*) that the present rates of 7d. and 2d. be maintained, and that an alternative flat rate of 4d. be adopted; (*b*) that for arc lighting the rates be 4d. per unit for a consumption of 700 units per annum, 3¾d. for 1,400, 3½d. for over 1,400; (*c*) for factory lighting 2½d. per unit up to 5 p.m., the ordinary rate after; (*d*) that no change be made in the rates for heating and power.

The income of the Corporation tramways department for the half-year to Sept. 30 is returned at £30,748. 1s. 2d., including £3,000 estimated revenue from the horse cars worked by the North Metropolitan Tramways Co.

Working expenses totalled £17,350. 9s. 8d., leaving a balance of £13,397. 11s. 6d. to meet interest on capital (£4,510. 5s. 9d.) and bank interest (£38. 10s. 11d.), leaving £8,848. 14s. 10d., out of which £2,162. 19s. 7d. has been appropriated to the sinking fund, £4,000 transferred to the borough rate and the balance (£3,016. 7s. 9d.) carried to reserve or renewals fund. Total capital expended is £196,538. 5s. 3d., an increase of £57,515. 18s. 6d. for the half-year. The electric car-miles run were 561,832. 7,632,604 passengers were carried and 498,603 units of energy consumed (0·88 units per car-mile). The percentage of working expenses to receipts was 59 and the average traffic revenue per car-mile 11·64d. The average working expenses per car-mile, excluding power costs, were 5·665d. and including power 7·035d., the average fare paid per passenger 0·85d.

West Hartlepool.—The Corporation have sealed the agreement with the National Telephone Co., whereby, in consideration of the Council granting the company permission to lay underground wires, the latter undertake to effect certain reductions in charges to subscribers. The revised rates are:—

A uniform charge of £8 for the first instrument, and £6. 16s. for the second, additional connections to be available to any member of a firm having the first connection; £7 to cover 1,200 calls per annum (receiving an unlimited number), £6 for 900 calls, and £5 for 600 calls; calls in excess of this number to be still at 1d. per call.

An inquiry was held here on Tuesday into the application of the Corporation for sanction to borrow £13,861 for electricity extensions.

Wolverhampton.—For the six months ended Sept. 30 the total receipts of the tramways department were £18,078, against £12,460 in the corresponding period last year.

Receipts per car-mile 11·85d., against 11·2d. For maintenance and renewals the total cost was £869, average cost per car-mile 0·55d., against £825 and 0·74d. last year. The total cost of the Lorain equipment is put at £379, against £244. Total general costs £1,204, compared with £1,101; total working costs £9,911, against £7,799. The profit on the six months is £1,442, compared with a loss of £262.

Workington.—The Council have applied for an extension of time for carrying out the provisions of their electric lighting order, 1901.

Yarmouth.—The Corporation have decided to grant a rebate of ½d. per unit on the present charge of 2½d. per unit for the supply of electric energy to the Tramways committee after a consumption of 100,000 units.

Dinners.—On Friday last the second annual dinner of the Newcastle branch of the Electrical Contractors' Association was held, Mr. Wm. Cross presiding. The guests included Mr. Harford (Liverpool), Messrs. Giepel and Prescott (W. Hartlepool), Mr. W. P. Steinthal (Bradford), Mr. Eugene Brown (Newcastle), Messrs. Gowdy, Usher and R. Robson (hon. sec.), members of the committee, and other gentlemen.

The chairman gave a concise report on the work of the association during last year, and referred to the great amount of work the incorporation threw upon the leading members. Mr. Steinthal said he was glad to propose the toast of the pioneer association, and was pleased to see four of the original five members present that evening.

The members of the staff of Sunderland Corporation electrical department and their friends (to the number of 94) dined together on the 7th inst.

The chief engineer (Mr. John F. C. Snell) presided, and among those present were the mayor (Councillor Foster), the town clerk (Mr. F. M. Bowey), the chairman of the Electricity and Lighting committee (Ald. Bruce), Dr. T. C. Baillie and Mr. A. R. Dayson (tramways manager).

The Mayor, in responding to the toast of "The Mayor and Corporation of Sunderland," said the Corporation was now one of the largest employers of labour in the town, and one of their chief money-making concerns was the electricity department. He paid a high tribute to the services rendered by Ald. Bruce and to Mr. Snell their chief engineer.

In replying to a toast of the guests, Dr. T. C. Baillie remarked that at present there was far too great a tendency to supply electric power at almost cost price. He hoped lighting consumers would be considered first, because it was owing to their demand that the generating plant was first laid down. In regard to educational matters he foreshadowed the day when Sunderland would be equipped with a university. Their technical college was not a dividend-earning department. They spent money; and although the returns were not quick he felt sure that the rising generation of the town would some day look back upon their time spent in the college as having been a genuine blessing in their life.

Ald. Bruce responded to the toast of "The Electricity Department," and announced that as soon as the accounts for the current year were produced the Electricity committee hoped to make a material reduction in the charge for current, both to light and power consumers. In Mr. Snell, he added, they had one of the ablest electricians that could be found in England. Ald. Bruce also quoted figures showing the marvellous growth of the department.

The annual dinner of the employés of Messrs. J. H. Holmes & Co. took place at Newcastle on Friday last.

Mr. G. Cook (a workman) presided, and urged his fellow employés to do their best to maintain the highest possible standard of character. Much (he said) that was bad in the workman's character was due to the absence of helpful conditions of work.

Mr. Alfred Holmes, who replied to the toast of "The Firm," said the firm were proud of their workmen. A few years ago things were prosperous and prices were high in the electrical business, but all that was changed. They had, however, made arrangements which had decreased the cost of production all round, and the result was that they had practically shut out the Americans, and he did not think German competition was nearly so serious as it had been.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Sunderland Corporation invite tenders for one wooden cooling tower, capable of cooling the circulating water for a surface condenser dealing with 30,000lb. of steam per hour. Specifications, &c., from the borough electrical engineer (Mr. John F. C. Snell) and tenders (addressed chairman of Electricity and Lighting committee) to the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon Dec. 30. See also advertisement.

Neath Corporation invite tenders for supply and delivery of wattmeters. Forms of tender, &c., from the town clerk (Mr. Edwin C. Curtis) or from the consulting engineer (Mr. Herbert E. Sully), Scottish Widows'-buildings, Baldwin-street, Bristol. Tenders to town clerk by Wednesday, Dec. 28. See advertisement.

The agents of the Municipal Corporation of *Port Elizabeth* (South Africa) are prepared to receive tenders for the following works in connection with the Corporation electricity undertaking:—(*a*) boiler house plant, (*b*) engine room plant, (*c*) electricity supply mains, (*d*) accumulators and boosters, (*e*) switchboard and instruments, (*f*) crane, (*g*) public lighting, (*h*) meters, (*i*) workshop equipment. Further particulars are given in an advertisement. Specifications, &c., from the agents (Messrs. Davis & Soper), 54, St. Mary-axe, London, E.C., to whom tenders by noon, Jan. 16.

The Directors of the *Great Western Railway Co.* invite tenders for the supply and delivery of the following material required in connection with the electrical equipment of the Hammersmith and City Railway, &c.: Steel conductor rails, cast-iron and steel ramps and fastenings; porcelain insulating supports and their fastenings for conductor rails; copper bonds, insulated cable connections, cable terminals, bonding presses and accessories for connecting up connector rails. Tenders to the Secretary of the Company, Paddington Station, W., until Tuesday, Jan. 3.

Cardiff Corporation invite tenders for the following plant for the extension of their power station on the extra high-tension three-phase system—viz., two 1,600 H.P. slow speed vertical engines, two 1,100kw. three-phase alternators, four Lancashire boilers, with accessories, steam and other piping, switchboard gallery and staircase, extensions to central service gangway, extra high-tension three-phase feeder cables. Tenders to the town clerk (Mr. J. L. Wheatley) by Dec. 19.

Bradford Corporation invite tenders for miscellanous stores required by their tramways department during year ending Dec. 31, 1905, including electrical accessories, paints, varnishes, &c., asbestos and insulating materials, armature repairing material, lamp fittings, &c. Tenders to the town clerk (Mr. Fredk. Stevens) by Dec. 17.

Rochdale Corporation invite tenders for the supply, delivery and erection of high-tension three-phase switch gear and extensions to low-tension continuous-current switchboards. Tenders to the town clerk (Mr. W. H. Hickson) by 27th inst.

Southend-on-Sea Corporation invite tenders for additional plant for their generating station, comprising two boilers, one steam dynamo, one fuel economiser, and two electrical feed pumps. Tenders to the town clerk (Mr. Wm. H. Snow) by Dec. 21.

Fulham (London) Council invite tenders for supply and erection at their generating station, Townmead-road, of a 3,000-volt steam alternator of 1,000kw. capacity coupled to Belliss engine. Tenders to the town clerk (Mr. R. M. Prescott) by noon 20th inst.

Tenders are invited for steel and iron work of a two-storey warehouse at the electric works, West Strand, *Preston*. Tenders to Mr. Mott (Dick, Kerr & Co.), Abchurch-yard, London, E.C., by noon 26th inst.

Erith Urban District Council invite tenders for overhead-line equipment, &c., underground feeder cables, &c., rotary converters, transformers and motor booster, main high and low-tension switchboards, cable connections, &c. Tenders by noon, Jan. 9.

Belfast Public Health committee require tenders by 11 a.m. of Jan. 12 for boilers and independent electric lighting plant at the new infectious diseases hospital, Purdysburn.

East Ham Council invite tenders for the supply of physical and chemical apparatus, &c., for their new technical college and secondary day school. Tenders by noon Dec. 29.

Glasgow Corporation require tenders by 19th inst. for an electric light installation, &c., at Bridgeton District Library.

Manchester Tramways committee want tenders by 20th inst. for motors and gearing for their machine shops.

The *Christiania* (Norway) electricity works require tenders for 1,000 tons of Cardiff coal delivered by Feb. next. Tenders to the works, Tordenskjolds-gade, Christiania, by Jan. 10.

TENDERS RECEIVED AND ACCEPTED.

14 tenders were received by Yarmouth Corporation for 800 tons of straight steel rails, 25 tons of curved rails, 50 tons of fish-plates, 13 tons of sole-plates, 21 tons of tie-bars, and 10 tons of bolts and nuts, for the Gorleston tramways. The tenders received were:—

Jacobs Bros. & Co. (Belgian rails) (*accepted*)	**£4,665**	**16**	**0**
Walter Scott (Ltd.) (English)	5,651	10	0
North-Eastern Steel Co.	5,400	2	6
Bolckow, Vaughan & Co. (English)	5,257	12	0
Barrow Steel Co. (English)	5,174	2	6
MacClellan & Co. (not stated)	5,141	0	0
A. Penny & Co. (Belgian)	4,919	7	6
Le Bas & Co. (Belgian)	4,749	8	2

The Surveyor reported that the lowest tender was £4. 17s. per ton for rails, against £5. 18s. 6d. per ton paid for the last work, and all the other items were proportionately low, the total saving working out at upwards of £950.

Mr. F. Arnold said it was important that a tender should be accepted that day, and to expedite matters he moved that the lowest tender (Jacobs Bros. & Co.) be accepted at £4,665.

Mr. Goode said it was a matter of principle, and whether the difference was £500 or £600 it meant employing English workmen. He moved that the lowest English tender (MacClellan & Co.) be accepted at £5,141. Why should there be such a draining away of English money to pay for Belgian or other foreign materials?

Mr. Saul said the lowest English tender came below the surveyor's estimate.

In reply to questions, the Surveyor said he adopted a specification drawn by probably the most practical men in the country. It was the standard adopted by English makers of rails, and this the Continental manufacturers promised to abide by. They gave the constituent parts of the steel, and there was no difference.

After discussion, the resolution to accept the lowest tender was carried by a large majority.

Salford Council have accepted the following tenders for supplies to the electricity and tramway departments:—

W. Smith & Co., ironmongery; Sturtevant Engineering Co., large motor starters; Veritys Limited, double-pole main switches; Electromotors Limited, electric motors (¼ H.P. to 3 H.P.); Lancashire Dynamo & Motor Co., electric motors (5 H.P. to 30 H.P.); Chamberlain & Hookham, motor meters (25 to 100 amperes); General Electric Co., steel insulated screwed tubing, electric fittings, &c.; Hartcliffe, Lee & Malkin, brass and gunmetal castings.

Blackpool Council have accepted the following tenders in connection with the new promenade tramways:—

Walter Scott (Ltd.), tram rails, fish plates and anchor joints; Guest, Keen & Nettlefolds, tie bars; Edgar Allen & Co., points, connecting boxes, crossings, manganese steel rails and drain boxes; Bayliss, Jones & Bayliss, bolts, nuts and washers.

We are informed that Messrs. Merryweather & Sons have recently obtained orders from the Admiralty for several of their portable electric pumps for dockyard use at Devonport and Portsmouth, the outfit consisting of a "Hatfield" pump driven by an electric motor on a light carriage.

Stalybridge, Hyde, Mossley and Dunkinfield Tramway and Electricity Board have accepted the tender of Underwood & Bro. for joining the tramway with that of the Ashton-under-Lyne system; that of Dick, Kerr & Co. for overhead equipment; and of Cook & Son for heating apparatus for the car shed, stores and fitting shops.

Hammersmith (London) Council have accepted the tender of the Western Electric Co. for joint boxes at £59. 15s. and for road draw-box frames and covers at £33. 6s. For path draw-box frames and covers the tender of the Imperial Engineering Supplies Co. at £31. 10s. was accepted.

The British Electric Plant Co., Alloa, N.B., have obtained an order from the Alloa Coal Co. for a complete electric power plant on the direct-current system for Bannockburn Collieries, together with engines for same.

Leith Town Council are recommended to accept the tender of the North-Eastern Steel Co. for rails and fishplates required for the reconstruction of their tramways. The price is stated to be below £5. 10s. per ton.

Lowestoft Corporation have accepted the tender of Callender's Co. for the supply of about 4,000yds. of feeder cable, and have also placed an order with W. F. Dennis & Co. for 1,500yds. of cable at £23 per 100yds.

Ferrybridge Council have accepted the tender of the Wheldale Coal Co. for providing and erecting electric lamps and supplying electric current for public lighting at Frystom.

Canterbury Council have accepted the tender of the Reason Mfg. Co. for meters for one year, and that of Mr. J. S. Dadds for extensions of electricity station building at £358. 16s.

Deptford (London) Council have accepted the tender of the Hart Accumulator Co. for additions to and alterations of the existing battery at New Cross public baths.

Yarmouth Town Council received four tenders for the supply and laying of cables to Gorleston, and the lowest (that of Callender's Co.) at £259, 4s. was accepted

Swansea Electric Lighting committee have accepted the tender of Herbert Morris & Bastert for a hand travelling crane, for £106, the lowest tender submitted.

Mr. P. Dewhirst has secured the contract for the erection of a switchboard at Blackpool Corporation destructor works.

East Ham (London) Council have placed an order with Dick, Kerr & Co. for top covers for 10 electric tramcars at £85 each.

Battersea (London) Borough Council have placed an order with the General Electric Co. for 50 arc lamp globes at 6s. 9d. each.

Woolwich (London) Council have accepted the tender of Callender's Co. for high-tension cable at £8,493.

BUSINESS NOTICES.

We understand that Mr. Carter, late managing director of the Cross Electrical Mfg. Co. (now in voluntary liquidation) has joined the staff of E. P. Allam & Co., 11, Hatton-garden, London, E.C. Messrs. Allam have purchased the bulk of the stock and plant of the Cross Co., and to deal with this increase in their business will remove their offices and works to 11, Red Lion-street, Clerkenwell-road, London, E.C., as soon as the necessary alterations are completed

Messrs. Shippey Brothers, 13 and 14, King-street, Cheapside, London, E.C., notify us that they have been appointed sole agents for the sale of the Gordon battery, of which various sizes will be stocked. A catalogue is available.

After the 23rd inst. the general offices of the Great Northern & City Railway Co. will be removed to 3, Highbury-place, N. Telephone, 853 North.

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against B. G. Hodges, electrical engineer, 20 and 21, St. Luke's-street, and 23, Crown-street, Derby, by 23rd inst., to Mr. D. Sibbald, 23, St. James's-street, Derby.

The estate of John Hill, electrical engineer, Glasgow, has been sequestrated.

W. H. L. Watson and G. Huntington, electricians, 83, Battersea-rise, S.W., and Dering-street, Bond-street, W., London, have been adjudicated bankrupt.

A meeting will be held on Jan. 18, at Boardman's-lane, Parr, St. Helens, to receive an account of the winding-up of the Electro-Chemical Co. (1900) (Ltd.)

The first meetings of creditors and contributories of the Sir Hiram Maxim Electrical & Engineering Co. (Ltd.) will take place on 21st inst., at the Holborn Restaurant, London, W.C.

Electric Fittings for Sale.—Messrs. J. G. Statter & Co., Cornwall-buildings, Birmingham, are offering for sale a large stock of Admiralty, Post Office and other standard pattern lampholders, ceiling roses, tumbler switches, &c., all suitable for 220-volt circuits. See advertisement.

Business for Sale.—Messrs. William Rock & Son, 25, Lord-street, Liverpool, have for sale a small electrical manufacturing business. See advertisement.

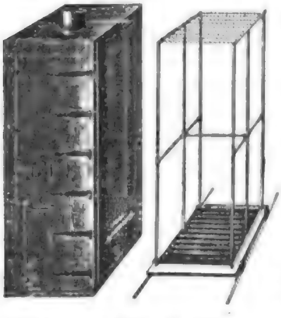
Electrical Exhibition.—The Metropolitan Electric Supply Co. are organising an exhibition of electrical appliances for lighting, power, heating, &c., to be held at Paddington Public Baths, Queen's-road, Bayswater, London, from March 27 to April 1, 1905, and intending exhibitors are invited to communicate with the company. Some further information is given in an advertisement elsewhere.

Engineers' Stores.—At the recent Smithfield Club Show there were few exhibits of special interest to our readers, but we may mention the display of Messrs. W. H. Willcox & Co., of Southwark-street, London, S.E., who make a special feature of cylinder oils, injectors and ejectors, water lifters, and other specialities for use with traction engines, road locomotives, and all classes of fixed and portable engines and boilers. The firm also exhibited a great variety of patent wire-bound hose for traction-engine work, and a large assortment of rotary and semi-rotary pumps, together with an infinite variety of general engineers' stores, tools, belting, &c. To their branch of general engineering supplies Messrs. Willcox & Co. are paying increased attention, and the number of articles of this class now listed by the firm is of a very varied character to meet the larger requirements of the engineering industry.

A Fault-Localising Bridge.—With regard to the brief description of Mr. Trubie Moore's bridge published in our last issue, Mr. Moore writes us that he has found it possible to locate a fault within 0·4 per cent., and that it is quite possible to balance the bridge in less than one minute.

New Terminal.—We have received from Ross, Courtney & Co. a sample box of terminals designed for use with wires affixed to binding screws or under nuts. Wires which have to be frequently fixed to and removed from terminals soon break, and there is always the danger of an imperfect contact. This terminal obviates these difficulties in an ingenious manner. A small brass disc, having its edge cut radially and turned up all round, receives the end of the wire, and a washer is then placed on the top of the latter. The edge of the disc is then turned down over the washer and the binding screw inserted through a hole in the bottom of the disc.

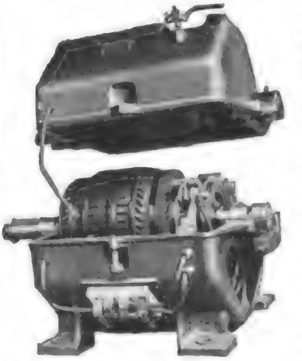
Japanning Stoves.—Mr. E. Gibbs, of 13A, Edgbaston-street, Birmingham, has issued a new list of japanning stoves, the point of special interest in these stoves for electricians being a special long stove and carrier for japanning conduit tubes. The illustration shows a conduit-tube blacking stove and carrier for tubes 10ft. to 12ft. long, the carrier holding 250 tubes. Everyone is familiar with the japanned conduit tubes, but not with the way these tubes are japanned. It is, of course, necessary that the tubes should be well coated both inside and out, and yet be put on the market at a low price. The illustration of stove and carrier shows how this work is expeditiously done. The tubes are dipped into a vat of japan, stood up on end on the carrier to drain, and the carrier is then run upon rails into the japanning stove, where the heat is brought up to 380°F. for 1½ hours. A second carrier is loaded and drained, and the work of drying proceeds. By this simple method a competent workman can japan 20,000ft. of tubes per day.



Japanning Stove and Carrier.

Catalogues, &c.—Messrs. Dick, Kerr & Co., have forwarded two publications containing general technical descriptions of their standard continuous-current and alternating-current dynamos respectively. These particulars are very artistically got up, and include a number of fine illustrations from photographs. The continuous-current generator book is a revised issue of a former edition. After a brief historical introduction, the process of manufacture and the component parts of the well-known "Preston" generator are described. A short chapter at the end of the book relates to the method of testing adopted by Messrs. Dick, Kerr & Co. The second book, which is new, deals with alternators, motor-generators and rotary converters. It is on similar lines to the continuous-current book, and will be appreciated by the profession to the same extent.

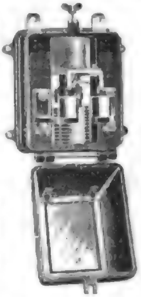
The Electrical Company, 121 to 125, Charing Cross-road, London, W.C., are issuing two pamphlets, which contain much technical and commercial data with regard to their continuous-current series-wound motors for intermittent service (type W.D.) These motors are especially suited for rolling mills, turn-tables, capstans and cranes, but may be used for many other applications which are enumerated in the pamphlet. The motors are supplied either with or without a reduction gear, to suit particular cases. All W.D. motor cases are divided horizontally in line with the shaft. The lower half is provided with cast motor feet, and carries the oil wells for ring lubrication and the terminal block. Openings with easily removable covers are provided to permit of an inspection of the commutators while the motor is in operation, and to afford a ready access for adjusting or exchanging the brushes These motors are fitted with ring bearings. The oil rings may be observed through an opening on the upper part of the bearing; but this is not intended for filling the oil wells. The openings specially provided for this purpose are so arranged that the oil will flow out when the wells have been filled to the proper level, in this way preventing the oil from flowing into the motor housing. Carbon brushes are used throughout. Intending purchasers and users of these motors will find in the pamphlets many valuable hints regarding the choice and treatment of motors to suit given cases, and tables give complete information with regard to dimensions, weight, speed, torque, prices, &c.



Electrical Co's Totally-Enclosed Continuous-Current Motor, W.D. Type.

The Electrical Co. have also ready a new list of switches, describing and illustrating Tumbler and Royal switches.

Ernest F. Moy (Ltd.) issue a list dealing with automatic battery switches, an example of which is shown in the illustration. This switch automatically closes the circuit when the E.M.F. of the dynamo exceeds that of the cells, and opens in the event of the charging volts falling below the battery volts. As shown, it has only two terminals, which can be utilised for back or front connections.



The Moy Automatic Battery Switch.

Lessing dry batteries and other goods are listed in a set of illustrated sheets issued by Messrs. Krupka & Jacoby, 61-62, Watling street, London, E.C.

The Dominion Belting and Mill Furnishing Co., 12, Colonial-avenue, Minories, London, E.C., have prepared for publication a pamphlet relating to their improved woven belting, to which the attention of electrical and general engineers is directed. Among the company's manufactures, besides belting fire hose may be mentioned.

"Cyclone" engines are described in a new pamphlet issued by Matthews & Yates, Swinton, Manchester.

The American Lava Co., of Chattanooga, Tenn., U.S.A., have prepared a pamphlet describing the use of lava in electrical and mechanical work. It is claimed for this material that, being baked at a temperature of 2,000 F. it is unaffected by any subsequent temperature short of that heat, and, for this reason, is valuable when employed in the construction of arc lamps, rheostats, electric heating apparatus, &c. In the construction of instruments requiring a fixed relation of their parts under all conditions the company claim that lava is of great value as its coefficient of expansion with temperature is negligibly small. The pamphlet illustrates a variety of articles manufactured of this material.

A pamphlet dealing with air compressors and vacuum pumps is issued by the Clayton Air Compressor Works, Liberty-street, New York. Numerous illustrations of this class of machine are included in the list.

Calendars, Diaries, &c.—The Direct United States Cable Co., of Winchester House, Old Broad-street, London, E.C., publish a handy hanging or standing desk calendar, which has the merit of being compact and provides room for daily memoranda.

From Messrs. G. Street & Co., 30, Cornhill, London, E.C., we have to acknowledge the receipt of the usual well-printed framed and glazed calendar for 1905. Copies of this calendar have reached us with unerring regularity for many years, and a place is always found for it.

Petrol Motor Car for Railways.—To meet the exigencies of intermittent traffic on short branch lines of railway, for which it has been found steam traction is too costly, some railways have been carrying out experiments with steam automobiles, others have adopted petrol cars, and in one case a combined petrol and electric has been employed. But there are certain conditions which the automobile cannot meet. It is essential that such a vehicle should deal with traffic under periods of abnormal demand, and yet be capable of economical operation when traffic is light. To meet this particular condition, the Great Northern Railway Co. have during the past four months been carrying out some interesting experiments with a petrol car. This car possesses certain features which constitute it a distinct advance in this type of vehicle. The car has been specially designed by Messrs. Dick, Kerr & Co. The principle of applying two electric motors to a tramcar has been copied by the employment of two petrol engines. In all probability the car will be utilised on one of the branch lines running from Hatfield. Its seating capacity is 32 passengers. The whole of the machinery is assembled upon a frame, which is directly supported from the axles, so that even while standing at "rest" the noise and vibration from the engines is imperceptible to the passengers. The engines are not connected independently to the axles, although both axles are driven, but in normal circumstances they drive on to a common longitudinal shaft, which is connected to the axles by bevelled gearing. To overcome the difficulty of one axle over-running the other, owing to any possible inequality in the diameter of the wheels, a special form of differential gear is introduced, and combined with this special gear is the reversing mechanism. The engines are connected through independent clutches to a common change speed box, from which the power is transmitted, by means of the longitudinal driving shaft referred to above, into gear boxes suspended on each axle, and at this point the engine speed is reduced as required on the axles by means of single reduction gearing, very similar to that used in electric tramway motors. Standard Daimler type engines are employed, each capable of developing 36 H.P. when running at full speed. The complete car weighs something under 16 tons, including its full complement of passengers, and although the normal speed for which it is designed is 30 miles per hour, it has on several occasions attained a speed of over 50 miles. It is lighted by electricity from storage batteries, which also supply current for the ignition and magnetic clutches. The patents covering the arrangement are entirely controlled by Messrs. Dick, Kerr & Co. The design of the car and its experimental operation have been under the personal supervision of Mr. Oliver Bury, general manager of the Great Northern Railway Co.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Dec. 7 to 13, with the ports of destination :—

Africa—Alexandria, £408; Cape Town, £528 (including £270 telegraph material); Durban, £3,379 (including £981 telegraph material); East London, £96; Port Elizabeth, £709 (including £51 telegraph material); *Argentina*—Buenos Ayres, £244. *Australasia*—Adelaide, £15; Auckland, £299; Brisbane, £690; Fremantle, £785; Hobart, £553; Launceston, £370; Melbourne, £147; Otago, £267; Perth, £2,781; Sydney, £8,574; Wellington, £896 (including £179 telegraph material). *Belgium*—Ostend, £97. *Brazil*—Bahia, £10,311 (submarine cable). *British Guiana*—Berbice, £8; Demerara, £36. *Canary Islands*, £20. *China*—Shanghai, £394. *Denmark*—Copenhagen, £30. *France*—Le Treport, £45; Marseilles, £15 (telegraph instruments). *Germany*—Bremen, £1,138 (including £1,125 (telegraph material); Hamburg, £445 (telegraph material). *Gibraltar*, £394. *Holland*—Amsterdam, £703; Flushing, £44. *Hong Kong*, £594. *India*—Bombay, £737; Calcutta, £888 (including £407 telegraph material). *Japan*—Tokyo, £8,130. *Java*—Batavia, £8,440 (submarine cable). *Malta*, £51 (telegraph material). *North Atlantic*, £19,680 (submarine cable). *Norway*—Christiania, £38. *Russia*—Odessa, £70 (telegraph instruments). *Spain*—Bilbao, £50. *Straits Settlements*—Singapore, £969. *Sweden*—Stockholm, £69 (telegraph material). Total, £74,137, against £10,190 in the corresponding week last year (Dec. 9 to 15).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

November 8, 1904.

24,101 A. D. Barty. Prescot. Automatic machinery for winding wires, cables, &c.

24,102 Phœnix Dynamo Mfg. Co., W. Oelschläger and F. Haddock. Mountings and connections for conductors, especially for collecting brushes.*

24,138 W. T. le Feuore and F. A. Greene. Cable junction disconnecting fuse boxes.

24,142 G. E. Johnson. Interrupters for high frequency currents.*

24,165 J. W. Griffin. Automatic fire alarms.*

24,166 F. Mouterde. Accumulators.

24,177 and 24,178. J. Y. Johnson (A. Wolf, Jun., & Co., Germany). Thermo-electric batteries.

24,180 B.T.-H. Co. (G.E. Co., U.S). Protective devices for electric transmission systems.

24,181 B.T.-H. Co. (G.E. Co., U.S.). Systems of electric distribution.

24,187 C. W. Maunsell and F. R. Butt. X-ray shield.

24,190 V. A. Fynn. Alternating-current motors, also relating to generators and direct-current machines.

24,192 S. G. Brown. Telegraphy.

24,200 P. L. Clark. Switches.*

November 9, 1904.

24,225 E. Nicholson. Carlisle. Wheel guards and obstruction removers for electric vehicles.

24,267 G. R. Hingelberg, D. G. Jones and F. L. Berry. Sheffield. Electro-mechanical typewriters.

24,276 V. A. Fynn. Alternating-current motors.

24,286 S. O. Cowper-Coles. Anodes.

November 10, 1904.

24,310 G. Wilkinson. Harrogate. Lighting by Nernst lamps.

24,316 A. Eckstein and A. E. Angold. Manchester. Arc lamps.

24,323 J. Birkbeck. Bradford. Electric traction.

24,341 O. D. Lucas. Switches.

24,342 F. J. Green. Carbons for arc lamps.

24,343 J. Heinemann. Electric signs.*

24,351 M. Walker. Dynamos and other rotary electric machines.

24,353 G. D. Mantle. Carbon-feeding mechanism for arc lamps.

24,369 F. Brandt. Arrangement of electric emergency lamps in buildings.*

24,384 J. S. D. MacCormac and Dental Mfg. Co. Combined mouth gag and electric light.

24,388 B.T.-H. Co. (G.E. Co., U.S). Circuit brakes.

24,389 B.T.-H. Co. (G.E. Co. U.S.). Controlling devices for electric motors.

24,390 O. Erlande. Insulators for live rails.

November 11, 1904.

24,399 P. Schiemann. Glasgow. Electric tools.*

24,423 Chamberlain & Hookham and S. H. Holden. Birmingham. Electricity meters.

24,429 W. Aitken. Liverpool. Telephone systems.

24,432 B. Bonniksen. Coventry. Electro-mechanical synchronisation apparatus.

24,448 J. Kloppenstein. Multiple filament incandescent lamp.

24,464 A. F. Hills, D. Urquhart and A. E. Honey. Field windings of series-wound dynamo-electric machinery.

24,466 S. O. Cowper-Coles. Electrical conductors.

24,470 P. C. Hewitt. Electric, gas or vapour apparatus. (Date applied for, Nov. 24, 1903, date of application in U.S.)*

24,477 F. M. Lewis, G. W. L. Case and Reason Mfg. Co. Arc lamps.

24,485 B.T.-H. Co. (G.E. Co., U.S.). Electricity meters.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1904.

12,097 Akt. Ges. Brown, Boveri & Cie. Regulating apparatus for automatically maintaining electric accumulator charging currents constant.

12,643 Mégroz. Control of continuous current for electric motors for electric traction. (Date applied for June 4, 1903.)

14,526 Barrett. Electric-motor controllers.

15,382 Birnbaum and White. Sub-station connecting arrangement for telephone systems.

15,952 Behn. Electrode for accumulators. (Date applied for July 18, 1903.)

16,581 Bouchet. Electrical binding screws. (Date applied for, Feb. 15, 1904.)

17,046 Marshall. Electric traction for railways and tramways.

17,243 Keith. Fenders for electric and other vehicles.

17,600 Baumer. Relays.

18,021 Kitsee. Insulating conductors.

18,098 Dymond (Ges. fur drahtlose Telegraphie, m.b.H.). Wireless telegraphy.

COMPANIES' MEETINGS AND REPORTS.

BRITISH THOMSON-HOUSTON CO. (LTD.)—At the ninth ordinary general meeting of this company, held yesterday, the chairman (Mr. W. A. McArthur, M.P.) moved the adoption of the following report of the directors for the year ended March 31:—

The additions to the factory and office buildings at Rugby have been completed and the number of hands employed, excluding the office staff, amounted at March 31 to 1,704 and has since increased. The electrification of certain local lines of the North-Eastern Railway in the Newcastle district has been completed and is in satisfactory operation. During the period under review the company secured contracts for the electric equipment of the trains of the Underground Electric Railways Co. of London, the system of control being the multiple-unit system, similar to that of the Central London, the Great Northern & City and the North-Eastern Railways, with satisfactory results. The manufacture of the Curtis steam turbines has progressed satisfactorily, and those machines in operation are giving excellent results. The directors believe that the company has good value in the lighting and traction enterprises in which it has investments. The usual practice has been followed in providing for depreciations of buildings and plant, patents and stock in hand, besides making reserves sufficient to cover risks in connection with bad debts, depreciation of shares held by the company and other contingencies. The profits, after deducting general and technical expenses, discounts and interest, amount to £55,713. 8s. 1d. The excess costs of manufacture incidental to the establishment of the manufacturing business of the company to date amount to £63,326. 15s. 6d., of which £20,000 is now written off, and further amounts will be written off until finally disposed of.

The report and statement of accounts were taken as read, and the chairman said the directors had, as usual in their treatment of the accounts, adopted a fairly drastic method of valuation, and the figures in these accounts were a fair representation of the actual values of the properties which they represented. The period of development was happily nearly past, and they would soon be entering upon what he hoped would be a long and profitable career. The report and accounts were adopted.

INDIA RUBBER, GUTTA PERCHA & TELEGRAPH WORKS CO. (LTD.)—The directors' report for the year ended Sept. 30, to be presented at the meeting of shareholders at the company's offices, 106, Cannon-street, London, E.C., on Dec. 20, at 12 noon, states that after provision for doubtful debts, there is a net profit of £11,343. 19s. 3d. Adding £66,930. 7s. 10d. brought forward, and deducting £12,500 interim dividend paid in June, there is a disposable balance of £65,774. 7s. 1d. The directors recommend the distribution of a dividend of 5s. a share, tax free (requiring £12,500) making a total of 5 per cent. for the year, and leaving £53,274. 7s. 1d. to be carried forward. The general business of the company shows an increase when compared with last year, but, unfortunately, the sales have been made on a rapidly rising market for raw material, and the selling prices of manufactured goods have not proportionately increased. Moreover, the revenue for the year has been charged with amounts expended on the development of a new business which has not yet reached a remunerative stage. These two causes account for the serious falling off in revenue, but the directors think that the revenue for the current year will not be injuriously affected to a like extent. The cable steamers "Dacia" and "Buccaneer" have been employed in cable repairing work during the year, and both vessels are at present under charter. The works at Silvertown and Persan have been maintained in their usual state of efficiency, and extensions continue to be made. In April last the directors made an issue of £100,000 second debentures.

ISLE OF THANET ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—In moving the adoption of the report at the meeting on Wednesday, the chairman (Lord A. Butler) said that examination of the traffic statement disclosed the fact that, although they carried a much larger number of people, a considerable number of these were short-distance passengers. The passengers carried numbered 4,673,611. In the electric lighting department the income had increased from £904 in 1903 to £2,201. There was a steady growth in the demand for electricity for private lighting, particularly at Margate, and as the directors had lately introduced a lower rate for current, it was hoped that the consumption would be increased.

LANCASHIRE POWER CONSTRUCTION CO. (LTD.)—The report to Sept. 30 states that £90,000 remains to be called up on A shares, and £116,000 of B shares to be issued. The directors anticipate that further calls on A shares will require to be made and the B shares to be issued (to contractors) during the next few months. Satisfactory progress has been made with the construction of the power station at Radcliffe, which is likely to be ready early in 1905. Negotiations are proceeding with a number of local authorities for giving a supply in their respective districts, and an agreement has already been entered into with Swinton and Pendlebury. A report of the progress of the works by the company's joint consulting engineers (Mr. H. F. Parshall and Messrs. Lacey, Sillar & Leigh) accompanies the report and is, in abstract, as follows:—

Considerable difficulty was experienced in obtaining satisfactory foundations for the buildings, and that somewhat delayed progress in the early stages of the work. The difficulty has been overcome, and the only work remaining to be done is of a nature which is dependent upon the delivery of the generating plant. The whole of the plant is either erected or in course of delivery, with the exception of the four main generating sets. It is anticipated that the first of these generating sets will be ready for delivery during February, and by this time the whole of the other work on the power station will be finished, and all that will remain to be done will be to erect and connect up this generating set, so that there is every prospect of its being ready for service some time in April. So far as the works have progressed the expenditure has been well within the estimate contained in our report of Feb. 17, 1903, and there will be a substantial saving on this part of the contract. Orders have been placed with Callender's Co. for nearly 10 miles of cable, to serve the districts of Kearsley, Clifton and Pendlebury. A second cable will serve the districts of Bury, Tottington, Ramsbottom and Haslingden. We have had under consideration the design of the several types of sub-stations needed to meet the requirements of the different local authorities, and this matter is now so far advanced that the company will be in a position to order the necessary sub-station plant immediately agreements are concluded. With reference to cost of distribution, we are glad to be able to report that the demand for power so far has been in such form as is most advantageous to the company, both as regards capital cost and working expenses.

SOUTH STAFFORDSHIRE TRAMWAYS CO.—At the meeting on Wednesday the chairman (Mr. W. S. L. Schuster) said that for the last 10 years they had had a difficult task. They had been in conflict with various bodies, but he was glad to say they had come to a settlement with the lessee company. The offer made by the latter had been accepted by a majority of the proprietors.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—On Friday a resolution was passed authorising the directors to raise £60,000 additional debenture stock. At present the company are under contract to supply 10,400 H.P., are in negotiation for an additional 11,700 H.P., and have inquiries for 23,000 H.P. In Cwmbran area the company are extending their mains to Abersychan, Crumlin and Risca, and in the Pontypridd area to Caerphilly, Aber, Senghenydd and Mardy.

W. R. SYKES' INTER-LOCKING SIGNAL CO. (LTD.)—At the meeting on Friday the chairman (Major-Gen. Hutchinson) said that new workshops had been erected out of revenue. The orders received during the year were greater in number and in value than those of the previous year, and if the cost of the works extensions had not been debited to revenue it would have been possible to increase the dividend beyond 6 per cent. The signalling installation at St. Enoch's Station, Glasgow, had proved successful and had been the means of bringing in large orders from Scotland. Russia was the only European country which had given them an order.

NEW COMPANIES, STATUTORY RETURNS.

NEW COMPANIES.

MARLBOROUGH ELECTRIC SUPPLY CO. (LTD.) (82,810.)—Reg. Dec. 8, capital £1,000 in £1 shares, to carry on the business of suppliers of electric light and power, electrical engineers, electricians, contractors, tramway and railway proprietors, &c., and to enter into an agreement with Bristol Trust (Ltd.).

MORS LIMITED. (82,811.)—Reg. on Dec. 8, capital £15,000 in £1 shares, to acquire English patents relating to motor cars of the Société Anonyme d'Electricité et d'Automobiles Mors, or others, to manufacture and sell in United Kingdom and British colonies and dependencies motor boats and accessories in accordance with such patents, to deal in motor cars and accessories made by the Compagnie Française des Voitures Electromobiles, and to carry on the business of garage proprietors, motor car and vehicle manufacturers, agents and merchants, electrical and general engineers, &c. First directors L. Carle (ch.), P. Singer (man. dir.), G. de Wilde, L. Haarbleicher, F. Kerr, L. Auscher, M. Drummond and C. Banbury. Reg. office, 55-9, Shaftesbury-avenue, London, W.C.

STATUTORY RETURNS.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—Return to Aug. 31 gives capital as £135,250 in 62,000 preference, 33,250 ordinary and 40,000 undenoted shares of £1 each, of which 62,000 preference and 33,250 ordinary shares have been taken up. £1 per share has been called up on 48,750 preference and 16,250 ordinary, and £65,000 has been received. £30,250 is considered as paid on 13,250 preference and 17,000 ordinary. Mortgages and charges, £20,090.

EDISON & SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—The return to Oct. 31 gives the capital of the company as £941,090 in 150,000 A shares of £5 each, 26,436 B shares of £5 each and 23,564 B shares of £2. 10s. each, of which 89,261 A, 17,139 £5 B and 23,564 £2. 10s. B shares had been taken up. 10s. per share has been called up on 89,261 A shares and £44,630 10s. has been paid. £3 per share is considered as paid on 10,000 and £2. 10s. per share on 89,261 A shares, and all the B shares are issued as fully paid, making £397,757. 10s. considered as paid. Mortgages and charges, £143,023.

MATHER & PLATT (LTD.)—In return to Sept. 7 the capital is £1,000,000 in 50,000 preference and 50,000 ordinary shares of £10 each, of which 40,000 preference and 40,000 ordinary have been taken up. £10 per share has been called up on 29,200 preference and 2,500 ordinary, and £317,000 has been received. £483,000 is considered as paid on 10,800 preference and 37,500 ordinary. Mortgages and charges, nil.

HENDERSON'S TRANSVAAL ESTATES (LTD.)—In the directors' report it is stated that the Delagoa Bay Development Corpn., in which the company was interested, had opened for traffic their electric tramway system in Lourenço Marques.

CITY NOTES.

MEMORANDA (Dec. 15).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 27¹³⁄₁₆d. per oz. Consols 87⅞—88 for money, 88—88⅛ for account; 2½ per cent. annuities 87¼—88¼. Consols Pay Day, Jan. 5. Stocks and Shares Continuation Days, Dec. 28 and Jan. 11; Ticket Day, Dec. 29; Pay Day, Dec. 30; Mining Share Carry-over Days, Dec. 27 and Jan. 10.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—The coupons on this company's 4 per cent. mortgage debentures to bearer, due Jan. 1, will be paid on Jan. 2 at Parr's Bank, Bartholomew-lane, London, E.C. Interest warrants will be sent out on Dec. 31. The debenture register will be closed from 27th to 31st inst. inclusive.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—The transfer books and register of holders of debenture stock will be closed from 19th to 31st inst. inclusive, preparatory to payment of interest due Jan. 1.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The transfer books and register of holders of the 5 per cent. first and 4½ per cent. second debenture stock will be closed from 17th to 31st inst. inclusive.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The transfer books and register of holders of first debenture stock will be closed from 19th to 31st inst. inclusive, preparatory to payment of interest due Jan. 1.

EASTERN TELEGRAPH CO. (LTD.)—Payment will be made on Jan. 15 of dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock of this company for the quarter ending 31st inst., and an interim dividend of 1¼ per cent. on the ordinary stock, tax free, in respect of profits for the quarter ended Sept. 30, 1904. The transfer books of the ordinary stock will be closed from Jan. 7 to 14 inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO (LTD.)—The directors have declared an interim dividend for the quarter ended Sept. 30 of 2s. 6d. per share, tax free, payable Jan. 14. The share register will be closed from Jan. 6 to Jan. 13 inclusive.

PROVINCIAL TRAMWAYS CO. (LTD.)—The directors recommend a final dividend of 3s. on the ordinary shares, making 6s. per share for year ended Sept. 30, placing £7,000 to depreciation and carrying forward £3,400. The net revenue for the year was £26,359.

RAWORTH'S TRACTION PATENTS (LTD.)—An abridged prospectus of this company, which has been formed with a capital of £30,000, divided equally into preferred ordinary and deferred ordinary shares of £1 each, will be found set out on another page. Subscriptions are invited for the 15,000 preferred shares, payable 2s. 6d. per share on application, 7s. 6d. on allotment, and the balance as required. These preferred shares are entitled to a fixed cumulative dividend of 6 per cent. per annum, and, after a like dividend in any one year has been paid on the deferred shares, will participate in any surplus profits. Both the preferred and deferred shares rank pari passu as regards capital. The company has been formed to acquire the British patents granted to Mr. John S. Raworth for a system of automatic regenerative control of electrically-propelled vehicles, and for a patented "one-man" car. Our readers are acquainted with the principles of these inventions and with their merits and utility in electric tramway working, and from the favourable reception which both patents have received from the technical press it may be said that the public are offered an unusually favourable opportunity to take a share in a promising enterprise. The price which Raworth's Traction Patents (Ltd.) will pay to the vendor for the patents is £18,600, of which £3,600 is in cash and the balance represents the 15,000 deferred ordinary shares, fully paid up, which will receive no dividend until the ordinary shareholders have first been satisfied. For this purchase money the vendor transfers to the company all uncompleted orders as from Oct. 1 last, and receives as part of the purchase money £100 for the goodwill of the business up to that date. Eight British patents in all are acquired by the company, dated 1903 and 1904. It is stated that the work of the company will include the conversion of existing tramway cars to regenerative control and granting licences to electrical manufacturing companies for the manufacture of the company's patented system. The regenerative control system acquired by the company is also applicable to electric railway trains and to electric vehicles. The prospectus states that 15 tramway cars are already in active service equipped with this regenerative control system, and that the equipments for 65 further cars are on order. Some of these are repeat orders. Mr. Raworth acts as managing director of the company for the present, and his co-directors are all prominent men in the electrical industry, and engaged in practical electrical work. It will be seen from the prospectus that no part of the capital is underwritten, there being no intermediate profit, and nothing is being paid for financial assistance in the exploitation of Raworth's Traction Patents (Ltd.). It may, perhaps, be added that Mr. Raworth has endeavoured, in connection with the patents acquired by the new company, to express his view of the manner in which patents should be treated when they are handed over to a joint stock enterprise—the patentee receives a good share of the business without making any undue profit out of his shareholders.

We may add that since the issue of the prospectus new installations of regenerative control have been made at Birmingham, Bournemouth and Havre, in each case with a pattern of motor which has not previously been tried—*i.e.*, a Brush 1,002 B motor and a Westinghouse 49 B and and G.E. 1,000. We learn, further, that an order has also been received to fit up a car for the Corporation of West Ham.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Dec. 21 a special settling day in and have ordered to be quoted a further issue of 20,000 ordinary £5 shares (£3 paid) of the *Calcutta Electric Supply Corpn. (Ltd.)* The committee have been asked to grant quotations to £200,000 4½ per cent. redeemable debenture stock of the *Birmingham & Midland Tramways (Ltd.)* and a further issue of £85,100 5 per cent. redeemable first mortgage debenture stock of the *Auckland Electric Tramways Co. (Ltd.)*

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Dec. 10	1,036	− 44	26	40,634	+ 5,728
Airdrie	,, 2	169	...	48	8,458	...
Ayr Corporation	,, 11	165	− 4	30	11,296	+ 499
Barnsley	,, 2	147	− 5	48	8,114	− 555
Barrow	,, 2	180	...	43	8,514	...
Bath Electric Trams, Ltd.	,, 7	530	...	49	31,197	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 11	989	− 86	...	...	...
Birmingham Corporation	,, 10	325	...	36	14,784	...
Birmingham Tramways Co.	,, 10	6,064	+ 110	28	124,196	+ 5,749
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 8	278	+ 81	26	42,837	+ 5,961
Blackpool and Fleetwood	,, 10	157	− 2	28	20,783	+ 868
Blackp'l, St. Anne's & Lytham	,, 8	128	− 7	¶15	790	145
Bolton Corporation	,, 11	1,026	− 34	37	64,296	+ 498
Bournemouth Corporation	,, 7	762	− 8	‡36	41,540	+ 2,035
Bradford Corporation	,, 10	3,595	+ 384	34	165,733	+ 26,717
Brighton Corporation	,, 11	719	− 2	36	37,487	+ 3,250
Brisbane Tramways	...	...	...	...	...	...
Bristol Trams & Carriage	,, 9	4,634	+ 225	18	149,119	+ 1,570
Buenos Ayres & Belgrano	...	...	...	...	...	...
Burnley Corporation	,, 10	943	+ 196	10	10,124	+ 2,161
Burton Corporation	...	...	...	...	...	...
Calcutta Tramways Co.	,, 10	a13,100	+ a7,468	24	a569,720	+ a94,765
Camborne-Redruth	,, 11	94	− 93	6	636	− 211
Cardiff Corporation	,, 10	1,871	+ 56	36	74,644	− 1,556
Carlisle Tramways Co.	,, 10	166	− 8	49	9,671	+ 210
Central London Railway	,, 10	7,030	+ 46	24	146,183	− 154
Chatham & Dist. Lt. Rys.	,, 8	473	− 15	49	26,518	+ 2,107
City & South London Rly.	,, 11	3,312	− 146	24	62,335	− 2,306
Colchester Corporation	,, 8	152	...	19	5,047	...
Cork Electric Trams Co.	,, 8	431	+ 46	49	22,948	− 2,416
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 2	415	− 5	48	23,517	+ 3,258
Dover Corporation	,, 10	171	− 4	37	8,461	− 190
Dublin & Lucan Railway	,, 9	100	+ 16	23	2,924	− 16
Dublin Southern District	,, 9	818	+ 59	23	117,916	− 2,479
Dublin United	,, 9	3,686	+ 198			
Dudley—Stourbridge	,, 2	707	− 26	48	41,695	+ 1,343
Dundee Corporation	,, 7	808	+ 40	¶33	24,512	+ 69
East Ham Council	,, 10	584	+ 20	36	26,431	− 1,445
Gateshead & Dist. Trams	,, 2	687	+ 3	48	43,705	+ 1,456
Glasgow Corporation	,, 10	13,419	− 164	†28	349,161	+ 20,115
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 2	165	− 23	48	12,065	+ 400
Gt. Northern & City Rly.	,, 10	1,842	...	48	64,543	...
Greenock & Port Glasgow	,, 2	465	+ 27	48	27,744	+ 1,898
*Halifax Corporation	...	...	—	...	...	...
Hartlepool Tramways	,, 2	236	+ 2	48	14,105	+ 1,041
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 10	2,497	+ 214	36	79,606	+ 10,303
Ilford District Council	,, 10	840	+ 27	¶36	16,923	+ 719
Ilkeston Corporation	,, 7	93	− 17	10	1,170	− 161
Ipswich Corporation	,, 10	314	+ 145	36	17,965	...
Isle of Thanet Co.	,, 10	101	− 12	10	3,273	− 146
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	,, 9	88	− 11	49	6,136	+ 6
Kirkcaldy Corporation	,, 7	196	+ 6	49	11,116	...
Lanarkshire Trams Co.	,, 8	608	+ 75	49	31,967	+ 19,181
Leeds Corporation	,, 10	5,180	+ 141	37	215,047	+ 123,497
Leicester Corporation	,, 10	1,089	...	30	44,186	...
Liverpool Corporation	,, 8	9,691	+ 374	49	476,570	+ 14,036
Liverpool Overhead Rly.	,, 11	1,344	− 129	†44	57,770	− 2,091
London County Council	,, 3	11,576	+ 2,604	‡35	452,626	+ 97,564
*Lowestoft	,, 10	183	− 1	...	...	...
Maidstone Corporation	,, 8	67	...	21	3,181	...
Manchester Corporation	,, 10	11,400	+ 663	16	414,785	+ 18,944
Mersey Railway	,, 10	1,535	+ 181	18	34,065	+ 3,072
Merthyr	,, 2	167	− 15	48	9,652	+ 40
Metropolitan Elec. Trams	,, 9	1,877	+ 901	23	43,011	+ 12,409
Middleton	,, 2	238	− 12	48	15,606	+ 385
Nelson Corporation	,, 10	102	+ 8	37	4,006	+ 1,284
Newcastle-on-Tyne Corp.	,, 10	3,431	− 9	23	84,634	+ 3,549
Newport (Mon.)	,, 10	498	+ 70	10	4,963	+ 493
Oldham, Ashton & Hyde	,, 2	445	− 49	48	26,806	− 1,109
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams.	,, 9	1,451	+ 81	‡49	68,918	+ 6,808
Peterborough	,, 2	98	− 7	48	7,193	− 340
Poole and District	,, 2	194	− 5	48	14,625	+ 36
Portsmouth Corporation	,, 10	1,333	+ 46	§36	73,016	+ 5,739
Potteries	,, 2	1,032	− 17	48	82,601	+ 5,926
Reading Corporation	,, 8	543	+ 55	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 2	32	− 1	48	6,834	− 6
Salford Corporation	,, 12	3,719	+ 8	26	109,654	+ 7,877
Sheerness	Nov. 30	48	+ 2	48	3,085	− 475
Sheffield Corporation	Dec. 11	4,874	+ 191	§37	178,425	+ 3,566
Southampton Corp'ation	,, 8	805	− 55	36	36,015	− 2,387
Southend Corporation	,, 7	107	+ 25	36	13,761	+ 1,883
Southport Tramways	,, 2	281	− 14	48	15,577	+ 448
S. Staffordshire Trams.	,, 2	619	− 331	48	16,760	− 7,853
Stockport Corporation	,, 9	404	+ 56	36	10,996	+ 7,969
Sunderland Corporation	,, 11	1,063	+ 70	36	46,149	+ 1,644
Swansea Trams	,, 2	444	− 34	48	26,000	− 984
Taunton Trams	,, 2	37	− 6	48	2,014	− 304
Tynemouth and District	,, 2	162	− 18	48	14,064	− 940
Tyneside Trams Co.	,, 7	237	+ 74	49	19,012	+ 3,160
Wallasey District Council	,, 10	640	+ 47	§36	27,767	+ 1,778
Walsall	,, 10	425	...	47	23,553	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 8	1,088	...	41	34,751	...
Weston-super-Mare	Nov. 30	23	− 3	48	6,162	+ 496
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	Dec. 2	231	− 6	48	19,720	− 53
Worcester	,, 2	227	+ 131	48	18,226	+ 6,793
Wrexham	,, 2	83	− 27	48	5,353	− 961
Yorkshire Woollen District	,, 2	463	+ 58	48	27,969	+ 6,224

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Dec. 14	Rate per Cent. Yielded			Dividend Due.	Business, Week to Dec. 14.	
				£	s.	d.		Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.							
5	3/0	Anglo-Argentine Ordinary Shares	7⅛—7⅜	4	0	0	April, Oct	7⅜	7⅛
5	2/6	Do. 5% Cum. Pref.	5⅞—6⅛	4	9	11	—	5⅞	5¾
St.	6%	Do. Permanent 6% Deb. Stock	142—146	4	2	9	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	106—107	4	15	3	—	106¼	106¼
10	6%	Barcelona Tramways Ord.	10¾—11	2	14	6	—	10¾	10¾
10	5/0	Do. 5% Cum. Pref.	1¾—2¼	5	2	6	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	95—97	4	14	9	—	..	..
100	5%	Do. 5 per Cent. Debs.	98—101	4	19	6	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	½—¾	..			..	..	..
1	..	Do. 5% Cum. Pref.	1⅛—1⅜	..			..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..			..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5	17	8	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	96—100	4	11	9	..	98¼	98¼
10	8%	Bristol Tramways and Carriage Ord.	19—20	4	0	0	Feb, Aug	..	—
10	4%	Do. Cum. Pref. (fully paid)	10—10½	3	16	2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107—109	3	13	4	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100—108	5	16	8	—	100½	..
St.	5%	Do. Pref. Ord. Stock	100—103	4	17	2	—	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10¼—[illegible]	4	18	0	—	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102%—104%	4	6	9	..	..	..
100	4½%	Do. Vancouver Power Debs.	98—101	4	11	0	..	100½	..
10	6/0	British Electric Traction Ord.	9¾—10¼	5	17	8	..	10	9¾
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾—11	5	9	1	Feb, Aug	11	10¾
St.	5/0	Do. 5 per Cent. Perpetual Debs	117—119	4	4	3	—	118½	..
St.	4½	Do. 4½ per Cent. 2nd Deb. Stock	95—97	4	12	10	..	96¼	96¼
5	1/6	Buenos Ayres and Belgrano Ord.	2¾—3¼	5	18	0	—	3¼	3¼
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¾—6¼	5	4	4	—	5¾	..
5	3/0	Do. "B"	5¼—5¾	5	11	8	—	5⁵⁄₁₆	..
St.	5%	Do. 5 per Cent. Debs.	106—108	4	13	8	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	103—106	4	15	9	—	—	..
St.	6%	Buenos Ayres Elec. Trams (1901) Ltd. 6% Deb. Stk.	96—99	6	2	6	..	..	..
5	3/0	Calcutta Tramways	7¾—8¼	3	13	11	—	8⅛	7¾
100	4½%	Do. 4½% 1st Deb. Stock (red.)	107—109	4	3	6	—	109	..
1	1/0	Cape Electric Tram Shares	1⅛—1⅜	6	8	0	..	1¼	1¼
St.	4%	Central London Ordinary Stock	91—93	4	6	0	June, Dec	92	91
St.	4%	Do. 4 per Cent. Pref. Stock	101—103	3	17	9	..	101½	101
St.	4%	Do. Deferred Stock	84—86	4	13	6	—	84	..
100	4%	Do. 4 per Cent. Debs.	108—110	3	13	4	—	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4¾—5¼	4	17	6	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	96—101	3	19	3	..	99	..
St.	2½%	City and South London Rly. Con. Ord.	46—47	4	15	2	Feb, Aug	47	46½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122—125	4	0	3	Feb, Aug	..	..
St.	5%	Do. (1896)	117—120	4	3	6	..	..	..
St.	5%	Do. (1901)	116—119	4	4	10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104—107	3	14	9	May, Nov	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	101—104	4	16	8	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13—14	4	5	8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15—16	3	15	0	—	..	..
10	2/0½	Gt. Northern & City Rly. Prf. Ord. (4%)	5½—6	..			—	..	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8½—9½	..			..	..	..
10	10%	‡ Imperial Tramways Ord	19—20	5	0	0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—15½	3	18	4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	110—112	4	0	0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6	5	0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90—93	4	7	3	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3¼—3¾	3	13	8	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10—10½	4	15	3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—101	3	19	3	Jan, July	..	..
10	6/0	London United Trams. 6% Cum. Pref.	10¼—10¾	4	12	0	..	10½	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	103—105	3	17	4	..	104	103½
St.	..	Madras Elec. Trams 5% Deb. Stk.	103—105	..			Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6—9	..			..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10—13	..			—	..	..
1	..	Metropolitan Electric Trams Def	⅛—⅜	..			—	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1	5	0	0	—	..	..
St.	13/7	Do. 4½ Deb. Stock	103—105	..			..	104½	104½
100	5%	Montreal St. Ry. St'g 5% Mrt. Dbs. (1908)	100—103	4	17	3	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103—105	4	5	9	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—1½	..			May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	103—106	4	16	9	..	..	..
10	10/0	Potteries Electric Traction Ord.	8—9	5	11	2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9½—9¾	5	5	3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99—102	4	8	3	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..			..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..			April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..			Jan, July	..	—
St.	3%	Waterloo and City Ord.	88—90	3	7	0	June, Dec	..	..
		ELECTRIC MANUFACTURING, &c.							
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	⅜—⅝	5	14	2	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	½—⅝	..			..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5¾—6¼	6	19	2	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5½—5¾	5	4	4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102—105	4	6	3	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	100—102	4	8	6	—	..	..
5	3/0	British Westinghouse 6% Pref.	2½—2¾	..			—	3	2¾
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	88—90	4	10	3	..	88½	88½
2	..	Brush Electrical Engineering	½—¾	..			March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼—1½	8	0	0	Mar, Sept	1⅜	1⁵⁄₁₆
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	93—96	4	14	6	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	68—72	6	5	9	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	9½—10	5	5	0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4	13	0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104—106	4	6	7	Nov, May	..	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1¼—1½	4	18	9	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	94—96	4	13	4	..	..	..
1	0/9½	Chadburn's (Ship) Telegraph Ord.	1—1¼	8	17	6	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1¾—2	3	16	1	Jan, July	1¾	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	93—96	5	4	5	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	7½—7¾	6	8	8	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	5¼—5¾	5	4	4	Sept	5⅝	5½
St.	4½%	Do. 4½% Deb. Stock	106—108	4	5	1	..	107	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..			Feb, Aug	¾	..
5	..	Do. (£5 paid)	1—1¼	..			Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	79—83	4	17	9	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79—84	6	0	6	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6¼—6¾	5	9	10	H'lf-yearly	6⁵⁄₁₆	6¼
5	3/0	Do. 6 per Cent. Cum. Pref.	6—6¼	4	16	0	—	6⅛	6
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106—108	4	4	8	..	107½	107½
2	1/7½	Electric Construction Co.	1½—1¾	6	8	0	July	1⅝	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2½—2¾	5	12	0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98—100	4	0	6	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90—96	5	5	3	—	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10	5	0	0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91—96	4	3	4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½—11	6	7	3	Feb, Aug	10¾	..
5	2/3	Do. 4½ per Cent. Pref.	4¾—5¼	4	3	9	Feb, Aug	5¼	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	110—112	4	0	10	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	15—16	6	6	0	Feb, Aug	15½	15
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99—102	3	18	5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11½	4	5	10	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	35—40	5	18	6	Mar, July	39	38½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	103—105	3	17	0	Jan, July	..	..
5	—	Willans and Robinson Ord.	1—2	..			Apr, Oct	..	..
5	—	Do. 6 per Cent. Cum. Pref.	2—3	—			Apr, Oct	—	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	74—79	5	1	3	May, Nov	..	—

Share.	Last Dividend	Name.	Price Wed., Dec. 14.	Rate per Cent. Yielded			Dividend Due.	Business, Week to Dec. 14.	
				£	s.	d.		Highest.	Lowest.
		ELECTRICITY SUPPLY.							
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12—13	6	3	1	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9¾—10	4	10	0	..	..	—
10	6/0	Do. 6% Cum. Second Pref.	11—12	5	0	0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104—106	4	5	9	—	..	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5¼—5¾	3	9	7	..	5¼	..
St.	4½%	Do. Do. 1st Debs	101—104	4	7	0	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4	10	11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10¼—10¾	3	5	1	Mar, Sept	..	..
5	3/0	Calcutta Electric Supply Ord.	7¾—8	4	7	6	..	7⅞	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	104—107	3	14	9	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8¼—8¾	4	11	6	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5⅛—5⅜	3	17	5	Feb, Aug	5¼	5¼
St.	4%	Do. 4% Deb. Stock (red.)	103—105	3	17	8	..	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4	10	0	—	4⅞	..
5	2/3	Do. Do. (1903)	4¾—5	..			..	4⅞	..
5	2/3	Chelsea Electric Supply Ord.	6¼—6¾	4	5	2	March	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109—111	4	1	9	Jn, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	10½—11	4	10	11	Feb, Aug	10¾	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12½—14	4	5	9	Jan, July	13¾	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123—127	4	0	0	Jn, Dec	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	103—105	4	6	4	..	..	..
10	4/0	County of London Elec. Supply Ord.	9—9½	4	4	2	..	9¼	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13—13½	4	18	0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107—110	4	3	3	..	108½	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101—103	4	7	5	..	102½	101½
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88—93	5	7	6	..	..	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5½—6	4	11	9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	102—105	4	7	0	—	102½	—
10	..	Havana Electricity Co. Shares	9½—10½	—			..	..	—
5	2/6	Hove Electric Lighting Ord.	7½—8	5	6	3	..	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	100—102	4	5	9	..	101	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	1⅛—1¼	..			—	1	..
5	5/0	Kensingtn & Knghtsbdge Ord.	12¼—12¾	4	8	11	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6¾—7	4	5	9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102—106	3	17	8	—	103½	..
5	..	London Electric Supply Ord.	2⅛—2⅜	..			—	2¼	..
5	5/0	Do. 6 per Cent. Pref.	5¼—5¾	5	2	1	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb	97—99	4	2	0	Mr, Jn, S, D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	16½—17	5	5	11	April, Oct	16¾	16⁹⁄₁₆
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅛—5⅜	4	0	10	Jan. July	5¼	5¼
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	115—117	3	18	0	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97—99	3	10	6	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	93—95	4	13	0	..	93½	—
10	5½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	13¼—13¾	5	12	3	Feb, Aug	..	..
5	5%	Newcastle Elec. Supply Ord.	6⅛—6⅜	4	17	6	Feb, Aug	..	..
5	5%	Do. 4 per Cent. Non. Cum. Pref.	6⅛—	3	19	1	Feb, Aug	..	..
1	5%	Northern Counties Elec. Sup. 17/- paid	15/6—16/0	3	6	8	Mar, Sep	..	..
10	6/0	Notting Hill Electric Ord.	14½—15	4	0	0	March	14¾	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	101—103	3	18	2	..	..	..
5	2/6	Oxford Electric Ord.	6¼—6¾	5	2	2	March	..	..
St.	4%	Do. 4% Deb. Stock	99—101	4	0	0	..	..	..
1	..	Rand Electric	1—1¼	..			..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mt. Deb	100—102	4	8	9	April, Oct	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	14—14½	5	0	0	Feb, Aug	14⅛	14
5	3/6	Do. 7 per Cent. Pref.	8¾—9	3	17	9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	99—101	3	10	0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¾—3¼	6	3	1	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83—87	4	12	6	..	..	..
5	2/0	South London Electric Supply Ord.	4¼—4¾	3	3	8	—	4½	..
1	..	South Metrop'n Elec. Lt. & Power Ord.	½—1	..			—	..	..
1	0/8¾	Do. 7% Cum. Pref.	1⅛—1¼	4	16	9	—	1⅛	1⅛
St.	4½	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. Accm.)	107—109	4	2	3	—	..	..
5	2/0	Urban Electric Supply Ord.	4¾—5⅛	4	18	9	..	4⅞	..
5	2/6	Do. 6% Cum. Pref.	5—5¼	4	17	7	..	5⅛	..
St.	..	Do. 4½ 1st Mort. Deb.	104—106	—			..	..	..
5	6/6	Westminster Electric Supply Ord.	12½—13	5	3	10	Mar, Sept	12¾	12½
5	2/6	Do. 5 per Cent. Cum. Pref.	6¾—7	3	11	5	—	..	—
		TELEGRAPHS.							
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.	100—103	3	19	2	Jan, July	..	..
10	..	Amazon Telegraph	1—1¼	..			Jn, Dec	..	..
St.	12/6	Anglo-American	55—57	4	13	10	F, My, Ag, N	56	55½
St.	25/0	Do. Preferred	103—104	5	1	0	F, My, Ag, N	103½	102
St.	2/0	Do. Deferred	12¾—13¼	0	15	9	F, My Ag, N	12¾	11¾
100	$2	Commercial Cable Capital Stock	170—190	4	4	2	Jn, Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93—96	4	4	4	Jn Ap, Jy, O	95	94½
10	5/0	Cuba Submarine Ord.	8¾—9¼	5	5	0	Feb, Aug	9⅛	8¾
10	10/0	Do. Preference 10 per Cent.	16½—17½	5	14	8	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	2¾—3¼	5	14	8	April, Oct	3⅛	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7½—8	6	5	0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. Deb.	101%—103%	4	8	3	Jan, July	..	..
20	3/0	Direct United States Cable	10¾—11	5	9	1	Ja, Ap, Jy, O	10⅞	10¾
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	101—103	4	9	3	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	123—126	4	0	7	Ja, Ap, Jy, O	126	123½
St.	17/6	Do. 3½ per Cent. Pref. Stock	88—90	3	18	0	Ja Ap, Jy, O	88½	88½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106—107	3	14	9	May, Nov	106½	106¼
10	2/6	Eastern Extension	13½—14	5	0	0	Ja, Ap, Jy, O	13¾	13½
St.	4%	Do. 4 per Cent. Deb. Stock	106—108	3	14	3	Feb, Aug	107½	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1900	101—103	3	18	0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3	15	5	May, Nov	101½	..
10	5/0	Gt. Nrthn. (of Copenhagen)	29—29½	6	1	6	Jan, July	..	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	101—103	4	9	2	June, Dec	..	..
25	12/6	Indo-European	44½—46½	5	7	6	May, Nov	45¾	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	98—100	4	0	0	June, Dec	..	—
10	4/0	West African Telegraph Shares	7¼—7¾	6	0	2	..	..	..
2½	..	West Coast of America	½—¾	..			..	¾	¾
100	4%	Do. 4 per Cent. Debs.	98—100	4	0	6	Jan, July	..	..
10	..	West India and Panama	½—1	..			May, Nov	..	..
10	6/0	Do. 6 per Cent 1st Pref.	7½—8	7	10	0	May, Nov	8	7¾
10	..	Do. 6 per Cent. 2nd Pref.	6¾—7¼	..			May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	103½—105½	4	15	11	Jan, July	..	..
10	5/0	Western Telegraph	13¾—14	5	0	0	Mr, Jn, O, D	13¾	13⅝
100	5%	* Do. 5% Debs. (2nd Series, 1900)	103—105	4	17	9	June, Dec	..	—
St.	4	Do. 4% Deb. Stock (red.)	101½—103½	3	13	5	—	..	..
		TELEPHONES.							
5	4/0	Chili Telephone (fully paid)	5¾—6	5	13	8	August	..	..
1	0/7½	Monte Video Telephone Ord.	¾—1⅛	..			..	..	..
St.	6%	National Co. Pref. Stock	108½—109½	5	9	7	..	109	108
St.	5%	Do. Def. Stock	99½—100½	4	19	6	..	100¼	99½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13—14	4	5	8	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12—13	4	12	4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5¼—5¾	4	13	0	Feb, Aug	5⅝	5½
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	96½—97½	3	11	8	June, Dec	96¾	96½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104½—105½	3	17	2	..	106½	..
..	5/0	Do. Do. Prov. Certs. 35/- to be pd.	67½—68½	..			..	68½	67½
1	0/7½	Oriental	1—1¼	5	18	6	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4	16	0	..	..	..
5	5/0	United River Plate	6¼—6¾	5	16	8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4	16	5	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	105½—107½	4	15	3	June, Dec	106	..
		FINANCIAL, INVESTMENT, &c.							
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5—5½	5	9	1	—	..	..
10	2/0	Globe Telegraph and Trust	10¼—10¾	5	5	9	Ja Ap, Jy, O	10⁷⁄₁₆	10¼
10	3/0	Do. 6 per Cent. Pref.	13¾—14¼	4	4	10	Ja Ap, Jy, O	14⅛	13¾
100	6%	Submarine Cables Trust (Cert.)	120—123	4	18	4	April, Oct	..	..
—	6%	Underground Elec. Rys. Co. of London 6% Profit Sharing Secured Notes	97—98	6	2	0	..	97¾	97½

* In calculating the yield, allowance has been made for accrued interest but not for redemption. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

ONE of the next steam railways to follow the lead of the North-Eastern and the Lancashire & Yorkshire will be the London, Brighton and South Coast Railway, the directors of which, with the assistance of their consulting engineer, Mr. PHILIP DAWSON, are now preparing specifications for equipping a trial section electrically. In following this course the directors have been influenced by one of their board, Major CARDEW, who, needless to say, appreciates thoroughly the advantages of electric traction. The most important feature of the scheme is the decision to employ an overhead conductor in place of a third rail, and in conjunction with this it is practically certain that a single-phase alternating-current system will be employed. Only a comparatively short length of the line will be equipped at the outset—viz., the section of the South London Railway from Battersea Park to Peckham Rye, a distance of about five miles, with stations at Wandsworth-road, Clapham, Brixton and Denmark Hill. The electrical equipment cannot be carried into Victoria Station on account of the reconstruction that is now being carried on there. The experiment is to be made rather with a view to obtain experience on technical matters of design and working than as a test for financial results. We have reason to believe that the overhead wire will be supported more or less on the principle adopted on the line of railway recently running between Niederschoneweide and Spindlersfeld, near Berlin, described in *The Electrician* a year ago (Vol. LI., p. 1,039). In this system two steel suspension wires run the whole length of the track, and the conductor is suspended from them by pairs of wires at about 10ft. intervals. The line will probably be fed directly at a pressure of about 3,000 volts single phase, and each locomotive or motor car will carry a transformer to reduce the pressure sufficiently for a single-phase motor with a commutator. We look forward with interest to the progress of this scheme.

◆

WE are confirmed in our view, that the mishap at Bradford was chiefly due to serious faults of long standing in the design of the network, by the City Electrical Engineer's report published on another page. During Mr. BLACKMAN'S short occupancy of his present position, he has had to deal with a continuous series of troubles, those at the generating station having been of almost equal importance to those on the network. An investigation into the state of the network had just been concluded before the disaster, and this examination had been greatly retarded by the absence of proper plans and data concerning the position of the mains, and lack of system in the method of joining them up.

◆

INTERRUPTIONS, happily of a less serious nature, have been reported from other towns during the past two weeks, and we repeat once more the warning we gave to mains engineers a few months ago that a thorough examination and test of their networks should be made without delay, the conditions for the development of faults having been accelerated by a hot and dry summer followed by a wet autumn.

◆

A CASE of considerable interest came before a Divisional Court on Tuesday, when the Yorkshire (Woollen District) Electric Tramways (Ltd.) appealed against a conviction by the Dewsbury justices for using a conveyance to carry passengers within the Borough of Dewsbury without having made application for a licence. The action had been taken by the Dewsbury Corporation, who contended that the tramcar was really an omnibus according to the Town Police Clauses Act, 1889, and therefore came within the definition of a "hackney carriage" in sections 37 and 45 of the Town Police Clauses Act,

1847. The appellants disputed this, and, in addition, claimed exemption under the Light Railways Act of 1896. Fortunately the Lord Chief Justice and his judicial colleagues held that the legal aspect of the matter coincided with the commonsense point of view, and upheld the appeal, quashing the conviction of the local magistrates. As His Lordship pointed out, the decision of the local justices meant that every carriage, driver and conductor of a light railway would have to be licensed, and this was nothing short of an absurdity. Everything went to show that the law never intended a light railway to be anything but a railway, and that its vehicles did not come within the legal definition of a "hackney carriage" or a "tramcar." The anomaly will remain, however, that while a tramcar running on a line built under the Light Railways Act need not be licensed, the same type of car may have to be licensed by the Local Authority if it is to run on a line authorised under the Tramways Act of 1870. We trust that this antiquated Act, passed long before the advent of the electric tramway was contemplated, will be replaced by more suitable legislation next session.

The Dublin Corporation have gone a stage further towards a solution of the difficulty which has arisen in connection with the Pigeon House Fort electricity works since Mr. Hammond's period of supervision expired on July 31st. Without too much recapitulation we may remind our readers that in consequence of certain criticisms which were levelled at Mr. Hammond as to the soundness of his estimates, and also concerning his advice with regard to the future prospects of the undertaking, he made two offers to the Corporation by which he would manage the electricity department, guaranteeing a certain low cost of production, and offering to place himself under substantial financial guarantees to carry out an agreement based upon either offer. Eventually these offers were referred to a committee of the whole Corporation to consider and report upon. This committee met on Friday last week, and after a short discussion, in which some digressions were made to personal matters and motives, Mr. Hammond's proposals were rejected. The resolution which was carried called upon the Lighting Committee to furnish to the next meeting of the Corporation a report as to the exact financial position of the undertaking, and recommended that no further or additional constructional works be undertaken until the consulting engineer had reported that the works covered by his agreement with the Corporation, dated September 22nd, 1899, were finally completed. After being put to the meeting, an addition was made that this resolution should not interfere with any addition to consumers or extensions to mains, &c. This will have the effect of giving the city electrical engineer, Mr. Mark Ruddle, a free hand, if the Lighting Committee see fit, for carrying out the extensions to mains which he recommended in his report including the laying of three new trunk mains. Previously to passing the above resolution, the Committee considered for three hours a statement by the town clerk as to the amount of money already borrowed, paid off, outstanding, &c. We trust that the undertaking will now show better financial results, for Mr. Hammond's recommendations having been followed throughout as to the building of the new works and the reconstruction of the system, there should be no necessity for his taking over the management of the whole concern as a speculation. When a consulting engineer builds a municipal electricity works and prophesies that it can be run upon a paying basis, there should be no necessity for him to act as manager of it when it has been completed in accordance with his specifications.

The electrical engineer who sets out for Australia with the idea of making a fortune rapidly, or revolutionising the electrical industry of that country will meet with a severe disappointment on his arrival. Mr. C. L. Remington, a prominent Australian engineer, now on a visit to England, has been good enough to place before us a few of his impressions, and some of these are of considerable interest. It appears that the great colonial Continent is severely handicapped by its restrictive labour laws, which prohibit the importation of all persons under contract. Naturally, the effect of this extreme Protectionist policy is to discourage private enterprise and incidentally to restrict the growth of population, which is so greatly needed. Regarding the electrical industry in particular, it seems that competition is very keen indeed, all the large British, Continental and American firms being represented, in addition to Australian firms. There is room, however, for a few consulting engineers of high standing, not interested in any manufacturing concern. The men wanted are those of unquestionable ability and experience to whom local authorities and other clients can turn for advice. At present the best technical experts in Australia are those interested in one or another of the great engineering firms, and their opinions can scarcely be classed as unbiassed. At the same time, any engineer familiar with British or American practice will experience considerable difficulty in falling into Australian ways, and success must depend largely on ability to abandon some preconceived notions of how things ought to be done and to swim with the tide. As Mr. Remington put it: "It is easier and quicker for a man to be converted to Australian notions than for him to convert the whole of Australia to his own."

It has been an object with electro-chemists in many industries to secure the deposition of metals in a reguline state. The precipitation of metals as sponge is generally to be avoided. But there are some purposes for which spongy metal is useful. An excellent example is given by Mr. Gelsthorp, who in a Paper read at the recent meeting of the Faraday Society discoursed on tin paste. That quaint material, correctly known as silver paper, not to be confused with the "silver paper" of one's childhood, which is really tinfoil, is made by painting a mixture of glue and finely-divided tin on paper and burnishing the product. The preparation of tin in a proper state of division may be accomplished (*a*) mechanically by shaking melted tin in a box; (*b*) chemically by precipitating stannous chloride with zinc, and (*c*) electrolytically by depositing tin at so high a current density that the metal contains hydrogen and is not reguline. In fact, it is thrown down in the required form by observing those conditions which should be avoided if coherent metal is required. The author laments the low current efficiency, but clearly if he has his hydrogen he cannot burn it.

Faraday Society.—Lord Kelvin has consented to be nominated as President of the Faraday Society in succession to Sir J. W. Swan, F.R.S.

L.C.C. Trams and Iron Hoops.—A boy has succeeded in short-circuiting the conductors within the slot of the L.C.C. trams by means of an iron hoop. The daily newspapers report that the hoop was fused but that the boy was not killed. Presumably no member of the L.C.C. engineering staff was near at the time to do the deed.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne—Pinheiros	**Aug. 13, 1902**	—
Reissi-Issa (Yemen)—Camaran	**Oct. 22, 1902**	—
Tarifa—Tangier	**Jan. 18, 1904**	—
Cayenne—Paramaribo	July 13, 1904	—
Sitka—Valdez (Alaska)	Nov. 11, 1904	—
Falmouth—Bilbao	Dec. 14, 1904	Dec. 21, 1904
Trinidad—Demerara	Dec. 20, 1904	—

Society of Arts.—Among the Papers down for reading before the Society of Arts during January, 1905, are the following:—Wednesday, January 18th, at 8 p.m., "Wireless Telegraphy and War Correspondence," by Capt. Lionel James; Wednesday, January 24th, at 8 p.m., "The Manufactures of Greater Britain: I.—Canada," by C. F. Just; Wednesday, January 25th, at 8 p.m., "London Electric Railways," by Hon. R. P. Porter.

Crystal Palace School of Practical Engineering.—On Friday last week Mr. Charles Hawksley, Past-President of the Institution of Civil Engineers, distributed the certificates gained by the students of the above school during the 1904 winter session. The Wilson Premium, for the best Paper read before the Crystal Palace Engineering Society, was awarded to Mr. L. H. C. Palmer for his Paper on "Railway Practice and Construction in India." The report of the examiners was of a satisfactory character as regards the mechanical, civil and electrical sections of the school.

Efficiencies of Various Gears.—According to M. R. Lacau, in *L'Eclairage Electrique*, the efficiencies of various forms of gearing, as used for motor car purposes, are as follows:—

	Efficiency %. New.	Efficiency %. Worn.
Spur gearing, steel on steel, greased, exposed to street dust	90	80
Spur gearing, steel pinion engaging with fibre gear wheel	88	80
Spur gearing, leather pinion engaging with cast-iron gear wheel	88	80
Spur gearing, steel on steel, oil bath	92	90
Ditto, but with grease lubrication	somewhat lower.	
Bevel gearing, steel on steel, oil bath	88	82
Universal joint	95	—
Roller chain, lubricated and exposed to the air	94	91

Life of Tramway Axles and Wheels.—In a recent lecture before the Dundee Society of Experimental Engineers, Mr. J. S. Shepherd quoted some interesting figures regarding the life of axles and wheels used for the electric tramcars of Dundee. In 4,000,000 miles, representing approximately the aggregate distance travelled by the Dundee electric cars, they had only had one broken axle. Touching on the question of wheels, the lecturer remarked that the life of a chilled wheel (which cost about one-third of a steel-tyred wheel) was from 30,000 to 35,000 miles, whereas the life of wheels with steel tyres was much longer. One steel-tyred wheel on the Dundee tramways was taken off only the other day, after having run 60,397 miles.

Long-distance Telegraphy.—Direct Wheatstone working over the full length of the Indo-European Telegraph Co.'s route has now been in successful operation since January 1, 1903. The total distance is about 3,800 miles, London being at one end of the line and Teheran at the other. During the last few weeks, however, messages arriving in London from Teheran have been relayed in London direct to Liverpool and Manchester respectively, instead of the slip being gummed up in London and re-transmitted by Morse. It is found that the signals arrive in those places as clearly as they were formerly registered on the slip in London. Transmission from these stations to Teheran has proved equally successful, and the Manchester and Liverpool stations now exchange their messages direct with Teheran. We hope to publish an illustrated description of the method of working in an early issue.

The Cost of Lighting Cigars by Electricity.—According to the *Electrical World* of New York, an ingenious electric cigar lighter has recently been placed on the market, consisting of a metal box, perforated and mounted upon a standard and supplied with 110-volt continuous current from the lighting mains. Inside the box are two carbon pencils, which are brought in contact by the depression of a thumbpiece or button on the outside, and then separated by a spring mechanism which holds the carbons just far enough apart for an arc to be formed. By inserting a cigar in an orifice in the front, its unlighted end becomes ignited by contact with the arc, the whole operation taking scarcely 5 seconds. Our contemporary calculates the cost of lighting a cigar on the basis of 10 cents per kilowatt-hour. The current consumption is approximately 2·5 amperes, so that the energy consumption in a single 5-second contact comes to 0·000382kw.-hours, which cost 0·00382 cents. In other words, some 500 cigars may be lighted at the cost of one penny. Taking into account interest and depreciation, therefore, the new lighter will not be a formidable competitor of the safety match, except perhaps in France.

Report on the Electrical Industry in the United States and Canada.—A report has been compiled by Mr. S. E. Fedden, city electrical engineer of Sheffield, as a result of his recent visit to America. Mr. Fedden visited New York, Montreal, Quebec, Ottawa, Toronto, Niagara, Chicago, St. Louis, Schenectady, Pittsburg and Boston, and he draws some interesting comparisons between the condition of the electrical industry in those cities and that in English towns. Among other things the report deals with the electric lighting problem of New York, the new Rapid Transit Subway, and the St. Louis Exhibition. Considerable space is also devoted to the great power plants at Niagara and the General Electric Co.'s works at Schenectady. The author calls attention to the fact that the cables of the New York lighting network are very carefully racked, and that most of the manholes are ventilated, and, in many cases, drained. One special point is that the main feeders which supply each sub-station follow different subway routes, so as to ensure continuity of supply in case of any burn-out or trouble in the subway or manholes. A still more important point is that the insulation resistance of each high-tension feeder is tested every week, as required by the rules of the Subway Company. This, of course, enforces the laying of spare cables to enable continuous supply to be given during the disconnection for testing and repairs.

The Tramways and Light Railways Association.—A party of members of the Tramways and Light Railways Association paid a visit last Friday to the Great Northern and City and to the City and South London electric railways. The party was conducted over a portion of the G.N. and C. Railway and over the generating station at Poole-street by Mr. R. P. Brousson, engineer and traffic manager of the railway, who courteously explained all technical features. Of special interest was the siding at Moorgate-street station, the construction of which was rendered somewhat complicated on account of the acute angles obtaining there, and of the fact that there are two live rails—one positive, the other negative—the running rails not having been made use of as return path for the power current. Another interesting feature was the automatic electric signalling system, with which the greater part of the line is already equipped. In this system the track rails are divided up into sections which are sufficiently insulated from one another to allow of a pressure of a few volts being maintained between them. The signalling is automatically done by the train entering and passing out of a section, and the arrangement is such that the signal at once points to danger if the signalling current should fail for any reason. A visit was next paid by the party to the City and South London Railway and to its generating station at Stockwell. The carriages of this, our oldest electric tube railway, were lately beginning to look rather dismal, and the interior appearance especially had lost much of its former brightness. We were, therefore, pleased to note that a number of carriages have been thoroughly refitted and redecorated recently. This work was done by the company's own men, and we are informed that all the cars are to be gradually overhauled in this way.

Utilising the Magnetic Pull of Dynamos for Adjustment Purposes.—Mr. R. Klasson, of Baku, mentions in *Elektrische Bahnen* an instructive case where the air-gap of a 2,400kw. three-phase generator was adjusted by utilising the magnetic attraction between stator and rotor. The generator is driven by a horizontal steam engine, and from the very beginning it appears the gap on the steam engine side measured only 4½mm. (0·177in.) while the gap at the opposite side was 5½mm. (0·216in.). In the course of two years the one-sided pull resulting from these conditions had the effect that the bearing brushes (diameter of shaft 19·65in.) wore away rapidly on one side, and the rotating part shifted ¾mm. (0·03in.) towards the engine. Short-circuits occurred now more and more frequently, and one day it was found that the stator frame had shifted bodily, and that the rotating part touched the stationary part. The generating set was stopped at once, but was required to run again as soon as possible. As the weight of the stationary portion was 51½ tons, and the travelling crane of the station was designed for 25 tons only, it was necessary to find other means for shifting the huge magnet frame. The expedient of shifting it by means of jacks backed against the wall of the station building was considered, but abandoned, as it was feared it would lead to distortions of the frame. It was then decided to utilise the magnetic pull to equalise the air-gap. A one-sided pull was obtained by sending current through one-half of the rotor, the direction of the pull being upwards at an angle of 45deg. to the horizontal. With a current of 80 amperes through the rotor, the frame began to move, and, by cautiously varying the current, it was possible to obtain a fine adjustment. The whole adjustment occupied but 1½ hours.

On the Experimental Determination of Train Resistance.—In replying to the discussion on his Paper, entitled "Some Notes on High-speed Electric Railway Work" (*The Electrician*, December 16th, p. 361), Mr. F. W. Carter referred to the inaccuracies in the determination of train resistance which were unavoidable when the train experimented upon was either drawn by or pushed by a locomotive. He also pointed out the deficiency of the "retardation" method for obtaining train resistances. In the case of electric trains, however, we could obtain an accurate value for the train resistance if we performed the experiment properly. We simply had to measure the input of the motors when the train was running at uniform speed, and to deduce from the characteristic curves of the motor the corresponding speed and tractive effort. At free running —*i.e.*, the steady state which was reached by an electric train on level track—the tractive effort was generally small, and a small error in the reading of current at this point might result in a considerable error, both in tractive effort and speed. Moreover, on account of the slope of the speed curve, free running was approached very slowly, so that, unless one could arrange to run down grade and strike the level at free running speed, a long straight level stretch of track was needed to permit of this speed being reached. It was, therefore, preferable to use for experimental purposes a train much too heavy for the motors, so that when the train had attained a steady speed on the level the tractive effort of the motors was nevertheless large, and a small error of the current readings of correspondingly less importance. Moreover, as the speed curve of the motor was more nearly horizontal at lower speeds, free running was approached rapidly, and a satisfactory test could be made on a comparatively short piece of uniform track. Where there were several motor coaches in a train it would be preferable to run up to a suitable speed with all motors working and then to switch off all but perhaps one pair on the foremost coach. By making several tests in which free running was approached both from above and below it was possible to obtain consistent values for train resistance.

Wireless Telegraph Notes.—It is reported that the De Forest Company has established wireless communication from Kansas City to Cleveland, a distance of about 800 miles. This, continues the correspondent, is the longest overland wireless communication on record.

We are informed by Marconi's Wireless Telegraph Co. that, as the result of the adoption by the Admiralty of the latest type of Marconi apparatus for use in the Channel Fleet, the "Cæsar," flagship of Vice-Admiral Lord Charles Beresford, equipped with the Marconi system, succeeded in keeping in touch with the Marconi Company's station at Poldhu during practically the whole of the passage home this week from Gibraltar. By this means the vice-admiral commanding was able to transmit to the squadron news of the principal events of public interest from day to day. It is expected that the "Victorious," flagship of the second in command of the Channel Fleet, will be fitted with similar improvements to those made in the "Cæsar's" wireless installation.

We also learn from the same source that the system of wireless telegraphy employed by the Post Office authorities to maintain communication between Penzance and the Scilly Islands during the breakdown of the submarine cable was the Marconi system, the Post Office having requested the Marconi Company to make arrangements for carrying on the service for the department. The wireless stations used were the Admiralty station on the Scilly Islands (fitted with Marconi apparatus) and an ordinary Marconi shore station on the coast of Cornwall. It may be mentioned that the cable service was resumed and the wireless service discontinued on Friday last.

The *Western Morning News* states that rumours have been current at the Lizard respecting the transfer of the Marconi telegraph station to Lloyd's Signal Company. The transfer actually took place a few days ago, and Lloyd's signal men at the Lizard station were duly installed at the Marconi station, most of Marconi's assistants leaving the Lizard for other spheres of duty. The Marconi Company have, however, resumed operations, Lloyd's men retiring. Some of Marconi's assistants have already returned.

Brighton Municipal School of Science and Technology.—The new engineering department of the Brighton Municipal School of Science and Technology was formally opened by Sir W. H. White on Wednesday. In addition to the usual lecture and class rooms, there is a mechanics laboratory, engine room, boiler house, engineering workshop, electrical engineering laboratory and electrical testing laboratory. Amongst the more important machines in the mechanics laboratory are a large horizontal testing machine, made by Messrs. Greenwood & Batley, for carrying out either tension, compression or bending tests, a Bailey wire-testing machine and a cement tester. The engineering workshop contains a number of different lathes, ranging from a 10in. centre lathe downwards, a Herbert capstan lathe, and machines for milling, planing, shaping, slotting and drilling. A 12 H.P. Tangye gas engine drives the counter-shafting of this workshop. The heat engine laboratory contains a Marshall 30 H.P. compound steam engine, a 22 H.P. Crossley gas engine and a 22kw. turbo-generator of the De Laval type, built by Messrs. Greenwood & Batley. At a steam pressure of 150lb. to the square inch, the turbine runs at a speed of 22,000 revs. per min. This speed is reduced to 2,200 revs. per min. by means of a double helical gearing, the continuous-current dynamos being placed side by side. These generators, which may be connected in series or parallel, supply current both for experimental purposes and for the three-wire 230-volt lighting system of the buildings. The B. & W. boiler in the boiler house is capable of producing about 1,300lb. of steam per hour at a pressure of 160lb. per square inch. The principal machines in the electrical engineering laboratory are:—One 22 H.P. motor, one 15 H.P. motor, one 5kw. Fynn rotary converter, two 6·5kw. 230-volt dynamos, one 4kw. 50-volt dynamo with shunt and compound-winding, one 2kw. balancer set, one 5kw. revolving field-alternator generating single-phase, two-phase or three-phase current, and one 3 H.P. single-phase induction motor. These machines are of the following makes: Lancashire Dynamo & Motor Company, Royce (Ltd.), Easton & Anderson, the Electric Construction Company, British Westinghouse Co. and Crompton & Co. There is also the necessary switch gear (supplied by Messrs. Ferranti Ltd.), the British Thomson-Houston Co. and Messrs. Nalder Bros. & Thompson), and the wiring of this laboratory appears to have been done on sound lines. The electrical laboratory contains the usual series of testing and measuring apparatus and instruments, including a Kelvin quadrant electrometer and a D'Arsonval galvanometer.

THE METROPOLITAN RAILWAY.

(*Continued from page 344.*)

The condensing plant is of the barometric type, and was made by the British Westinghouse Company at their Trafford Park works to the designs of the Alberger Condenser Company. This is a form of condenser that is little known in England, but it was chosen because it is particularly adapted to maintaining the high vacuum at all loads that is such an important feature in the economical working of the steam turbine. Condensers are installed for each main generating unit, and they are separately capable of dealing with 66,500lb. of steam per hour at normal full load and 110,000lb. per hour at maximum overload for a period of one hour. At normal load a vacuum of 27in. is obtained, and the above overload reduces this only by 1in. Under the former condition the velocity of the steam at no point exceeds 270ft. per second or the maximum temperature of the circulating water 85°F.

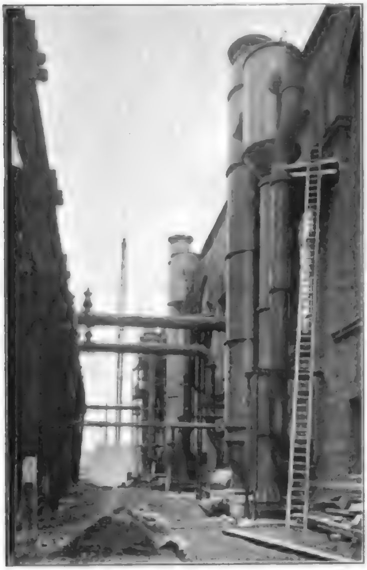


Fig. 9.—View of Condensers.

A steam-driven rotative dry vacuum pump is provided with each condenser, and its engine when working at full load develops 55 H.P. with a steam consumption of 1,375lb. per hour. By what is termed the two-stage arrangement of this pump, it is enabled to effect a vacuum of 29in. in the condenser when this is shut off from the engine. The chief feature of this two-stage method is that it makes it possible for the condensing plant to maintain a very high vacuum at all loads, even with a temperature of the circulating water considerably exceeding the normal. As may be seen from Fig. 9, each condenser consists of three vertical pipes terminating in a spacious chamber at the top. The bottom of the middle pipe leads directly into the hot well, the smaller pipe on the right-hand side, next to the ladder, conveys the cold or circulating water to the condensing chamber and the large pipe on the left-hand of the middle pipe is for exhaust steam. Water enters the chamber in finely divided spray and meeting the steam, whose velocity is considerably reduced, condenses it. Condensed steam and circulating water then fall together down the middle pipe and are brought into contact with steam from the exhaust before entering the hot well. Thus the temperature of the water in the hot well is almost equal to that of the exhaust.

The three-phase alternators are of the revolving field type, and have a normal output of 3,500kw.—viz., 184 amperes per phase at 11,000 volts with a non-inductive load. The frequency is 33⅓ per second, and the speed 1,000 revs. per min. A laminated ring with slots on its inner surface constitutes the fixed armature shell, and the ring is supported in a massive cast-iron frame which is divided horizontally. The revolving field core, which carries four poles, is made of a solid forging, which is pressed upon a high carbon shaft.

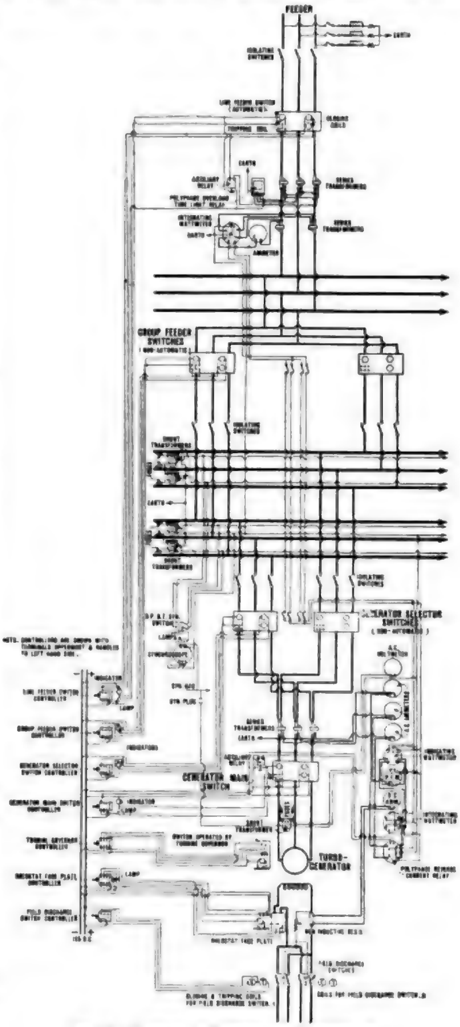


Fig. 10.—Diagram of Switchboard Connections.

This forging is of special steel, which combines strength with good magnetic permeability. It is of Whitworth fluid pressed steel, which is manufactured from the best Swedish iron. The latter is melted in a Siemens-Martin furnace and afterwards run into extra strong specially prepared steel mould boxes, and then subjected to hydraulic pressure whilst in a fluid state. By this means a much greater soundness is obtained than is possible when the metal is cast in the ordinary way. The material is afterwards taken and re-heated and forged under a powerful hydraulic press (10,000 to 12,000 tons), this ensuring the metal being thoroughly and uniformly worked. Lastly, the pieces are rough machined and carefully annealed before the finished machine work is done.

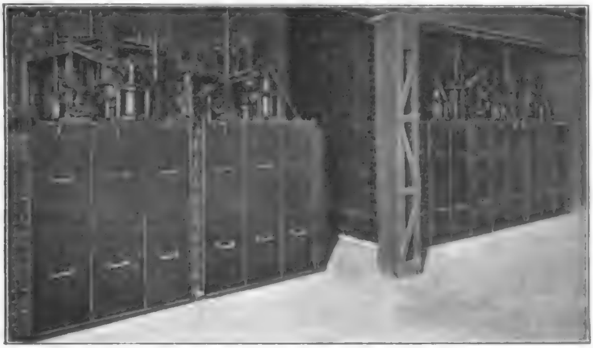


Fig. 11.—Selector and Group Switches.

Flexible claw couplings are employed for connecting the turbine rotor to that of the alternator. These are of forged steel, and run in oil, and they are arranged to allow for any inexactitude in the alignment of the two shafts. The bearings are of the spherical type, of cast iron, with babbitt metal linings. An efficiency of 96·5 per cent. at full-load is guaranteed for the generators, 95·5 per cent. at three-quarters, and 93·75 per cent. at half-load. Six coils are employed in the armature winding, and these are star-connected, with the middle point earthed through a resistance. For conveying the exciting current to the field magnets bronze slip rings are employed, in conjunction with carbon brushes, each ring having five brushes. There are two exciter units, each of which consists of a Westinghouse single-acting compound engine, running at a speed of 275 revs. per min., directly coupled to a 100kw. 125-volt continuous-current compound-wound generator. One such unit is sufficient to supply all the generators with exciting current at full-load.

The auxiliary plant is of a very extensive nature. Wherever possible induction motors have been employed for driving the auxiliary plant, such as economiser scrapers, coal and ash conveyors, &c. They are operated from a special three-phase 440-volt generating set of 100kw. capacity, which is driven by a directly-coupled single-acting compound Westinghouse engine. As an alternative source of power for this purpose four 50kw. transformers are installed, connected through oil switches to the high-tension switchboard 'bus bars. In addition, however, to such other auxiliary plant as has been previously mentioned, there are installed three 18in. centrifugal Gwynne cold water circulating pumps, each driven by a Westinghouse compound engine; three 16in. Worthington hot water circulating pumps, each driven by a slightly larger but otherwise similar engine; two surface heaters, each containing 1,000 sq. ft. of heating surface; one Alberger surface condenser of 700 sq. ft. cooling area, for condensing the exhaust steam from the exciter engines and the 100kw. auxiliary generating set; two Cole, Marchent & Morley grease extractors; two 20-ton overhead electric travelling cranes by Higginbottom & Mannock, fitted with Westinghouse motors.

Following the now-prevailing fashion, all high-tension switch gear at Neasden is of the remote-control electrically-operated type, and its construction certainly warrants the opinion that it is about as nearly perfect as human skill can make this class of apparatus. Referring to Fig. 10, which is a diagram of connections, it will be seen that the generator is excited from the exciter 'bus bars at 125 volts. These 'bus bars are situated on a low-tension white marble switchboard on the top gallery, and are in duplicate. Exciting current is taken through two main double-pole single-throw quick-break switches to the generator field. These switches are electrically operated by means of a solenoid controlled from the main operating bench-board; they may be used either singly or in parallel, and they also act automatically on overload or reverse current. In connection with them the usual discharge resistance is provided, and a field ammeter and an electrically-operated regulating resistance completes the equipment for each generator exciting circuit. The opening of each switch closes a small auxiliary switch, which in turn connects the resistance across the field-winding, allowing the discharge to die down automatically. Electrical control is also applied to the field rheostats, which are motor-operated. The contacts are arranged on a face-plate, and are connected to the rheostats, which consist of cast-metal grids supported by an iron framework. A cut-out switch is provided on the face-plate to open the motor circuit when the contact arm reaches either of the limiting positions. A device is also provided on the face-plate to indicate to the operator by means of a signal lamp whether the contact arm is between or fully on the contact.

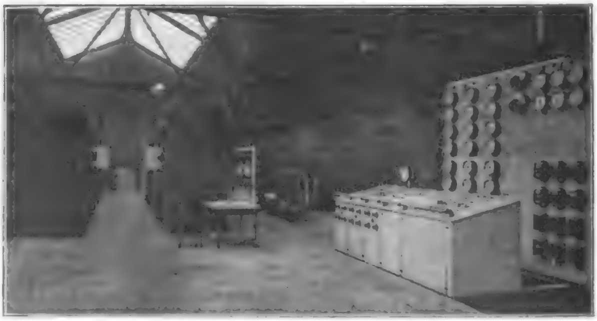


Fig. 12.—View of Control Board and Bus Bars.

As the potential of the current on the main switchboard is 11,000 volts, fireproof construction, safety and convenience of working have been the leading considerations in its design, and all these conditions are amply met by most efficient means. The 'bus bars and other conductors are supported on heavy porcelain insulators and, where a difference of potential exists, are separated by means of fireproof and insulating walls. All conductors are placed so as to offer the least risk to the switchboard attendants, but at the same time they are arranged to be readily accessible if necessary, and fully in sight. In the lower gallery the 11,000-volt generator and feeder main-circuit oil switches are placed, and in the gallery above them the selector switches (Fig. 11). The top gallery contains the main alternating-current 'bus bars and the various instrument and control boards. The latter (Fig. 12) is of the now very general desk type with an inclined top. On this is fixed the remote control apparatus for operating the main alternator, feeder and field switches, and the electrically operated resistances and turbine governors. On the top of the desk is drawn a diagram of the connections, showing the generators, 'bus bars and switches, and thus the attendant has always before him a clear representation of the conditions under which the station is working: a very commendable feature, and one that might be adopted with advantage in all stations of any considerable size.

On the control board are a button and signal lamp for each generator which indicate to the attendant the condition—open or closed—of each generator main oil switch. Indication as to the position of a selector switch is given by a button only. There are also lamps provided for synchronising, in addition to a synchroscope. All these lamps, it should be observed, are sunk below the level of the surface of the marble and the apertures are covered with wire guards. Thus although they are plainly visible yet they are quite out of harm's way. Facing the attendant and behind the control board are the instrument panels. On each generator panel there are: one voltmeter, three ammeters, a direct-reading wattmeter, a power-factor indicator, an exciter ammeter, a recording wattmeter, and a reverse-current relay indicator. The function of the last-named is to determine the amount of reverse current which has to pass through the main generator oil switch before it is opened automatically. This amount may be predetermined and the indicator set accordingly. There are three panels thus equipped, and the fourth carries the two main 'bus bar voltmeters. On the fourth panel of the control board are six feeder switches and four group switches. Each feeder is provided with an ammeter, a recording wattmeter and a polyphase overload time-limit relay. To indicate the position of each feeder oil switch there are a lamp and a button, but a button only for each group switch.

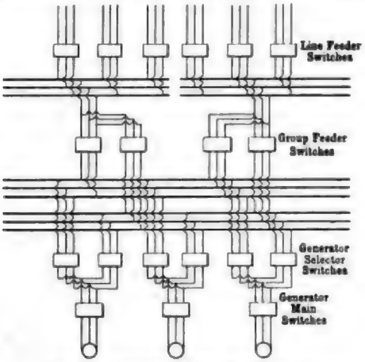


Fig. 13.—Arrangement of Bus Bars, &c.

Starting now from the generators, three lead-covered paper insulated cables are taken down through the bed-plate of each machine and carried along under the floor in concrete conduits to three separate brick compartments on the engine room floor level. Here they pass through porcelain sealing chambers and emerge as rubber-covered paper-insulated cables. They are next tapped, the tappings being taken, through high-tension fuses, to the floor below, where the potential transformers are situated. They then pass through the wall by means of earthenware tubes to the electrically-controlled oil-break switch designed to break the full load of the generator—viz., 3,500kw. at 11,000 volts. A full description of these switches was given in *The Electrician*, Vol. LIII., p. 595. They are next brought back through the wall and continued, still in separate brick compartments, through series transformers. Subsequently each cable is divided into two by means of a copper bar with thimbles bolted on. The two cables then proceed upwards, through the floor of the next gallery, to the selector oil switches. These switches are placed back to back, with a gangway about 6ft. in width between. The next break in the cable is effected by an isolating switch, consisting of a simple copper blade, which may, of course, only be opened when no energy is passing through it. By the opening of these switches cleaning and inspection is rendered perfectly safe and easy. After passing through the floor of the next gallery the cables are taken straight to the generator 'bus bars, housed in separate brick cells and separated by a gangway (Fig. 12). It will be observed that the 'bus bars are in duplicate, and that the selector switches, previously referred to, make it possible to connect any generator on to either or both sets. Each 'bus bar consists of four strips of bare copper, 3in. by ¼in., supported on porcelain insulators. From the generator 'bus bars on the top gallery, connections are taken down through the floor to isolating switches, and from thence to group switches which are electrically operated, the break taking place in oil. From these switches the cables proceed downward through the next floor to the feeder 'bus bars which are suspended horizontally on china insulators in separate compartments, the dividing partitions consisting of a special kind of cement. Cables are attached to these 'bus bars and led to vertical brick compartments in which they are supported on insulators. Here they pass through the instrument transformers, then through the wall to the feeder oil switches, back again, and through isolating switches. Lastly, they are taken through the engine-room floor, now no longer rubber insulated, asbestos covered, but paper insulated, lead covered. In the basement are the lightning arresters (Fig. 14); these it will be observed are connected on the substation side of the isolating switch, so that the feeder is never unprotected at any time. They consist of metallic cylinders connected to earth in series with a resistance. "Earth" is obtained by a tinned copper wire of very large section running all over the building and connected to proper earth plates. After passing through the floor, the three cables enter a trifurcating box and emerge as a three-core paper-insulated lead-covered cable armoured with galvanised steel wire, then proceeding straight to the sub-station.

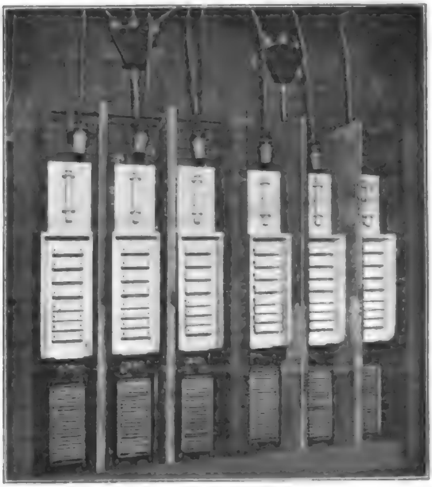


Fig. 14.—Lightning Arresters.

(To be continued.)

TESTS OF THE NEW YORK CENTRAL ELECTRIC LOCOMOTIVE.

The most important public electric railway tests ever made in the United States were conducted on November 12, by the New York Central and Hudson River Railroad Co., when the new high-speed electric locomotive built by the General Electric Co. and the American Locomotive Co. was given its first public trial. It is remarkable that only a bare year has passed since the New York Central authorities began active measures to inaugurate the régime of electricity on that great system. Such swiftness of decision and celerity of movement promise well for the abridgment of the intervening period of change, innovation and revolution before the New York terminal has been perfected on its vaster scale of magnitude and the electric locomotives are plying regularly 40 miles in and out of the city. The New York Central and Hudson River Railroad Co. is now electrically equipping its terminal network for a distance of 34 miles on the main line from the Grand Central station to Croton, near Peekskill, and for 24 miles on the Harlem Division as far as White Plains. It is the intention to handle all the traffic within this district or zone electrically, and the locomotive just tested is one of 30 to 50 which will be used in the haulage of the through passenger trains, the heaviest of which reach 875 tons in weight, and will travel at a maximum speed of 60 to 65 miles per hour. By the use of the Sprague-General Electric multiple-unit system of control two or more locomotives can be coupled together and operated from the leading cab as a single unit. A single electric locomotive will be able to maintain the schedule with a 450-ton train, two locomotives being coupled together for heavier trains.

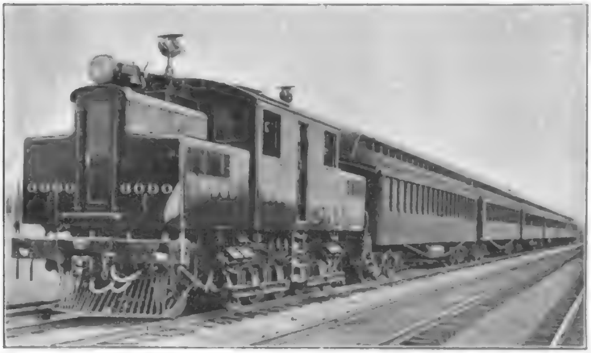


FIG. 1.—ELECTRIC LOCOMOTIVE OF THE NEW YORK CENTRAL AND HUDSON RIVER RAILROAD CO.

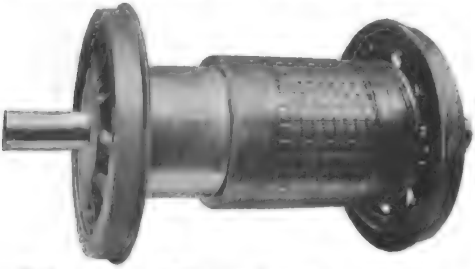


FIG. 2.—ARMATURE OF 550 H.P. MOTOR, MOUNTED DIRECTLY ON THE AXLE.

One step in the change of motive power has been the erection of two large central turbo-generator power plants, one on each flank of the district served—namely, at Yonkers on the Hudson and Port Morris on Long Island Sound. Each of these plants, already designed and in embryo construction, is to have an ultimate capacity of 80,000kw., with an auxiliary system of sub-stations and storage batteries and an interconnection that will enable either plant to do the whole duty and carry the entire load of a train service far beyond that which depends upon the present steam schedule.

The first locomotive (Fig. 1), which was tested on the special section of track laid with third-rail between Schenectady and Hoffmans, consists of four driving axles on each of which is mounted, without intermediate gearing, the armature of a motor having a normal rating of 550 H.P. (Fig. 2). For short periods a considerably greater power may be developed, making it more powerful than the largest steam locomotive in existence. Hitherto gearless locomotives have been built with the armature of the electric motors mounted on quills and spring suspended from the driving wheels. In the new locomotive the use of spring-suspended quills is dispensed with, the armature being mounted rigidly upon the axle, thus reducing the bearings to those of the pony trucks and the main journals, all of which are outside the driving wheels. The motor has two poles with flat faces so as to permit a large relative vertical movement between armature and poles as the latter move up and down with the riding of the frame upon the springs.

The general dimensions and data applying to the locomotive are as follows :—

Total weight of locomotive	95 tons
Weight on drivers	69 tons
Rigid wheel base	13ft.
Total wheel base	27ft.
Length over buffer platforms	37ft.
Extreme width	10ft.
Height to top of cab	14ft. 4in.
Diameter of drivers	44in.
Diameter of pony truck wheels ..	36in.
Diameter of driving axles	8·5in.
Normal draw bar pull	20,400lb.
Maximum starting draw bar pull	32,000lb.
Speed with 500-ton train........	60 m.p.h.
Voltage of current supply	600
Maximum full-load current......	4,300 amps.

A longitudinal section of the locomotive frame is shown in Fig. 3. The main frame is of cast steel and forms not only the mechanical frame of the locomotive but also part of the magnetic circuit of the electric motors. It will be seen that the armatures are arranged in tandem, the end pole pieces being cast as part of the end frames and the double pole pieces between the armatures being carried by heavy steel transoms bolted to the side frame and forming part of the magnetic circuit as well as cross braces for the truck. The field coils are wound upon metal spools, which are bolted upon the pole-pieces. Proper distribution and division of the weight of the locomotive among the axles has been accomplished by suspending the main frame and superstructure from a system of half-elliptic springs and equalised levers of forged steel, the whole being so arranged as to cross-equalise the load and to furnish three points of support. This construction, besides being strong and simple in design, greatly facilitates repairs and renewals, as an armature with its wheels and axles may be removed by lowering the complete element without disturbing the fields or any other part of the locomotive and a new element inserted in its place. All parts are also especially accessible for inspection and cleaning.

The pony trucks are of the radial type and are pivoted by means of radius bars to the end frame of the main truck. The frame of the locomotive immediately above the trucks is supported by means of suitable links, so that the truck is free to swing about its centre, and is self centreing on a straight track. This design is similar to the standard construction adopted by the New York Central and Hudson River Railroad Co. for its steam locomotives.

The brush holders are mounted on insulated supports attached to the spring saddle over the axle journal, thus maintaining a fixed position of the brush holder in relation to the commutator. These brush holders are made adjustable so as to allow for wear of the commutator and journal bearings. The dead weight on the axle is not materially greater than is customary with steam locomotives and in addition there is no unbalanced weight to produce vibration with attendant injuries to track and roadbed construction. The actual reduction in the expense of maintaining the rails and roadbed due to the absence of pounding and rolling will have an important bearing on the up-keep of the permanent way.

The superstructure consists of a central cab for the operator containing master controllers, engineers' valves and switches and valves required for operating, sanding, whistling and bell-ringing devices. This apparatus is furnished in duplicate, one set on each side of the cab, and is arranged so as to be easily manipulated from the operator's seat, while at the same time a practically unobstructed view to front and rear may be obtained from the windows. The air gauge, meters, &c., are located so as to be as easily read by the driver. There is a central corridor extending through the cab so as to permit access from the locomotive to the cars behind, and the contactors, rheostats and reversers are arranged along the sides of these corridors in boxes of sheet steel, which are sheathed on the inside with fire-proof insulating material. All of these appliances are, therefore, easily accessible for repairs or inspection.

The control system permits three running connections—namely, four motors in series, two groups of two in parallel series and all four motors in parallel. The motor reverser, contactors, rheostats and other controlling appliances are all of the well-known Sprague-General Electric multiple-unit type. The master controller (Fig. 4), however, is fitted with a special operating lever about 24in. long and capable of being moved through an angle of about 75deg. A current limiting device is provided in the master controller and consists of a friction clutch operated by an electric magnet, which is energised by the current passing through one of the motors, the arrangement being such that when the current exceeds a predetermined amount the cylinder cannot be rotated further until the current has fallen sufficiently to allow the relay to drop. As long as the current does not exceed the desired limit, the automatic feature is not in operation.

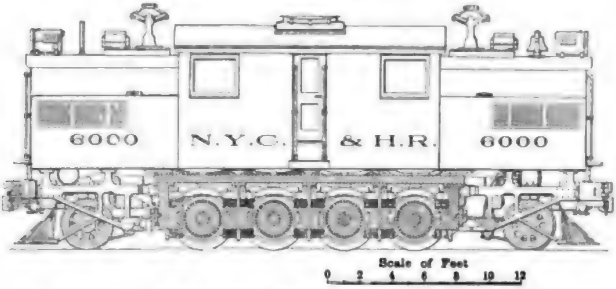


FIG. 3.—SECTION OF ELECTRIC LOCOMOTIVE.

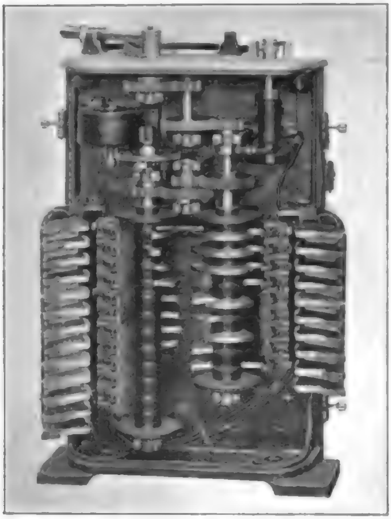


FIG. 4.—MASTER CONTROLLER.

In the operator's cab there is placed a General Electric motor-driven air compressor having a capacity of 75 cubic ft. of free air per minute and consisting of a twin vertical cylinder compressor driven by two 600-volt direct-current series motors. The compressor is controlled by a governor which automatically cuts the motors in and out of circuit when the air pressure falls below 125lb. or rises above 135lb. A reduction in air pressure sufficient to actuate any governor starts up the air compressors in both locomotives simultaneously when running double-headed, and likewise when the air pressure has been raised and any one air compressor is closed down the other will be cut out of service. The locomotive is equipped with Westinghouse air brakes.

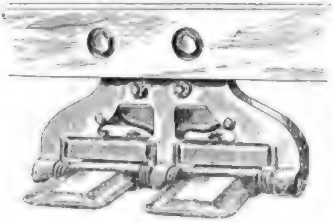


FIG. 5.—THIRD-RAIL SHOE.

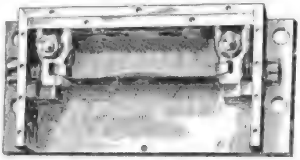


FIG. 6.—MAGNETIC-RIBBON FUSE.

Current is collected from the third-rail by multiple-contact, spring-actuated third-rail shoes (Fig. 5) whose supports are carried on channel irons attached to the journal box. There are four of these shoes on each side of the locomotive. Part of the third-rail is left exposed and part of it is protected by a hood. The region around Hoffmans is noted for heavy snow and high winds. In the yards at the terminals the large number of switches and crossings necessitates an overhead construction in places, and additional contacts are, therefore, mounted on the top of the locomotive for collecting current when the locomotive is passing over these points. This device may be raised and lowered by air pressure controlled from the engineer's cab. A magnetic ribbon fuse (Fig. 6) is placed in circuit with each shoe and overhead contact device, so as to secure protection in case of accidental short-circuit.

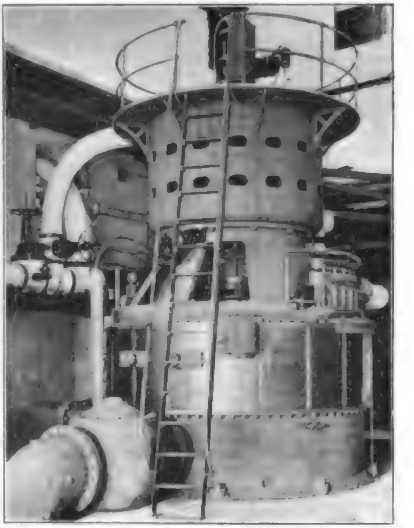


FIG. 7.—CURTIS TURBO-GENERATOR AT THE POWER HOUSE.
2,000kw., 25 ~ per sec., 11,000 volts.

Google

Current for operating the locomotive is furnished by the General Electric Co., and for this purpose there has been installed in the new power house at Schenectady a 2,000kw. three-phase 25-cycle Curtis turbo-generator (Fig. 7) delivering 11,000 volts to the line. A special high-tension transmission line has been constructed from the power station for a distance of 5 miles to the sub-station at Wyatts. This sub-station contains a 1,500kw. 650-volt 25-cycle General Electric rotary converter with three static air-cooled transformers for reducing the line potential from 11,000 to 460 volts, and a switchboard consisting of a 600-volt direct-current rotary converter panel, an alternating-current starting panel and a high-tension panel with electrically-operated type-H oil switch. The rotary converter is self-starting from the alternating-current end, thus requiring no synchronising or other complications when throwing the machine into service. The step-down transformers are provided with taps giving one-third, two-thirds and full voltage for starting the rotary converter, these voltages being applied successively by means of double-throw lever switches. The machine starts freely and easily without sparking and without drawing more than full-load current from the line. The apparatus in the sub-station, the location and arrangement of same, the width and dimensions are in general as proposed for the sub-stations to be built within the electric zone at the New York City terminal, so that practical experience with the plant may be obtained while the locomotive tests are being made and in advance of construction.

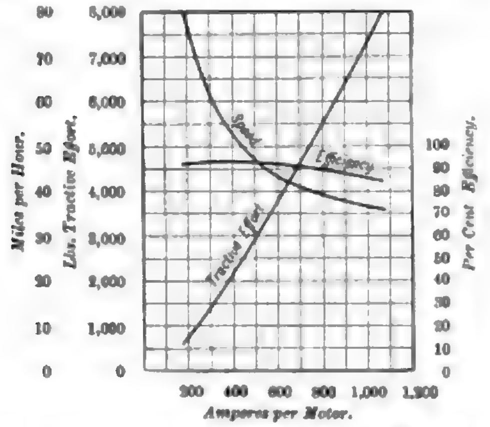


FIG. 8.—CHARACTERISTIC CURVES OF G.E. 84 MOTOR 600 VOLTS, DIAM. OF WHEELS 44in.

Owing to the fact that only a portion of the 6-mile track to be used for testing is available as yet—about 4 miles—no complete locomotive tests have been made. There has been installed in the cab a full set of recording instruments, and records have been obtained of some of the preliminary runs made to test the bearings and running qualities of the locomotive. The curves of Figs. 8 to 11 relate to an eight-car train weighing 336 tons, and a four-car train weighing 170 tons, both exclusive of locomotive. The total weight of train, including locomotive and passengers, was 431 and 265 tons for the eight-car and four-car trains respectively.

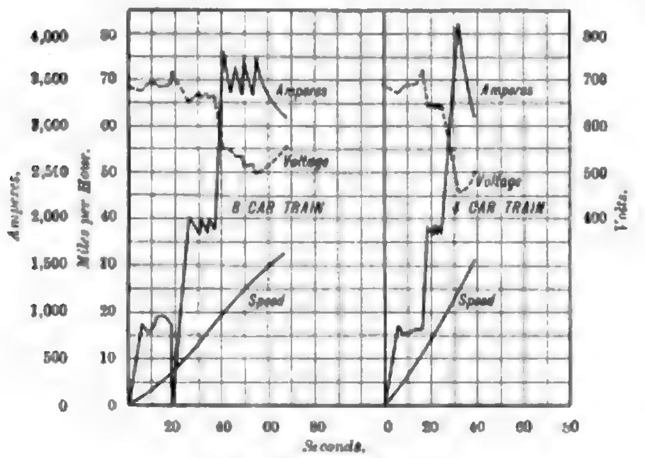


FIG. 9.—STARTING TEST.

Two sets of curves are shown, two running tests reaching as high a maximum speed as possible with the length of track available, and two sets of starting tests showing the more rapid rate of acceleration possible with the higher maintained voltage available near the sub-station. The maximum speeds reached were 68 miles per hour with an eight-car train and 72 miles per hour with a four-car train. It will be noted that the trains were still accelerating at these speeds, but the length of track so far equipped did not permit attaining higher speeds.

In the starting tests a speed of 30 miles per hour was reached in 60 seconds with an eight-car train weighing, including the locomotive, 431 tons, corresponding to an acceleration of half a mile per hour per sec. During certain periods of the acceleration the increase in speed amounts to 0·6 miles per hour per second, calling for a tractive effort of approximately 27,000lb. developed at the rim of the locomotive drivers. This value was somewhat exceeded with the four-car train, where a momentary input of 4,200 amperes developed a tractive effort of 31,000lb. at the drivers with a coefficient of traction of 22·5 per cent. of weight on drivers. The average rate of acceleration with the four-car train, weighing, including the locomotive, 265 tons, was 30 miles in 37½ seconds, or 0·8 mile per hour per second, calling for an average tractive effort of 22,000lb.

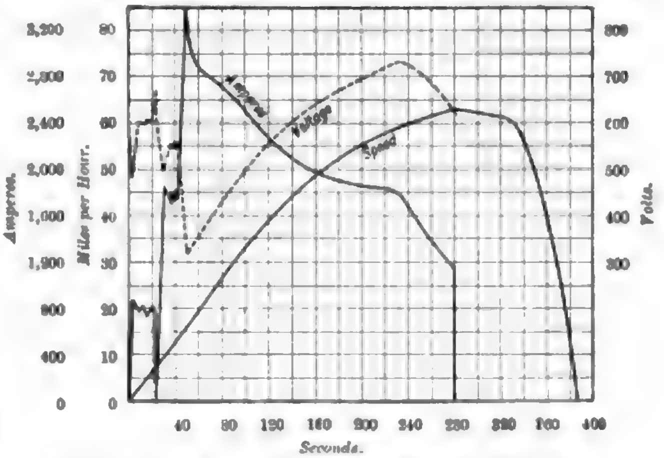
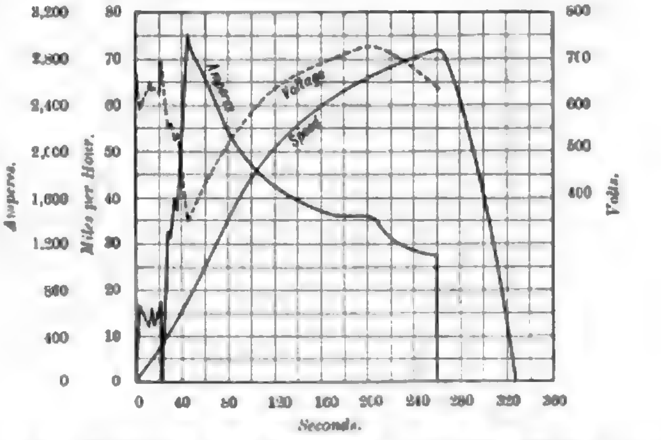


FIG. 10.—PRELIMINARY SPEED RUN NO. 1. 8-Car Train, 336 Tons, Locomotive 95 Tons, Total 431 Tons. Diam. of Driving Wheels, 44in.

The maximum input recorded, 4,200 amperes at 460 volts, or 1,935kw., gives an output of the motors of 2,200 H.P. available at the wheel. With 4,200 amperes and a maintained potential of 600 volts there would have been an input to the locomotive of 2,520kw., corresponding to 2,870 H.P. output of the motors. Reference to the motor characteristics shows a maximum efficiency of approximately 93 per cent., this value being fully 4 per cent. better than possible with motors of the geared type. This gain is especially noticeable at the high speeds, the efficiency curve remaining above 90 per cent. even at the free running speed of the locomotive alone, in contrast to the 85 per cent. or less which would be a good showing for a locomotive provided with geared motors.



NO. 11.—PRELIMINARY SPEED RUN NO. 2. 4-Car Train, 170 Tons, Locomotive 95 Tons, Total 265 Tons. Diam. of Driving Wheels, 44in.

Compared with existing steam practice, it is interesting to note that the heaviest "Atlantic" type locomotive of the New York Central Co. weighs approximately 150 tons, including the tender, on which but 47 tons are on two pairs of drivers. It will, therefore, be seen that for every pound of effective drawbar pull the steam locomotive has a weight of over 12lb., as compared with but 6lb. with the electric locomotive. Therefore, in a single electric unit, over 25 per cent. greater weight is available for traction than with the largest steam passenger locomotive now in use, with 37 per cent. less dead weight and with 28 per cent. less weight on each axle.

A question that arises in connection with the application of electricity to the heavy service of the New York Central is that of heating. It is expected that in the majority of instances sufficient heat will be retained in the trains delivered to the electric locomotive at the end of the steam run to carry the cars to the terminal without any additional heat from the locomotive. To meet an emergency or contingency of this kind, however, it is probable that a flash boiler of the automobile type will be used on the electric locomotive, occupying but a small space in the operator's central cab, where at present a good deal of room is available. It will be understood that for the ordinary suburban service of the company within the electrical area, the usual electric heating equipment now familiar on street cars will be installed. But, of course, at this early stage, all kinds of passenger cars will be coming in as usual over the New York Central from foreign systems where electric traction has not yet been adopted, and for these at least some such provision as that noted above is in contemplation.

THE COMBINATION OF DUST DESTRUCTORS AND ELECTRICITY WORKS ECONOMICALLY CONSIDERED.*

BY W. P. ADAMS.

(*Continued from page 350.*)

I will now proceed to lay before you the results of investigations I have recently had occasion to make while preparing a large scheme for combined works. While gathering information as to the actual quantities of electricity generated from refuse over a period of one year from the larger London and provincial installations, it became apparent that the average figures recorded in Table B, column 21, did not represent the ultimate value of the refuse. To take an instance, the electricity works at Fulham are alternating, and the day load is small even in winter. In summer the load is still smaller, and the peak load of short duration. Where some 120 tons of refuse are burnt per diem, any substantial increase in the rate of burning during the peak is, as I have indicated, inadmissible; at Fulham there is no increase. It was therefore plain that if an all-the-year-round figure of some 26 units per ton was obtained, this value must at times be largely exceeded, for it was certainly not reached in summer and on the small day load. I therefore set to work to plot out curves so as to gather some indication of the ultimate value to be anticipated. One curve led to another, and I have now to show you quite a representative collection. I shall only have time to deal with the five London combined undertakings and one or two provincial.

Specially arranged tests of steam generation give as a rule from 1lb. to 2lb. of steam per pound of refuse, and on the assumption that these figures could be maintained in practice, various ingenious estimates have been made showing fine values; but so many factors come into play under working conditions that are non-existent in tests, that such calculations may well be received with some scepticism. Under ordinary working conditions from 20 to 40 units per ton are often obtained, and occasionally claims are made that better values are being secured and from 50 to 60 units per ton are mentioned with diffidence, as figures that will probably be received doubtfully.

Shoreditch.—The Shoreditch Vestry adopted the first combined destructor and electricity works to supply more light, more power to the inhabitants. Their wisdom has often been called in question. Besides the awkward arrangement of the accounts, another matter which gave rise to no little controversy was the impression gained, how I know not, by some vestrymen and others, that the works would be able to supply all the requirements of Shoreditch without the use of coal—a very evident absurdity. I hope it is now generally recognised that only in the case of new works

Table B.—*Electricity obtained from Refuse.*

	Name of town.	Year.	Tons of refuse burnt.	Other purposes besides generating electricity for which steam is supplied.	Is steam or electricity generated from refuse used separately?	Coal burnt in electricity works.	Coal used for generating steam for other purposes.	Quality of coal		Lbs. coal per unit generated independently of dest'r.			Average steam used per unit generated.		Units generated exclusively from coal.	Units generated exclusively from refuse.			Est'd. ultimate value if all heat utilised in gen'g.		Units per ton of refuse burnt.		
								Name.	Cost per per ton in bunkers.	Winter.	Summer.	Av. for year.	Coal.	Refuse.		Total.	Units used in fan motor.	Net total.	Tons.	Units generated.	During year, net.	Jan., '04, engnrs' estimate.	All rfuse utilised. (Est'd.)
London	Shoreditch	1902-3	25,720	Bath and laundry Library heating Deep well pump	No	Tons. 6,376	Tons. 676	Welsh smokeless	21/8	..	..	9	Lbs. ..	Lbs. ..	1,420,000	633,958	100,000	533,958	26,000	1,000,000	21	31	38
	"	1903-4	26,201		..	1,344	..	..	19/6	..	..	8	..	..	879,000	849,140	105,000	744,140	..	..	28·5	..	..
	Stepney	1902-3	41,250	Clinker hoist	Yes	2,341	None	Welsh smokeless	20/11	5 3–6	6–8	7·13	50	60*	780,279*	1,168,627	..	1,168,627	42,000	1,680,000	28·3	40	40
	Fulham	1902-3	30,200	Disinfector Brick making plnt Clinker [illegible] plnt	No	1,920	..	Derbyshire	13/5	8	12	9·4	50–60		461,135	791,200	..	791,200	26,000	1,870,000	26·2	45	52
	Hackney	1902-3	34,006	None	Sometimes	1,255	None	Scotch	13/6-14/8	4·5	6·7	5	27–35		568,584	1,380,399	124,223	1,256,176	38,000	2,436,000	37	45	64
	Bermondsey	1902-3	13,506	Baths & wash houses	No	400	400	Welsh steam Hard steam	21/2 16/3	(esti mtd.)		9·4	50		Nil	436,157	25,600	410,557	14,000	1,200,000	20·8	..	86·5
	Woolwich	..	..	Disinfector & brick-making	..	..	..	..	..	..	..	..	..		..	..	..	..	..	..	..	..	70‡
Provinces	Shipley	1902-3	6,585	None	No	1,402	..	Smudge	7/-	7	11·8	11·4	..		274,500	196,000	..	196,000	6,500	260,000	30	40	40
	Beckenham	1902-3	7,105	None	No	1,277	..	Welsh	24/9	..	..	..	..		..	..	21,000	..	7,500	127,500	..	..	17
	"	1901-2	7,000	..	..	..	..	..	..	..	..	..	..		167,000	90,000	..	..	..	..	12·8	..	..
	Partick	1902-3	13,500†	None	Sometimes	225	..	Scotch bitumen	8/-	..	..	9·1	..		55,494	398,862	..	398,862	13,500	500,000	29·6	..	37
	Nelson	1902-3	6,658	Disinfector & mortar mill	No	1,040	..	Burgy slack	8/8	..	..	23	105		98,263	266,000§	..	..	6,700	268,000	40	..	40
	[illegible]	1903	5,486	None	No	75	..	Slack	8/-	10	..	12	80		14,000	140,000	..	140,000	5,500	182,000	25·5	..	33
	Gloucester	1902-3	7,800	None	No	1,280	None	Slack	10/-	5–6	10–12	15‡	..		180,000	149,591	est. 30,000	119,591	8,000	450,000	15·3	..	56
	Grays	1902**	2,886	None	No	348	..	..	..	8–10	9–14	9·5	..		82,360	85,606	..	85,606	2,500	75,000	15·0	..	30
	"	1903-4	2,383	None	No	326 60¶	..	Coal Coke breeze	17/6 6/6	..	..	9·0	..		88,500	50,100	..	..	..	..	21·0	..	..
	St. Helens	1901-2	10,864	3 mortar mills and steam winch	Yes	..	..	..	..	..	..	..	..		1,078,928	401,818	64,000	337,818	..	..	31	..	..
	Wimbledon	1902-3	9,000	Sewage pumping & hospital heating	No	..	5	..	21/6	..	..	..	..		..	None	..	..	9,000	300,000	..	..	33
	[illegible]	1902-3	11,945	None	No	316	..	Local steam	10/6	5	..	6·5	..		109,612	126,000	..	123,000	12,000	250,000	10·6	..	21
	Bangor	1902-3	2,505	None	No	400	None	Coke	13/3	..	..	17·2	..		91,487	43,513	6,000	37,513	2,500	52,500	15	20	21

* Inc. [illegible] and clinker hoist. † Inc. [illegible] from 1[illegible] tons burnt at destructor. ‡ Winter only. § Inc. 7,800 units gen. in destructor turbine. ‖ Assuming ½ refuse burnt usefully. ¶ Coke breeze taken = half value coal = 30 tons. ** Jan.-Dec.

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* Abstract of a Paper read before the Institution of Electrical Engineers Dec. 15.

starting on a small load, can a combined works be expected to run without coal, and that the second year of running is almost certain to bring a larger load than the destructor can cope with unaided.

As to the results obtained in the generation of electricity from refuse-raised steam I have little to add to Mr. Russell's figures of 1899 given to the Institution of Civil Engineers, for under the conditions of working it has not been possible to separate between refuse and coal-generated units. I have one curve, however, that is of interest; Fig. 2 shows the output for December 16, 1903, and is a typical winter day load. Below is plotted Mr. Russell's historical curve of a day's test in 1899; it will be observed that the maximum value of the refuse was 55 units per ton, and that during the test the full value of the refuse was not obtained owing to the smallness of the load for the greater part of the day. The dotted line shows the rate of burning now in vogue throughout a winter day, assuming a value of 55 units per ton. It will be seen that the load has enormously outgrown the capacity of the refuse, and that therefore its full value should now be obtained. The summer load is also considerably beyond the capacity of the refuse. At the time of Mr. Russell's test all steam was being used for generating electricity, while this is not the case now; in fact, a large and unknown quantity is supplied to the baths and washhouses, heating apparatus in the library, and to a deep-well pump. The whole of the exhaust steam is supplied to the baths gratis, and live steam, which is supplied *ad libitum*, is credited at £248 per annum. Steam for library heating is credited at £15 per annum; and that supplied to the deep-well pump at the baths at 1s. per hour. The whole credit for these purposes amounted for the year ending March 31, 1903, to £302. When it is remembered that the Shoreditch Baths are amongst the largest in London, and that the average coal consumption at the baths at Islington, Camberwell, St. Mary's, Westminster, and St. George's, Hanover-square, amounts to £700 per annum, it will be seen how inadequate £248 per annum is for Shoreditch.

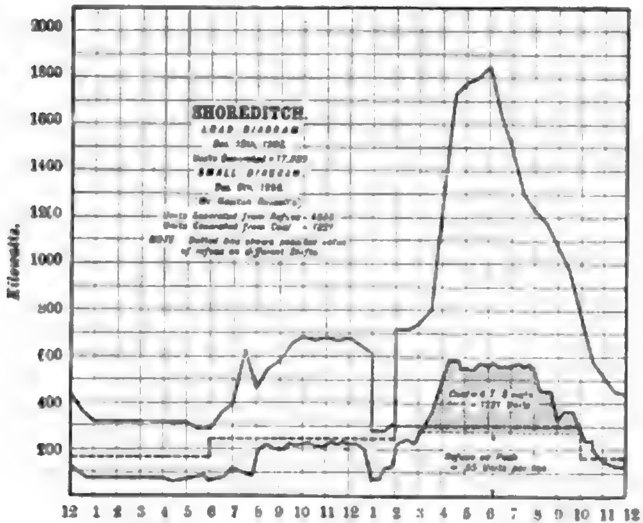
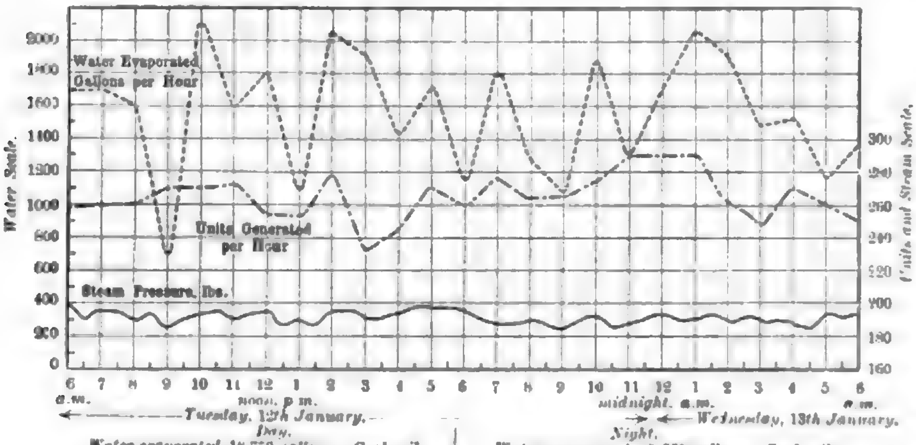


FIG. 2.



Day.
Water evaporated, 18,750 gallons. Coal, nil.
Units generated, 3,124.

Night.
Water evaporated, 15,560 gallons. Coal, nil.
Units generated, 3,240.

FIG. 3.—Chart showing 24 hours run at Destructor, water evaporated, steam and units generated
Five Boilers, viz., Nos. 1, 2, 3, 4, 5. Ten Furnaces, viz., Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.
9 inch Steam Main.

I have endeavoured to arrive at some idea of the true value of the electricity generated in the year from refuse. I do not think, in the light of Mr. Russell's figures for the test year, I should be justified in taking the average coal consumption per coal-generated unit at more than 9lb.—8 was the figure in the test year. Allowing £700 as the value of steam given to the baths, and accepting £15 for library heating and £39 for pumping as fair allowances, some 6,376 less 676 tons of coal will give 1,420,000 units generated leaving a balance of 633,958 (out of a total for the year of 2,053,958) as generated from refuse, or 21 units per ton net—*i.e.*, after deducting units supplied to fan motors: this result was exceeded in the test year by some 7·5 units per ton. 2s. per ton is allowed by the Scavenging Department for destroying the refuse; adding this to other receipts and deducting the total from the total cost of destruction, a balance of £3,755 remains, and this was debited to the electricity works as the coal value of the refuse. At 9lb. of coal per unit generated the coal cost is 1·04d.; £3,755 represents 1·42d. per refuse generated unit—a considerable overcharge.

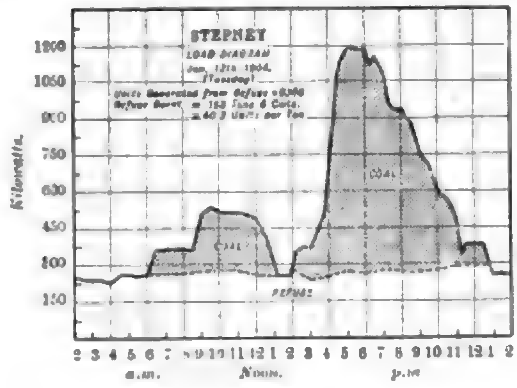


FIG. 4.

If 1·04d. be correct, the total charge would be £2,750, which is equivalent to 25·6d. per ton of refuse burnt; on this basis the Scavenging Department should allow Mr. Russell 2s. 4½d. per ton instead of 2s. Assuming also that the baths should pay £700 per annum instead of £258, and adding £201 for the disposal of trade refuse, the revenue without credit from the Scavenging Department would be £3,705, or 34·6d. per ton of refuse burnt; should the library heating and deep-well pump credits be inadequate, this figure should be increased.

Stepney.—Stepney does not present the same difficulties as Shoreditch, as the whole of the steam available outside the destructor is supplied to the electricity works. The destructor at Stepney is independent of the electricity works and is under the management of the surveyor, Mr. Jameson. The buildings are on the same site, and the steam main between them is about 200ft. in length. The destructor furnaces are of the same type and general arrangement as at Shoreditch—12 Manlove Alliott cells and six Babcock boilers. The blast is from steam-driven fans and there are no economisers, the boiler feed is therefore cold; besides the fan engines and a steam-driven clinker hoist there is no other machinery at the destructor. The generators at the electricity works are direct current, with high-speed vertical engines, non-condensing; the exhaust steam is partially utilised by feed heaters, and separate steam mains are provided for the destructor steam; generally one generating set is run throughout the day (24 hours) on destructor steam alone. A small battery only is in use.

The whole of the steam available from the refuse is not utilised at present, owing to the system of running on one generator. During hours of light load this takes the whole output of the works, and as the load varies the steam generation is varied to suit; when the load is light the surplus heat from the cells is bye-passed to the chimney. It will be seen that in course of time this waste should cease, as the generator will always be running at full load; even then some waste may occur, as often the available heat at the destructor is considerably in excess of the capacity of the one generator.

On January 12 and 13, 1904, Mr. Jameson took a set of readings at the destructor and set them out in the form of a curve (Fig. 3), which I am privileged to reproduce. The upper line gives water evaporation per hour, the middle line kilowatts, and the lower steam pressure. Seeing that for several hours during the day the heat from the furnaces had to be bye-passed to prevent blowing off, the regularity of the steam pressure is very creditable, the extreme variations being from 185lb. to 200lb. The variations in the supply of feed water are very considerable, and would appear to confirm my opinion that with larger load and a more elastic method of utilising the steam higher results would be obtained electrically. The results, however, are fairly satisfactory in view of the manner of working, and bearing in mind that economisers are not used, that the feed is cold, and that the engines are run non-condensing. The output for the 24 hours gives 40·2 units generated per ton, the water evaporated 1·05lb. per pound at a feed temperature of about 50°F., and a water consumption of 58·7lb. of water per unit generated. This figure of water consumption includes boiler feed pumps, fan engines, clinker hoist, and also condensation in the 200ft. of steam main. The water consumption in the electricity works averaged about 43lb. per unit generated, including steam to boiler feed pumps, in the same week—the various losses therefore represent 27 per cent. of the total steam generated; assuming that the fan-blast could be run on 10 per cent. and the clinker hoist 5 per cent., the remaining 12 per cent. represents condensation losses. Mr. Tapper states that the steam is often very wet. The water evaporated by the destructor during the year gave an average figure of 72·5lb. per unit generated.

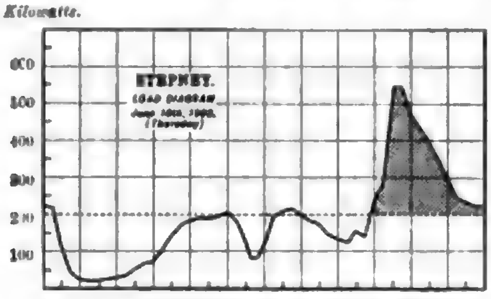


Fig. 5.

To illustrate the relation between the refuse value and electricity works load I have prepared a diagram for January 12th (Fig. 4); the uniform value of the refuse throughout the day is noticeable, and it will be seen that only during the small hours of the morning and the dinner hour can the refuse steam be counted upon to carry the station output. It would appear from this diagram that the ultimate value of the refuse had been realised, but with a different system of running I think we may fairly conclude from Mr. Jameson's figures that a better result may be anticipated; in summer also there are several big gaps in the load, as the curve for June 18th (Fig. 5) will indicate. The solid line is the station output, and the dotted line the approximate value of the refuse under the present arrangements. The quantity of refuse destroyed and also its quality in summer and winter is unusually uniform, and Mr. Jameson considers that its average value all the year round may be taken at 1·2lb. per pound from and at 212°F. The load curve for the year (Fig. 6) is remarkably like the day curve for its uniformity; the small difference between the summer and winter values is readily accounted for by the gaps in the summer load referred to. It would appear that the present value of 28·5 units per ton would readily rise to 40, the ultimate value estimated by the engineers, and if improved methods are adopted this might easily reach 50.

It is a convenience to the electricity works when the whole load of the station is being carried by the destructor to be able to rely upon the supply of steam, and, when variations in the load or quality of the refuse result in a shortage of steam, coal is burnt in the destructor boilers; in the year under review 290 tons were so burnt, and probably with better economy than if steam had been kept up in coal-fired boilers. The destructor costs come out second best in the London combined stations, and it is of interest to observe that the costs at the old destructor on the same site came to about 3s. 6d., or about 1s. per ton more. The present credit by the electricity works to the destructor is 0·5d. per unit generated. During the year 1902-3 the charge was first 0·3d., and then 0·5d., the average working out at 0·408d.; seeing that the cost of coal per unit generated during the same period was 0·8d., the credit was hardly adequate, as the committee has recognised by fixing the price at 0·5d. The capital charges on the destructor installation, including boilers, pumps, steampipes, &c., amount roughly to 0·2d. per unit, so the benefit of the destructor steam is divided equally between the destructor and the electricity works.

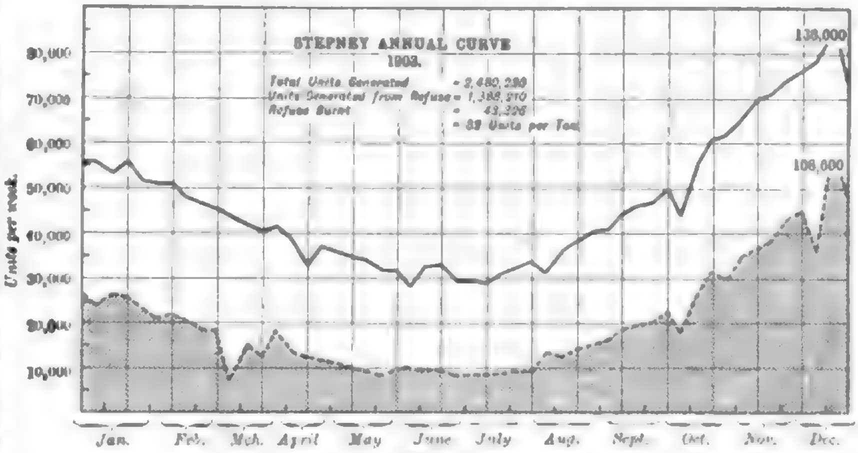


Fig. 6.

As the two works are, to all intents and purposes, independent undertakings, there are no savings in capital cost; on the contrary, assuming that one boiler would have been required in any case for the destructor and two of the remaining five have been saved to the electricity works, three extra boilers have been put down; there is also some extra cost in the steam mains between the works and in the pumps and water-softening apparatus. The old destructor chimney stack, though a source of saving at the first, is not so now, as a second stack has been built for the electricity works.

Fulham.—These works were started in December, 1900, and the first supply of steam from the destructor boilers was given in February, 1901. The electricity works plant is two-phase alternating, the engines are horizontal by Musgraves, and, so far as possible, are run condensing. In addition to three 800kw. generators there are three 100kw. direct-current exciters, used largely for lighting the works and driving motors on the works. There are five 20 H.P. electrically-driven centrifugal pumps, one deep-well 20 H.P. electric pump, four 10 H.P. motors for driving mechanical stokers and coal conveyor, two 5 H.P. motors for driving economiser scrapers, and there has recently been added a 30 H.P. Bellis engine operating a fan at the base of the chimney stack for assisting the draught; this runs continuously, sometimes non-condensing. The destructor consists of 12 Horsfall cells in two groups of six,

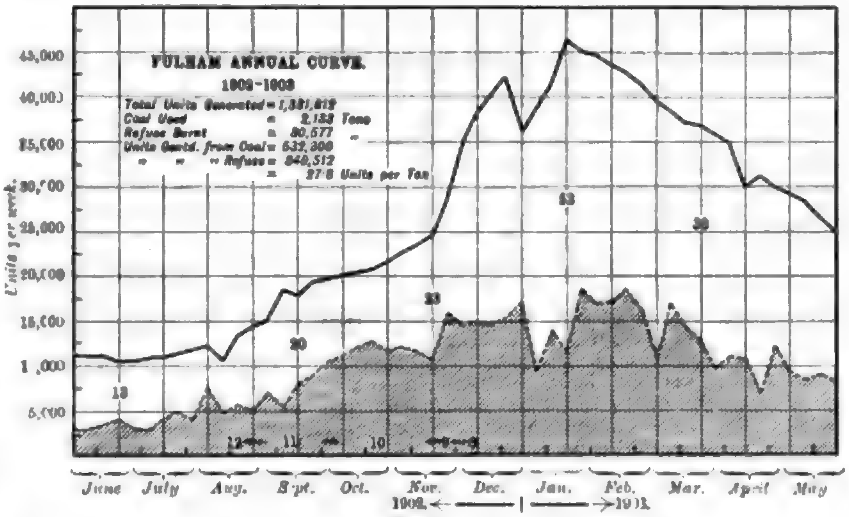


Fig. 7.

arranged back to back in threes. Between the two groups there are six Babcock boilers. Mechanical stokers are provided, and much care has been taken to render the fronts of the boilers airtight when under steam from destructor gases. The main flue is of considerable length. Blast is provided to the destructor cells by steam jets of the usual Horsfall type, and on test the steam consumption was 17·8 per cent. of the total steam generated. Economisers are provided in the main flue. At the outset the six destructor boilers were the only boilers installed; three marine-type dryback have been added. In addition to the electric generators, a supply of steam is given to a steam disinfector some 40yds. away, also to a clinker-crushing and brick-making plant. The clinker crusher is driven by an 8 B.H.P. simple vertical engine. This engine is run 54 hours per week, and is supplied through 80ft. of 1¼in. steampipe not lagged; it probably does not take less than 50lb. of steam per brake-horse-power-hour. The brick-making plant takes an unknown quantity of steam; the disinfector is generally in use some hours every day, and, although not liberal, £150 per annum is a fair charge for steam supplied. The Bellis fan engine is supplied through 100ft. of branch piping, and probably takes 80lb. of steam per brake-horse-power on the average; this plant was started in October, and has been running continuously since November, 1903.

I have gone into some detail with regard to the plant installed, as this has an important bearing upon the results. The steam-raising test when the plant was newly installed gave 1·15lb. of steam per pound of refuse. The load was absorbed electrically, and an average of 60 units per ton was obtained throughout a day's run.

The water consumption is not often measured, a large part being taken from a deep well in the works, but a test was taken in October, 1903—when the destructor was not running—from 2 p.m. on Saturday to 9 a.m. on Monday, and the average water consumption was 59lb. per unit generated. The steam disinfector, the brick-making plant and the clinker-crushing engine were shut down during this test, but the Bellis fan engine was in use.

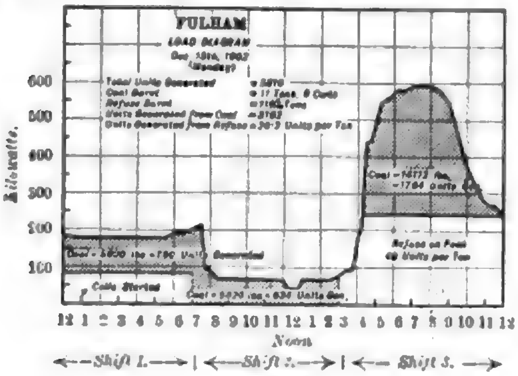


Fig. 8.

In the case of Fulham my investigations began with a curve for the year 1902-3 (Fig. 7). The average units per ton given me by Mr. Fuller over the year ending March, 1903, amounting to 25·5, aroused my curiosity as to the relative figures obtained in summer and winter. I judged from the arrangement of the plant and the smallness of the day load in summer that probably the 25·5 units would be largely exceeded, and when the curve was set out and the carefully-estimated coal value filled in, my suspicions were amply confirmed. I have taken great pains to obtain correct coal values, and although the average works out at 9lb. per unit generated, I am satisfied that this is correct. In the earlier part of the year—from June to September—I have ample evidence to show that 12lb. of coal were used per unit generated. From September to November the condensing plant was out of use, and the coal consumption has been taken at 10lb. per unit; from November onwards 8lb. is the ascertained figure; and, in view of the water-consumption test in October, 1903, I have taken this value in all the later day-load curves. I wish to draw special attention, while this annual curve is before you, to the increasing value obtained as the output grew. It is also important to observe that the whole of the coal consumed on the works has been plotted, and that steam supplied to the clinker, brick plant, and disinfector is *not accounted for* in the diagram. The Bellis fan engine had not been installed at that period. The large dip in December is caused by the Christmas holidays; the big rise between January 15th and 22nd is due to the switching on of 100 extra arcs for the street lighting. This increased public lighting load has doubtless some bearing on the fine results now obtained. In view of the undoubtedly very heavy water consumption when the destructor is working, 58 units per ton throughout the week is a very fine record figure.

As the refuse is delivered it is tipped on to a platform above the cells and burnt steadily throughout the 24 hours, no attempt being made to burn extra refuse during the peak. The delivery of refuse begins on Monday generally about 9 a.m., and ceases about midday Saturday. The destructor is generally entirely shut down from 11 p.m. on Saturday until the early hours of Monday morning; before the new refuse begins to come in, the cells are started on such refuse as was left over from Saturday. It has been the practice since the works started to weigh carefully the coal used on each shift, so the values of the refuse are readily obtainable on each shift. It will be seen from the diagram (Fig. 8) for Monday, December 15, 1902, that the day load is small, the early morning load large comparatively, and, of course, the peak shift the heaviest. On this day the cells were started at 1 a.m., and the greater part of the load was run on coal during the first shift; on the second shift no value appears to have been obtained from the refuse, as the coal works out at about 9lb. per unit generated; 10 cwt. of the coal, however, was used for banking, and no account is taken of steam supplied to the disinfector from 9·30 to 4·45. In *all the curves no allowance* is made for steam supplied to the disinfector, brick-making plant, &c., and the coal is worked out at 8lb. per unit throughout. On Mondays a poor value is obtained for the refuse, as the whole of the cells and flues have to be heated up from cold, and on Tuesday full value does not usually seem to be obtained, although (Fig. 9) December 16, 1902, shows an almost record value. Bearing in mind the maximum of 55 units per ton obtained by Mr. Russell at Shoreditch on test, this figure of 91·5 units per ton is not a little remarkable, as it was obtained under ordinary working conditions, and until I drew out the curve such a result was not even suspected. I may say that most of the curves from Fulham were selected almost at random from the log-books, and had never been plotted before with the coal and refuse values filled in.

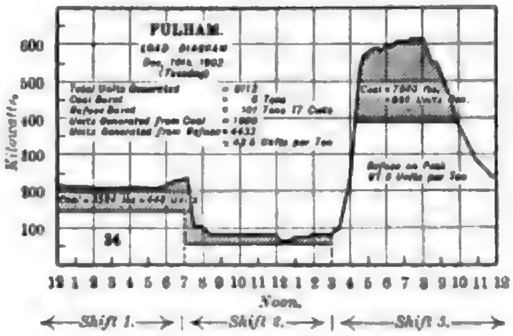


Fig. 9.

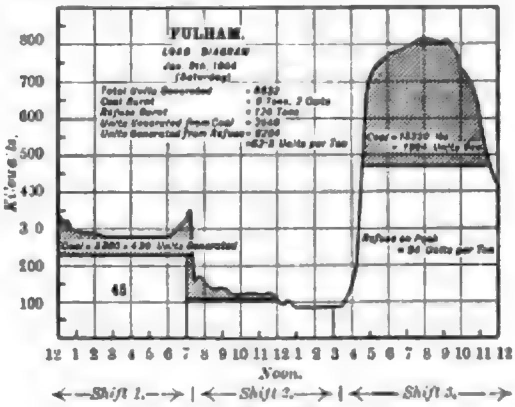


Fig. 10.

A second series of curves taken a year later showed very similar results, but the highest value obtained on the peak is 78 units per ton; the average value, however, is some five units per ton higher, notwithstanding the addition of the Bellis fan engine and of the brick-making and clinker plant. On both first and second shifts the load has largely increased, and a better value is obtained in consequence.

To bring the diagrams up to date I have prepared a series in January this year, and in these were found the best results; the average obtained for over three days—50·4 units per ton—is good, but the record value on the peak load of January 9th (Fig. 10) of 94 units per ton is very fine, and in view of the small day load an average for the day of 52·3 units is highly satisfactory. After studying these curves the first question that will be asked is, why, if such splendid results are obtained on the peak, are not better figures recorded on the two first shifts? Air leakages, I am given to understand, are largely responsible for this; troublesome cracks have been developed in the flues through the shrinkage of the soil upon which they are built, and, notwithstanding the care taken to make the destructor boiler fronts tight, considerable quantities of air pass into the flues, thus cooling the destructor gases. When the boilers are coal-fired this air is utilised in combustion in the usual way, and thus, the larger the load—*i.e.*, the more coal burnt, the better the value obtained from the refuse. The air leakages are without doubt serious, and are engaging the attention of Mr. Fuller. In addition to this, a fairly large proportion of the coal is used for banking spare boilers; this would appear to be a necessity in an alternating station where a convenient battery is not available in case of necessity. In course of time, with a larger day and early morning load, I can see no reason why the fine values obtained on the peak load should not be maintained throughout the day, and, if it were at all possible to avoid shutting down on Sundays for cleaning purposes, throughout the week. Under existing conditions, but with a large day load, I consider that some 70 to 80 units per ton ought eventually to be obtained in winter and some 50 to 60 units in summer. In deference to Mr. Fuller's wishes, I have given in Table B 52 units per ton as the ultimate all the year round average. As I have nothing at stake in the matter except perhaps my reputation as a prophet, I should have put the figure some 25 per cent. higher; the average value obtained on the peak on the 10 curves I have plotted is 75, and this at the present high water consumption.

During the year 1902-3 the clinker obtained was some 50 per cent. of the refuse burnt. Mr. Fuller tells me he has now reduced this to about one-third, and sometimes he gets as little as 28 per cent. This clinker is now being sold at a profit, so that on the present year's returns the rather heavy item for cost of disposal will disappear. The credit for electricity is about 20 per cent. less than the ascertained coal value. The costs, after deducting revenue, amount to 26·8d. per ton; this deficiency is met by a credit from the Health Department. The ultimate value of the steam based on the present coal costs amounts to about £5,000; it is probable that the cost of repairs will increase, but after making a reasonable allowance in this connection the figures would seem to justify one in concluding that when the full heat value of the refuse is utilised the Fulham destructor should earn a profit of approximately £1,000 a year after all costs of destruction have been paid. Such profit as results from the sale of clinker should be added. Fulham at present holds the record for lowest total costs of destruction in the London combined works.

(To be concluded.)

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

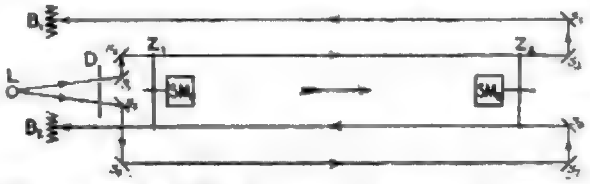
Size of Molecules.—There are five ways in which it is possible, in theory, to determine the size of molecules. These are observations: (1) on the viscosity of gases, (2) on the conduction of heat by gases, (3) on the diffusion of gases, (4) on the deviations from Boyle's law, and (5) on the volume occupied by matter in the solid and liquid states. The quantities which can be deduced from these five classes of observations depend, however, not only upon the size of the molecules, but also upon the constant N, which measures the number of molecules per cubic centimeter, in a gas at normal temperature and pressure. If we regard all molecules as spheres of diameter σ, we find that any of the first three kinds of observations give us $N\sigma^2$, while either of the last two give us $N\sigma^3$. The best experiments of either class are those on viscosity and on Boyle's law. The value deduced from the viscosity of air is $4{\cdot}92 \times 10^{19}$. The electric methods based upon the ionic charge give somewhat lower values. As regards the diameter of molecules of various gases, the author gives the following mean values among others, from the viscosity, conduction, diffusion, and Boyle's law experiments: Hydrogen 2·03, helium 1·81, water vapour 3·39, ethylene 3·81, air 2·84, oxygen 2·73, carbon dioxide 3·36, ethyl chloride 4·68, and chlorine 4·11. The fact that all molecules are assumed to be spheres introduces a large possibility of error, especially in dealing with the solid state. We cannot be surprised, therefore, at some difference between the values obtained by the consideration of the solid state and those obtained by the other methods.

[J. M. Jeans, *Philosophical Magazine*, December, 1904.]

Relative Motion of Earth and Ether.—A. A. Michelson points out a flaw in the method recently proposed by W. Wien for the measurement of the drag of the ether with the earth. The essentials in the proposed method are two Foucault mirrors or two Fizeau wheels, one at each station, revolving at the same speed. The synchronism is to be controlled by the constancy of the transmitted light. There lies the flaw, for the effect which it is proposed to measure is exactly the same as the effect on the light which is to furnish the test of synchronism. In 1887 the author proposed a method not essentially different from the foregoing, except that the control of synchronism was to be furnished by electrical methods. This was before Hertz showed that electrical impulses differ in no essential from light. Hence the same objection applied. It remains to devise a mechanical control, which might possibly not be influenced by the earth's motion. Suppose it were possible to transmit two pencils of light in opposite directions round the earth parallel to the equator, returning the pencils to the starting point. If the rotation of the earth does not drag or entrain the ether, one of the two pencils will be accelerated and the other retarded by a quantity proportional to the velocity of the earth's surface and the length of the parallel of latitude. But it is not necessary to have so wide a circuit to obtain measurable results. The pencils need only be sent in opposite directions round 1 sq. km. in order to produce a displacement of several fringes in the interferometer. A control is furnished by introducing another pair of mirrors in the path, so as to make the area of the circuit so much smaller that the displacement would be negligible. To apply the same principle to the revolution of the earth about the sun would require a circuit of 40km.

[A. A. Michelson, *Philosophical Magazine*, December, 1904.]

Relative Motion of Earth and Ether.—To determine the drag of the earth upon the ether, A. Schweitzer describes a method which requires the measurement of a difference of intensity of two patches of light to within 1 per cent. if the distance between the stations is some six miles. The apparatus is sketched in the diagram, where Z_1Z_2 are two toothed wheels as employed in Fizeau's method, B_1B_2 bolometers, $s_1s_2s_3s_4$ are mirrors, and SM_1, SM_2 are two synchronous motors which drive the wheels in synchronism. The beam of light from *l*, divided into two parallel beams by the diaphragm D, passes between the wheels in two opposite directions. The common axis of the wheels being in the direction of the earth's motion, it is supposed that one of the beams will experience an acceleration, and the other an equal retardation, and this difference would appear as a difference in the intensity of light striking the two bolometers, and hence also as a deflection. The author has not carried out the experiment on account of the cost, but he calculates the limits of accuracy attainable with modern experimental means. The difference of intensity being as high as 1 per cent., it would be easily measurable. The speed of revolution of the wheels, if they had a diameter of 50cm. and 2,500 teeth each, would have to be 300 per second.



[A. Schweitzer, *Physikalische Zeitschrift*, December 15, 1904.]

The Michelson-Morley Experiment.—E. W. Morley and D. C. Miller have endeavoured to eliminate the source of error pointed out by Fitzgerald and Lorentz in the Michelson-Morley experiment on the relative motion of the earth and ether by using a different material for the support of the mirrors. It will be remembered that the negative result of the experiment was attributed to the possibility of the dimensions of the stone slab having been changed by its drift through the ether. If the Fitzgerald-Lorentz effect exists, it may affect all materials to the same amount, independently of the nature of the material. But the effect may also depend on the physical properties of the material, so that pine may be affected more than sandstone. The author, therefore, repeated the original experiment, with the proviso that the distance between the mirrors depended only on pine-rods, while all other dimensions depended on steel. The result of the experiment was, however, again negative, the observed effect being only one-hundredth of the theoretical effect.

[Morley and Miller, *Philosophical Magazine*, December, 1904.]

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ELECTRIC TRACTION IN NEW YORK AND LONDON.

Recent progress in electric traction in different directions is illustrated by the article in this issue of *The Electrician* describing the first electric locomotive built for hauling main-line trains on the terminal divisions of the New York Central Railway, and the publication this week by the London County Council of Mr. J. ALLEN BAKER's report of his inspection of the Rapid Transit Subways of New York. Our readers will now be familiar with the principal engineering features of the last-mentioned great piece of work. We rather wish to consider now how far it can be held to serve as a model to be followed in dealing with the London traffic problem. As the chief engineer of the New York Subway is one of the technical advisers called in by the Royal Commission on London Traffic, it is quite certain that this question will be adequately considered by the Commission. Mr. BAKER's report is enthusiastically favourable, and he suggests several London routes as valuable and probably profitable, but apparently with the idea of forming connections with the surface tramways, and working the whole as one system. There are some very important differences between the traffic problem in New York and in London, and equally important differences affecting the relative cost of construction in the two cities which make a direct application of the New York example to London hardly possible. There is one matter, however, in which the New York example ought to be followed. The subway has been constructed under the direction and to the plans of a body created for the purpose by a special Act and invested with very considerable powers to enable it to perform its duties. Besides planning and entering into contracts for the construction and operation of the subway, the Board of Rapid Transit Commissioners were authorised to grant additional powers to companies already operating railroads within the city. Subject to a vote of the ratepayers, the cost of the subway construction was to be borne by the City of New York. Certain powers of approval and two seats out of six upon the board were granted to the New York Corporation. The working of the subway is to be carried out by the contracting company for a long term of years, at a rent covering the interest on the construction capital, and something more. It is the provision of an *ad hoc* body with extensive powers to deal with transit problems in the whole Metropolitan area that we hope will be applied to the London case.

The relative merits of surface tramways, deep or tube lines and shallow subway lines admit of no absolute pronouncement. Each has its place and its own duty to perform. For short-distance traffic, which forms the great bulk of the movement in the central area during business hours, the surface line is the only useful agent. Neither tunnel nor subway lines will attract the short-distance traveller even from the omnibus, and no endeavours to reduce street congestion in central London will have any great effect excepting such as will substitute quicker, less bulky, quieter and cleaner vehicles for the horse-drawn 'bus. Statistics have made it abundantly clear that neither the tube lines nor the shallow lines, such as the District and Metropolitan Railways, carry any appreciable proportion of short-distance passengers. For example, the District Railway on a certain day carried fewer than 700 third-class passengers between Charing Cross and Westminster Bridge and Victoria stations in the two directions, whilst the omnibuses between those points carried about 23,000. That there would be great difficulty and heavy expenditure in making surface tramways through central London is obvious enough, as extensive street widenings would be necessary; thus it might be preferable for financial reasons to adopt shallow subways for short distances; but the subways are at a clear disadvantage by reason of the stairs, and man's natural preference for daylight. We may say that in this matter the Boston Subway is a closer parallel to London's needs than anything in New York. The conditions have a great similarity, although on very different scales.

When we come to the long-distance traffic, the morning and evening journey between suburban homes and central work, or the getting across London, which is now so great a vexation, the case is altered. Time stands first, and no vehicle on the street can compete with the car or train in subway or tunnel. The shallow subway is preferable for ease of access, ventilation, some occasional daylight, and lower operating expenses. The points against it relate to the cost and inconvenience resulting from the wholesale disturbance of sewers, and all pipe and duct works along its course, the opening up of the street surface, or its efficient under-pinning, and the acquisition of private property wherever the route is away from a street line. This latter item will probably make the construction of shallow subways financially impracticable in London excepting upon the lines of main thoroughfares and across the parks. And unfortunately this restriction is a very serious one, especially as regards the provision of north and south lines. It will, in any case, be very difficult to make an accurate estimate of the cost of such lines, owing to the impossibility of accurate survey of all the underground structures affected. The County Council engineers have suggested £400,000 per mile of double line as a probable figure.

The cost of deep tubes is now pretty well known, and thanks to the uniformity and thickness of the London clay and the admirable suitability of the Greathead shield to its perforation, the engineering of such deep lines is fairly straightforward and the construction cost calculable; whilst the absence of interference with underground works and surface property much more than compensates for the capital expenditure on lifts and ventilation appliances. For the long-distance traffic then, we hold that, as between subways and deep tubes, the choice is mainly an economic question, but that the subway should have the preference where the difference of cost is not great, and regard should always be paid to the additional working costs due to lifts, ventilation and lighting of the tubes. It is disappointing to hear that travellers on the New York Subway are complaining of imperfect ventilation and other discomforts which were not anticipated, but we cannot suppose that these early troubles are inherent to subways or incapable of prompt remedy. Our readers may be reminded that Londoners need not look abroad for examples of either subway or tube lines. The Metropolitan was the first subway line built for city traffic, and that and the District together do not take a back place yet for extent. Their virtues have been sadly obscured by the incidents of steam haulage, but, purged as they shortly will be, there is good reason to hope that we may yet be proud of them and find them more useful than ever.

In the other direction of handling main-line traffic the great locomotive we describe represents an advance chiefly in power and dimensions. It is a direct descendant of the electric locomotives built to work the Baltimore Belt line, but designed for a much higher speed and greater hauling power. It has, however, some very interesting novelties in design worthy of study. Like those engines, it is intended for quite special conditions, and probably does not indicate the general direction of future progress in electric traction for long-distance work. As is well known, the New York terminus of the New York Central Railway is approached through lines in tunnels and cuttings, in which the smoke and steam of locomotives are highly objectionable and dangerous. The traffic is very heavy, and widening of the lines hardly practicable. Under these conditions there are very obvious advantages in the substitution of electric for steam locomotives. It is clearly desirable to make the change of locomotives on the long-distance trains at a place well clear of the heavy suburban traffic. Hence the electrification of the New York Central Railway for 34 miles on the main line and 24 miles on the Harlem branch. It was obviously necessary to give the locomotives at least equal speed to those they are to replace; indeed, if the time lost in changing engines is to be made up they must run faster, and from the tests given it is probable that they will prove fully equal to the task. This example has one point of interest as showing how it may be possible to run both main line and suburban trains on an electrified terminal section without mixing the methods of haulage, but whether this will hasten the electrification of our London suburban lines we rather doubt.

Mr. CARTER's Paper, printed in last week's *Electrician*, appears to be confirmed by this Schenectady monster; but there was no choice before the railway company. If the New York terminal had to be electrified the steam-drawn trains had to be electrically drawn. We do not think, however, that the general problem of main line passenger traffic will be put as a question of hauling long, heavy, infrequent trains. The advantages of electric traction will include that of much more frequent service (without increase of operating expenses in relation to earnings), which will certainly induce greater traffic and benefit both railway passengers and shareholders.

THE CHARGING OF A CABLE THROUGH A CONDENSER AND RESISTANCE.

BY OLIVER HEAVISIDE.

In vol. 2 of "Electromagnetic Theory" I have described in considerable detail how waves are sent along a cable, and how to calculate them. Also how to find the voltage and current impressed upon a cable by an impressed voltage in the terminal apparatus at its beginning, from which the waves mentioned are derived. There is a good deal of numerical work to be done to determine the curves of voltage and current in specified cases. It is not difficult, though sometimes laborious. In a recent article (*The Electrician*, vol. LIII., pp. 905, 954, 994 and 1,019), Mr. W. Gaye has done some of this work in a way that ought to be interesting to some of the many men all over the world who ought to be interested in this subject. The object of the present article is to promote the study of special cases numerically and graphically, especially as regards the inclusion of the self-induction of the cable, which is by no means a negligible quantity even now, whilst it ought to be a paramount agent. If it is love that makes the world go round, it is self-induction that makes electromagnetic waves go round the world.

But it is well to begin with simple cases, and then go on to the more difficult. So, first, considering no self-induction, the current sent into a cable at its beginning through a resistance r and condenser s by the impressed force e is

$$C = \frac{e}{r + \frac{1}{sp} + \left(\frac{R}{Sp}\right)^{\frac{1}{2}}}, \qquad V = \left(\frac{R}{Sp}\right)^{\frac{1}{2}} C, \tag{1}$$

where the denominator under e is the sum of the resistance operators of the terminal resistance, condenser, and cable, the last being necessarily very long, since no allowance is made for the effect of terminal reflection at the far end upon the state of things at the beginning. R and S are the resistance and condensance of the cable per unit length, and p is the time-differentiator d/dt. I am here using condensance on trial for the electrostatic capacity of a condenser, because people do not seem to care much about permittance, which I think a good name. Along with condensance goes condensivity, of course. It is by trial and error that terminology becomes established. International Conventions and Committees are not much good.

If $s=\infty$, the condenser is equivalently short-circuited, and if $r=0$ the resistance is similarly cut out. In either case only one curve requires to be calculated, as exhibited in a table by Mr. Gaye, because by altering the time-scale all other cases of a resistance alone or a condenser alone may be included. But it is different when the resistance and condenser are both on at once. Thus, put

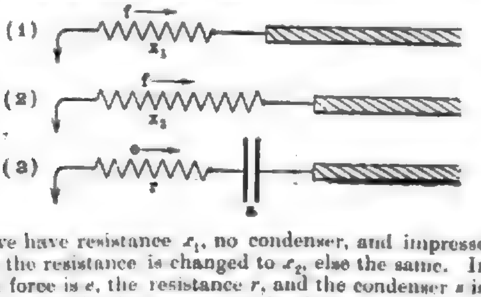
$$z = \frac{Rs}{rS}, \qquad q = \left(\frac{z}{rsp}\right)^{\frac{1}{2}}; \tag{2}$$

then

$$\frac{rC}{e} = \frac{1}{1+q+z^{-1}q^2}. \tag{3}$$

We see that by varying the constant z we change the type of the curve. Mr. Gaye has drawn the curves for several values of z; if he had given the sets of numbers as well, it would have been better still. Not to repeat too much methods described in "Electromagnetic Theory," vol. 2, it may be said that in these cases of simply formed operators, the way of algebrisation is merely to divide the numerator by the denominator, and so obtain a power series in terms of p, and then turn p^{-n} to $t^n/\lfloor n$.

Now there is a certain range for z in which we may make use of the table referred to to calculate C in the present more advanced case. This can be shown very simply.



In (1) we have resistance x_1, no condenser, and impressed force f. In (2) the resistance is changed to x_2, else the same. In (3) the impressed force is e, the resistance r, and the condenser s is put in. Let C_1, C_2, and C be the currents in the three cases. Then

$$\begin{aligned} C_1 - C_2 &= \frac{f}{x_1+\left(\frac{R}{Sp}\right)^{\frac{1}{2}}} - \frac{f}{x_2+\left(\frac{R}{Sp}\right)^{\frac{1}{2}}} \\ &= \frac{(x_2-x_1)f}{x_1x_2+\left(\frac{R}{Sp}\right)^{\frac{1}{2}}(x_1+x_2)+\frac{R}{Sp}}; \end{aligned} \tag{4}$$

and in the third case

$$C = \frac{e}{r+\frac{1}{sp}+\left(\frac{R}{Sp}\right)^{\frac{1}{2}}}. \tag{5}$$

By inspection it can be seen that the constants can be adjusted so as to make $C = C_1 - C_2$. We require

$$\frac{e}{r} = \frac{x_2-x_1}{x_1x_2}f, \qquad es = \frac{f(x_2-x_1)S}{R}, \qquad e = \frac{(x_2-x_1)f}{x_1+x_2}; \tag{6}$$

or

$$e = f\frac{x_2-x_1}{x_2+x_1}, \qquad r = \frac{x_1x_2}{x_1+x_2}, \qquad s = \frac{S}{R}(x_1+x_2). \tag{7}$$

Any two values of x being given, the corresponding r and s become known. So the required curve of current through the condenser is the difference of the curves of current in two cases of terminal resistance only. We also have

$$z = \frac{(x_1+x_2)^2}{x_1x_2}. \tag{8}$$

It follows that the least value of z is 4, or this reduction to simplicity ranges from $z=4$ to $z=\infty$. Or thus,

$$\frac{e}{f} = \left(1-\frac{4}{z}\right)^{\frac{1}{2}}, \qquad \begin{matrix} x_1 \\ x_2 \end{matrix} = \frac{z}{2}r\left\{1 \pm \left(1-\frac{4}{z}\right)^{\frac{1}{2}}\right\}. \tag{9}$$

The range from $z=0$ to 4 requires imaginary x's and f. Example,

$$\begin{matrix} x_1=100, \\ x_2=200, \end{matrix} \qquad \frac{e}{f}=\frac{1}{3}, \qquad r=66\tfrac{2}{3}, \qquad z=4\tfrac{1}{2}.$$

Since z means Rs/rS or $(R/S)/(r/s)$, the ratio r/s must be less than one-fourth of the cable ratio. So, with a fixed s, we may range r from 0 up to a limiting value; or, with a fixed r, we may range s from ∞ down to a limiting value.

The principal utility of the condenser is to curb the signals. The curbing is increased by reducing the condensance. But as this also reduces the charge and the strength of the signal, compensation by increased battery is needed. So a practical compromise has to be made.

The above being a practical simplification, what follows next relates to the general theory to exhibit the effect of z above and below the critical value and connect with other matters. Go back to equation (3). The roots of the denominator equated to zero are

$$\begin{matrix} q_1 \\ q_2 \end{matrix} = \tfrac{1}{2}\left(-z \pm \sqrt{z^2-4z}\right),$$

$$\therefore \quad q_1q_2 = z, \quad q_1-q_2 = \sqrt{z^2-4z}, \quad q_1^2 = \frac{z}{2}\left(z-2-\sqrt{z^2-4z}\right).$$

We may therefore write

$$\begin{aligned} \frac{rC}{e} &= \frac{z}{q_1-q_2}\left(\frac{1}{q_2-q} - \frac{1}{q_1-q}\right) \\ &= \frac{z}{q_1-q_2}\left\{\frac{1}{q_2}\left(1+\frac{q}{q_2}+\frac{q^2}{q_2^2}+\dots\right) - \frac{1}{q_1}\left(1+\frac{q}{q_1}+\frac{q^2}{q_1^2}+\right)\right\} \end{aligned} \tag{11}$$

The result is algebrisable at sight, as the difference of two convergent series. Now, when z is greater than 4, it represents the already described differential problem. Or, which is the same,

$$\begin{aligned} \frac{rC}{e} &= \frac{z}{q_1-q_2}\left[\frac{1}{q_2}\epsilon^{zt/rsq_2^2} + \frac{q}{q_2^2} + \frac{q^3}{q_2^4} + \frac{q^5}{q_2^6} + \dots\right] \\ &\quad - \frac{z}{q_1-q_2}\left[\frac{1}{q_1}\epsilon^{zt/rsq_1^2} + \frac{q}{q_1^2} + \frac{q^3}{q_1^4} + \frac{q^5}{q_1^6} + \dots\right]. \end{aligned} \tag{12}$$

By pairing terms, and using the values of $q_1^{2n} - q_2^{2n}$, this form may be converted to the convergent series used by Mr. Gaye, obtained by division. But as the table has been calculated to suit this case, with any two positive values of x_1 and x_2, which mean real negative values of q_1 and q_2, it is not necessary to transform further. If, however, $z<4$, it is possible that this form may also be useful, noting that it is only the real parts of the two series that are effective. The value of q^n is

$$q^n = \left(\frac{z}{rsp}\right)^{\frac{n}{2}} = \frac{\left(\frac{zt}{rs}\right)^{\frac{n}{2}}}{\lfloor \frac{1}{2}n}. \tag{13}$$

When we transform (12) to divergent form, it makes

$$\frac{rC}{e} = \frac{z}{q_1-q_2}\left[\left(\frac{1}{q}+\frac{q_1^2}{q^3}+\frac{q_1^4}{q^5}+\dots\right) - \left(\frac{1}{q}+\frac{q_2^2}{q^3}+\frac{q_2^4}{q^5}+\right)\right] \tag{14}$$

This is done by using the generalised exponential formula, remembering that q_1 and q_2, when real, are negative. It goes equally well when they are imaginary, with real parts negative.

It is remarkable that the series in (12), involving the odd powers of q, contain an oscillating part when $z<4$. For we may write (12) thus:—

$$\begin{aligned} \frac{rC}{e} &= \epsilon^{\frac{(z-2)t}{2rs}}\left[\cos + \frac{z}{(4z-z^2)^{\frac{1}{2}}}\sin\right]\frac{t}{2rs}(4z-z^2)^{\frac{1}{2}} \\ &\quad + \frac{z}{q_1-q_2}\left[\frac{1}{z^2}(q_1^2-q_2^2)q + \frac{1}{z^4}(q_1^4-q_2^4)q^3 + \dots\right]. \end{aligned} \tag{15}$$

But since there is no self-induction, there can be no oscillations in C. So the second line really involves an oscillating part which is the negative of the first line, the remainder being non-oscillatory. It is by conversion to the divergent form (14) that we get rid of the redundant mutually cancelling oscillations. Furthermore, by pairing terms to get rid of the powers of q_1 and q_2, (14) may be converted to the divergent series used by Mr. Gaye.

The singular case $z=4$ makes $q_1=q_2$, and $x_1=x_2$. There is another case of simplification, viz. $z=2$. Then $q_2^1=-1\pm i$; $q_1^2=-2i=-q_2^2$; $q_1^4=q_2^4=-4$; $q_1^6=8i=-q_2^6$; $q_1^8=q_2^8=16$; $q_1^{10}=-32i=-q_2^{10}$ and so on. Also $q_1-q_2=2i$. These reduce (15) to

$$\frac{rC}{e}=\sqrt{2}\cos\left(\frac{t}{rs}-\frac{\pi}{4}\right)-\sqrt{2}\left\{\left(\frac{1}{rsp}\right)^{\frac12}-\left(\frac{1}{rsp}\right)^{2\frac12}+\left(\frac{1}{rsp}\right)^{4\frac12}-\dots\right\},\tag{16}$$

where

$$\left(\frac{1}{rsp}\right)^{n}=\frac{\left(\frac{t}{rs}\right)^{n}}{\underline{|n}}.$$

Now this special formula is an interesting example of the generalised cosine series, namely

$$\cos\left(x-\frac{n\pi}{2}\right)=\dots-\frac{x^{2n-2}}{\underline{|2n-2}}+\frac{x^{2n}}{\underline{|2n}}-\frac{x^{2n+2}}{\underline{|2n+2}}+\dots,\tag{17}$$

the series to be made complete both ways, x being real positive and n any number from $-\infty$ to $+\infty$. We are concerned at present with the value $n=\frac12$. It makes

$$\cos\left(x-\frac{\pi}{4}\right)=\dots-\frac{x^{-1\frac12}}{\underline{|-1\frac12}}+\frac{x^{\frac12}}{\underline{|\frac12}}-\frac{x^{2\frac12}}{\underline{|2\frac12}}+\dots.\tag{18}$$

Give to x the value t/rs, then

$$\cos\left(\frac{t}{rs}-\frac{\pi}{4}\right)=\dots-\left(\frac{1}{rsp}\right)^{-1\frac12}+\left(\frac{1}{rsp}\right)^{\frac12}-\left(\frac{1}{rsp}\right)^{2\frac12}+\dots.\tag{19}$$

This transforms (16) to

$$\frac{rC}{e}=-\sqrt{2}\{(rsp)^{1\frac12}-(rsp)^{3\frac12}+(rsp)^{5\frac12}-\dots\}$$

$$=\frac{1}{(2\pi)^{\frac12}}\left(\frac{rs}{t}\right)^{1\frac12}\left\{1-8.5\left(\frac{rs}{2t}\right)^2\left(1-7.9\left(\frac{rs}{t}\right)^2\left(1-\dots\right.\right.\right.\tag{20}$$

Finally, this is what (14) reduces to when $z=2$. Half the terms cancel out.

The cosine transformation occurs in a variety of physical problems. It is not fancy work, as some ignorant people have supposed, to use divergent series, but is highly practical in general, and is sometimes the only way to work. Here is an example—deep water plane waves. Given the initial state of vertical displacement at the surface to be D_0 condensed at the origin, and everywhere at rest, what is the vertical displacement D at time t on the surface at distance x from the origin? The usual theory when worked out gives

$$D=\frac{D_0}{\pi a^2t^2}\left\{\frac{y}{\underline{|2}}-\frac{\underline{|3}}{\underline{|6}}y^3+\frac{\underline{|5}}{\underline{|10}}y^5-\frac{\underline{|7}}{\underline{|14}}y^7+\dots\right\}\tag{21}$$

where $y=a^4t^4/x^2$. The constant a means $\sqrt{g}$. Although mathematically perfect, the result is only directly calculable within a small range. Proceeding from $x=\infty$ towards the origin, D rises from zero up to a hump at a certain distance, depending upon the value of y. Going nearer, the hump becomes a hollow. After that, the labour of calculation is too great. But by the look of the formula there is an infinite series of alternate humps and hollows between the outermost hump and the origin. Now the above generalised cosine formula (which may be obtained from

$$\epsilon^x=\Sigma\frac{x^r}{\underline{|r}},\tag{22}$$

by $x=ai$, where a is real positive), when applied to (21) above, turns it to

$$D=\frac{D_0}{2\sqrt{\pi}}\frac{at}{x^{1\frac12}}\cos\left(\frac{a^2t^2}{4x}-\frac{\pi}{4}\right)-\frac{2D_0}{\pi a^2t^2}\left(1-\frac{\underline{|5}}{\underline{|2}}\frac{1}{y}+\frac{\underline{|9}}{\underline{|4}}\frac{1}{y^2}-\dots\right).\tag{23}$$

The second part is divergent, so the formula is only closely calculable when y is large enough to make the second term in the divergent series small compared with the first. Now this is just when the previous formula is unusable. So the changed form allows us to calculate the oscillatory region.

Although this is the fundamental solution in the usual incompressible theory of deep water surface waves, it must be taken with much salt, being physically absurd. Nor do we arrive at intelligibility by allowing for the compressibility of the water. In the incompressible case the wave speed varies as the square root of the wave length. It is infinity for infinitely long waves. This is why the initial disturbance is immediately communicated to any distance. It is also zero for infinitely short waves. This is why there is such a packing of infinitely rapid vibrations close to the origin, where there was initially a discontinuity in the vertical displacement. Now, allowing for compressibility, the relation between wave speed and vibration frequency is exhibited in the periodic solution

$$D=A\sin n\left[t-\frac{x}{v}\left(1+\frac{n^2v^2}{a^4}\right)^{\frac12}\right],\tag{24}$$

where v is the speed of sound in water. So the wave speed w is

$$w=\frac{v}{\left(1+\frac{n^2v^2}{a^4}\right)^{\frac12}}.\tag{25}$$

As n goes from 0 to ∞, w goes from v to 0. There is a remarkable improvement in so far as the long waves are concerned. The greatest wave speed is v, so there is a real proper wave front at distance vt, at time t after a disturbance begins at the origin. But still the shortest waves have speed 0, so we do not get rid of the infinitely closely packed vibrations by the improvement. We must go deeper, and see what happens underneath the surface. Define a point by the coordinates r, ϕ, where $r=\sqrt{z^2+x^2}$ is its distance from the origin, and ϕ the angle between **r** and the vertical downward. Then if D_z is the vertical displacement

$$D_z=\frac{1}{\pi}\left\{\frac{\cos\phi}{r}-\frac{a^2t^2}{\underline{|2}}\frac{\cos 2\phi}{r^2}+\frac{\underline{|2}\,a^4t^4}{\underline{|4}}\frac{\cos 3\phi}{r^3}-\frac{\underline{|3}\,a^6t^6}{\underline{|6}}\frac{\cos 4\phi}{r^4}+\dots\right\}\tag{26}$$

is the convergent solution corresponding to (21). There is a similar formula for D_x the horizontal displacement. Both are contained in

$$D_z-iD_x=\frac{1}{\pi R}\left\{1-\frac{a^2t^2}{\underline{|2}R}+\frac{\underline{|2}}{\underline{|4}}\frac{a^4t^4}{R^2}-\frac{\underline{|3}}{\underline{|6}}\frac{a^6t^6}{R^3}+\dots\right\},\tag{27}$$

where $R=r\epsilon^{\phi i}$. This shows the helical nature of motion. There is nothing unintelligible about it, except at the surface, where $z=0$, or $\phi=\frac12\pi$. It is a limiting surface of absurdity. It is therefore the boundary condition assumed in this theory that is imperfect. The condition

$$\dot{D}_z=g\frac{dD_z}{dz}\tag{28}$$

is indeed approximately true at the plane $z=0$, when this is underneath the surface, but is not true at the surface itself. But if we give z a small finite value the initial state of vertical displacement will be the hump represented by

$$D_z=\frac{zD_0}{\pi(z^2+x^2)},\tag{29}$$

and now the initiation, growth, and decay of the wave trains to right and left can be followed.

It is also interesting to see that in the vertical plane $x=0$ the generalised ϵ^{-z} formula turns up. That is

$$\epsilon^{-z}\cos r\pi=\Sigma\pm\frac{z^r}{\underline{|r}}\tag{30}$$

when z is positive. For put $\phi=0$ in (26). Then

$$D_z=\frac{1}{\pi z}\left\{1-\frac{a^2t^2}{\underline{|2}z}+\frac{\underline{|2}}{\underline{|4}}\frac{a^4t^4}{z^2}-\frac{\underline{|3}}{\underline{|6}}\frac{a^6t^6}{z^3}+\dots\right\}.\tag{31}$$

This is the convergent result. As t increases from 0 upward, D falls to zero, reverses itself, and then rises again. Is there any oscillation? It appears not, but calculation becomes difficult. Now, the generalised ϵ^{-z} formula turns (31) to

$$D_z=-\frac{2D_0}{\pi a^2t^2}\left(1+\frac{\underline{|3}}{\underline{|1}}\frac{z}{a^2t^2}+\frac{\underline{|5}}{\underline{|2}}\frac{z^2}{a^4t^4}+\dots\right),\tag{32}$$

and this shows the subsidence to equilibrium from the negative maximum without oscillation. The vertical plane $x=0$ must be uniquely non-oscillatory. By actual numerical calculation it may be shown that the convergent and divergent formulæ join properly in the middle region where both are calculable. The effect of surface tension does not appear in the deep water wave theory; only gravity.

Returning to the submarine cable, I have, in "Electromagnetic Theory," vol. 2, pp. 346, 348, &c., given a general method of expanding the required formulæ when the self-induction is taken into account (and also leakage if desired), which saves a great deal of experimental work, and puts the results in the form suitable for showing the progress of the waves along the cable. Thus, with a condenser and resistance at the beginning, to illustrate, if there is no leakage the current entering the cable is given by

$$\frac{C}{e}=\frac{1}{r+\frac{1}{sp}+\left(\frac{R+Lp}{Sp}\right)^{\frac12}}.\tag{33}$$

Let $R/2L=\sigma$, $LSv^2=1$, then

$$\frac{C}{e}=\frac{1}{r+\frac{1}{sp}+Lv\left(\frac{p+2\sigma}{p}\right)^{\frac12}}.\tag{34}$$

Introduce the prefactor $\epsilon^{-\sigma t}$. To do this, change p to $p-\sigma$, and put on the postfactor $\epsilon^{\sigma t}$ or $p/(p-\sigma)$. So we get

$$\frac{C}{e}=\epsilon^{-\sigma t}\frac{\dfrac{p}{p-\sigma}}{r+\dfrac{1}{s(p-\sigma)}+Lv\left(\dfrac{p+\sigma}{p-\sigma}\right)^{\frac{1}{2}}}. \tag{35}$$

Expand this in $I_n(\sigma t)$ functions. To do this, put

$$p=\frac{\sigma}{2}(a+a^{-1}), \tag{36}$$

and introduce the postfactor $(1-a^2)/(1+a^2)$. See "Electromagnetic Theory," vol. 2, p. 348. We come to

$$\frac{C}{e}=\frac{\epsilon^{-\sigma t}}{r+Lv}\,\frac{1-a^2}{1-2a\dfrac{r-1/s\sigma}{r+Lv}-\dfrac{Lv-r}{Lv+r}a^2}. \tag{37}$$

Or

$$\frac{C}{e}=\frac{\epsilon^{-\sigma t}}{r+Lv}\,\frac{1-a^2}{1-ma-na^2}. \tag{38}$$

This is, in a condensed form, the algebraical solution of the problem. To exhibit fully, expand in powers of a, and then turn a^n to $I_n(\sigma t)$. The expansion is easily done. Thus,

$$\begin{aligned}\frac{C}{e}=\frac{\epsilon^{-\sigma t}}{r+Lv}(1-a^2)\{&1+a(m+na)+a^2(m^2+2mna+n^2a^2)+\\&a^3(m^3+3m^2na+3mn^2a^2+a^3)+a^4(m^4+4m^3na+6m^2n^2a^2+\\&4mn^3a^3+n^4a^4)+\ldots\}\\=\frac{\epsilon^{-\sigma t}}{r+Lv}\{&1+am+a^2(m^2+n)+a^3(m^3+2mn)+a^4(m^4+3m^2n+n^2)+\ldots\\&\qquad -a^2\qquad\qquad -a^3m\qquad\qquad -a^4(m^2+n)\qquad\qquad -\ldots\}\end{aligned} \tag{39}$$

Or, finally

$$\frac{C}{e}=\frac{\epsilon^{-\sigma t}}{r+Lv}\{1+am+a^2(m^2+n-1)+a^3(m^3+2mn-m)+a^4(m^4+3m^2n+n^2-m^2-n)+\ldots\}. \tag{40}$$

To carry this on to the extent desired for calculation, all that is wanted is the law of the coefficients. It is easiest to do it arithmetically thus,

1						
1						
1	1					
1	2					
1	3	1				
1	4	3				
1	5	6	1			
1	6	10	4			
1	7	15	10	1		
1	8	21	20	5		
1	9	28	35	15	1	
1	10	36	56	35	6	1

The first two columns explain themselves. All the rest follow this rule:—The sum of the first n terms in any column $=n^{th}$ term in the next column. Taking the figures in the rows, they are the coefficients, as in the first line of (39) above.

Another way of expounding (38) is similar to (11) above, in terms of a_1 and a_2, the roots of

$$1-ma-na^2=0,$$

thus making a difference problem, meaning the same as (40).

For small values of σt the convergent formula is

$$a^n=I_n(\sigma t)=\frac{(\frac{1}{2}\sigma t)^n}{\underline{|0}\,\underline{|n}}+\frac{(\frac{1}{2}\sigma t)^{n+2}}{\underline{|1}\,\underline{|n+1}}+\frac{(\frac{1}{2}\sigma t)^{n+4}}{\underline{|2}\,\underline{|n+2}}+\ldots\,. \tag{41}$$

But for larger values,

$$\epsilon^{-\sigma t}I_n(\sigma t)=\frac{1}{(2\pi\sigma t)^{\frac{1}{2}}}\left\{1+\frac{1^2-4n^2}{1.8\sigma t}\left(1+\frac{3^2-4n^2}{2.8\sigma t}\left(1+\frac{5^2-4n^2}{3.8\sigma t}\left(1+\ldots\right\}\right.\right.\right. \tag{42}$$

So the problem is brought to complete numerical realisation. There are tables of $I_n(\sigma t)$ in Gray and Mathew up to $\sigma t=5$ or so. But the divergent formula may be used for much smaller values in some cases.

To find V, the potential, go thus:—

$$V=\left(\frac{R+Lp}{Sp}\right)^{\frac{1}{2}}C=Lv\epsilon^{-\sigma t}\frac{1+a}{1-a}C\epsilon^{\sigma t} \tag{43}$$

$$=\frac{Lv}{r+Lv}\epsilon^{-\sigma t}\frac{(1+a)^2}{1-ma-na^2}. \tag{44}$$

The net result is that the multiplier $1-a^2$ in the C expansion becomes $(1+a)^2$. See how equation (39) is constructed from the preceding one. Do similarly with the changed multiplier to find V.

Details of these processes will be found in the work referred to. Also how to include the influence of leakage by having $\epsilon^{-\rho t}$ instead of $\epsilon^{-\sigma t}$ as factor. Also more primitive methods, obtaining power series directly. But the systematic development is best in advanced work. How to turn the terminal solutions into progressive waves need not be considered here.

The values of m and n are

$$m=2\frac{r-1/s\sigma}{r+Lv}, \quad n=\frac{Lv-r}{Lv+r}. \tag{45}$$

They may be positive or negative. One or other of them may be zero. When both are zero we have a remarkable reduction to simplicity. We require

$$r=Lv=(s\sigma)^{-1}. \tag{46}$$

These give the values of r and s in terms of the cable constants. The terminal resistance r equals the initial impedance of the cable, and the terminal condensance s is $2L/Rr$. That is, the time constant of the condenser and resistance on short-circuit equals twice the time constant of the cable itself on short-circuit when supporting a current of uniform strength, meaning C uniform all along the cable, varying with the time as $\epsilon^{-Rt/L}$.

The terminal potential and current are

$$V=\tfrac{1}{2}e\epsilon^{-\sigma t}(I_0+2I_1+I_2)(\sigma t), \tag{46}$$

$$C=\frac{e}{2Lv}\epsilon^{-\sigma t}(I_0-I_2)(\sigma t)=\frac{e}{Lv}\epsilon^{-\sigma t}\frac{I_1(\sigma t)}{\sigma t}. \tag{47}$$

Now, if the cable were direct to earth, $r=0$, $s=\infty$, we should have

$$C=\frac{e}{Lv}\epsilon^{-\sigma t}I_0(\sigma t); \tag{48}$$

and if, further, $L=0$, this reduces to

$$C=e\left(\frac{S}{\pi Rt}\right)^{\frac{1}{2}}. \tag{49}$$

Now these formulæ are all very easily calculated and graphed. So the influence of the L of the cable, and also the influence of the terminal resistance and condensance in a special case are easily obtainable. For example, comparing (48) with (47), the effect of r and s is to turn $I_0(\sigma t)$ to $I_1(\sigma t)/\sigma t$, or

$$1+(\tfrac{1}{2}\sigma t)^2+\frac{(\frac{1}{2}\sigma t)^4}{2\cdot 2}+\frac{(\frac{1}{2}\sigma t)^6}{\underline{|3}\,\underline{|3}}+\ldots \quad\text{to}\quad \tfrac{1}{2}\left(1+\frac{(\frac{1}{2}\sigma t)^2}{1.2}+\frac{(\frac{1}{2}\sigma t)^4}{\underline{|2}\,\underline{|3}}+\ldots\right). \tag{50}$$

The factor $\frac{1}{2}$ comes in because $r=Lv$. The current is halved at the first moment. But of course the curves are not otherwise similar. Introducing the factor $\epsilon^{-\sigma t}$, we may write

$$C=\frac{e}{2r}\left\{1-\sigma t\left(1-\frac{5}{8}\sigma t\left(1-\frac{7}{15}\sigma t\left(1-\frac{9}{24}\sigma t\left(1-\frac{11}{35}\sigma t\left(1-\ldots\right\}\right.\right.\right.\right.\right.. \tag{51}$$

or

$$C=\frac{e}{r\sigma t(2\pi\sigma t)^{\frac{1}{2}}}\left\{1-\frac{3}{2}\frac{1}{4\sigma t}\left(1+\frac{5}{4}\frac{1}{4\sigma t}\left(1+\frac{21}{6}\frac{1}{4\sigma t}\left(1+\frac{45}{8}\frac{1}{4\sigma t}\left(1+\ldots\right\}\right.\right.\right.\right.. \tag{52}$$

Use the first when σt is small and the second when work by the first becomes too long. Or, the tables may be used in the first case. *E.g.*, $\sigma t=5$ makes the first sum very long; so use the second, and a short sum makes $rC/e=\cdot 032$. The value $\sigma t=2$ seems about the neutral place; by both formulæ, $rC/e=\cdot 108$. My general practice is to count half the smallest term in the divergent series.

But let us see if the critical values of r and s are practical. Say $R=2\times 10^4$, or 2 ohms per kilom., and $S=2\times 10^{-21}$, or $\frac{1}{5}$ microfarad per kilom. Then

$$r=\sqrt{\frac{L}{20}}\times 10^{11} = 100\sqrt{\frac{L}{20}}\text{ ohms.}$$

Giving L values from 2 to 100 for example, it is seen that the values are practical. Also

$$s=\frac{2L}{Rr}=\frac{2L}{2\times 10^4\times\sqrt{L/20}\times 10^{11}}=\frac{\sqrt{20L}}{10^{15}}=\sqrt{20L}\text{ microfarads.}$$

This again gives practical values. It is certainly striking that the values of r and s should be just in the proper region. There is a Providence in these things.

It would be possibly of interest to cable electricians if someone would work out the curves for various values of L; say, 0, 2½, 5, 10, 20, etc., to show the effect of L on the sent currents, not merely with the critical values of r and s, but with various values. The general effect is not difficult to see.

If leakage is allowed for, Sp becomes $K+Sp$ in (33). Then let

$$\rho=R/2L+K/2S, \qquad \sigma=R/2L-K/2S. \tag{53}$$

This makes

$$\frac{C}{e}=\epsilon^{-\rho t}\frac{\dfrac{p}{p-\rho}}{r+\dfrac{1}{s(p-\rho)}+Lv\left(\dfrac{p+\sigma}{p-\sigma}\right)^{\frac{1}{2}}}, \tag{54}$$

which by the a transformation leads to

$$\frac{C}{e}\epsilon^{\rho t}=\frac{\frac{1}{2}s\sigma(1-a)(1-a^2)}{A_0+A_1a+A_2a^2+A_3a^3} \tag{55}$$

where

$$\begin{aligned}A_0&=\tfrac{1}{2}s\sigma(r+Lv), & A_1&=1-\rho s(r+Lv)+\tfrac{1}{2}s\sigma(Lv-r),\\A_2&=\tfrac{1}{2}s\sigma(r+Lv)-1-s\sigma(Lv-r), & A_3&=\tfrac{1}{2}s\sigma(Lv-r).\end{aligned} \tag{56}$$

Here (55) is the complete solution, on expansion in rising powers of a. But it is very complicated in general. An exception, of course, is the distortionless case, which should not be done through a at all; but direct from the primitive operational solution, making

$$C = \frac{e}{r+Lv}\epsilon^{-\rho t}I_0(\sigma t) \qquad (57)$$

Nevertheless a great simplification of (55) occurs in the critical case. For $A_0 = 0$ when $r = Lv$; and thus $A_1 = 0$ if $r\sigma = 1$ as well. But we cannot make $A_1 = 0$ with possible values of cable constants. In this critical case,

$$\frac{C}{e}\epsilon^{\rho t} = \frac{1}{2r}(1-a^2)\frac{1-a}{1-ca}, \qquad \text{if } c = \frac{2\rho}{\sigma} - 1. \qquad (58)$$

$$= \frac{1}{2r}\{1 + (c-1)a + (c^2 - c - 1)a^2 + \dots\}. \qquad (59)$$

Although making an infinite series of $I_n(\sigma t)$ functions, the coefficients are very simply formed.

STUDIES IN MAGNETIC TESTING.*

BY G. F. C. SEARLE, M.A.

(Cavendish Laboratory, Cambridge.)

(Concluded from page 361.)

Influence on Partial Demagnetisation on the Permeability of Virgin Iron.

§ 23. As the experiments described in § 22 showed that effective demagnetisation causes a very considerable increase in the permeability of virgin iron for small magnetic forces, it seemed of interest to trace the effect of a gradual increase in D, the maximum force used in the demagnetisation, upon the permeability for some constant small magnetic force. Mr. T. G. Bedford kindly assisted me in these experiments.

The alternating current for demagnetising was obtained by connecting the magnetising solenoids with a secondary coil wound upon an ebonite tube together with a primary coil, which was supplied with current from the laboratory mains. The effective value of the alternating current flowing through the solenoids was measured by a sensitive electrodynamometer. To obtain any definite value of D, we first calculated the corresponding deflection of the dynamometer and then slowly inserted iron rods into the ebonite tube until the deflection reached the calculated value.

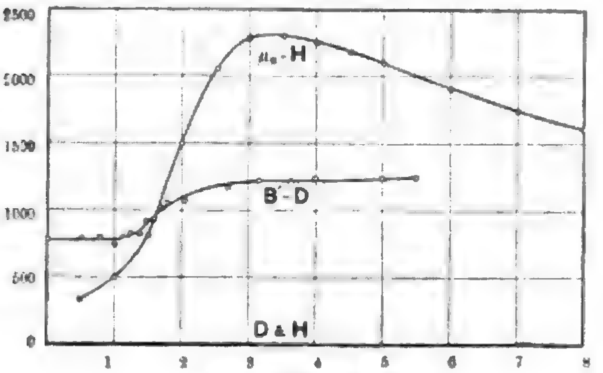


Fig. 7.—Schultz Iron.

In these experiments we used four fresh strips of Schultz iron, and tested them in the magnetic square, the induction being found for the standard force of 1·5 gausses.

The strips were put into the square when no current was flowing. The circuit was then completed, and a force of 1·5 was applied. After this had been reversed 100 times the ballistic effects of a pair of reversals of the force were observed, and from them the value of B′ for H = 1·5 was found. The connexions were now changed, so as to allow the alternating current to flow through the solenoids, and an iron rod was slowly inserted into the tube transformer until the dynamometer indicated that D, the amplitude of the magnetic force, had reached 0·5 gauss. The rod was then slowly drawn out of the tube, and the current was further reduced to zero by means of the liquid resistance slide (§ 9). The connexions were next re-arranged, and the force of 1·5 was applied and reversed 100 times before the observations for B′ were made. The iron was again demagnetised, this time with D = 0·75, and then B′ was found for H = 1·5. This process was repeated, D being increased step by step up to 5·3. The resulting B′-D curve is shown in Fig. 7, where (for this curve) the abscissa represents D and the ordinate the value of B′ for H = 1·5.

Observations were then made for the normal permeability curve in the manner described in § 11, the iron being demagnetised with D = 4·43. The resulting μ_0-H curve is shown in Fig. 7, where (for this curve) the abscissa represents H and the ordinate μ_0.

The B′-D curve shows that the course of the phenomenon maybe divided into three stages. In the first stage, from D = 0 to D = 1·0, the demagnetisation has no effect, the apparent induction B′ retaining the virgin value 775. In the second stage, from D = 1·0 to about 3·2, B′ increases with D, the rate of increase becoming smaller as D approaches 3·2. In the last stage, from D = 3·2 onwards, B′ remains constant and is equal to 1,240, the value of the normal induction B_0. Since μ_0 attains its maximum value when H = 3·25, we see that the demagnetisation brings the virgin specimen to the normal state as soon as D reaches M_0, the critical force for which μ_0 is a maximum.

Constancy of the Specimens.

§ 24. As my experiments extended over several months, I thought it would be well to take the opportunity of testing whether the normal permeability of the specimens had changed appreciably with lapse of time, and two specimens were tested for this purpose. One specimen consisted of 16 strips of "Tagger Plate," and two permeability tests were made on October 7, 1902, and on August 10, 1903.

The results of the experiments on the "Tagger Plate" are given in the following table:—

H.	μ_0. 1902.	μ_0. 1903.	H.	μ_0. 1902.	μ_0. 1903.
0·4	905	876	2·0	4,113	4,128
0·8	1,974	1,929	3·0	3,436	3,450
1·2	3,687	3,714	5·0	2,457	2,479
1·6	4,212	4,243	8·0	1,705	1,714

It will be seen that the numbers of 1902 and 1903 are practically identical.

The Preparation of Specimens.

§ 25. In the practice of magnetic testing the preparation of specimens for testing has naturally a very important place. It seemed, therefore, profitable to examine how the normal permeability curve is affected by mechanical operations of the kind that naturally occur in the preparation of specimens for testing. In these experiments I employed two brands of iron—viz., "Schultz" and "Sankey," and I examined the effects arising from the process of cutting the iron into strips, as well as the effects due to roughly handling the strips after they had been cut. It was found that bending the strips had the effect of causing a large decrease of permeability.

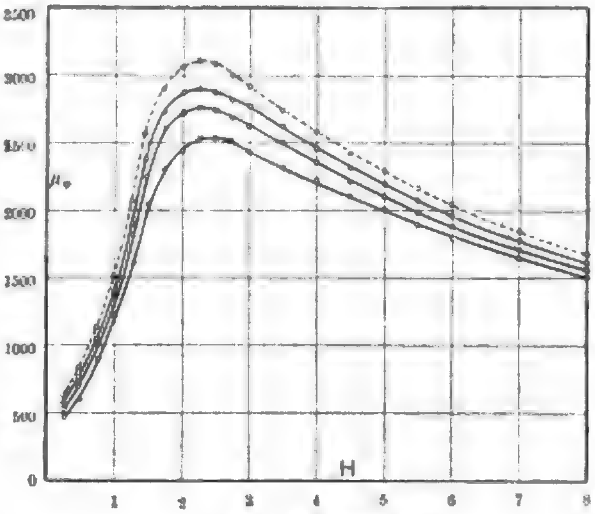


Fig. 8.—Sankey Iron.

To study the effects of cutting the iron, I first cut, by means of hand shears, four strips 4cm. wide out of two strips, each 10cm. wide. A piece 1cm. wide was cut off each edge of the 10cm. strip, and the remaining 8cm. strip was cut into two equal portions. The four strips so obtained were then tested for normal permeability. For each value of H the iron was demagnetised with D = 16·4, and was then subjected to 50 reversals of H. The strips were next taken out of the square, and one cut was made along each strip to within 3cm. of one end. The strips were then straightened only just enough to allow them to be replaced in the square. The strips were then re-tested for normal permeability, and the process was repeated for each successive cut. The Sankey strips were cut twice, each cut being 1⅓cm. from an edge.

The resulting μ_0 – H curves for the Sankey iron are shown as continuous lines in Fig. 8.

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* Paper read before the Institution of Electrical Engineers on Dec. 8th. Specially abridged for *The Electrician* by the author.

Each fresh cut lowers the normal permeability. In the case of the Sankey iron, when H exceeds 3 gausses, each cut has about the same effect. It thus appears that with this iron the disturbance arising from the cutting does not extend to a distance of ¾cm. from the cut.

If we assume that the effects of cutting do not extend to a distance of ¾cm. with the Sankey iron, we can use the curves of Fig. 8 to enable us to find the true form of the $\mu_0 - H$ curve. We have only to add to the value of μ_0 for the highest curve the difference between that value and the value of μ_0 for the next lower curve. The corrected $\mu_0 - H$ curve is shown in Fig. 8 as a broken line. The experiment shows that the process of cutting the sheet produces a serious change in its permeability.

Want of Uniformity of Specimens.

§ 26. I have examined a large number of strips of "Tagger Plate," of Schultz, and of Sankey iron for uniformity of magnetic quality.

As each strip was cut off a number was stamped upon it, and the strip was then placed in one solenoid of the square, the magnetic circuit being completed by three other strips of the same brand. These last three strips remained unchanged during each set of experiments. Only one secondary coil was used, and this, of course, encircled the strip under test. After effective demagnetisation, a suitable magnetic force, H, was reversed several times, and then the ballistic effects of a pair of reversals of H were noted. As this process was repeated for each strip it was found that the ballistic effects varied considerably and far more than could be accounted for by the slight variations existing among the masses of the strips. It is evident, moreover, that the association of the three auxiliary strips with those under test tends to diminish the variations in the ballistic effect for that strip.

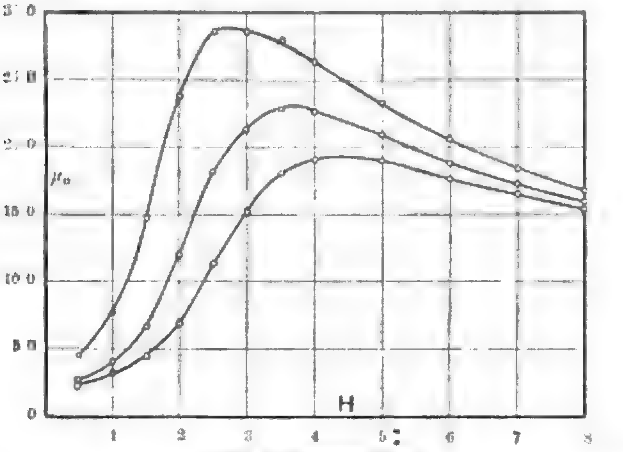

Fig. 9.—Schultz Iron.

By this examination it was easy to select, from the strips tested, the four of highest permeability and the four of lowest permeability for each brand. The four most permeable strips were then placed in the magnetic square and were tested for normal permeability, and the process was repeated for the four least permeable strips. The resulting $\mu_0 - H$ curves for the Schultz iron are shown in Fig. 9, where the $\mu_0 - H$ curve for a set of Schultz strips of intermediate quality is also shown. These curves show that very serious differences of magnetic quality may exist among transformer plates of the same brand.

Each set of curves possesses the feature that the higher the maximum value of μ_0 the smaller the critical magnetic force M_0 at which the maximum occurs. Indeed, the product of the maximum value of μ_0 by the value of M_0 is nearly constant for any set of curves, and thus the critical value of B_0, the normal induction corresponding to the maximum of μ_0, is nearly constant for each set of curves, as the table shows.

	Tagger Plate		Schultz.			Sankey.	
Maximum μ_0	4,570	2,870	2,880	2,290	1,920	3,335	2,675
Critical H (= M_0) ..	1·60	2·75	2·75	3·65	4·40	2·00	2·50
Critical B_0 (= $\mu_0 H_0$) ..	7,310	7,890	7,920	8,360	8,450	6,670	6,690

APPENDIX.

Mr. Campbell's Experiments.

Mr. Albert Campbell has kindly furnished me with some results obtained by him at the National Physical Laboratory. The effect of a strong magnetic force in reducing the apparent induction subsequently found for a small force was noticed by him in May, 1902, while I did not begin the work described in the present Paper until July, 1902. My own experiments on this point were, however, completed before I knew of Mr. Campbell's result. We compared notes in October, 1902, and since then he has verified some of my results. Mr. Campbell has also been so good as to read the Paper in manuscript and to give me the benefit of his criticism. With respect to his own work he writes as follows:—

"Whilst testing some ring-stampings of transformer sheet iron at the National Physical Laboratory during May, 1902, I noticed that the results were much affected by the previous magnetic history of the iron. I found, however, that perfectly consistent results could always be obtained by thorough demagnetisation, by reversals, starting from a sufficiently high value of H. An ordinary commutator, worked by hand, was employed in this process. The following instance will show the general nature of the effects observed. After the ring had been demagnetised, H = 1·240 gave B_0 = 2,500. The ring was then cycled a number of times with H = 27·5; after 10 cycles at H = 1·240, B′ had the lowered value 1,950. After 100 cycles at H = 1·240, B′ had fallen to 1,910. The ring was again demagnetised, when (after 100 cycles) H = 1·240 gave the original value B_0 = 2,500. It will be seen that these effects are similar to those described by Mr. Searle."

"In 1902 Mr. Searle told me he had found that virgin iron is magnetically improved by demagnetisation. I have since tested the point for a number of different specimens of iron sheet, which, so far as I know, had never been magnetised before. The specimens were in the form of rings and were tested by the ballistic method, the hysteresis loop being obtained. In all cases the demagnetisation increased the permeability for moderate values of B and decreased the hysteresis loss for loops in which both before and after the demagnetisation B had the fixed limits ± 2,500 or ± 4,000. In one case, with ± 2,500 as the limits of B, demagnetisation increased the permeability from 2,030 to 2,130, and decreased the hysteresis loss by about 3 per cent."

"Since reading the manuscript of Mr. Searle's paper in September, 1903, I have made a few experiments upon a ring of steel piano wire in its commercial state, the procedure being practically that mentioned by Mr. Searle in § 18. The ring was demagnetised, starting from 40 gausses, a value much exceeding 20 gausses, the critical magnetic force found for this specimen. The $\mu' - H$ curve found after the application of a large magnetic force of 60 gausses differed from the normal curve in a manner similar to that shown in Fig. 3 (§ 18) which refers to material of widely different magnetic quality. The following table shows the results; in it μ_0 denotes the 'normal' permeability and μ' the 'apparent' permeability after the application of the force of 60 gausses."

H	2	4	6	8	10	12	14	16	18	20	22
μ_0	73	77	86	99	117	152	233	457	597	630	625
μ'	55	57	63	71	84	114	192	424	596	633	

[The numbering of the sections and figures in this abridged version of Mr. Searle's paper is not the same as the numbering in the full paper.—Ed. *E.*]

The following is an abstract of the discussion which took place at the Institution of Electrical Engineers on Thursday, December 8th, in connection with the above Paper:—

Dr. **R. T. GLAZEBROOK**, F.R.S., thought that the magnetic square devised by the author was at once useful and simple. It was a great advantage to be able to test the material in rectangular strips instead of having to cut it into rings and having to wind each one separately. In this instrument the magnetising coils were permanent fixtures and nothing was required to be done, except to place the specimen in position. Of course, various questions arose as to the leakage at the corners. Mr. Searle had shown, however, that within the limits that were desirable in practice, the form of apparatus exhibited was satisfactory and sufficient. At a very early stage in the Paper the author had spoken of the very grave uncertainties that were introduced into the ordinary methods of testing by the ballistic method. It would be interesting if in the reply we were told what kind of uncertainties were introduced by the neglect of the precautions described in the Paper. It was, of course, known in a general way that care had to be taken with regard to the previous magnetic history of the iron if accurate results were wanted. The author had referred to a Paper by Prof. Callendar and Prof. Ewing, but he did not think that there had previously existed such a careful and elaborate investigation as that described in the present Paper.

Mr. **ALBERT CAMPBELL** said that Mr. Searle had put into his appendix practically all he himself could say. He had made a few experiments in corroboration of the interesting discovery which Mr. Searle had made with regard to the behaviour of virgin iron. No one apparently had noticed before, that if one took a piece of iron that had not yet been acted upon by magnetic forces and tested it and then demagnetised it thoroughly, a great improvement in the magnetic quality was effected. Its normal permeability was much better than the apparent permeability before it had been demagnetised. The other experiments of his showed a verification for the harder kinds of irons of what Mr. Searle had shown for softer iron—viz., that if demagnetisation took place from a point above the critical point, the previous history was wiped out, and, if this were not done it was very possible that erroneous results would be obtained for the permeability curve.

Mr. **F. HOLDEN** asked what would be the effect of the substitution of a make-and-break switch for the alternator giving approximately a sine wave. His opinion was that it would change the value of the critical magnetising force very considerably.

Mr **W. M. MORDEY** thought the Paper was more valuable to physicists and instrument makers than to people who used transformer iron in large quantities. The flux-densities employed by Mr. Searle seemed to be low, and in transformer, dynamo and alternator work very different conditions ndeed were encountered. However, it seemed very clear from the Paper that iron with a "past" must be avoided if accuracy was to be obtained. His own objection to the ballistic method was that, however useful it might be, it required very great care and skill. The Paper showed, indeed, that it required even greater care and skill than had hitherto been supposed in order to obtain accurate results. But he would go further and say that the method did not give in most cases what was required to know—viz., the total amount of energy that was being dissipated in the iron when used in transformers. He had recently read a Paper before the British Association, in conjunction with Mr. Hansard (see *The Electrician*, Vol. LIII., p. 790), pointing out the limitations of the ballistic method for engineering purposes relating to transformer work; their opinion was that it gave, so far as the energy losses were concerned, often considerably less than half the true values. In their Paper the authors had advocated the use of wattmeter methods rather than galvanometer methods, and had given curves which were plotted from results obtained by wattmeter tests. He would give one or two figures from the tabulated results, which, he thought, showed the importance, at even comparatively low densities, of measuring the losses with alternating currents at ordinary frequencies and in working conditions. One of the objects of the Paper in question was to find out how these losses were affected by the thickness of the iron, and therefore some tests were made with three thicknesses of iron—viz., 0·0136in., 0·0189in. and 0·0254in. With even such very low densities as 2,500 lines per square centimetre the losses due to eddy currents were from 36 per cent. to 57 per cent. of the total iron losses. With $B = 4{,}000$ the percentage loss due to eddy currents varied from 39 to 60 per cent., and at $B = 6{,}000$ from 43 to 64 per cent. These results were obtained with 100 ~ per second. At $B = 10{,}000$ and 50 ~ per second, the percentage losses due to eddies were from 36 to 56 per cent. He mentioned these figures to show that however interesting the ballistic galvanometer methods might be for the study of certain physical conditions in iron they were quite useless when it was desired to deduce the very serious losses of energy that occurred in transformers or dynamos in working conditions.

The PRESIDENT asked Mr. Searle to send in his reply in writing on account of the lateness of the hour.

ELECTROLYTIC PREPARATION OF TIN PASTE.*

BY F. GELSTHARP.

Tin paste is used for the production of metallic or silvered paper, having the appearance of tin or lead foil, and it is also used for ornamental purposes. As I believe members are interested in any process in which electro-chemistry advantageously takes the place of the older chemical methods, I beg to bring before the Faraday Society the following description of a process for manufacturing tin paste which was specially designed for a firm of paper makers. The oldest method of making tin paste was that carried out by the natives of India. They melted block tin at a high temperature, and poured it into a wooden box, which was then shaken vigorously; the tin was thus converted into very fine shot and dust. The finer particles which they used for the paste were separated from the coarser granules by gravitation by means of water. It was afterwards dried and mixed with a weak solution of glue, and in this state it was ready for use. This they used as a paint, the article to be ornamented was coated with it, and after being dried it was burnished.

The chemical process for making tin paste as generally carried out in this country is as follows. The commercial ingot is reduced to what is known as feather tin by melting it and then allowing it to fall some distance. The tin in this form is dissolved in strong hydrochloric acid, with the aid of heat, in copper vessels, and a concentrated solution of stannous chloride thus obtained. The liquid is diluted and the tin precipitated in the form of paste by introducing metallic zinc. The process is troublesome on account of fumes, and, moreover, does not give the whole of the precipitated tin in the form of paste, but partly as bright metallic feathers and crystals, which have to be worked over again; whereas in working the electrolytic process about to be described there are no fumes, and the paste is perfect in every respect. Further, the process is not so costly and can be worked continuously, the deposited paste being removed at intervals without stopping the current.

The electrolytic process is similar to the electro-refining of metals. Anodes of tin are dissolved in an electrolyte of dilute hydrochloric acid and the tin is deposited in the form of a sponge or paste on cathodes of the same metal. The spongy deposit is lighter than the electrolyte on account of the hydrogen it contains, and consequently floats on the surface of the solution after being detached from the face of the cathodes, so that it can be conveniently removed without breaking the current.

An apparatus capable of producing 20 cwt. of tin paste per week consists of a generating plant giving 1,500 amperes at 8 to 10 volts. There are five vats, which are worked in series and are made of slate or pitch-pine wood 106 × 106 × 91·5cm. deep (3ft. 6in. × 3ft. 6in. × 3ft. deep), each containing four anodes and five cathodes coupled in parallel. The anode plates are about 2·5cm. (1in.) thick, roughly cast from commercial ingots of tin; the surface exposed to the electrolyte being 91·5 × 76cm. (3ft. × 2ft. 6in.). The cathode plates are of block tin or tinned iron, the active surface being 91·5 × 76cm. (3ft. × 2ft. 6in.). The anodes are supported at the two top corners, and in each vat are all connected to one conductor. The cathodes are supported by and soldered to copper conductors, which are all connected to a main conductor. These main conductors are of circular copper bars 3·2cm. (1¼in. in diameter). The electrolyte is a dilute solution of hydrochloric acid in 5°Tw., which must be free from arsenic. The current density is 270 amperes per square metre, or 25 amperes per square foot of cathode surface.

As the anodes are dissolved away they are removed before they crumble and fall to pieces, and what remains of them is melted up with fresh ingots and cast, to form new anodes. The electrolyte is kept in circulation by means of a small turbine or plunger pump of lead or block tin driven by a small motor; the liquid is drawn from the bottom of the vats and discharged into the top; this is found necessary, as otherwise the electrolyte at the bottom of the vats would soon become very rich in tin, and instead of tin paste at the lower parts of the cathodes there would be crystal or leaf tin deposited.

When the deposited tin sponge has grown to about an inch in thickness it is detached from the cathodes by means of a T-shaped scraper, which is pushed down the face of the cathode plates; the floating, spongy tin is removed from the surface of the vat by means of a perforated scoop to prevent short-circuiting of the current through the floating tin; the cathode plates are varnished or painted with a non-conducting material from 5cm. to 7·5cm. (2in. or 3in.) below the surface line. The tin paste is allowed to drain, and is then thoroughly washed with water and dried to make it ready for use.

This may not seem to be an efficient way of utilising the electric current, because the current-efficiency is only about 50 per cent.; but any attempt that I have made to produce tin in the form of paste or sponge at a higher efficiency has been futile; it appears to be necessary to have hydrogen deposited along with the tin, for when no hydrogen is deposited the tin comes down in a crystalline or bright leaf-like form.

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* Paper read before the Faraday Society, December 19, 1904.

SOME NEW SWITCHES AND FUSES.

Messrs. Dorman & Smith have issued a new catalogue of switches, fuses, fittings and similar apparatus. Among the various devices described is a liquid motor starter (Fig. 1) recommended for cranes, hoists and similar purposes, where it is required to start, control or reverse continuous-current motors more or less continuously. The insulation is porcelain throughout, and the liquid resistance is metallically short-circuited in the last position of the handle. The reversal of current in the motor armature is obtained by either one or the other of the two cast-iron plates dipping

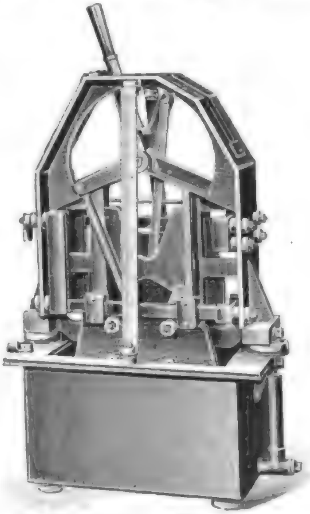


FIG. 1.—REVERSING LIQUID MOTOR STARTER.

nto the solution, and the simple arrangement of cranks by which these desired movements are obtained is clearly shown in the figure. A solution of caustic potash or of washing soda is used as electrolyte.

Fig. 2 is an iron-cased distributing box for 250-volt supply. It is fitted with sliding porcelain switches and damper replacement fuses (Fig. 3). The cast-iron case has a hinged lid with indiarubber joint. The switches are single-pole, but the fuses can be either of the single or double-pole type. Fig. 3 is an illustration of the damper replacement fuse, referred to above. It is characterised by a very quick blow-out action, and is claimed to be absolutely reliable up to 250 volts. As shown, there is a solid wall of porcelain between the fuse terminals, and since, moreover, the arcing passage is completely blocked for a short length by a soft asbestos damper (a patented device of the firm), it is next to impossible for an arc to be maintained. These fuses are made in three sizes, the distance between the inside edges of the spring clips being ¾in., 1¼in. and 2¼in. respectively.

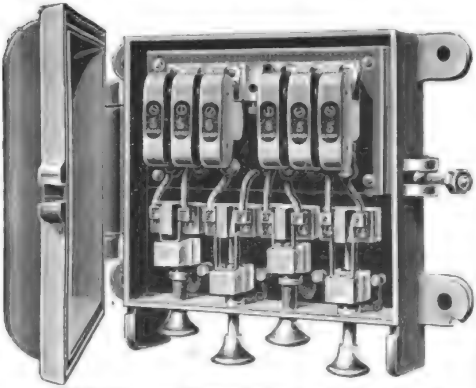


Fig. 2.—Iron-cased Distributing Box for 250-volt Supply.

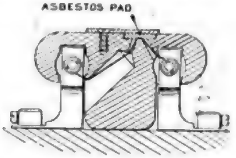


Fig. 3.—Section of "Damper" Fuse.

THE BRADFORD BREAKDOWN.

Further particulars with regard to the cause of the total breakdown on the supply network at Bradford last week are given in a report which Mr. Alfred S. Blackman, the city electrical engineer, has presented to the Electricity committee. We have been unable to obtain a full copy of the report, but are indebted to the *Yorkshire Observer* for the following extracts. As mentioned in our last issue, the cables that were the cause of the mishap were laid between 8½ and 16 years ago, and were burned through in many places at old-fashioned cast-iron straight-through joint-boxes, fitted with rubber glands, the cables having lead sheaths and hygroscopic insulation. The mains have, until the last few months, consisted wholly of single-core cables, and there are no fuses upon these.

Various faults have been discovered and remedied during the present week, but the work has been carried on under difficulties which could not very well have been foreseen. "The work of restoring these cables has been exceedingly difficult owing to the fact that the maps are incorrect, and as the whole of the work is very old, and has undergone several alterations, the cables now appear to be arranged in an erratic manner." Instances of this state of affairs are quoted, one being in Hustlergate, where two pairs of cables cross the road in such a manner as to make it difficult to determine which is which. The report continues:—

This will serve to show the difficulties that have had to be contended with and why so many openings have been made in the town. Six holes had to be opened in Hustlergate to ascertain what had been done, and we, of course, can only now surmise the position of the cables between these six points. In other cases, where the cables were shown under the pavement upon the plans, they were ultimately found under the roadway, and vice versa, and in still other cases, shown upon one side of the street, and after holes had been opened to no purpose, afterwards found upon the opposite side of the street. This state of affairs also necessitates great caution, because cables found in any trial hole cannot be counted upon as being those one would assume they are, so that when dead cables are being followed up there is always a chance of cutting into a live cable. Another difficulty in tracing cables was inadvertently discovered in Kirkgate, where in sinking a trial hole a 9in. stoneware drain pipe was broken and found to contain two cables. It is true we were not looking for these at the time, but had we been doing so, and had the drain pipe not been accidentally broken, the hole would probably have been closed in again, under the impression that the cables were not there. These matters are mentioned in justification of the electricity department against criticisms that have been made in regard to the opening of the streets in so many places, and in explanation of the present state of affairs.

It has in the first place to be remembered that the Bradford network was probably the first low-tension network of any size laid down, and the portion we have been working upon is one of the oldest parts of it. The mains have also undergone several alterations, the supply having been first commenced as a two-wire parallel system at 115 volts, and the two small lead-covered cables just mentioned would have been the original Bank Street parallel network. Subsequently a change was made to the three-wire system, which meant that an additional cable had to be introduced everywhere, and finally the system of supply was changed from 115 volts and 230 volts to 230 and 460 volts, and each of these changes would necessitate alterations, which, while requisite and necessary, and well understood at the time, are now very confusing.

The cause of the trouble in both cases is undoubtedly due to electrolysis, and in the case of the general supply mains a contributory cause has been the manner in which the joints have been made. The faults occurred at old-fashioned joint-boxes with rubber glands, the use of which in many cases resulted in an imperfect contact, or none at all, between the lead sheath and the joint-box. As no special means for preserving the metallic continuity of the sheath were adopted, corrosion took place at these points, ultimately breaking the cables down, and either causing a leak to earth adjacent to the spot or raising the potential of the sheath to the potential of the core of the cable. This caused arcing at adjacent joints before finding a way to earth, and in this manner a fault, once started, may lead to many others, as in the present instance. At the time these cables were laid the importance of this matter was not generally recognised. All joints in feeder cables, for both lighting and traction purposes, have been sleeved with lead, or the electrical continuity of the sheath otherwise pressed, for the last three years. Electrolysis is popularly accredited to the fact of the tramways being operated with many of the conductors earthed, but it must not be understood that the tramways system is the only one capable of causing electrolysis, and it is possible to have this trouble upon general supply mains, owing to leakages, &c., in places where there are no electrical tramways, as occurred in your engineer's experience in Aberdeen before the adoption of electrical traction there. The fact of the sheaths not being electrically continuous past the joints would be sufficient to account for trouble from this cause, even though no electric tramways existed.

The stray currents from the trams are, however, an additional and serious element of danger, but your engineer desires that this should be understood in view of the fact that it is quite possible that cables may break down from electrolysis after the proposed augmentation of this service. Such breakdown may be due either to trouble commenced before or after the carrying into effect of the proposals referred to. It is also quite possible that trouble may have been caused last week which has not yet had time to develop. In view of the present condition of affairs, your engineer would advise that his recommendations with regard to the augmentation of the tramway distribution system be put into operation with all speed, and that the following modifications be made to the single core general supply system:—

The most important section of the mains are the five 1·6sq. in. interconnector cables between the Valley and Bolton-road works, which were laid about eight years ago. There are probably about 50 joints upon these cables, and when one of them was opened it was found that no provision had been made for preserving the electrical continuity of the sheath.

Your engineer would advise that the whole of the joints be partly re-made and sleeved that is, a lead sleeve placed over the joint and attached to the lead sheath upon either side by a plumber's wiped joint. Those cables at present terminate in the Bolton-road works, where they are bolted to the 'bus bars, and feeders run from thence to different parts of the town. Your engineer would advise that an underground brick chamber be constructed in the private road at the back of the Bolton-road works, the inter-connectors carried into it and fused, and that the feeders to the town be also taken into it and fused. The internal construction of the Bolton-road premises is of a highly inflammable nature, and under existing arrangements a fire there might most seriously disorganise the town supply. Fuses should also be inserted at the feeding points, and also at all points where feeder cables divide into two or more branches. The town network should be divided into four districts, and for this purpose approximately 50 network fuse and disconnecting boxes will be required.

Your engineer estimates the cost of this work at £2,970, and it should be pushed to completion as soon as possible. Your engineer also considers it necessary to use and separately switch each feeder and interconnector at the works, and has made provision for doing this upon the switchboard now under course of erection, and upon the completion of this board, together with the recommendations of this report, a repetition of the catastrophe of last Thursday will be impossible. Cables may.

and no doubt will, from time to time go wrong, but when the new arrangements are completed they will automatically disconnect themselves from the system with the minimum amount of disturbance and of cost for reinstatement.

Your engineer has all along recognised the necessity of what is herein proposed, and arranged to carry out the first and most important instalment of the alterations 12 months ago, when the new switchboard was proposed. Designs have been prepared for additional main disconnecting boxes, and some of these are now in use, and partially prepared for main fuse boxes. Had it not been for the delay caused last summer by the engine breakdown in the works, and the demand upon the time of the staff from other sources, some of these at any rate would have now been in use.

The proposals contained herein do not cover the cost of all it is desirable to do to the mains, as the introduction of fuses should be continued until the distributing mains are separated into sections corresponding approximately to the different feeders, and only inter-connected through fuse boxes, and the carrying out of this work may necessitate alterations in the disposition of certain cables. Your engineer has, however, not had time to go into this matter in detail. The cost of these breakdowns will amount to approximately £900, and with reference to the cables in the culverts, it is proposed to run these in solid with pitch, and fill up the spaces not thus occupied with sand, with a view to preventing as far as possible the accumulation of gas. The gas main in Forster-square and the liquor pipe in Canal-road are also being diverted.

BILLS IN PARLIAMENT NEXT SESSION.

In our issues for Nov. 25 and Dec. 2 we gave brief particulars of the Parliamentary bills for next session, taken from the notices. Now that the period for depositing the bills themselves has expired, we are able to give more complete particulars of the various bills of electrical interest, together with their financial proposals, &c. We deal this week with the electric supply and power bills and the combined electric lighting and traction bills. Next week we hope to conclude by giving the traction bills and some miscellaneous measures of more or less direct electrical interest.

Electric Supply and Power Bills.

Bolton Corporation, in a general powers bill, make further provision with regard to their electricity supply undertaking, such as accepting transfers of electric supply undertakings in adjoining districts, &c.

Metropolitan Electric Supply Co. seek the authorisation of an agreement arrived at with the Acton Urban District Council for a supply of electrical energy.

Metropolitan Electric Supply Co. (Various Powers) Bill gives power to supply electrical energy for all purposes in St. Pancras, Hampstead, Hammersmith, Holborn, Kensington, Paddington and Fulham; in bulk to the St. Marylebone Borough Council and to authorised distributors and persons requiring a supply for power in the following districts: Acton, Hanwell, Southall-Norwood, Greenford, Uxbridge, Hayes, Chiswick, Brentford, Heston and Isleworth, Twickenham, Teddington, Hampton, Hampton Wick, Sunbury-on-Thames, Feltham, Staines and Uxbridge. Existing generating stations will be used. Power is also taken to divide amongst the shareholders, within twelve months, the revenue from the sale of the Marylebone undertaking not exceeding £250,000, the ordinary share capital being reduced accordingly.

Woolwich Borough Council seek power to enter into agreements with neighbouring bodies for the supply of electricity in bulk, and also wish to make provision with regard to stand-by supply.

Great Berkhampstead Gas Bill provides for the incorporation of a company with powers to apply for electric lighting provisional orders.

The Charing Cross & Strand Electricity Supply Corpn. seek powers to supply in bulk and for power purposes in the following districts: St. Martin-in-the-Fields and Strand districts of the City of Westminster, High Holborn and St. Giles districts of the Borough of Holborn, the City of London and the liberties thereof, the Metropolitan Boroughs of Islington, Stoke Newington, Hackney, Finsbury, Shoreditch, Bethnal Green, Stepney and Poplar, the County Borough of West Ham, the Borough of East Ham, the Urban Districts of Barking Town, Ilford, Romford, Wanstead, Leyton, Walthamstow, Woodford, Buckhurst Hill, Chingford, Edmonton, Tottenham, Hornsey, Wood Green and Southgate, and the parish of Dagenham in the Rural District of Romford. A supply is only to be given to authorised undertakers and to persons requiring energy for power purposes. The consumption of energy by the latter for lighting purposes is not to exceed 20 per cent. of the amount used for power. The Board of Trade is to be appealed to in the event of an authorised distributor unreasonably withholding consent to a supply to a power consumer. The undertaking under this bill is not to be purchased under the Electric Lighting Acts. Land for additional generating station is scheduled at 85, Commercial-road, Lambeth.

Chelsea Electricity Supply Co. propose to acquire powers for the extinction of their founders' shares and the issue of ordinary shares in lieu thereof.

County of London Electric Supply Co. apply for powers to supply electricity in the City of London, the Metropolitan Boroughs of Hackney, Shoreditch, Southwark, Lambeth and Battersea, and a portion of the Urban District of Tottenham. Supply is to be given only in bulk to authorised distributors and for power purposes, similar provisions as to consent, &c., as in the Charing Cross bill applying.

Central Electric Supply Co. propose to supply in bulk to authorised distributors and for power purposes in Hampstead, St. Marylebone, Paddington, St. Pancras and all the City of Westminster except Strand and St. Martin-in-the-Fields districts. The bill also allows agreements with authorised undertakers in neighbouring districts, and at the same time authorises such undertakers to take supply. Provisions as to consent and Board of Trade appeal same as in Charing Cross bill.

Andover Lighting & Power Co.'s Bill seeks to incorporate a company for the supply of electricity and gas in Andover with an original capital of £28,000 and additional capital to the extent of £35,000 with one-third borrowing powers. The gas and electrical undertakings are to be kept separate. The bill schedules land for an electric generating station.

City of London Electric Lighting Co. seek to extend their area of supply by taking in a large area in the south-eastern portion of the County of London on the south side of the River Thames, and a portion of the County of Kent. Supply to be given in bulk to authorised distributors and for power purposes. No supply for lighting, except that a power consumer must not use for lighting a quantity in excess of that used for power purposes. Overhead wires to be used and consents not to be unreasonably withheld. In that event an appeal is to be made to the Board of Trade. Powers are also taken to lay cables over or under the river Thames, at heights or depths determined by the Board of Trade. The company may use its existing power station, take transfer of provisional orders, apply for provisional orders and supply to authorised distributors beyond the area scheduled in the bill. Powers cease if no supply is given within four years.

Administrative County of London & District Electric Power Co.'s Bill proposes to incorporate a company with the capital of £5,000,000 in £10 shares and one-third borrowing powers for the erection of three generating stations for the purpose of supplying electrical energy in an area, comprising large portions of the Counties of Middlesex, Surrey, Essex and Kent and the whole of the administrative County of London. The subscribers to the scheme include the Right Hon. W. H. Armstrong, Right Hon. G. D. Taubman-Goldie, Sir James Joicey, Bart., Sir Andrew Noble, Bart., Mr. J. H. Armstrong, Mr. Philip Wigham Richardson and Mr. A. F. Jarrow. Supply is to be given in bulk to authorised distributors and for power purposes. The company also take power to supply to others than authorised undertakers and power consumers, and also to supply in bulk to neighbouring authorised distributors. The dividend is never to exceed 8 per cent., any surplus to be invested to form an insurance fund. The powers under the bill cease after three years. Interest on capital during construction at the rate of 3 per cent. The bill also provides for the transfer of provisional orders to the company and for the exemption of their generating stations from the London Building Acts.

Aylesbury Gas Co. seek powers to apply for electric lighting provisional orders.

South Wales Electrical Power Distribution Co ask for the transfer of the Carmarthenshire Electric Power Co., authorised in 1903, an agreement having been entered into between the parties by which the South Wales Company pay £1 000 in cash and £18,000 in fully paid-up shares. The Carmarthenshire Company are then to be dissolved. The South Wales Company also ask for the repeal of the section of their Act of 1903 which prohibits them giving a supply in Llanelly, and for authorisation to supply there. An extension of time for carrying out the powers of the Carmarthenshire Act is asked for. It is also proposed to give the company the right to take a transfer of provisional orders without the operation of any purchase clause which might be contained therein. The capital powers of the Carmarthenshire Company are to be conferred upon the promoters.

Southend Corporation General Powers Bill includes provision for the extension of the generating station upon lands to be compulsorily acquired, the supply of electrical energy outside the borough to authorised distributors, and to deal in electrical fittings by contract or otherwise. £16,000 is to be borrowed for the acquisition of land for the generating station, repayable in 60 years.

Rathmines and Rathgar Urban District Council ask for powers to purchase the rights of the National Electric Construction Co. in that district under agreement by notice within two years of the passing of the act. Power is also taken to deal in electrical fittings.

Morley Corporation in an omnibus bill include powers for the compulsory acquisition of lands for the purposes of extending the generating station, and to make provision for the laying of electric light mains in private streets.

Shropshire and Worcesterhire Electric Power Co. wish to include the Boroughs of Lichfield and Tamworth, the Urban Districts of Brown Hills and Cannock, and the Rural Districts of Cannock, Lichfield, Seisdon, Tamworth, and Walsall, within their area of supply, and to change the name of the company to the Shropshire, Worcestershire and Staffordshire Electric Power Co. It is also proposed to pay interest out of capital during construction at the rate of 3 per cent. per annum. Transfers of undertakings of local authorities are proposed, but any purchase clause contained therein is to be inoperative. Certain amendments of the company's Act of 1903 are also proposed.

East London and Lower Thames Power Bill seeks the incorporation of a company with this name. The subscribers and first directors are G. Herring, J. B. Braithwaite, F. W. Reynolds and P. D. Tuckett. The capital is £2,000,000 in £10 shares, and land for the generating station is scheduled in the Counties of London and Essex. The area of supply includes the Metropolitan Boroughs of Hackney, Bethnal Green, Stepney, Poplar, Deptford, Woolwich, Greenwich and Bermondsey, the Urban Districts of Ilford, Woodford, Wanstead, Leyton, East Ham, Barking, Romford, Grays Thurrock. The Rural District of Romford, parts of the County Borough of West Ham, and parts of the Rural District of Orset. It is proposed to use overhead wires and, if consent is unreasonably withheld, the Board of Trade is to be called upon to arbitrate. Power is to be supplied only to authorised distributors and persons requiring a supply for power purposes, with the usual limitations. It is also proposed to supply energy outside the area scheduled, but only to authorised distributors. Applications may be made for provisional orders. A substantial commencement must be made with the works within two years, and works must be in operation before four years, otherwise the powers under the bill will cease. 3 per cent. interest out of capital will be paid during construction.

North Metropolitan Electric Power Supply Co. ask for an extension of their limits of supply so as to include Islington, Stoke Newington and Hackney. Power is also asked to make agreements with the County of London Electric Supply Co. as to a mutual supply of electricity, and to supply electricity to the trustees of Alexandra Palace Trust. The conditions of the company's original act are to apply to the increased areas. Further borrowing powers are also sought, and it is proposed to take transfers of other undertakings.

Combined Lighting and Traction Bills.

Aberdare Urban District Council propose, *inter alia*, to construct new tramways, but not to carry goods, animals, &c. Power is taken to lease the tramways for which borrowing powers to the amount of £66,800 are asked. The bill also proposes the erection of an electric generating station and refuse destructor, and the supply of electricity outside the borough to authorised distributors. £14,300 is the amount to be borrowed for this latter purpose, both this and the tramway loan being repayable in 30 years. The Council also desire to deal in electric fittings.

Croydon Corporation seek powers to construct additional tramways, to run omnibuses for a distance of 1 mile beyond the borough boundary, and to supply electricity in bulk to neighbouring authorities who are authorised distributors. The bill also takes powers to promote and hold electrical exhibitions. Tramways to be completed in five years. Borrowing powers: for tramway purposes £132,142 for 30 years; omnibuses £12,000 for seven years. These sums may be augmented at the discretion of the Board of Trade.

Bury Corporation (Various Powers) Bill seeks the repeal of the Ramsbottom Urban District Council Tramways Order 1903, the partial repeal of the Radcliffe Tramways Improvement Act 1904, and to give the Bury Corporation power to make these and additional tramways. Powers to borrow £144,000 for new lines are sought repayable in 40 years; £50,000 for the electrical equipment of existing lines repayable in 30 years, and £50,000 for the purchase of the Bury portion of the Rochdale, Bury & Oldham Tramways repayable in 40 years. Power is also taken to supply electricity in bulk to outside bodies authorised to distribute.

Colne Corporation seek powers, *inter alia*, to deal in electrical fittings, to alter the date for filling up the accounts, to supply electricity in bulk to neighbouring authorities who are authorised undertakers, and also to supply electricity for traction purposes within the Corporation boundary or in adjoining districts.

Accrington Corporation, propose the construction of new tramways and the reconstruction of existing lines, the running of omnibuses, to enter into agreements with neighbouring authorities as to running powers, &c. The lines are to be completed within five years. Power is also taken to lease tramways. Part VI. of the bill authorises the Corporation to supply electricity in bulk outside the borough, for tramway purposes, to deal in electrical fittings, and also to take transfers of other electrical undertakings. The borrowing powers are as follows:—Tramways £86,060, repayable in 40 years; electrical equipment of reconstructed lines £35,556, repayable in 20 years; and £5,000 for fittings, &c., repayable in 15 years.

Wigan Corporation Bill revives powers for tramways and their completion within five years. The bill also empowers the Corporation to supply electrical energy to tramways outside the borough, to accept leases of tramways outside the borough and to enter into working agreements. A portion of the South Lancashire Electric Tramways Co.'s undertaking authorised by the South Lancashire Act of 1900 is to be purchased. Provision is also made for taking the transfer of provisional orders and for the supply of electricity to outside authorities in bulk. It is proposed to borrow £31,000, repayable in 30 years, for the construction of new tramways and a sufficient sum for the purchase of the portion of the South Lancashire Company's lines.

Wellingborough District Tramroads and Electricity Supply Bill empowers the British Electric Traction Co. to construct new tramroads or tramways and to erect generating stations and to supply electricity in the poor law unions of Wellingborough and Kettering, and to supply in bulk and for power purposes in the whole of the counties of Northampton, Bedford and Huntingdon. Works to be completed within three years. An extension of time is asked for for the construction of tramways under 1900 Act, and it is also proposed to abandon certain portions of the lines sanctioned by that Act. Power is further taken to deal in electrical fittings, and to take transfers of provisional orders.

West Cumberland Electric Tramways Bill seeks an extension of time for two years for tramways authorised in 1901, extension of time for the compulsory acquisition of land and an extension of time within which compulsory works for the supply of electricity are to be laid down as determined by the Company's Act of 1903.

Ealing Corporation, inter alia, wish to attach brackets to buildings for overhead mains for lighting purposes, to supply electrical energy for traction purposes, and to supply electrical energy beyond its boundaries to authorised distributors. Power is also taken to supply electrical fittings through a contractor, but not otherwise. A postponement of two years of the date of the commencement of repayment of loans is asked for and provision made with regard to persons already having an independent supply.

Mexborough & Swinton Tramways Co. ask for an extension of time for the compulsory purchase of land and for the construction of tramways as authorised in 1902. Also an extension of time for the construction of the authorised tramways in Rawmarsh. The bill also defers the commencement of the electric supply works in Rawmarsh and Swinton, the provisional orders for which the company have acquired.

Oldham & Saddleworth District Tramways Co. ask for powers to construct a tramroad in the urban district of Springhead to join up with the tramways authorised by the Saddleworth and Springhead Tramway Act of 1902. This line is to be completed within three years, but the company is not to be bound to fence the tramroad. An extension of time for the remaining powers of the Saddleworth and Springhead Act of 1902 are also asked for, deferring the commencement of the Saddleworth and Springhead Electric Light Orders of 1902, which the company took over with the other powers of the Saddleworth & Springhead Co. Additional capital is to be raised to the amount of £15,000, and 3 per cent. interest out of capital during construction is to be paid.

Heckmondwike Urban District Council have deposited an Improvement Bill, Part III. of which deals with refuse destruction and electricity supply. It confirms an agreement with the British Electric Traction Co. made on December 1, 1902, and gives the Council power to supply electricity in parts of the urban district of Liversedge and the Borough of Batley, and also to supply electricity outside its district to authorised distributors. Power is also taken to supply electricity for traction purposes and to purchase electricity in bulk. Fittings are also to be dealt with and powers are taken to manufacture and sell slabs of artificial stone bricks from the clinkers of the dust destructor. It is proposed to borrow £15,000 for the purpose of the electricity undertaking and £7,500 for the electrical fittings, both repayable in 30 years.

CORRESPONDENCE.

LONDON BOROUGH COUNCILS AND THE L.C.C. TRAMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the opposition of the London Borough Councils to the trolley system of electric traction, may I be allowed to point out a matter which your leading article of 9th inst. appears to overlook.

As you say, "The conduit line will cost twice as much as the overhead line . . . so it simply means that the former system will necessitate higher fares," and such no doubt is the case. But if the trolley system is adopted throughout a certain borough, and lower fares are thereby rendered possible, who is to receive the benefit of the lower fares? What evidence is there that the L.C.C. will not use the surplus revenue obtained from trolley lines in one borough to reduce fares on conduit lines in others? This is where the difficulty comes in.

Self-interest and rivalry are very common failings—if, indeed, they can be termed failings when business matters are involved—and it is but natural that a Borough Council should object to the trolley system while other boroughs have been and are being indulged with the conduit until they are ensured some counterbalancing advantage. If the London County Council, in inviting the consent to the trolley system, were to agree to one-half the saving over the cost of the conduit being allowed as a rebate against the Borough's contribution to the necessary street improvements; or if, alternatively, the L.C.C. guaranteed that the fares charged upon the trolley lines should at all times be lower than those upon conduit lines to the full extent justified by the lower capital expenditure, then I think there can be little doubt but that the opposition of the Borough Councils to the trolley system would largely vanish. And surely this is not an unreasonable attitude for Borough Councils to take.—Yours, &c., EDWD. V. CLARK.

Pontypridd, Dec. 16, 1904.

BENEVOLENT FUND FOR THE ELECTRICAL INDUSTRY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Whilst fully sympathising with the efforts of Mr. Justus Eck and his friends to promote a benevolent fund for the benefit of necessitous members of the electrical industry, may I be permitted to point out that there is already in existence a Benevolent Fund in connection with the Institution of Electrical Engineers for the purpose of assisting members, or the families of members, in temporary or permanent need. Efforts are now being made to improve the position of this fund, and I shall be pleased to forward the rules to any member who may desire to have a copy.—Yours, &c.,

G. C. LLOYD,

Hon. Secretary to the Benevolent Fund of the I.E.E.

92, Victoria-street, London, S.W., Dec. 21.

LEGAL INTELLIGENCE.

Yorkshire (Woollen District) Electric Tramways (Ltd.) v. Ellis.

This case came before the Lord Chief Justice and Justices Kennedy and Ridley on Tuesday on an appeal from a conviction under the Town Police Clauses Act, 1847, by the Dewsbury Justices. Appellants, who were working under an order under the Light Railways Act, 1896, were summoned by the town clerk of Dewsbury (Mr. H. Ellis) for allowing one of their cars to ply for hire in the borough without a licence. Respondent contended that under the act the vehicle must be regarded as a hackney carriage. The magistrates upheld this contention, hence the present appeal.

Mr DANCKWERTS, K.C., said the decision that a carriage running upon a light railway was a hackney carriage carried with it this absurdity, that a light railway must get a licence from every local authority through which the line ran, and there might be a great number of them. Consequently, although the railway company was bound to run such a number of cars as was necessary to meet public requirements, each one of the local authorities would have the discretion of saying how many of these carriages there must be.

Mr. MACMORRAN, K.C., on technical grounds arising out of several acts of Parliament connected with tramways and other vehicles, supported the conviction.

The LORD CHIEF JUSTICE said the point involved did the greatest credit to the ingenuity of the people who raised it. The Court, however, could not come to the conclusion that that which was in substance a railway was to be subject to the provisions of the Town Police Clauses Act in regard to the licensing of hackney carriages. The absurdity of the thing was too great. The appeal, therefore, must succeed.

The other judges concurring, the appeal was allowed with costs and the conviction quashed.

Hornsey Tramways.

At the Guildhall, Westminster, on Monday, Sir Colin Moncrieff sat as arbitrator upon the claim of Hornsey Borough Council against Middlesex County Council for the recovery of £2,000.

It appeared that in connection with the construction of the Middlesex electric tramway system the County Council required the Borough Council to carry out certain alterations to a number of sewer manholes. The plan proposed by the former was regarded by the latter Council as dangerous, and accordingly the Borough Council carried out the work themselves and sought repayment of the cost from the County Council.

The arbitrator reserved his award.

Brimlees v. Mersey Railway Co.

On Wednesday Mr. Justice Lawrence delivered a considered judgment in this action (reported in our issue of Aug. 12) for a declaration that an agreement (dated May 4, 1881) with defendants employing him as chief engineer with Sir Douglas Fox was still existing, and to recover damages, roughly estimated at £10,000, for the refusal of the company to engage him in connection with a contract for about £250,000 given to the British Westinghouse Co. for the electrification of the line.

His LORDSHIP said the point was whether the agreement was confined to the then existing state of things, and did it cease to have effect when it was decided to employ electric power. In his opinion, neither party having contemplated any change from the original system of working, this contract was not binding upon the company, but came to an end when electricity was adopted. He therefore gave judgment for defendants with costs.

Tramways Purchase.

Mr. Justice Bray delivered reserved judgment on Wednesday in the special case arising out of the purchase by London County Council of the London, Deptford & Greenwich Tramways Co. Before the arbitrator appointed to ascertain the purchase price the company contended that the present value of the tramways was enhanced by reason of their being freed from liability to contribute to the widening of some streets in which the tramways were laid. The arbitrator found that the contention of the company was unfounded, and fixed the purchase price at £91,363. 7s. 6d., but assessed the additional compensation, if the company's contention were valid, at £22,773. 6s. 8d.

His Lordship now held that the company's contention was unsound, and that they were only entitled to receive £91,363. 7s. 6d.

Workmen's Compensation.

On Monday, Mr. Justice Phillimore had before him a special case arising out of the arbitration between the Tees-side Bridge Co. and the Life & Health &c., Association.

In 1903 the Tees-side Co., whose works are at Middlesbrough and Leeds, took out a policy with respondents to insure themselves against injury or death claims by their workmen under the Workmen's Compensation Act. Certain claims were made, but the association refused to pay, on the ground that there had been misrepresentation in the proposal form. The question was whether there had been misrepresentation, and whether or not, under the circumstances, the appellants were not entitled to recover their premium. The association did not, however, dispute the latter point. At the solicitation of an agent of the association negotiations were entered into for workmen's insurance by the secretary of the Bridge Co. (Mr. Lewis) and the agent filled in the answer had form from Middlesbrough statistics as to compensation which been paid by the company to their employés at the same time stating that he knew nothing as to what had been paid in Leeds. On finding that the percentage of accidents was higher among the company's men there than at Middlesbrough, the association, on a claim being made upon them, disputed the validity of the policy which was subsequently entered into. It was admitted by respondents that the misrepresentation on which they relied arose through a mistake, but their contention was that the premium accepted and paid in consequence was an inadequate one and that the policy ought to be made void accordingly.

Mr. Justice PHILLIMORE held that though the mistake on the part of Mr. Lewis had been quite unintentional as to the number of accidents in Leeds, which he apparently took to be quite small, and hardly worth mentioning to the association's agent, yet that could not stop the insurance company from setting out the incorrectness of the answer. Therefore the arbitrator was right in finding that the employers could recover nothing. The parties were agreed that the employers were entitled to recover their premium. Therefore the award would stand.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A Telegraph Inspector is required for service in the Postal Telegraph Department of Southern Nigeria. Salary £300 per annum, with free single quarters or camp equipment, and free first class passage out and home on satisfactory termination of engagement. Further particulars in an advertisement. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., up to Dec. 31.

Hanley Corporation require an electrical engineer to take entire charge and management of their electricity undertaking. Salary £300, rising, by annual increments of £10, to £350 per annum. Applications to the town clerk (Mr. Arthur Challinor) by Jan. 10. See advertisement.

The Rhodes Electrical Mfg. Co., 70-71, Bishopsgate-street Within, London, E.C., require a capable commercial engineer to start a branch office in Manchester. See also advertisement.

A lecturer in electrical engineering is required at Queen's College, Galway, early in January, 1905. Salary £125, with class fees. Applications to the registrar, Mr. Edward Townsend, M.A., by 31st inst. See advertisement.

An assistant engineer is wanted for Mexico City. Salary £200 per annum, on three years' agreement. Applications to Mr. E. Bartlett, 15, Bishopsgate-street Within, London, E.C. See advertisement.

An electrician accustomed to Eisemann ignition, wiring of petrol cars, &c., is required. See advertisement.

An engine driver is wanted for Dover electricity works. Applications to the borough electrical engineer (Mr. L. W. Woodman), Park street, Dover. See advertisement.

A general manager is required for Newcastle-upon-Tyne Corporation's electric tramways. Salary £700, with increases of £50 per annum to £800. Applications by Jan. 7.

The Council of Victoria University, Manchester, propose to appoint a professor of engineering. Total income not less than £1,000 per annum during the first three years. Applications by Feb. 15.

A lecturer and demonstrator in engineering is required at Woolwich Polytechnic. Commencing salary £150. Applications to Principal by 31st inst.

A chief assistant is required in the mechanical engineering department of Northampton Institute, St. John Street-road, London, E.C. Applications to principal by Jan. 3.

The East Indian Railway Co. require a signal inspector, not over 35 years of age, and with sufficient knowledge of electric fittings to put in and maintain electric slots, &c. Salary R.350 to R.450 per month. Applications by 31st inst. to the secretary (Mr. C. W. Young), 28-30, Nicholas-lane, London, E.C.

Mr. A. Zoller, of Croydon, has been appointed shift engineer at Fulham.

Mr. H. H. Heayberd (late with R. W. Blackwell & Co.) has been appointed outside equipment assistant by Hull Corporation tramways department.

Mr. T. Lewis, permanent way inspector at Leicester, has been appointed permanent way inspector at Belfast.

Mr. L. D. Coulesant, B.Sc., senior lecturer in engineering at the South-Western Polytechnic, London, has been appointed lecturer in mechanical and civil engineering at the Municipal Technical College, Sunderland.

Argentina.—The Cia de Luz y Fuerza Motriz de Cordoba has been supplying electric current since November, 1897, to a population of about 75,000. At November, 1904, there was an equivalent of 36,000 8 c.p. lamps connected, including 780 H.P. for motors. The number of consumers has reached 2,000. The price charged per kilowatt-hour is 20 cents (gold) for lighting and 5 cents (gold) for power.

Australia.—The Redfern (N.S.W.) Corporation electricity undertaking, which has been established since 1892, has a total plant capacity equivalent to 8,000 8 c.p. lamps. There are 10,118 lamps connected. The charge for current is 5½d. per unit for lighting with 55 per cent. off the lighting charge for power.

Penrith (N.S.W.) Municipality started their system of supply in 1890, and have now a total connection of 1,100 8 c.p. lamps. The charge for lighting is 25s. per annum per 16 c.p. lamp by contract. There is, so far, no motor load on the Penrith mains.

Australasia.—At the annual dinner of the Engineering Association of New South Wales at Sydney last month, Prof. W. H. Warren urged the advisability of supporting local industries if possible, and Mr. W. H. German said he thought this might most easily be effected by combination. He considered the Engineering and Electrical Associations should join together. Mr. T. H. Houghton urged federation, and Prof. Warren preferred amalgamation.

The Borough Council of The Glebe, a suburb of Sydney, are promoting a bill to sanction the borrowing of money for lighting the borough electrically.

Fremantle (W.A.) Electric Tramways Board have been invited by the Harbour Trust to quote terms for the supply of current for lighting the wharves and operating cranes, but the board have intimated that they are not at present in a position to give a quotation.

The contractors for the equipment of the tramways and power station at Fremantle (W.A.) have placed a trial order for cars with a local firm.

The Victorian Premier (the Hon. T. Bent) will support a proposal for an electric tramway from Port Melbourne to Brighton to connect up with the proposed electric street railway between Port Melbourne and St. Kilda, for which a bill is being promoted, as announced in our issue of Dec. 9. Mr. Bent, at a recent public meeting, urged the Prahran and Malvern (Victoria) Councils to formulate a scheme for an electric tramway between their districts to connect up with the railways.

At the recent meeting of the East Greta Coal Mining Co. at Newcastle (N.S.W.) the general manager (Mr. A. Thomas) said their electric coal cutters were doing good service in the hardest and most difficult seams in the mine. They were the most suitable type for working in places with a bad reef, and the cost was about the same as for coal won from the most favourable places by hand. The use of such machines, the extended use of which was under consideration, also seemed (he said) to be the solution of the labour problem.

The electricity supply works of the Hawera Electric Lighting Co. at Hawera, New Zealand, were recently inaugurated. Messrs. Steuart & Fenn, of Dunedin, were contractors for the supply and equipment of the station and laying distribution system. Power is obtained from the Waingorgora River. Two turbines develop 230 H.P. at a speed of 600 revs. per min., and each drives a 65kw. three-phase generator. Current is generated at 5,500 volts. The company supply current to the towns of Hawera, Manaia, Normanby and Okaiawa, and have contracts for lighting the streets of the three first-mentioned places. Further power can be obtained, and the works have been built in such a way as to permit the increase of the plant up to 700 H.P.

A "Financial Times" correspondent says a proposal is on foot to solve the problem of the disposal of the accumulated "tailings" on the Kalgoorlie gold field by erecting a plant for the treatment of 5,000 tons of residues per day on the outskirts of the field, and conveying the residues to it by means of electric tramways to be constructed for the purpose.

The Corporation of Launceston, Tasmania, have now a lamp connection to its electricity undertaking of the equivalent of 42,300 8 c.p. lamps. The plant capacity is 40,000 lamps. There are now 2,440 consumers connected for a population of 23,000. Supply is now wholly on the alternate-current system.

Ayr.—The accounts of the Corporation tramways department for the year ended May 15 last show total capital expenditure £77,259. 10s. 11d., or an increase of £3,578. 18s. 8d. during the year. Traffic revenue was £13,957 and other receipts made the total £14,221. 18s. 9d. The total working expenses were £7,621. 14s. 8d., leaving £6,600. 4s. 1d gross profit. The addition of £106. 3s. 9d. interest made the disposable balance £6,706. 17s. 10d., of which interest on capital required £2,297. 10s. 3d., £628. 19s. 9d was devoted to repayment of loans and £267. 1s. 11d. to sinking fund. £1,367. 2s. 5d. was placed to reserve and £2,151. 4s. to depreciation and renewals. 353,945 car-miles were run and 3,316,390 passengers carried. The average consumption of energy was 0·91 unit per car-mile and the average receipts were 9·44d. per car-mile. There are 17 passenger cars in use, of which 10 are fitted with tyred wheels, though the latter have not the life that was expected, running only from 20,000 to 30,000 miles although not touched by the brake shoes. In December, 1903, an increase in speed of two miles an hour on nearly every section of the system was authorised, the maximum now being 12 miles.

Bermondsey (London).—The electrical engineer (Mr. W. H. Vincent) has reported to the committee that

At 4:30 a.m. on 3rd inst., a short-circuit occurred on a distributing main in Bermondsey-street, by Messrs. Christy's, followed by an explosion in the brick chamber, opposite the "Prince William Henry" public-house. The force of the explosion raised the cover from the chamber and caused a slight upheaval of the roadway, the next chamber (in the direction of the parish church) was also badly cracked and a piece forced off the cover of a fire hydrant close by, and a large number of windows were broken. On finding that steam pressure could not be maintained to supply the power necessitated by the short-circuit before it cleared itself, the switchboard attendant on night duty at the station promptly disconnected the feeders supplying the Bermondsey area (the Rotherhithe supply being still maintained), and in the meantime sent for the second assistant who arrived at 4:55. More power was shortly after available, and the fault cleared by 7 a.m. and the supply reinstated. On examination of the faulty section of the cable it was found to have completely fused between the chamber in which the explosion occurred and the service box to Messrs. Christy's. This box was found to be resting on a cast-iron water service to a fire hydrant, both being pitted by electrolytic action, causing a small hole in the pipe from which water issued. Mr. Vincent is of opinion that the short-circuiting occurred through the pitting having extended to the lead covering of the cable, causing the insulation to break down, this being accelerated by the water from the damaged pipe finding access to the cable. He is also of opinion that the explosion occurred through an accumulation in the chamber of gas given off by the melting of the pitch used for the solid filling in of the cables, which would become ignited by the fusion.

The Electricity committee intimated that they would bring up a report at the next meeting.

Birmingham.—The Traction Corpn. (Ltd.) have made an offer to the Council to equip 4 or 5 miles of tramway track on the Kingsland surface-contact system at a price to be agreed, and if it fails to pass the agreed tests and fulfil the agreed conditions, the company will substitute the overhead system without further charge.

Blackburn.—At a recent inquiry into the application of the Corporation for sanction to borrow about £9,000 for the erection of new baths, the inspector (Col. Coke) asked the cost of the electric lights for baths, and was told 1s. each. He explained that, in accordance with special instructions from his board, the amount of the loan would have to be decreased by £15, the cost of 300 lights, because they could not possibly last as long as the building.

Chesterfield.—The municipal electric tramways were officially inspected by Major Pringle and Mr. A. P. Trotter on Tuesday, and the lines were afterwards opened for traffic.

Dublin.—An adjourned meeting of the Corporation was held on Friday to consider various reports on electric lighting, including one on the offer of Mr. Robert Hammond to take over the electric lighting undertaking on terms already published in *The Electrician.*

The report referring to the offer stated that, "If it would pay Mr. Hammond or his syndicate to work the undertaking, surely it will pay the Corporation of Dublin." Loans to the extent of £392,747 had already been sanctioned by the Local Government Board for electric lighting, and two further loans, amounting to £49,000, had been inquired into, to which was to be added the amount of consulting engineer's estimate to meet further expenditure to Dec. 31, 1906, £60,000; total £501,000.

The chairman of the Electric Lighting committee (Mr. J. Irwin) made a statement, and, after discussion, it was decided that the electric lighting scheme and its working be kept in the hands and under the control of the Corporation.

Ald. Bergin's motion—"That the committee undertake no further or additional constructional works until the consulting engineer has reported that the works covered by his agreement with the Corporation of Sept. 2, 1899, have been finally completed" was adopted, with an addendum that the passing of same should not in any way interfere with the present scheme or any additions to consumers or extensions or mains, &c.

The letter of the city electrical engineer (Mr. M. Ruddle) was also dealt with, and the committee decided that the adoption of the first resolution, which retained the control and management of the undertaking in the hands of the Corporation, covered Mr. Ruddle's report.

Dundee.—In consequence of representations made to them by the National Telephone Co.'s officials regarding the difficulty of modernising the Dundee telephone service if the committee's proposed restriction of the company's facilities for laying underground lines were adhered to, the committee have decided to reconsider the position.

Ealing.—The increase in revenue of the electricity department for the half-year ended Sept. 30 is £939. There are 2,253 consumers, representing an equivalent of 84,459 8 c.p. lamps connected. A scheme for the construction of a light railway from Ealing to Brentford will come before the next sitting of the Highways committee. Councillor Farr has also given notice of a motion in favour of the Council applying for powers to construct a light railway from the north and along Ealing road.

Edmonton.—On Friday the Council again considered the offers recently made by four companies for the supply of electricity in this district. It was considered that the terms offered by the North Metropolitan Electrical Power Distribution Co. were the most favourable. It is therefore probable that, provided details can be settled, a definite agreement will be entered into between the Council and that company for a supply of electricity in bulk.

Electric Traction Notice.—Liverpool Corporation give notice of intention to ask leave to insert in their bill in Parliament provision for the construction of an additional tramway along Hill-street, Upper Hill-street, Selborne-street, Beaumont-street, Earle-road, Lawrence-road and Wellington-road, terminating in Picton-road.

Epsom.—From Jan. 1 the charge for electric current for private incandescent lighting is to be reduced from 6½d. to 5½d., and for arc lamps for outside lighting to 4d. per unit.

Floating Exhibition.—It is announced that on Nov. 15 the ss. "Ohio" sailed from Seattle to the Orient as a floating exhibition of the goods which the United States has to offer to Far Eastern buyers. The "Ohio" carries no passengers but the exhibitors, whose exhibits are each given deck space of from 100 to 500 sq. ft. The trip is to Yokohama, Kobe, Hong Kong, Shanghai, Mauritius, Manila, Ceylon, Singapore, Cape Town, Delagoa Bay, Melbourne, Adelaide and Sydney; returning via Honolulu, across to the Chilian coast, Santiago, Valparaiso and Callao. The programme is, all things permitting, to have the exhibition on view in the harbours of these ports of call for from two to 10 days, according as circumstances necessitate. The "Ohio" is expected to return to the States in about eight months.

German Telegraphs.—The "Kölnische Zeitung" (Berlin) last week gave its readers the benefit of a re-hash of recent statements regarding telegraphic arrangements between Germany and the German colonies in Africa, which (according to the "Zeitung") "will make Germany independent of the British cable companies." First, it is stated, Germany intends to construct a telegraph line along the route of the Bagdad Railway from the Bosphorus to the terminus on the Persian Gulf. But, so far as we have been able to ascertain, no concession for this line of telegraph has been, or is likely to be, granted by Turkey. Our German contemporary proceeds to state that subsequently the cable will be laid from the Persian Gulf to German East Africa. It is, perhaps, too much to say that this cable is an impossible one, but we can go so far as to give the opinion that it is a most unlikely one. The "Zeitung" proceeds to inform us that "France will then probably seize the opportunity of liberating herself from the British cable monopoly by constructing a cable from German East Africa to Madagascar."! As France has already a cable from Portuguese East Africa the probability of this new line is, on the face of it, somewhat remote. We are then told that "a Belgium 'cable' already connects Libreville with the Congo Free State." This is, of course, wholly inaccurate, as the line is a French land-line. As the "Standard" (London) considers the particulars published by the "Kolnische Zeitung" worthy of telegraphic summary, we have taken the trouble to publish the real facts of the matter.

Glasgow.—At the meeting of the Corporation last week the Tramways committee presented a report dealing with the salary of the tramways manager (Mr. Dalrymple).

Mr. DALLAS said that in proposing that Mr. Dalrymple's salary be £850, rising by £50 until it reached £1,000, he did not put forward his motion in any mean or parsimonious spirit. In giving him £850 they would practically be giving him an increase of £300 in one year. If they had advertised the post at £850 they would have had an unlimited number of suitable applicants. Whatever experience Mr. Dalrymple had obtained, he had got it during the time he had been in the service of the Corporation. There were only five municipalities in Britain which paid a larger salary than that suggested now.

Mr. HUGH ALEXANDER held that £1,000 was not too much to pay to the manager of Glasgow tramways. Glasgow had the biggest and most successfully managed tramway system in Great Britain, and should be compared only with departments of the same calibre. The manager of the London tramway system, which was about three-quarters of the extent of Glasgow, got £1,500. In Liverpool, which was two-thirds the size, the salary was £1,200, to rise to £1,500 in January, 1905. In Birmingham, where the system was one-third the size of Glasgow, the salary was £1,500 a year, and in Leeds £1,000. Neither Glasgow nor any other city which had any regard for its municipal enterprises could afford to have any but the best men for the heads of departments. He moved that the salary be £1,000.

After discussion, the Council divided, when 29 voted for the motion and 31 for the amendment.

On the question of the generating plant at the electricity works,

Mr. FRASER asked the convener of the Electricity committee to state if the German-built generators which broke down immediately after installation were yet in working order.

The LORD PROVOST said that from the nature of the question it would be reasonable that Mr. Willock should have time to consult the engineer before committing himself, and be allowed to give an answer at next meeting.

Mr. WILLOCK: It is a technical answer that must be given, and without consulting the engineer I do not profess to be able to answer it.

Glasgow Tramways.—The Parliamentary Bills committee of the District committee of Upper Renfrewshire recommend the County Council to petition against Glasgow Corporation's draft order for an extension of their tramways to Barrhead on the ground that the width of the roads is insufficient to permit of the safe working of a single line with loops. The order of the Paisley District Tramways Co. is also to be opposed for a similar reason.

Greenock.—An arrangement has been made between the electricity department of the Corporation and the local tramways company by which the latter, while not admitting that they are liable to pay at an increased rate for an additional guaranteed consumption of current, are prepared to temporarily increase their guarantee from 500,000 to 600,000 units per annum, and to pay 1½d. per unit for the additional 100,000, this arrangement to take effect from Aug. 1 last, and to remain in force until the next term for the revision of rates.

Grimsby.—Sanction to a loan of £3,000 for extensions of the electric lighting mains and the purchase of additional meters has been obtained by the Council.

Huddersfield.—At the Council meeting on Wednesday Mr. Brook took exception to the proposal of the Tramways committee to extend the Outlane tramways to a point opposite Gosport Mills, and to enter into an agreement to convey coal by tram haulage for Messrs. Sykes, a firm of mill-owners, at 1s. 9d. per ton for 7 years.

The CHAIRMAN (Ald. Moore) said that by the arrangement the Corporation would convey 10 tons of coal per day, and would make a profit of £100 a year. He hoped that other large consumers of coal would follow. The committee had got to the maximum of their passenger receipts, and it was imperative that they should tap all other sources of revenue they could.

The recommendation was carried.

The tramcars are to be run on Christmas Day as on Sundays, the employés to be paid double wages. Motormen and conductors are to be granted permission to place in the cars books for recording Christmas gifts from passengers, &c., but there is to be no touting, and the men are recommended to divide the money equally.

India.—Simla Municipality have asked the approval of the Punjab Government to a proposed municipal scheme for the electric lighting of the town hall and some of the streets at an estimated initial cost of R22,000. Mr. Pook, electrical engineer, of the United Service Club, Simla, prepared the estimates.

Messrs. Crompton & Co. have secured a concession from the Madras Municipal Commissioners for the erection of electricity works and the supply of current in the city for 21 years. Messrs. Crompton have also obtained a licence under the Indian Electricity Act from the Government. The maximum price per unit is 2½ annas for public and 8 annas for private lighting.

The Municipal Buildings and the Crawford Market, Bombay, which have hitherto been lighted from a small municipal plant, are in future to be supplied with current by the Brush Co. at 3 annas per unit. Re-wiring and refitting is estimated to cost R.16,345, and the cost of current is put at R.10,375 per annum, compared with R.11,227 under the old system.

The Indian Government have authorised the introduction of "Simplex" electric punkah-pulling machines in all the Government offices.

Inverness.—Edmundson's Electricity Corpn. have submitted to Dean of Guild Court plans for the erection of electricity supply station buildings, the estimated cost of which is about £4,000.

Japan.—The Osaka Electric Light Co has been supplying current at Osaka since May, 1888, and has now a total connection of 100,000 equivalent 8 c.p. lamps to 12,000 consumers out of a population of 800,000. The total plant capacity at Osaka is about 120,000 8 c.p. lamps.

Kensington (London).—On Tuesday the Council authorised the Kensington & Knightsbridge Electric Light Co. to erect a Bastian mercury vapour electric lamp in Kensington-court.

Light Railways.—The Board of Trade have granted an extension of 12 months for completing the lines authorised by the Durham and District Light Railways Order.

London County Council.—At Tuesday's meeting the Finance committee reported on the application by Marylebone Council that the first instalment of the principal of the loan of £433,800 be repaid at the expiration of three years from the date of borrowing. The committee raised no objection to the proposal and the Council agreed.

Camberwell Tramways.—It was agreed that the junction line between the tramways in Camberwell New-road and those in Denmark Hill should be constructed by Messrs. J. G. White & Co. (Ltd.) at rates 15 per cent. in excess of those specified in the contract with that firm.

Maidstone.—In a report of the Electricity and Light Railways committee presented at the last meeting of the Council it was recommended that arc lamps be supplied on hire at 6s. per lamp per annum, including trimming and keeping in repair.

In moving the adoption of the report the Chairman (Mr. E. Vaughan) said that the committee were endeavouring to compete with the gas company so far as outside lighting of shops was concerned, and he thought the recommendation of the committee would prove a satisfactory means of starting this competition with the company.

The report was adopted.

Mansion Lighting.—A complete electric lighting installation is being put in by Messrs. Drake & Gorham at St. Michael's Mount, for Lord St. Levan.

The generating plant will consist of two gas engines and dynamos, and a D. P. storage battery has also been put in. Concentric water-tight conductors have had to be designed, as the walls are often soaked with spray.

The Earl of Dunraven's residence at Adare (Limerick) is to be supplied with an electric lighting and power plant. His lordship, it is stated, contemplates the public lighting of the village.

Metropolitan Pneumatic Dispatch Scheme.—The consulting engineers for this scheme (Sir J. Wolfe Barry and Col. Crompton, C.B.) have arranged to meet the Metropolitan borough surveyors and engineers at the Municipal and County Club at 7 p.m. on Friday next, to discuss and explain the details and proposals of this scheme.

Munich (Germany).—The electric street tramways in this city are 58½ miles in length single track. The number of motor cars employed is 288 and of ordinary passenger cars 281. Nearly the whole of the public thoroughfares in Munich are now electrically lighted.

Municipal Telephony.—At the meeting of Brighton Corporation last week Councillor Lintott, in moving the adoption of the minutes of the Telephone committee, said that a communication had been received stating that—

> The Postmaster-General had again given consideration to the various representations made to him by his licensees concerning the establishment of call offices on Post Office premises, and that he was willing to afford facilities of this nature wherever there was sufficient accommodation for a silence cabinet and the necessary attendance could be given without prejudice to the business of the Post Office. Where the Post Office was a Crown Office certain conditions would apply, and where such was not the case lincensees might establish call offices under private arrangements with the sub-postmaster.

The terms set out in the letter were recommended for approval, and the Council agreed.

Mr. A. R. Bennett has recently issued a group of comparative figures showing the terms upon which the telephone service is provided in Glasgow, Hull, Portsmouth, Brighton, Swansea and Guernsey, where the municipal system is in competition with the National Telephone Co. Some statistics relating to Sheffield and Tunbridge Wells are also given.

Natal.—In a report on the Natal coal trade "The Times" states that during last year 13 electric coal cutters were employed in two collieries and undercut 168,360 tons of coal, or 24 per cent. of the colony's total output.

P. O. Telephone Service.—Thames Ditton Council have sanctioned the proposal of the General Post Office to erect posts on, or to lay a tube in, several roads in Thames Ditton, Claygate and Esher, for the extension of the telephone service to Claygate.

Para (Brazil).—The special correspondent of the "Glasgow Herald" states that the tramway system is about to be converted from mule to electric traction, while Manaos has possessed an excellent system of electric tramways for some years. The capital of the Para Tramway Co., which owns about 40 miles of line, as well as electricity supply works, is about £400,000. The company's concession runs on for over 40 years, but the company have only 12 months in which to complete the electrical conversion. A new company is to be formed to buy the whole of the company's business, to be worked as an English company, the purchase price named being £500,000. The cost of electrification is estimated at about £350,000, and most of the material and plant will come from Great Britain.

Paris Underground Railway Disaster.—The Eighth Correctional Tribunal delivered judgment on Saturday in the case of the disaster which occurred at the Couronnes station in August, 1903. The guard of the train and the station master were each sentenced to a month's imprisonment under the First Offenders Act, with a fine of 2,000f. damages, while the motor man was ordered to pay a fine of 3,000f., and another guard one of 2,000f.

Personal.—Mr. S. Woodfield has resigned his position with the British Thomson-Houston Co. in order to join the staff of J. G. White & Co.

Peru.—The electric railway which has recently come into operation between Lima and Callao is the second enterprise of its kind in Peru, the other line being that between Lima and Chorillos and adjacent seaside places. The new line is constructed on the overhead trolley system, and is 8·6 miles in length. A 15-minute service has been established. Pending permission to run through the chief streets of Lima, the electric cars have to stop at a point where the horse-driven cars join the line. It is hoped, however, that very shortly permission will be given to the railway company to continue their track through the main thoroughfares. The cars run through the principal streets of Callao, and there is a 1½ mile extension line down to the coast. The new railway is very popular

Poole.—The Rural Council have assented to the application of the Bournemouth & Poole Electricity Supply Co. for a provisional electric lighting order.

Presentation.—A smoker's cabinet and a slide rule were presented by the staff and employés of Farnworth Electricity and Tramways departments to Mr. J. D. Pember, chief engineer, on his departure for Dartford.

Private House Lighting.—An electric lighting plant was recently installed at the house of Mr. L. A. Waterfield, Dunstable, by Garrett Bros. & Co., electrical engineers, Dunstable. The plant includes a 7 H.P. Crossley gas engine, a d.-c. "Castle" dynamo capable of supplying 70 16 c.p. lamps. A battery of E.P.S. "K" type cells is included in the installation.

Provisional Order Revocation.—The Board of Trade have revoked the Tadcaster and District Extension Electric Lighting Order, 1903.

Rawtenstall.—The Board of Trade have decided not to revoke for another six months the Rawtenstall Electric Lighting Order, 1899.

Redditch.—The Council are borrowing £16,000 from the Victoria Legal Friendly Society for the electric lighting undertaking, at 4 per cent. for 25 years

Rochester.—The first section of the municipal electric tramways was officially inspected on Wednesday and opened for traffic yesterday. The new line places Rochester in direct tramway communication with Chatham. The Chatham & District Light Railways Co. will work the line by agreement with Rochester Council.

St. Austell.—On Friday last the new electricity works of St. Austell & District Lighting & Power Co. commenced supply. It will be remembered that Veale & Co. (Ltd.) were supplying current here for some years, and about 12 months ago the St. Austell & District Co. acquired their undertaking. The equipment of the new station has cost £7,000, and includes three dynamos, two 85 H.P. gas engines, gas producer plant, and there is a storage battery which supplies current after midnight and at other periods of small demand. The company have secured about 75 per cent. of the old consumers, and have fixed the charge for current for private lighting at 5d. per unit. The resident engineer is Mr. A. Childs.

Scarborough.—The Electric Supply Co. are reducing the price of current for lighting from 6½d. to 6d. per unit, with discounts varying from 5 to 15 per cent., and for power from 2½d. to 2d.

Southampton.—At the last meeting of the Council a long discussion took place on a motion to appoint a general manager of the tramways undertaking. An amendment to postpone consideration of the matter until the next Council meeting was carried, it being intimated that the Tramways committee were preparing a report on the subject.

Stepney (London).—On Wednesday the Council resolved to apply to London County Council for a loan of £10,000 for the eastern extension of the electricity undertaking.

Stoke Newington (London).—The Council have been asked by the local ratepayers' association to withdraw their consent to the adoption by London County Council of the overhead system of traction on the Green Lanes tramways. The Council have replied that they are not prepared to reconsider the matter.

Stratford-on-Avon.—At a meeting on Monday the Council decided to apply for an extension of the time allowed for complying with their 1901 electric lighting order, which is to be transferred to the Birmingham Installation Co. The company's charges for public and private lighting are not to exceed 2½d. and 5d. per unit respectively.

Sudbury.—The Mayor announced at the Corpn. meeting last week that proceedings had been commenced in the High Court against the Empire Electric Light and Power Co. and it was necessary to appoint a small committee, who might deal with matters which might arise. It was stated that the company had undertaken to give a guarantee of £2,000, but had not done so, and a writ had been issued to compel them to provide the guarantee or the money.

Sumatra.—The owners of the electricity works here (the Electriciteit Maatschappij Medan) commenced the supply of electricity in 1898, and have now a total of 140 customers, with an equivalent on Nov. 1 of 5,000 8 c.p. lamps connected. The supply is by overhead cables. The plant at the station is to be increased by the addition of a 100 H.P. Diesel gas engine and belt-driven alternator.

The owners of the telephone service of Deli-Sumatra are the Deli Railway Co., with head offices at Medan. The service has been in existence since 1887, and there are now eight exchanges with 269 subscribers. The subscription ranges from £1. 5s. to £2. 10s. per month. A twin-wire service for the whole system is in course of construction.

Switzerland.—Mr. G. Anselmier, of Berne, has obtained a concession to construct and work three electric funicular railways in Berne, the estimated cost of which is £16,000.

Tramway Contracts.—Messrs. J. G. White & Co. (Ltd.), 22A, College-hill, London, E.C., recently secured two important contracts for the construction and equipment of electric tramways at Belfast and Monte Video.

The *Belfast* contract is divided into five sections—viz.: Sec. 1, permanent way, 28½ miles d.-t., 2 miles s.-t., and 8 miles of d.-t., repairing and bonding only. The rails are B.S. Nos. 4 and 4C: the concrete bed is 7in. thick. The special work amounts to £25,000; the paving is granite setts. Sec. 2, 37 miles overhead construction, mostly span wire; the trolley wire is 4/0 S.W.G. Sec. 3, cables, comprising feeders, telephone and test cables, the cables to be laid on the solid system in earthenware troughs, filled in with bitumen; the dielectric being vulcanised bitumen. Sec. 4, engines, dynamos, switchboards, three-phase condensing plant, &c. There are three 1,000kw. d.-c. steam dynamos, two 250k.w. three-phase motor generators, two 125kw. three phase motor generators and there is also a 25-ton crane. Sec. 5, boiler house, containing superheaters, mechanical stokers, condensers, coal and ash conveying plant and the usual piping. There are four boilers working at a pressure of 170lb.

In the case of the *Monte Video* contract, there are 51 miles of permanent way, with the accompanying overhead construction. There are 100 cars. The power station will contain generating sets to the extent

of 2,000kw. The value of this contract, for which the firm are engineers and contractors, exceeds £400,000.

Messrs. J. G. White & Co. have also secured the contract for the Mansfield and District light railways, Messrs. Bramwell & Harris being the consulting engineers. The value of this contract is £48,000.

Transvaal Imports.—The value of the imports of tramway material into the Transvaal for the nine months ended Sept. 30 was £117,000, compared with £62,000 in the corresponding period of 1903. Electric cables, wires and fittings stand for £54,000, compared with £53,000.

Village Lighting.—In regard to the electric lighting of Broxburn and Uphall, briefly referred to in our last issue, the contract for the erection of the generating plant and the laying of mains, &c., was carried out by the Glasgow branch of Drake and Gorham. Electric current is generated by a d.-c. dynamo driven by a Hornsby-Akroyd oil engine, distribution being on the three wire system. Jandus arc lamps have been erected in the main thoroughfares and Nernst lamps in the side streets.

Walthamstow.—It was reported on Wednesday that the number of 8 c.p. lamps applied for was equal to 50,333, against 39,838 in the corresponding period of 1903. Good progress is being made with the erection of the new plant at the station.

Wellington (N.Z.).—The new overhead electric tramway service although not completed is now running. Single and double deck cars are provided, but owing to the wind storms for which "windy Wellington" is famous it is not always desirable to occupy an outside seat on a tramcar, and the majority of the cars are therefore single deck.

Westminster (London).—The Works committee reported on Tuesday having come to a working arrangement with the electric lighting companies with regard to access to boxes and notice of works.

Willesden (London).—The Electricity committee recommended the Council on Tuesday to purchase 4 acres of land (part of the Neasden allotments) out of the profit of £3,300 made on the sale of the Taylor's-lane works to the North Metropolitan Electric Supply Co., as it was considered desirable to have an alternative site for a station should it become necessary at any time to determine the agreement for bulk supply. The purchase price is £800 per acre. This recommendation was adopted. The engineer was also requested to enter into further negotiations for a site for a substation on the Gibbons estate.

The committee also reported that the time has not yet come for the adoption of a flat rate, either as an alternative to or in lieu of the maximum demand system.

Worcester.—On Monday the Electricity committee considered the 95 applications received for the position of borough electrical engineer, vacant by the resignation of Mr. C. J. Sutherland. The number was reduced to the following six—viz., Messrs. H. E. N. Applebee (Ashton-under-Lyne), W. J. Bache (Gloucester), H. H. Denton (Crewe), S. C. Gibson (Nuneaton), E. E. Hoadley (Maidstone), and C. M. Shaw (Wakefield). After an interview the committee will make a selection of three to be presented to the City Council who will make the appointment.

Worthing.—An inquiry was held on Tuesday into the application of the Council to borrow, among other sums, £1,600 for extensions of the electric lighting mains. The resident electrical engineer (Mr. G. Porter) gave evidence in support of the application.

Dinner.—On Saturday last about 70 members of the staff of the Electric & Ordnance Accessories Co. met at the Grand Hotel, Birmingham, on the occasion of the first annual staff dinner and concert of "Stelliters." Mr. R. F. Hall occupied the chair and was supported by Mr. D. C. Bate (sales manager) and Mr. J. R. Garner (works manager). After an excellent dinner the toast "Success to Stellite" was given by Mr. Bate. Both dinner and concert proved the capacity of the organising committee (Messrs. Barker, Harrison, Pope and Robertson).

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Directors of the *South London Electric Supply Corpn. (Ltd.)* invite tenders for supply and erection at their works, Bengeworth-road, Loughborough Junction, London, S.E., of one 750kw. steam alternator and pipe connections and sundry iron work. Specifications, &c., from the consulting engineers (Messrs. Kincaid, Waller, Manville & Dawson), 29, Great George-street, Westminster, S.W. Tenders to the secretary (Mr. H. H. Boyer), at the above-mentioned works, by noon Jan. 16. Further particulars are given in an advertisement.

The Public Health committee of *Belfast* Corporation invite tenders for supply and erection at the new infectious diseases hospital, Purdysburn, of steam boilers, &c.; heating of pavilions and administrative block; electric light installation, including engine, dynamos, &c. Plans, &c., from the town clerk (Sir Samuel Black), to whom tenders by 11 a.m. Jan. 12. See also an advertisement elsewhere.

Johannesburg Municipal Council invite tenders for Vignoles rails, fishplates, angle steel guard-rails, bolts, nuts, coach-screws, and dog-spikes. Specifications, &c., may be seen after Dec. 30 at the offices of the consulting engineers (Messrs. Mordey & Dawbarn), 82, Victoria-st., Westminster, S.W., to whom tenders by noon Jan. 26. See also advertisement.

The Municipal Council of *Johannesburg* is prepared to receive tenders for 100 electric tramcars, two electric water cars, one 5-ton travelling crane, one electric car traverser and various workshop tools, including erection at Johannesburg, to specification No. 10, of the consulting engineers (Messrs. Mordey & Dawbarn, 82, Victoria-street, London, S.W.). The specification may be seen after Jan. 7 at the Council's offices, Johannesburg, and at Messrs. Mordey & Dawbarn's offices, where tenders are to be sent by March 6.

The Directors of the *Great Western Railway Co.* invite tenders for the supply and delivery of the following material required in connection with the electrical equipment of the Hammersmith and City Railway, &c.: Steel conductor rails, cast-iron and steel ramps and fastenings; porcelain insulating supports and their fastenings for conductor rails; copper bonds, insulated cable connections, cable terminals, bonding presses and accessories for connecting up connector rails. Tenders to the Secretary, Paddington Station, London, W., by Jan. 3.

Sunderland Corporation invite tenders for one wooden cooling tower, capable of cooling the circulating water for a surface condenser dealing with 30,000lb. of steam per hour. Tenders (addressed chairman of Electricity and Lighting committee) to the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon Dec. 30.

Neath Corporation invite tenders for supply and delivery of wattmeters. Tenders to town clerk by Wednesday, Dec. 28.

Pudsey Corporation invite tenders by 5 p.m. Jan. 20 for underground electric mains, junction boxes, switchboard, &c.

The Deputy Postmaster-General, *Melbourne*, will receive until noon Feb. 7 tenders for the supply and delivery of (1) 3,500 trunk-line multiple jacks in strips of 20; (2) 1,320 yards of 64-wire wool-insulated switchboard cable. Specifications can be seen at the General Post Offices of Melbourne, Sydney, Brisbane and Adelaide. Tenders must be registered, and 5 per cent of the gross amount has to be enclosed with the tender.

The agents of the Municipal Corporation of *Port Elizabeth* (South Africa) are prepared to receive tenders for the following works in connection with the Corporation electricity undertaking:—(*a*) boiler house plant, (*b*) engine room plant, (*c*) electricity supply mains, (*d*) accumulators and boosters, (*e*) switchboard and instruments, (*f*) crane, (*g*) public lighting, (*h*) meters, (*i*) workshop equipment. Specifications, &c., from Messrs. Davis & Soper, 54, St. Mary-axe, London, E.C., to whom tenders by noon Jan. 16.

The Public Lighting Office, *Copenhagen*, invites tenders for the erection and equipment of an electricity supply station at Valley gas works. Conditions and drawings are on view at the Ostre and Valley gas works, Copenhagen. Tenders to the Director for Public Lighting, 22B, Vestre Boulevard, Copenhagen, by noon Jan. 23.

The Council of *Porto*, Portugal, have opened a competition for a concession of the exclusive right to work tramways in the town. Particulars at the town hall. The competition closes at 3 p.m., March 15. Senhor Manoel de Sousa Avides is president of the Council.

TENDERS RECEIVED AND ACCEPTED.

Wandsworth (London) Council received the following tenders for the installation of electric lighting at the Council House to the specification and under the supervision of Mr. W. P. Adams:—

W. H. McKone (*accepted*)	**£281**	**14**	**May, Calder & Co.**	**£390**	**19**
Fred Hayes	550	10	Hooper, Neary & Co.	388	10
Davidson Bros...........	540	0	Hemingway & Pritt......	379	6
F. J. Coleby & Co.	525	0	Salisbury Elec. Eng. Co..	370	0
W. S. Murin	504	0	Jackson Bros.	359	8
Tamplin & Makovski	500	0	J. E. Spagnoletti & Co. ..	355	0
Alliance Electrical Co. ..	495	5	Holmes & Cooper	333	10
Grundy & Coombe	460	0	W. Wallace & Co.	326	1
D. Hulett & Co.	447	11	Bromley & Batstone	323	12
Wright, Methuen & Co. ..	433	17	E. Probert & Co.........	315	15
W. J. Fryer & Co.	431	8	G. Candler & Sons	313	0
Strode & Co.............	425	0	Leo & Warren	303	10
Ward Bros.	418	0	James Wilson	295	0
A. White & Co.	400	0			

Hackney (London) Council have accepted the following tenders:—

General Electric Co., 50,000 pairs of carbons at £3. 7s. per 1,000, and 10,000 pairs at £2. 5s. per 1,000.

W. & T. Avery, lead-weighing machine and hopper, £117.

Babcock & Wilcox, steel work, driving gear, &c., £111. 15s.

Johnson & Phillips, 10 arc lamps and columns at same price as previous contract placed with the firm.

Stepney (London) Borough Council received the following tenders for supply and delivery of conduits, troughs and covers for 12 months:
Conduits: W. T. Henley's Telegraph Works Co. (*accepted*), **£1,807. 13s. 4d.**; J. Knowles & Co., £2,053. 6s. 8d.; Albion Clay Co., £1,910. 16s. 10d.; Siemens Brothers & Co., £1,840. 13s. 4d.; Doulton & Co. (informal).
Troughs and Covers: Siemens Brothers & Co (*accepted*), **£1,235. 13s. 4d.**; do. alternative, £1,301. 13s. 4d.; J. Knowles & Co., £1,917. 13s. 4d.; Doulton & Co., £1,353; W. T. Henley's Co., £1,501. 13s. 4d.; do. alternative, £1,290. 12s. 4d.

The Council has placed an order at £300 with Babcock & Wilcox for an exhaust stack in connection with the extension of the generating station.

The Lancashire Dynamo & Motor Co., Trafford Park, Manchester, have received an order from the Admiralty for the whole of the electrical equipment for Malta Dockyard, including boilers, engines, dynamos, motor-generators and motors, in accordance with the specification of Messrs. Preece & Cardew.

Nearly 50 firms submitted tenders for the delivery and erection of seven cast-iron water tanks required for the first portion of the Greenwich generating station of London County Council, and that of Russell & Sons, Leicester, at £1,178. 12s. was accepted.

Bermondsey (London) Council have accepted the following tenders: Babcock & Wilcox, cast-iron U-bend and valve, £5. 15s.; Phillips & Co., iron ladders, £12. 2s.; Hughes & Stirling, 3in. valve, &c., £9. 15s.

Llandudno District Council have accepted the tender of the Hart Accumulator Co. for replacing the storage battery at their electricity works with 256 of the company's standard lighting type cells having a capacity of 450 ampere-hours.

Burslem Council have accepted the following tenders:—
General Electric Co., balancer and booster, £347.
Dick, Kerr & Co., engine and dynamos, £1,863.
Callender's Co., cables, £9,554. 1s. 8d.

Messrs. Watson & Co., 119, Victoria-street, London, S.W., have again secured the contract for the supply of insulating compound to the National Telephone Co.

Shoreditch (London) Council have accepted the tender of Hemingway & Pritt at £58. 8s. for rewiring Hoxton Baths and Washhouses.

Shoreditch (London) Council have decided to purchase the following meters for their requirements for the next four months:—52 5-ampere 240 volts; 64 10-ampere 240 volts; 30 25-ampere 240 volts.

Wandsworth (London) Council have also placed an order with Matthews & Yates for an electric ventilating fan for the council chamber at £77. 2s. 6d.

Leeds Corporation Hospitals committee recommend the acceptance of the tender of the Magneta Company, of London, for the supply of the electric time system to the Seacroft hospitals.

Blackpool Corporation have accepted the tender of Morrison & Roebuck for wiring the sanatorium.

London County Council have accepted the tender of Ward Bros. for wiring and fitting the fire station at the Isle of Dogs at £140.

West Ham Education committee have accepted the tender of J. T. Halsey for electric fire alarm gongs at £141.

BUSINESS NOTICES.

Messrs. Lionel Robinson & Co. (Ltd.), of Ferry Works, Thames Ditton, Surrey, announce that they have made Messrs. Frampton & Paine, 29, Old Queen-street, London, S.W., their sole selling representatives for all apparatus made by them, with the exception of those specialties for which Messrs. Monté Callow & Co. are sole agents. The last-mentioned firm will still continue to act, as in the past, as special agents for Messrs. Lionel Robinson & Co.'s switch gear.

In connection with the "Clayton" air compressors and vacuum pumps, to which reference was made in our last issue, the Worthington Pump Co., 153, Queen Victoria-street, London, E.C., ask us to state that they are agents for the sale of these machines.

Messrs. W. H. Massey and V. S. Allpress, consulting engineers, 25, Queen Anne's-gate, London, S.W., have dissolved partnership. Mr. Vincent S. Allpress informs us that he will continue to practise as a consulting electrical and mechanical engineer at 25, Queen Anne's Gate, Westminster, S.W.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of the creditors of the Sir Hiram Maxim Electrical & Engineering Co. (Ltd.) (in liquidation) was held on Wednesday.

Proofs amounting to £10,611 were lodged by 167 creditors, but the chairman (Mr. Cully) reported that the statement of affairs had not been lodged. So far as the Official Receiver had been able to ascertain the unsecured debts amounted to £29,801, in addition to loans on debenture bonds (£20,000) and interest (£305). The assets were valued at £57,000, showing a surplus of about £7,000. The company was incorporated on May 6, 1899, as the Maxim Electrical & Engineering Export Co. (Ltd.), with a nominal capital of £100,000, to acquire the sole rights for the sale in Australasia, Africa and Asia of the electrical appliances and all articles manufactured by the Hiram Maxim Electrical Co. (Ltd.) and J. F. Pease & Co. (Ltd.). The company was promoted by Jules de Meray, who was also the vendor. In Feb., 1901, the name was changed to the Hiram Maxim Electrical & Engineering Co. (Ltd.), and the capital increased to £175,000. In Sept., 1903, a further increase of £15,000 was made. The present issued capital is £170,390. In March, 1904, the company acquired from Sir Hiram Maxim his patent rights in captive flying machines, and another company was formed with a nominal capital of £30,000, and acquired those rights for £20,000, payable in shares.

The Chairman said he understood a reconstruction scheme was contemplated, and in that case it would be desirable to appoint a liquidator other than the Official Receiver.

Mr. Alfred Hardie, who has been managing director of the company since Jan. 21 last, said a considerable amount of capital had been sunk, but the difficulty had been in not having more capital at a time when the company's business was largely increasing. The company's prospects were very good, and it had a valuable business and assets which ought to be preserved for the benefit of all concerned.

Sir Hiram Maxim said he had put a deal of money into the company, and had not sold a single share. Owing to the state of his health he had been out of England during the greater part of the company's existence, and had, therefore, little knowledge of its affairs. He had derived no pecuniary benefit from his association with the company.

Mr A. Hardie and Mr. A. F. Whinney were nominated for the position of liquidator.

The liquidator (Mr. H. E. Abbott) in the winding-up of the Electrical Regulating & Lighting Synd. (Ltd.) has been released.

The Rhyl & Prestatyn Light Railway Co. (Ltd.) is to be wound up voluntarily. Mr. W. Webb, 46, Queen Victoria street, London, E.C., is liquidator.

The Electro Institute (Ltd.) is to be wound up voluntarily. Mr. T. P. Wayte, 61, Elgin-crescent, London, W., is liquidator.

The public examination of Harry Cooke, electrical engineer, Normacot, Longton, took place at Stoke-on-Trent on Monday. Liabilities £244, deficiency £225.

Debtor stated that he formerly carried on business with Frederick Smith at Nottingham, as the Electrical Motor Supply Co., but the partnership was dissolved in Sept., 1903. The concern was taken over by his late partner's son (Albert Smith), and as he neglected to withdraw a guarantee which he had given to the bank he was sued for £200, amount of an overdraft which the bank had allowed to Albert Smith. He had practically no other creditor but the bank. Examination closed.

The application of Max Margowski for an order of discharge again came before Mr. Registrar Brougham on Friday at the London Bankruptcy Court. The Official Receiver, in his report, alleged as offences—insufficiency of assets to pay 10s. in the £ to the creditors, and bringing on the bankruptcy by rash and hazardous speculations. Mr. Hart, on behalf of the trustee (Mr. Salaman), charged fraud in connection with the bankrupt's dealings with shares in the Automatic Telephone Co. (Ltd.) and other matters. The Registrar held that the trustee must prefer specific charges, giving dates and particulars. After discussion, the hearing was further adjourned to Jan. 31.

The public examination of W. C. Bersey, consulting engineer, Arundel-street, W.C., late of 34, Queen street, E.C., took place last week. Total liabilities £4,371. 1s. 9d., of which £4,368. 1s. 9d. is unsecured; assets £22. 12s. Since 1895 debtor had been engaged in assisting in the promotion of, and acting as manager and director of, the Electrical Cab, Motor Car, and other companies, most of which had been wound up.

A receiving order has been made against Edward Sumner, electrical engineer, 140, Dale-street, Liverpool.

Claims against P. J. Murley, formerly fire alarm contractor, 18, Park-row, Leeds, and 26, Brook-street, Manchester, by Jan. 6 to Mr. J. Bowling, 22, Park-row, Leeds.

Mr. F. S. Salaman, 1, Oxford-court, London, E.C., has been appointed trustee in the bankruptcy of W. H. L. Watson and G. Huntington, electricians, 83, Battersea-rise, S.W., and Dering-street, Bond-street, W., London.

Plant Wanted.—The Cowburn Safety Valve Co., Ambrose-st., West Gorton, Manchester, require an old type a.-c. generator. See advertisement.

Plant for Sale.—West Ham Electric Lighting and Tramways committee have plant for sale, including a fan engine and Sirocco fan, steel chimney stack, condensing set, cast-iron tanks, hot well, piping, &c. Particulars from the borough electrical engineer, Electricity Works, Tucker-street, London, E. See also advertisement.

Electric Fittings for Sale.—Messrs. J. G. Statter & Co., Cornwall-buildings, Birmingham, are offering for sale a large stock of Admiralty, Post Office and other standard pattern lampholders, ceiling roses, tumbler switches, &c., all suitable for 220-volt circuits. See advertisement.

Old P.O. Stores Sale.—Tenders are invited for the purchase of about 450 tons of gutta-percha, 75 tons of copper, a quantity of other metals, gutta-percha-covered copper wire, tools, electric glow lamp tops, &c. Forms of tender from the Controller of the Stores department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders by 10 a.m. Jan. 18. See also an advertisement.

Business for Sale.—Messrs. William Rock & Son, 25, Lord-street, Liverpool, have for sale a small electrical manufacturing business. See advertisement.

Premises to Let.—Messrs. Marshall & Co., Campbell Works, Stoke Newington, have to let some premises (ground floor, 2,750 super. ft.) suitable for a general engineer. See advertisement.

A factory in Pentonville (3,000 super. ft.) is to be let. Applications to Mr. H. Holme, 472-4, Caledonian-road, London, N. See advertisement.

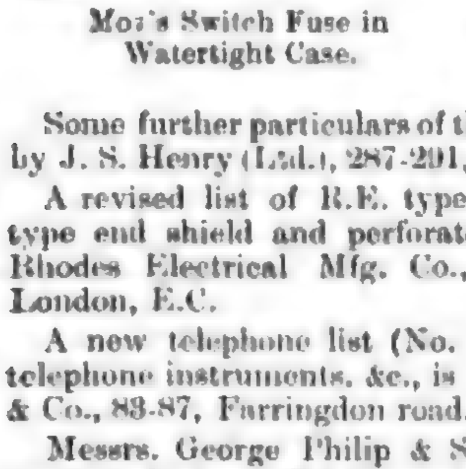
Electrical Exhibitions.—The Metropolitan Electric Supply Co. are organising an exhibition of electrical appliances for lighting, power, heating, &c., to be held at Paddington Public Baths, Queen's-road, Bayswater, London, from March 27 to April 8, 1905, and intending exhibitors are invited to communicate with the company. Some further information is given in an advertisement elsewhere.

Bexhill Council have instructed their electrical engineer (Mr. W. T. Le Feuvre) to arrange for the holding of an electrical exhibition, and a sub-committee consisting of the chairman (Councillor Douglas), Ald. Young and Councillors Longman and Paton has been formed to supervise the arrangements.

Electrically-direct-driven Spinning Frames.—The Alliance Electrical Co. have forwarded an illustrated pamphlet describing an application of electric motors to direct driving of spinning frames. The company recently carried out an installation for the Paley Brake Co., and the results of tests made by Mr. W. H. Cook on this plant are embodied in the pamphlet. These tests showed that the power taken increased almost directly as the speed, and not, as generally assumed, as the square of speed. For two frames the countershaft, without belts, took 0·48 E.H.P.; with belts on loose pulleys, the power taken was 2·13 E.H.P., this latter figure being equal to the power required to drive three frames of 62 spindles each and gearing at 5,200 revs. per min. by the direct driven method. Another important point was the regularity of speed of the spindle, which, during repeated trials, was never found to vary. This is quite contrary to what is found with belt-driven ring frames, since the tension of the belt may cause a variation of as much as 1,000 revs. per min. The directly-coupled motor can be so arranged that when the cop is full the frame is stopped automatically. This method of driving is also claimed to be very much more cleanly than older and less efficient methods. The pamphlet contains many interesting items relating to these tests, and will be read with interest by those engaged in the spinning industry.

Catalogues, &c.—A handsome catalogue of electric light fittings has been published by Messrs. J. M. Doughty & Sons, 214-222, St. John-street, Clerkenwell, London, E.C. These goods, which are very varied in character and design, are manufactured at the firm's works at Birmingham. There is an excellent assortment of pendants, standards, hand lamps, suspension fittings, electroliers, &c.

Messrs. Ernest F. Moy (Ltd.), Camden Town, London, N.W., have issued particulars of switch fuses for pressures up to 500 volts, fitted in watertight cast-iron cases, as shown in the accompanying illustration. The boxes are fitted with two No. 104 switch fuses, separated by a stout slate partition, the sides of the boxes being also lined with slate and the lid and ends with a thick insulating material to prevent the fuse from arcing to the case when it blows.



Moy's Switch Fuse in Watertight Case.

Condensers, vacuum pumps and exhausters are catalogued by the Deane Steam Pump Co., Holyoke, Mass., U.S.A., in a new list just published. A mass of information is given in the pamphlet concerning these machines.

Some further particulars of the wood electric fittings manufactured by J. S. Henry (Ltd.), 287-291, Old-street, London, E.C., are issued.

A revised list of R.E. type continuous-current motors with new type end shield and perforated enclosing cover is issued by the Rhodes Electrical Mfg. Co., 70-71, Bishopsgate street Within, London, E.C.

A new telephone list (No. 216), showing further reductions in telephone instruments, &c., is being sent out by Falk, Stadelmann & Co., 83-87, Farringdon road, London, E.C.

Messrs. George Philip & Sons, 32, Fleet-street, London, E.C., have ready a new list of maps, globes, models, &c.

The Electrical Co. have ready new sheet lists of ceiling roses, fuse boards, wall sockets and plugs, "Ideal" candle lamps, &c. The sheets are illustrated.

A comprehensive list of steel conduits, &c., is issued by the New Brotherton Tube Co., comprising some new designs for watertight work in conjunction with the company's speciality of solid drawn tubes.

The British Thomson-Houston Co., in pamphlet No. 177 just issued, treat of rheostatic controllers and resistances. A number of effective illustrations of this type of controller are shown.

Calendars, Diaries, &c.—The Eastern and Associated Telegraph Companies have again issued their neat and serviceable calendar, diary and memoranda, which has been published regularly for some years past. The chronological events set out in the calendar have been brought up to date, and other information given includes telegraph tariffs, stations where telegrams are received, and a comprehensive map of the cable communications of the world.

Messrs. Cochran & Co., of Annan, Scotland, forward a neat hanging-pad calendar for 1905.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Dec. 14 to 20, with the ports of destination :—

Africa—Alexandria, £253 (including £101 telegraph material); Bona, £182; Cape Town, £2,353 (including £84 telegraph material); Durban, £3,038; East London, £582 (including £16 telegraph material). *Argentina*—Buenos Ayres, £542. *Australasia*—Adelaide, £24; Auckland, £163; Brisbane, £56; Christchurch, £37; Lyttleton, £258; Melbourne, £710 (telegraph material); Otago, £99; Perth, £28; Sydney, £1,056; Wellington, £188. *Belgium*—Ostend, £18. *Brazil*—Rio Janeiro, £855 (including £800 telegraph material). *Burma*—Rangoon, £17. *Canada*—St. John (N.B.), £7. *Ceylon*—Colombo, £259 (including £20 telegraph material). *China*—Shanghai, £201. *France*—Boulogne, £10; Paris, £191. *Germany*—Bremen, £260; Hamburg, £189 (including £160 telegraph material). *Gibraltar*, £24 (including £6 telegraph material). *Holland*—Amsterdam, £1,809; Flushing, £18. *Hong Kong*, £104. *India*—Bombay, £245 (including £54 telegraph material); Calcutta, £1,936; Madras, £31. *Italy*—Leghorn, £595. *Japan*—Hiogo, £1,155; Tokyo, £400; Yokohama, £89. *Malta*, £16. *Mauritius*, £18 (telegraph material). *Russia*—St. Petersburg, £469 (including £440 telegraph cable). *Siam*—Bangkok, £18. *Spain*—Huelva, £20; Madeira, £110. *Straits Settlements*—Penang, £238. *Sweden*—Gothenburg, £33. Total, £18,752, against £16,001 in the corresponding week last year (Dec. 16 to 22).

COMPANIES' MEETINGS AND REPORTS.

India Rubber, Gutta Percha & Telegraphs Works Co. (Ltd.)

The forty-first ordinary general meeting was held on Tuesday, Major LEONARD DARWIN presiding.

The CHAIRMAN (after referring to the absence of their chairman, the Hon. Henry Marsham, in Japan, where he was doubtless doing all that he could to forward the company's interests) regretted that he had to move the sanctioning of a dividend on this occasion which, though a fair one as dividends went, yet was about one-half of the amount that the company had been accustomed to distribute among its shareholders during the last 26 years, and half of the average of the rate divided annually since 1868. The board debated as to whether they should pay the usual 10 per cent. in spite of the small available balance shown in the profit and loss account, but although fully realising the inconvenience to the shareholders, they decided that it would be in the best interest of the company not to do so. Several reasons induced them to adopt this resolution, and so far as he could, without disclosing trade secrets, he would endeavour to show that the decision was a prudent one. The present price of raw material was very high, raw indiarubber, amongst others, had reached quite a phenomenal price, some 30 per cent. higher than the highest it had ever reached before, and twice the price at which it has been sold at a fairly recent date. In a market of this nature and in its present state it was quite impossible to predict the future, but if this high price should continue and show some steadiness they would doubtless be permitted by their competitors to charge higher prices for the company's productions. The trade had some 10 days ago agreed to advance selling prices. This advance would not, however, suffice if the price of the raw material should not show a considerable lowering in the current year. The development of a new line of business was progressing, and the inevitable expenses connected with such development, though diminishing—were still very heavy, and had made serious inroads into such reserve as was applicable to this purpose and also on the year's revenue. Moreover, increased vigilance and great prudence were necessary on the board's part on account of the ever-increasing though only too often ephemeral competition to which their productions were subjected. If one looked round for competitors of 30 years ago, few were to be found, and, while the competitors of 20 years ago were naturally more in number, many had gone under in the struggle for existence. Local taxation was another point which industrial undertakings should always have in view, and reference should be made to it on every occasion in the hope that frequent repetition might lead at least to the curbing of an extravagance which was undermining the manufacturing interests of the country. So far as the question affected them they hoped they had reached the limit in West Ham, where their Silvertown works were situated. Their rating there had reached no less than 10s. 2d. in the £. By the nearest estimate they could make, the board believed that the establishment of the works in that district brought in from £45,000 to £50,000 per annum to the corporation—an amount about equal to the average earnings distributed among the shareholders. This was an illustration of the difficulties under which they traded. Through an average of years their net profit had not greatly increased but the amount of business they had been obliged to do in order to maintain this position had had to be increased at least fourfold. They could not allow themselves to think that they could always pick out the good things and leave the bad, and they could only hope to keep a good average, and this the board believed had been the case for many years In the question of extravagance against prudence the board would certainly counsel the latter, but they believed that their actions proved that experiments must be made and new things tried on occasions at a loss and at considerable risk, but in this they must not go beyond their means. They were developing a new business which might prove profitable, but on the other hand might involve loss. This development was within their means and the Board hoped for success or they would not undertake it. In the meantime, however, the board were of opinion that under the present circumstances it was unwise to ask the shareholders to sanction the payment of a larger dividend than 5 per cent. for the year. He moved the adoption of the report.

Mr. GEORGE HENDERSON seconded the motion

Mr. H. CARUS-WILSON urged the directors to pay the higher dividend to which the shareholders had been accustomed for so many years. For 25 years the dividend had been maintained at not less than 10 per cent. even in years when that dividend had not been actually earned. He was afraid the directors' action would result in a permanent reduction in the value of the shares.

In reply the CHAIRMAN expressed his keen regret that the board had felt it necessary to reduce the dividend. The money that had been put into buildings, machinery, &c., had been taken out of the profits of the past year, and had not that policy been adopted additional capital would have had to be raised. Had they done so the dividends in the past would have been much larger, but what would have been their position at the present time? Were the reserve fund represented by capital the dividend at the present time would probably be only 2½ per cent. The shareholders were not in a good position to judge of what was best in the interests of the company. The directors had resisted the temptation to keep up the dividends, but after calm and careful deliberation the board had come to the conclusion not to pay a higher dividend than 5 per cent. The board had hopes for the future—but only hopes. The cost of raw material was now £80,000 more than last year. The golf-ball trade had been lost through a clever American invention, and the board were now working very hard to get back that business. The shareholders must trust their directors. A manufacturing business must either go backwards or forwards. If the directors had not followed the policy which they had followed, the company would have drifted into the position of a lower-class concern, with the permanent payment of lower dividends. With regard to the future he was hopeful, provided that local taxation, the general trade of the country, and the price of raw material did not assume more unfavourable aspects.

The resolution was then carried unanimously.

The proceedings then terminated.

ARC LAMPS (LTD.)—The directors' report for the year ended July 31, presented at the meeting on Wednesday, stated that the gross profit was £5,112, compared with £5,835 for the previous year. After payment of all management expenses and substantially depreciating machinery and plant, the surplus was £1,243, compared with £2,629. Owing to depression in the electrical trade during the year the turnover suffered to the extent of 5 per cent., but prices had been very considerably reduced, chiefly due to the keen competition created by the British market being flooded with cheap American and Continental lamps. By reason of the new patent referred to in the directors' last report and other improvements of more recent date, the directors hope to considerably increase the profits in the current year. The construction of the lamp had been simplified and the cost of manufacture reduced Business relations with the engineers of corporations and urban and rural district councils had been further extended. The action commenced in March, 1903, against the company by the Jandus Arc Lamp & Electric Light Co. (Ltd.) had not yet been finally disposed of. The position at the date of the last report was that the judge had, with the imposition of terms favourable to this company, granted permission to the Jandus Company to postpone still further the trial to enable them to amend their patents. In January last they lodged a print of the alterations which they applied for liberty to make, and in March a Mr. Holford lodged objections to the amendments, which had the effect of hanging the action up. In May the solicitors for the Jandus Company approached the company with a view to stay the proceedings upon terms. The board declined the proposed terms, and made a counter proposal to which no reply was received till August, when plaintiffs' solicitors intimated that the terms suggested were not acceptable to their clients. In November Arc Lamps (Ltd.) successfully applied for the restoration of the case to the list, and every effort would be made to get the action fought with the least delay. The directors had not charged the cost of the action against revenue; a proportion thereof was payable by plaintiffs under the terms imposed by the Court in Nov. 1903. An interim dividend at the rate of 5 per cent per annum was declared for the first half of the year, and, although there was a balance of £1,168 at credit of revenue and expenditure account, it was not proposed to pay a further dividend.

On the motion of the chairman (Mr. C. Williamson Milne) the report and accounts were approved.

MANX ELECTRIC RAILWAY CO. (LTD.)—The report for the year ended Sept. 30 states that the gross receipts amounted to £30,818, and expenditure to £17,279, leaving a net profit of £13,538. After adding balance from last year (£3,266) and paying preference share dividend there remains to be carried forward £789. During the year a large amount had been spent out of revenue in raising and ballasting the Douglas and Laxey track, and also the Snaefell Mountain track, and the whole line had been kept in a good state of repair. Upon capital account there had been expended during the year £20,414 in the completion of the new generating plant and equipment, on rolling stock, the erection of carsheds, goods sheds and other works. £1,000 had also been set aside out of revenue towards renewal fund.

NEW COMPANIES, LIENS REGISTERED, &c.

NEW COMPANIES.

ABERAVON DISTRICT TRAMWAYS SYND. (LTD.) (82,801.)—Reg Dec. 8, capital £2,000 in £1 shares, to apply for a provisional order or Act of Parliament authorising the construction of an electrically equipped tramway in Aberavon and Margam (Glam.) and elsewhere, to construct or acquire any tramways, buildings, plant and equipment and to maintain, develop and work same. Reg. office, Arlington-chambers, 4-5, Commercial-street, Newport, Mon.

AUTOMATIC ELECTRIC CO. (LTD.) (82,897.)—Reg. Dec. 16, capital £1,000 in £1 shares, to carry on the business of suppliers of light, heat and power, carriers of passengers and goods, manufacturers of telephones, telegraphs, dynamos, accumulators, lamps and all apparatus used in connection with the generation, accumulation, distribution, supply and employment of electricity, &c. D. L. Chalmers is first managing director. Reg. office, 12, St. John's-lane, Liverpool.

CHECKOGRAM LIMITED. (82,778.)—Reg. Dec. 6., capital £42,500 in £1 shares, to adopt an agreement and to carry on the business of manufacturers of and dealers in mechanical and electrical appliances for registering, indicating and other purposes, makers of turnstiles, gates, tickets, checks, perforating and stamping presses, contact makers, &c. First directors, A. Cohen, A. Collins, W. Stark and A. E. Wells.

DORCHESTER & DISTRICT ELECTRIC SUPPLY CO. (LTD.) (82,854.)—Reg. Dec. 13, capital £1,000 in £1 shares, to construct, lay down, establish and maintain cables, wires, lines, accumulators, lamps and works, and to carry on the business of electricians, electrical and general engineers, suppliers of electric light and power, tramway proprietors, &c., in Dorchester or elsewhere. Reg. office, 11, Carteret-street, Westminster.

KRAMOS LIMITED. (82,859.) Reg. Dec. 13, capital £4,000 in £1 shares, to acquire business of Bath Electric Mfg. Co. (Ltd.), to adopt an agreement with H. von Kramer, and to carry on the business of mechanical and electrical engineers, manufacturers of and dealers in electric and other motors and engines, &c. The subscribers are H. von Kramer, engineer, J. H. Brown, electrical engineer, J. Wolff, electrical engineer, M. Wolff, engineer, Mrs. B. R. von Kramer, Miss G. C. Simons and S. Parkhill. Reg. office, Locksbrook Engineering Works, Weston, Bath.

SHROPSHIRE, WORCESTERSHIRE & STAFFORDSHIRE SYND. (LTD.) (82,906.)—Reg Dec. 16, capital £10,000 in £10 shares, to carry on business of producers, suppliers, buyers, sellers and users of electrical energy, engineers, metal and wood workers, agents, railway and tramway proprietors, contractors, &c. Reg. office, 51, Victoria-street, Westminster, London.

MORTGAGES AND CHARGES.

CHISWICK ELECTRICITY SUPPLY CORPN. (LTD.)—Issue on Nov. 16 of £500 debentures, part of series created Nov. 2, 1900, and covered by deed of March 8, 1901, to secure £50,000, charged on company's undertaking and property, present and future, including uncalled capital, Holder, W. B. Esson. No trustees. Previously issued of same series, £31,000.

DUNDERLAND IRON ORE CO. (LTD.)—Trust deed reg. Dec. 10 for £200,000 6 per cent. first charge debenture stock. Trustees, Lord Armstrong, Sir D. Dale, Bart., and J. F. Mason Secured on all assets and undertaking (present and future), including uncalled capital and various lands, tenements, &c., in Norway.

FULLER, MACLEOD & CO. (LTD.)—Debenture dated Dec. 13, 1904, to secure £100, charged on company's undertaking and property, present and future, including uncalled capital, has been registered. Holder, J. A. Ekrenfest. No trustees.

HARTLEPOOL ELECTRIC TRAMWAYS CO. (LTD.)—Particulars of a series of debentures created by resolution of Nov. 30, 1904, securing an amount equal to half issued share capital, have been filed pursuant to sec. 14 (4) of Companies Act, 1900. Property charged, company's undertaking and property, present and future, including uncalled capital. No trustees.

LIVERPOOL ELECTRIC CABLE CO. (LTD.)—Debenture dated Dec. 9, 1904, to secure such sum (not exceeding £6,000) as may be for time being owing to holders in respect of any liability other than that for ordinary monthly trading account, has been registered. Property charged, company's undertaking and property, present and future, including uncalled capital. Holders, Liverpool Rubber Co.

FRINTON-ON-SEA & DISTRICT ELECTRIC LIGHT & POWER CO. (LTD.)—Issue on Dec. 8 of £500 5 per cent. debentures, part of series created May 7, 1903, to secure £3,000, charged on company's undertaking and property, present and future, including uncalled capital. Holders, W. Webster and Miss A. A. Mackay. No trustees. Previously issued of same series, £2,500.

VIENNA.—The undertaking of Czeija, Nissl & Co., of Kaiserstrasse, Vienna, has been converted into a company with a capital of 4,000,000k. It is proposed to build new works and to exploit the European patents which the company hold from the Western Electric Co. of Chicago.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Dec. 17	2,753	− 14	29	41,687	+ 5,714
Airdrie	,, 9	142	...	44	8,839	—
Ayr Corporation	,, 17	170	+ 8	31	10,456	+ 497
Barnsley	,, 9	183	+ 7	49	9,297	− 648
Barrow	,, 9	180	...	44	8,793	...
Bath Electric Trams, Ltd.	,, 14	135	...	50	31,692	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 18	966	− 14	...	...	...
Birmingham Corporation	,, 17	344	...	50	15,128	...
Birmingham Tramways Co.	,, 17	6,408	+ 473	24	139,783	+ 6,233
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 15	261	+ 6	37	43,899	+ 5,940
Blackpool and Fleetwood	,, 17	158	...	24	30,916	+ 868
Blackp'l, St. Anne's & Lytham	,, 15	119	− 21	¶17	849	− 165
Bolton Corporation	,, 18	1,478	+ 68	38	69,973	+ 556
Bournemouth Corporation	,, 14	791	− 12	‡37	41,619	+ 2,028
Bradford Corporation	,, 17	3,729	+ 304	25	149,463	+ 27,081
Brighton Corporation	,, 18	758	+ 7	37	39,896	+ 3,257
Brisbane Tramways	Oct. 26	2,816	+ 119	18	62,734	+ 432
	Nov. 2	2,438	+ 41			
Bristol Trams & Carriage	Dec. 16	4,506	+ 81	19	153,625	+ 1,651
Buenos Ayres & Belgrano	Nov. 13	3,475	+ 788	5	16,908	+ 822
	,, 20	3,615	+ 359			
Burnley Corporation	Dec. 17	957	+ 218	11	11,111	+ 2,979
Burton Corporation	,, 18	299	+ 6	¶37	13,010	...
Calcutta Tramways Co.	,, 17	a41,678	+ a6,128	15	a911,398	+ a160,893
Camborne-Redruth	,, 19	98	− 3	7	734	− 214
Cardiff Corporation	,, 17	1,832	+ 53	37	76,566	− 1,513
Carlisle Tramways Co.	,, 17	170	+ 7	50	9,842	+ 217
Central London Railway	,, 17	7,162	− 74	24	153,863	− 256
Chatham & Dist. Lt. Rys.	,, 15	404	− 17	50	29,080	+ 2,190
City & South London Rly.	,, 18	7,960	− 111	25	65,298	− 2,416
Colchester Corporation	,, 15	109	...	20	5,207	...
Cork Electric Trams Co.	,, 15	316	− 13	50	23,319	− 2,420
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams.	,, 5	437	− 26	49	23,951	+ 3,926
Dover Corporation	,, 17	190	+ 11	35	8,641	− 179
Dublin & Lucan Railway	,, 15	91	+ 9	24	8,015	− 7
Dublin Southern District	,, 16	156	+ 52	24	131,232	− 2,927
Dublin United	,, 16	3,618	+ 6			
Dudley—Stourbridge	,, 9	734	+ 19	49	42,418	+ 1,360
Dundee Corporation	,, 14	787		¶29	25,299	+ 60
East Ham Council	,, 17	618	+ 24	37	27,048	+ 1,619
Gateshead & Dist. Trams.	,, 9	873	+ 30	49	41,077	+ 1,893
Glasgow Corporation	,, 17	18,860	+ 191	†30	412,621	+ 30,256
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 9	148	− 8	49	12,253	+ 301
Gt. Northern & City Rly.	...	...	...	...	...	...
Greenock & Port Glasgow	,, 9	517	+ 34	49	28,272	+ 1,482
Halifax Corporation§	,, 14	2,251	+ 169	37	65,846	+ 4,070
Hartlepool Tramways	,, 9	242	+ 7	49	14,347	+ 1,058
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 24	2,114	+ 175	37	81,790	+ 10,484
Ilford District Council	,, 17	332	+ 29	¶37	17,275	+ 790
Ilkeston Corporation	,, 14	93	− 21	11	1,965	− 184
Ipswich Corporation	,, 17	368	+ 154	37	18,832	...
Isle of Thanet Co.	,, 17	281	− 6	11	3,509	− 157
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	,, 9	52	− 1	49	6,229	+ 5
Kirkcaldy Corporation	,, 14	184	− 82	50	11,103	...
Lanarkshire Trams Co.	,, 15	595	+ 70	50	32,661	+ 19,750
Leeds Corporation	,, 17	6,411	+ 424	38	250,003	+ 12,845
Leicester Corporation	,, 17	1,701	...	31	45,869	...
Liverpool Corporation	,, 10	9,707	+ 181	50	416,577	+ 14,277
Liverpool Overhead Rly.	,, 18	11,422	− 157	†26	84,102	− 7,249
London County Council	,, 10	11,930	+ 3,022	‡31	454,618	+ 100,[illegible]
*Lowestoft	,, 17	181	− 6	...	...	...
Maidstone Corporation	,, 15	65	...	22	3,376	...
Manchester Corporation	,, 17	11,6[illegible]7	+ 687	37	456,462	+ 19,891
Mersey Railway	,, 17	1,648	+ 224	24	25,784	+ 3,[illegible]44
Merthyr	,, 9	17[illegible]	− 5	49	9,850	+ 25
Metropolitan Elec. Trams	,, 10	1,[illegible]11	+ 749	24	41,[illegible]	+ 13,157
Middleton	,, 9	165	+ 31	49	16,864	+ 866
Nelson Corporation	,, 17	1[illegible]3	+ 14	35	4,510	+ 1,298
Newcastle-on-Tyne Corp.	,, 17	3,514	+ 23	24	88,174	+ 3,591
Newport (Mon.)	,, 17	511	+ 97	11	5,461	+ 692
Oldham, Ashton & Hyde	,, 9	483	+ 9	49	16,788	− 1,059
Oldham Corporation	,, 4	1,310	+ 330	37	45,430	+ 1,510
	,, 11	1,449	+ 241			
Perth (W. A.) Elec. Trams.	,, 16	1,155	+ 87	50	65,870	+ 6,485
Peterborough	,, 9	101	− 2	49	7,096	− 261
Poole and District	,, 9	196	− 15	49	14,823	+ 22
Portsmouth Corporation	,, 17	1,437	+ 63	§37	54,442	+ 5,792
Potteries	,, 9	1,864	+ 98	49	64,0[illegible]	+ 6,0[illegible]4
Reading Corporation	,, 15	563	+ 47	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 9	23	− 7	49	6,896	− 13
Salford Corporation	,, 18	5,8[illegible]7	+ 101	37	154,476	+ 7,978
Sheerness	,, 7	63	+ 6	49	3,184	− 409
Sheffield Corporation	,, 18	4,[illegible]	+ 310	§38	177,931	+ 8,896
Southampton Corp'ation	,, 15	816	− 27	37	38,831	− 2,355
Southend Corporation	,, 11	305	+ 9	37	18,268	+ 1,310
Southport Tramways	,, 9	318	− 10	49	15,700	+ 439
S. Staffordshire Trams.	,, 9	640	− 224	49	57,[illegible]76	− 7,949
Stockport Corporation	,, 16	197	+ 54	37	21,9[illegible]4	+ 7,963
Sunderland Corporation	,, 16	1,1[illegible]6	+ 44	37	47,[illegible]01	+ 1,092
Swansea Trams	,, 9	429	− 21	49	26,159	− 9[illegible]8
Taunton Trams	,, 9	42	− 4	49	2,654	− 308
Tynemouth and District	,, 9	106	− 16	49	14,[illegible]82	− 953
Tyneside Trams Co.	,, 14	306	+ 45	50	19,319	+ 3,[illegible]44
Wallasey District Council	,, 17	6[illegible]6	+ 81	§37	28,443	+ 1,251
Walsall	,, 17	452	...	49	43,926	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 15	1,014	...	42	39,765	...
Weston-super-Mare	,, 7	26	+ 4	49	6,188	+ 502
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 9	348	+ 22	49	19,064	− 63
Worcester	,, 9	251	+ 148	42	10,850	+ 6,9[illegible]0
Wrexham	,, 9	81	− 18	49	5,319	− 978
Yorkshire Woollen District	,, 9	510	+ 57	49	28,490	+ 3,896

(a) These comparisons are with the corresponding period last year.

* Partly electrical † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

CITY NOTES.

MEMORANDA (Dec. 22).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 28 1/16d. per oz. Consols 88—88⅛ for money, 88⅛—88¼ for account; 2½ per cent. annuities 87½—88½. Consols Pay Day, Jan. 5. Stocks and Shares Continuation Days, Dec. 28 and Jan. 11; Ticket Days, Dec. 29 and Jan. 12; Pay Days, Dec. 30 and Jan. 13; Mining Share Carry-over Days, Dec. 27 and Jan. 10.

BATH ELECTRIC TRAMWAYS (LTD.)—The directors have declared the dividend on the 5 per cent. cumulative preference shares to Dec. 31, 1903, payable (less tax) on 29th inst.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—With regard to the issue of 3,000 ordinary shares of £10 each which were lately offered to the shareholders, we learn that the issue was subscribed for twice over. Allotment letters have been posted.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The directors have declared the usual interim dividend on the ordinary shares at the rate of 6 per cent. per annum for the half-year ended Sept. 30.

COSTA RICA ELECTRIC LIGHT & TRACTION CO. (LTD.)—The net earnings in Costa Rica for the year ended June 30 amounted to £9,155. 10s. 7d., against £7,099. 10s. 11d. and £6,965. 6s. 2d. in the two previous years. A further issue of £32,100 debentures was made during the year, and the proceeds have been devoted to payment to Mr. Keith (in debentures) of amount due him for tramway extensions and extra land, acquisition of a large water power at Brazil Falls, and the purchase of extra plant, machinery and cars, which were not, however, installed in time to benefit the accounts of the year under review.

GREAT NORTHERN & CITY RAILWAY CO.—The Earl of Lauderdale has been elected chairman of this company in succession to Sir Chas. Scotter, who has resigned.

PROVINCIAL TRAMWAYS CO. (LTD.)—At the meeting yesterday (Thursday), on the motion of the chairman (Mr. A. Beattie, J.P.), the report abstracted in our last issue was adopted, and a resolution carried authorising the company to supply electric energy for power and lighting in Gosport and Alverstoke.

VULCANITE LIMITED.—After payment of dividends on preference shares, and interim dividend of 7½ per cent. on ordinary shares, the directors have declared a further dividend for six months on the ordinary shares at 7½ per cent.

WESTERN TELEGRAPH CO. (LTD.)—The coupons of the second issue of 5 per cent. debentures, due 31st inst., will be paid on and after that date at Parr's Bank, Bartholomew-lane, London, E.C.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., Dec. 21.	Rate per cent. yielded.	Dividend Due.	Business, Week to Dec. 21. Highest.	Business, Week to Dec. 21. Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
£	3/0	Anglo-Argentine Ord. shares	[illegible]	4 19 9	Ap. Oc	[illegible]	[illegible]
5	2/6	Do. 5% Cum. Pref.	[illegible]	4 9 11	—	[illegible]	[illegible]
St.	6%	Do. Permanent 6% Deb. Stock	145—148	4 2 9	—	..	..
St.	6%	Auckland Elec. Trams 6% Deb. (red.)	106—107	4 15 3	—	106⅜	..
10	6%	Barcelona Tramways Ord.	10¾—11¼	2 13 3	—	11⅛	[illegible]
10	5/0	Do. 6% Cum. Pref.	9½—10	6 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	93—97	4 14 9	—	..	—
100	5%	Do. 5 per Cent. Debs.	98—101	4 19 6	—	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2	..	..	..	..
5	6/0	Do. 6 per Cent. Cum. Pref.	[illegible]—4½	5 17 8	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	98—100	4 11 9	..	99½	99½
St.	6%	British Columbia Elec. Rlwy Def. Ord.	100—108	3 15 6	—	105½	..
St.	[illegible]%	Do. Pref. Ord. Stock	100—103	4 17 2	—	..	..
10	4/0	Do. 5% Cum. Perp. Pref.	10¼—10¾	4 [illegible] 0	..	..	..
St	4½%	Do. 4½ per Cent. 1st Mort. Dbs	102½—104½	4 6 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	98—101	4 11 0	..	100½	100½
5	1/6	Buenos Ayres and Belgrano Ord.	3¼—3½	5 16 6	..	3½	3¼
5	6/0	Do. 6 per Cent. "A" Cm. Pref	[illegible]	5 4 4	—	[illegible]	..
5	4/0	Do. "B"	5½—6	5 11 6	—	[illegible]	..
St	5%	Do. 5 per Cent. Debs.	105—108	4 [illegible] 6	—	..	..
St	6%	Do. 6% 2nd Deb. Stock Prov. Certs.	103—106	4 15 9	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	96—99	5 2 6	..	..	..
£	3/0	Calcutta Tramways	7¾—8¼	3 13 11	—	8¼	8
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106—110	4 3 3	—	109	..
1	1/0	Cape Electric Tram shares	[illegible]	6 8 [illegible]	—	1⅜	[illegible]
St.	6%	Colombo Trams & Ltg. 6% 1st Mt. Deb. (red.)	101—104	4 16 3	..	..	..
St	..	Madras Elec. Trams 5% Deb. Stk.	103—106	..	Ja, Jul	..	..
100	5%	Montreal St. Ry. St'g 5% Mort. Debs. (1908)	100—103	4 17 3	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103—106	4 5 0	..	..	..
St.	6%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	103—106	4 16 9	..	..	..
		ELECTRICITY SUPPLY.					
5	3/0	Calcutta Electric Supply Ord.	7¾—8¼	4 6 3	..	7¾	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88—92	5 7 6	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	—	..	..	—
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	[illegible]	..	—	[illegible]	..
1	..	Rand Electric	[illegible]	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb.	100—102	4 8 9	Ap, Oc	..	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Dec. 21	Rate per Cent. Yield	Dividend Due	Business, Week to Dec. 21. High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
1	..	Bath Elec. Trams Pref. Ord.	½—⅝	..	..	..	..
1	..	Do. 5% Cum. Pref.	1¼—1⅜	..	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19 —20	4 0 0	Feb, Aug	..	—
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	107 —109	3 13 4	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	9½—10½	5 17 2	..	10	9¾
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅞—11⅛	5 8 7	Feb, Aug	10⅞	..
St.	5/0	Do. 5 per Cent. Perpetual Debs	117 —119	4 4 3	—	118½	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	95 —97	4 12 10	..	96¼	96½
St.	4%	Central London Ordinary Stock	90 —92	4 6 11	June, Dec	92	91½
St.	4%	Do. 4 per Cent. Pref. Stock	101 —103	3 17 9	..	100	..
St.	4%	Do. Deferred Stock	54 —56	4 13 6	—	54	..
100	4%	Do. 4 per Cent. Debs.	106 —110	3 13 4	—	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—4¾	4 17 6	—	100½	100½
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	99	..
St.	2½%	City and South London Rly. Con. Ord.	45½—46½	4 16 0	Feb, Aug	46½	46¼
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 3	Feb, Aug	..	..
St.	5%	Do. (1896)	117 —120	4 3 6	..	..	..
St.	5%	Do. (1901)	116 —119	4 4 10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 —107	3 14 9	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13 —14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	—	..	..
10	3 0½	Gt. Northern & City Rly. Prf. Ord. (4%)	6—6½	..	—	6½	6
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8½—8¾	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19 —20	4 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	110 —112	4 0 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —98	4 7 3	—	..	..
10	1½%	Liverpool Overhead Railway Ord	8¼—8¾	3 11 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10⅛—10½	4 12 0	..	10½	10¼
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 —106	3 17 4	..	105	104½
St.	..	Mersey Con. Ord. Stock	8 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10 —12	..	—	9	..
1	..	Metropolitan Electric Trams Def	½—¾	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	—	..	..
St.	13/7	Do. 4½% Deb. Stock	105 —106	..	..	101½	..
6	..	New Gen. Tract. 6 per Cent. Cum. Pref.	¾—1¼	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	8/0	Do. 5 per Cent. Cum. Pref.	8¾—9¼	5 5 3	Feb, Aug	8¾	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —102	4 8 3	—	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
..	[illegible]	Underground Elec. Rys. Co. of London	97 —98	5 2 0	..	97½	97½
St.	3%	Waterloo and City Ord.	58 —59	5 7 0	June, Dec	..	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	100 —103	3 19 2	Jan, July	..	..
10	..	Amazon Telegraph	1 —1½	..	Jn, Dec ..	..	..
St.	12/6	Anglo-American	55 —57	4 13 10	F,My,Ag,N	56½	56
St.	25/0	Do. Preferred	103 —104	5 1 0	F,My,Ag,N	104½	103½
St.	2/0	Do. Deferred	12½—12¾	0 16 0	F,My,Ag,N	13⅛	12¾
100	[illegible]	Commercial Cable Capital Stock	170 —190	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93 —96	4 4 4	Jn,Ap,Jy,O	94¾	94½
10	5/0	Cuba Submarine Ord.	8½—9½	5 8 0	Feb, Aug	9¼	8¾
10	10/0	Do. Preference 10 per Cent.	16½—17½	5 14 3	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	3¼—3¾	5 11 9	April, Oct	3¼	3⅜
5	5/0	Do. 10 per Cent. Cum. Pref.	7½—8½	6 1 3	April, Oct	..	..
60	4½%	Do. 4½ per Cent. Deb.	102%—103%	4 8 6	Jan, July	..	..
20	2/0	Direct United States Cable	10½—11	5 9 1	Ja,Ap,Jy,O	10¾	10½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	101 —103	4 9 3	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	131 —133	5 1 5	Ja,Ap,Jy,O	137	134½
St.	17/6	Do. 3½ per Cent. Pref. Stock	88 —90	3 18 0	Ja,Ap,Jy,O	89	88½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —107	3 14 9	May, Nov	105½	105
10	2/6	Eastern Extension	13½—14	5 0 0	Ja,Ap,Jy,O	13⅝	13½
St.	4%	Do. 4 per Cent. Deb. Stock	106 —108	3 14 3	Feb, Aug	107½	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	101 —103	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 6	May, Nov	101½	..
10	5/0	Great Northern (of Copenhagen)	28½—29½	5 2 9	Jan, July	..	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	101 —103	4 9 2	June, Dec	..	..
25	12/6	Indo-European	44½—45½	5 7 6	May, Nov	45⅛	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	98 —100	4 0 0	June, Dec	..	—
10	4/0	West African Telegraph Shares	7¼—7¾	5 9 2	—	..	..
2½	..	West Coast of America	½—⅝	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	98 —100	4 0 3	Jan, July	99½	98½
10	..	West India and Panama	½—¾	..	May, Nov	..	..
10	7/0	Do. 6 1st Pref. ex 7 on act. of arrears	7½—7¾	7 17 6	May, Nov	7½	..
10	..	Do. 6 per Cent. 2nd Pref.	6½—7½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	102½—104½	4 13 11	Jan, July	..	..
10	2/0	† Western Telegraph	13½—14	5 0 0	Mr,Jn,O,D	13⅞	13⅝
100	5%	* Do. 5% Debs. (2nd Series, 1906)	103 —106	4 17 9	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	101½—103½	3 18 5	—	..	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid)	5½—6	5 16 8	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	¾—1⅛	..	..	..	..
St.	6%	National Co. Pref. Stock	108½—109½	5 9 7	..	109½	108
St.	6%	Do. Def. Stock	101 —104	4 18 0	..	105⅝	104½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	15 —16	4 0 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12 —13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅜—5⅝	4 11 9	Feb, Aug	5⅝	5½
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 —99	3 12 3	June, Dec	98½	98¼
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103½—105½	3 17 2	..	105	103⅜
..	5/0	Do. Do. Prov. Certs., 35% to be pd.	63½—65½	..	..	63¾	63½
1	0/7½	Oriental	1—1½	5 18 6	April, Oct	1⅛	—
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼—1½	4 [illegible] 0	..	..	..
5	5/0	United River Plate	6¼—6½	5 16 5	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 [illegible] 6	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	106½—107½	4 16 8	June, Dec	107½	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	—	..	..
10	2/0	Globe Telegraph and Trust	10½—11½	5 4 9	Ja Ap Jy O	10⅝	10½
10	3/0	Do. 6 per Cent. Pref.	14 —14½	4 3 9	Ja Ap Jy O	14⅛	13⅞
100	6%	Submarine Cables Trust (Cert.)	120 —125	4 18 4	April, Oct	..	..

Share.	Last Dividend	Name.	Price Wed., Dec. 21.	Rate per Cent. Yield	Dividend Due	Business, Week to Dec. 21. High-est.	Low-est.
		ELECTRICITY SUPPLY.		£ s. d.			
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12 —13	6 3 1	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10	4 10 0	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104 —106	4 5 9	—	..	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5½—5¾	3 9 7	..	5½	..
St.	4½%	Do. Do. 1st Debs	101 —104	4 7 0	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 5 1	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	104 —107	3 14 9	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8½—8¾	4 11 6	Feb, Aug	8⅝	8½
5	2/3	Do. 4½ per Cent. Pref.	5⅝—5⅞	3 17 5	Feb, Aug	5¾	5⅝
St.	4%	† Do. 4% Deb. Stock (red.)	101 —103	3 17 8	..	102½	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4 8 9	—	5	..
5	2/3	Do. Do. (1902)	4½—5	..	..	5¼	4⅞
5	2/3	Chelsea Electric Supply Ord.	5½—5¾	4 8 9	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109 —111	4 1 9	Jn, Dec ..	110½	110
10	5/0	City of London Electric Lighting Ord.	10½—11½	4 9 0	Feb, Aug	11	10½
10	6/0	Do. 6 per Cent. Cum. Pref.	13½—14	4 5 9	Jan, July	13⅝	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	125 —127	4 0 0	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	103 —105	4 6 4	..	104½	..
10	4/0	County of London Elec. Supply Ord.	9 —9½	4 4 2	..	9¼	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —12½	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 —110	4 3 3	..	108½	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 —103	4 7 5	..	102½	101½
5	2/0	Folkestone Electricity Supply Co. Ord	5½—6	4 11 9	—	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	102 —105	4 7 0	—	103½	—
5	3/0	Hove Electric Lighting Ord.	7½—8	5 6 3	..	..	..
St.	4½%	I. of W. Elec Lt. & Power 4½% Db St (red.)	100 —102	4 8 9	..	101½	..
5	5/0	Kensington & Knightsbridge Ord	12½—13	4 12 4	..	12⅝	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —104	3 17 3	—	103½	..
3	..	London Electric Supply Ord.	2⅛—2¼	..	—	2⅛	..
5	3/0	Do. 6 per Cent. Pref.	5¾—5⅞	5 3 3	..	5¾	5⅝
St.	4%	† Do. 4 per Cent. 1st Mort. Deb.	95 —97	4 2 6	Mr,Jn,S,D	96½	..
10	9/0	Metropolitan Electric Sup. Ord.	16¾—17¼	5 4 4	April, Oct	17⅛	16¾
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½—5¾	4 0 6	Jan. July	5⅝	5½
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	113 —117	3 18 0	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 —99	3 10 6	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	93 —96	4 13 9	..	94½	—
10	5½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	12½—13½	5 12 0	Feb, Aug	..	..
5	5%	Newcastle Elec. Supply Ord.	5⅛—5¼	4 17 6	Feb, Aug	..	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5½—5⅝	4 10 1	Feb, Aug	..	..
1	8	Northern Counties Elec. Sup. 17/- paid	15/6—16/6	3 6 9	Mar, Sep	..	..
10	6.0	Notting Hill Electric Ord.	14½—15	4 0 0	March....	14½	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	101 —103	3 18 2	..	..	..
5	2.6	Oxford Electric Ord.	5½—6½	5 2 2	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99 —101	4 0 0	..	..	..
5	5.0	St. James' & Pall Mall Elec. Ord.	13½—14½	5 1 9	Feb, Aug	14	..
5	3/6	Do. 7 per Cent. Pref.	8½—9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	99 —101	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3¼—3¾	5 3 1	—	3½	..
St.	4%	Do. 4 per Cent. Deb. Stock	83 —87	4 12 0	..	..	..
5	2/0	South London Electric Supply Ord.	4¼—4½	3 3 8	—	4½	..
1	..	South Metrop'n Elec. Lt. & Power Ord.	¾—1	..	—	..	..
1	0/8½	Do. 7% Cum. Pref.	1½—1⅝	4 16 9	—	1⅝	1½
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. Accn.)	107 —110	4 2 3	—	..	..
5	2/6	Urban Electric Supply Ord.	4½—5	4 18 9	..	5¼	..
5	2/6	Do. 5% Cum. Pref.	5 —5½	4 17 7	..	5¼	5
St.	..	Do. 4½ 1st Mort. Deb.	104 —105	—	..	..	..
5	6/6	Westminster Electric Supply Ord.	12½—13½	5 1 11	Mar, Sept	13¼	13
5	2/6	Do. 5 per Cent. Cum. Pref.	6½—6¾	3 14 0	—	6½	6½
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 6% Cum. Pref.	½—⅝	5 14 2	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	¾—⅞	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5½—5¾	6 19 2	July, Feb	..	..
5	2.0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —106	4 6 5	—	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	100 —102	4 8 6	—	..	..
5	3/0	British Westinghouse 6% Pref.	2½—2¾	..	—	2½	2½
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	58 —60	6 10 8	..	59	..
2	..	Brush Electrical Engineering	½—¾	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½—1⅝	7 7 6	Mar, Sept	1½	1⅝
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	93 —96	4 14 6	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	69 —73	6 7 6	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	9½—10	5 5 0	Jan, July	..	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	5 —5½	4 15 3	Jan, July	5½	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —106	4 6 7	Nov, May	106	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1½—1¾	4 16 9	—	1	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	96 —98	4 13 4	..	..	..
1	0/9½	Chadburn's (Ship) Telegraph Ord.	¾—1½	8 17 6	..	..	..
2	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—2	8 15 1	Jan, July	1¾	1½
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	94 —96	5 3 7	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	7½—7¾	6 6 5	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	6½—6¾	5 4 4	Sept	6⅝	6½
St.	4½%	Do. 4½% Deb. Stock	107—109	4 4 6	..	107	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	½	..
5	..	Do. (£5 paid)	1 —1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	78 —82	4 17 9	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 —84	6 0 6	..	..	—
5	4/6	Edmundson's Elec. Corp. Ord.	6½—6¾	5 9 10	H'lf-yearly	6⅛	..
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 16 0	—	6¼	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	107 —109	4 4 0	..	108	..
2	1/7½	Electric Construction Co.	1½—1¾	6 8 0	July	1¾	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2½—2¾	5 12 3	July	2⅛	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98 —100	4 0 6	Jan, July	99½	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	—	..	—
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10	5 0 0	—	10	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91 —93	4 3 4	..	93	..
5	5/0	Henley's Telegraph Works Ord.	10½—10¾	5 10 3	Feb, Aug	10½	10½
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4 3 9	Feb, Aug	5⅝	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	110 —112	4 0 10	Feb, Aug	..	..
10	6/0	India Rubber, Gutta Percha, &c., Wrks.	15½—16½	6 1 3	Feb, Aug	16	15½
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11 —11½	4 7 0	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	38 —40	5 18 6	Mar, July	39	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	103 —105	3 17 0	Jan, July	..	..
5	—	Willans and Robinson Ord.	1 —2	..	Apr, Oct	..	..
5	—	Do. 5 per Cent. Cum. Pref.	2 —3	—	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	74 —79	5 1 3	May Nov	76½	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

THE gradual evolution of cable systems is an interesting study. Fifteen years ago vulcanised indiarubber was employed almost exclusively for electric lighting mains in this country, and the manufacturers of lead-covered cable had some difficulty in persuading customers that lead-covered cables would be more durable. In fact, at first the durability of indiarubber was hardly called in question, and thus lead-covered cables laid directly in the ground were introduced to compete in price with rubber-insulated cables drawn into iron pipes. The drawn-in system continued as chief favourite, however, until the first bad troubles occurred from explosions of gas which had got into the manholes and junction pits and circulated through the pipes or conduits. These accidents gave an impetus to the "solid" system, but recent events have shown that this system may have its defects also. On the mains of one of the London companies, an explosive gas was given off by the bituminous composition surrounding the cables, when faults were burnt out, and this gas even spread to the surface boxes of another company and caused explosions in them. A similar case occurred in Bermondsey this month, an explosion occurring some distance away from the actual short-circuit which was the prime cause of the mishap. This effect may be almost eliminated, however, by greatly reducing the unoccupied space in the boxes; in the case at Bermondsey, however, we believe that the gas travelled through some spare ducts which had been laid as provision for extensions. Another possible defect in the "solid system" is pointed out by Mr. JAMES PERRY in our Correspondence columns this week. He has observed cases in which the bitumen composition does not cling around the lead of the cable, and thus may allow a film of moisture to surround the lead covering in some places. Mr. PERRY'S suggestion that tarred sand might take the place of the bitumen is worthy of consideration. It must be remembered that an extremely good insulator is not needed for this purpose, the chief function of the compound being merely to protect the lead of the cable from chemical action of the soil and moisture. Tarred sand would also doubtless be far cheaper than bitumen.

◆

BOURNEMOUTH ratepayers are just now rejoicing at the award of Mr. Justice LAWRENCE in connection with the recent arbitration proceedings to determine the price which should be paid for the undertaking of the Poole & District Electric Traction Co. It will be remembered that the numerous witnesses for the company estimated about £430,000 as the value of the undertaking, whilst those for the Corporation valued it at about £65,000. Consequently, the award of the Umpire, which decrees that the Corporation shall pay to the Company £112,000 and costs, is in the nature of a victory for the municipality. The huge disparity in the estimates of the two parties was brought about by the wording of the agreement entered into for the purchase. At an early stage in the arbitration proceedings this threatened to create a deadlock, and the Umpire offered to state a case for the Courts. As, however, the Umpire's view as to the meaning of the agreement did not interfere with the case prepared by either side, matters proceeded smoothly, and the result above given, it will be seen, distinctly favours the Corporation. The full text of the award is not yet available, but we hope to publish this at an early date.

◆

THAT influential ratepayers are now taking more interest in matters connected with municipal expenditure was evidenced in the Local Government Board Inquiry at Oldham, a report of which appears elsewhere in this issue. Application had been made for sanction to borrow £48,114 for extensions of the electricity supply system, and it appears that a large portion of this amount had already been expended previous to the inquiry. At the inquiry many awkward questions were also asked as to the absence of any provision for depreciation, excessive expenditure on architectural work, and on the things not included in the original estimates, including a sum of £565 on "photographs, souvenirs, &c." In connection with the last item, presents of gold watches and silver brooches were mentioned. The inquiry has been adjourned *sine die* for further particulars to be supplied to the Local Government Board, whose inspectors, we are glad to see, are now becoming more particular with regard to these inquiries. In this connection it may be mentioned that the Board now prescribe 10 years instead of 15 as the period of repayment for loans for motors intended to be hired out to consumers.

◆

There is a general consensus of opinion that the greater the difference of potential between any two conducting sheets the greater is the stress to which the intervening insulator is subjected, and it is also usually supposed that the less the thickness of the insulating sheet for a given potential the greater is the stress. A true proportionality, however, has by no means been proved, and it has not yet been proved that the material of which the conducting sheets is made has no effect upon the stress. It is possible, even probable, that the character of the conductors does not have a large effect with ordinary P.D.s. At very high electrical pressures we are completely in the dark. We know, or think we know, that a submarine cable which has long been submerged and in use, if stripped of its gutta, will show that a certain small amount of copper has apparently penetrated the insulator, but we are not sure that this has ever been directly ascribed to electric action, though this may, of course, be the cause of the phenomenon, should it ever be satisfactorily established that the phenomenon exists. If, however, copper particles are shot off from an electrified conductor of this metal, accumulations of years must affect the dielectric's strength. It is remarkable that experiments in which a great expenditure of time is an important factor are but little recorded, though their results are frequently quite well known to the craftsmen who meet them every day. The text books, for example, make very little of the fact that lead is attacked by distilled water; most of them add that a thin coating of oxide forms upon the lead as a paint and preserves it. Since lead has been brought prominently under more scientific investigation of later years it has become well known amongst the electrical trades that very small electric currents appear to have remarkable disintegrating effects upon commercial lead in the presence of water which approximates in purity to distilled water. The owners of frozen meat stores who have used lead-covered wires know that what is known as "condensed breath" has a remarkable effect upon the very purest English lead used as a sheathing for working cables. Similarly, in the matter of cable insulations, there is a great dearth of well co-ordinated experimental research and well-established results.

◆

The mere fact that we constantly assume that stress is measured by potential gradient is a case in point. Mr. Jona, in a Paper on "Insulating Materials in High-tension Cables," read at the St. Louis Congress, does not even suggest that there is the shadow of a doubt upon the most vital question of proportionality of stress to P.D. per unit thickness, although we are confronted with certain experiments, such as Mr. T. Gray's, which have shown that dielectric strength per centimetre thickness of certain insulators diminishes with increasing thickness of the substance (*Proceedings* of the American Association for the Advancement of Science, Vol. XLVIII., pp. 122, 123, 1899). Similarly, there is the almost universal experience that, from the point of view of resisting puncture, the theoretical insulation on small wires at high voltages is gravely in excess of that which is practically needed, even after making the assumption that the inner layers are broken down so as effectively to give a conductor of larger diameter than appears to be in use. The assumption that there is effectively a conductor of larger diameter than the copper is recognised in Mr. Jona's Paper and exemplified therein by the statement that when small wires at a high potential are glowing in the dark they present the appearance of luminous cylinders of the same size. This, however, is quite satisfactory, and the somewhat inconclusive experiments which he appears to have made from the point of view of the advancement of the science of cable-making represent an expenditure of vitality which would have been perhaps more advantageously directed to explaining the resistance to disruption of thin coats on small wires. He is doubtless substantially correct in adopting the formula which Mr. Swinburne gave on June 7, 1899, before the Engineering Conference (*The Electrician*, Vol. XLIII., p. 272). This formula—$\frac{dV}{dp}=\frac{rS}{\rho}$ or $\log R = \frac{E}{rS} + \log r$, wherein S is the maximum allowable stress, *r* the radius of the conductor and R the radius of insulation for a given voltage V—was taken up and worked upon by Mr. O'Gorman in a Paper read before the Institution of Electrical Engineers in 1901 (*The Electrician*, Vol. XLVI., p. 868). A more definite acknowledgment of Mr. Jona's indebtedness to these two investigators should have been made in the Paper under review.

◆

The writer appears to be impressed with the feasibility of grading cables so that the stress throughout the dielectric is uniform according to the formula mentioned, but he claims to be ahead of any patent on this subject by applying paper over rubber as early as 1898, and having a cable of this kind at 25,000 volts during the Paris Exhibition of 1900. Whether any properly graded cable existed at this early date is a matter which may perhaps some day have to be established in the law courts; so far, we are informed, a claim for a prior date to 1900 has been decided in Germany against a claimant. No very ardent interest in this matter is to be expected in this country just yet, however. Pending the more scientific analysis of the meaning of dielectric strength, we must for the present accept Mr. Swinburne's dictum that the cable problem is very much the same as that of a gun; but while adopting this view, it would appear that until dielectrics can be commercially obtained so that their own impurities do not make vastly more difference to their effective strength than can be provided against by such elaboration as "grading," no serious importance can attach to the methods of designing the insulating shell which appear desirable from the logarithmic theory of stress. We must first find a dielectric for high-tension work which approximates in constancy of composition and purity to the gutta of transatlantic cables.

IN a Paper read before the St. Louis Electrical Congress, and published elsewhere in to-day's issue, Mr. H. M. HOBART elucidates a practical and speedy method for arriving at the approximate principal dimensions of modern and economical three-phase squirrel-cage induction motors. The author's faculty of tackling technical problems from different points of view is well illustrated in this method, which is based on two empirical, semi-commercial equations lacking a rigid scientific foundation. The first equation connects the dimensions and speed of a motor with its output, while the second one expresses a relation between motor dimensions and total works cost of the motor. By combining these two equations, Mr. HOBART finally arrives at the principal equation, from which one of the chief dimensions of an induction motor—viz., the pole-pitch, may be calculated if the motor output, speed, frequency and output-coefficient are known. This dimension conduces to the cheapest commercial design, and, after it is once known, the other chief data of the motor required are obtained without difficulty from a series of inter-connected equations. It will readily be granted that the two relations upon which this method is based are somewhat flexible, depending on a host of conditions, such as size of works, place of manufacture, details of construction and so on. The constants which the author suggests for use in both equations represent the mean found in a large number of motors of good design, and the dynamo designer whose products satisfy them can feel assured to some degree that he has designed a marketable article. If it be found in certain cases, on the other hand, that Mr. HOBART's curves for the output-coefficient and cost-coefficient vary too much from actual figures, then nothing is easier than to adapt the equations to the new results.

THERE is a tendency on the part of many electrical engineers, when they are disinclined to tackle a problem that is unfamiliar to them, to say that it is incapable of solution, in this country at any rate, owing to the regulations and restrictions imposed by the Board of Trade. This has been particularly marked in connection with overhead wires for electric light and power purposes, the adoption of which in suitable positions and with reasonable precautions is not opposed by the Board. Another case is the connection of motors to tramway circuits for power purposes. It was stated recently at Ipswich, for instance, that the laundry machinery at the workhouse could not be electrically driven, as the house was at too great a distance from the Corporation distributing system, and "the Board of Trade will not permit any supply to be given to a consumer from the tramway circuits." This statement is not correct, for there are many cases in which motors have been supplied precisely under these conditions, and with the knowledge and sanction of the Board of Trade. It would be interesting to know whether the Ipswich Corporation Electrical Engineer, who made the above statement, had first taken the trouble to apply to the Board of Trade or its Electrical Adviser.

IN the first part of an article on "The Effect of Vacuum and Superheat in Steam Turbines," which will be found on another page of this issue, Mr. J. R. BIBBINS computes the percentage gain in steam consumption due to vacuum and superheat, and he is able to confirm broadly what Messrs. PARSONS, STONEY and MARTIN said in their Institution Paper on steam turbines some time ago (*The Electrician*, Vol. LIII., pp. 221, 265 and 305)—namely, that the percentage gain in steam consumption due to an increase of the vacuum by 1in. is roughly from 3 to 5 per cent. for a vacuum between 23in. and 28in., and that for any 10° F. increase in superheat (up to a limit of about 150° F.) the steam consumption is reduced by about 1 per cent. So far, Mr. BIBBINS only confirms earlier experiences. The second part of the article touches on the commercial aspect of maintaining high vacua and superheat, and the author shows by three parallel, numerical examples, that high vacua and superheat may be truly economical when expensive coal has to be used, but that the reverse might be the case with cheap coal. These reflections have often been advanced in a general way, but it stands to the credit of Mr. BIBBINS to have represented the facts in a clear numerical manner, which is more convincing to many engineers than a general statement. With regard to the power required to operate a high-vacuum condensing plant, it is interesting to learn that the power necessary to maintain a vacuum of above 27in. for an actual 400kw. plant at full load amounted to 2¼ per cent. only. In the second plant mentioned, which was exhibited at the St. Louis Exhibition and consisted of a 2,000kw. Curtis turbine equipment, the power consumed at full load by the condenser auxiliaries had amounted to 7 per cent. of the generator output. This high figure is partially explained by the fact that the speed of the auxiliaries was not regulated as closely as it might have been to the turbine load and that, also, the cooling water had an exceptionally high temperature. What is possible in a 400kw. plant ought, on the face of it, to be possible in a plant four times its size, and, given a sufficient amount of cooling water at a low temperature, the above-stated figure of 2¼ per cent. certainly ought not to be exceeded.

THE letter from Mr. B. A. BEHREND which appears in ou Correspondence columns this week, and relates to Mr. SWINBURNE's address to the students of the Institution of Electrical Engineers, constitutes an exceedingly apt and timely expression of opinion by one of the leading electrical engineers on the other side of the Atlantic. Although, in general, Mr. BEHREND expresses the same opinion as we have already done, exception must be taken to the sentence: "It is undoubtedly true that if you want to get on in the world you had better not study engineering or any other scientific pursuit." Of his own showing, "to get on" does not necessarily imply "to get rich"; there are other aims and ambitions in life besides the mere amassing of wealth. "The world," to an engineer, is engineering; to a surgeon, surgery; and to a financier, finance.

Rugby Engineering Society.—A meeting of the Rugby Engineering Society will be held in the Benn Building, High-street, Rugby, on Thursday next, January 5th, when Mr. R. Watson on "Pattern Making."

Röntgen Society.—A meeting of the Röntgen Society will be held at 20, Hanover-square, London, W., at 8:15 p.m., on Thursday next, January 5th. The following three items, by Mr. C. E. S. Phillips, constitute the agenda :—(1) Description of an Automatic Vacuum Pump; (2) Exhibition of a Method by which Strongly Adherent Films of Aluminium may be applied to Glass; (3) A Note on the Colouration of Glass by Radium Radiation.

The Junior Institution of Engineers.—The election is announced of Mr. Philip Watts, F.R.S., Director of Naval Construction, as a vice-president of the Junior Institution of Engineers. On January 7th, at 2:30 p.m., the Institution will visit the factory of the Voelker Incandescent Mantle Co., Albert Works, South-street, Wandsworth. Prof. Vivian B. Lewes will deliver a lecture before the Institution on January 13th on "The Theory of the Incandescent Mantle."

Service Work in Sheffield.—We have received from Mr. S. E. Fedden, general manager and engineer of the Sheffield Corporation electric supply department, a photograph illustrating some very excellent plumbing work carried out by his staff in a private sub-station at a large steel works in that city. The two-phase concentric mains are teed off into three oil fuse distributing boxes, those boxes being used to exhaust a stock instead of employing three-way boxes, as is usual. The top box on each side controls the spark-gaps and the lower ones feed the stationary transformers.

Cable Interruptions.	Date of Interruption
Cayenne—Pinheiros	Aug. 13, 1902
Beissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Cayenne—Paramaribo	July 13, 1904
Sitka—Valdez (Alaska)	Nov. 11, 1904
Trinidad—Demerara	Dec. 20, 1904
Assab—Perim	Dec. 26, 1904
St. Vincent—San Thiago	Dec. 27, 1904
Bathurst—Sierra Leone	Dec. 27, 1904
Cap Haytien—Puerto Plata	Dec. 27, 1904
Gibraltar—Tangier	Dec. 28, 1904

The Dissipation of Fog by Electrical Means.—Sir Oliver Lodge has written an interesting letter to *The Times* on the question of the electrical dissipation of fog. He points out that an electrical method of dissipation is not the right remedy for this artificially intensified evil, though it is a hopeful and proper method of attacking natural mist in places where it interferes with navigation or commerce. The proper remedy, Sir Oliver remarks, is the removal of the cause, which is imperfect methods of combustion and the habitual employment of crude fuel. But, although it is not the right remedy, any more than free meals and free doles are a sound remedy for the problem of poverty, yet, like them, it may have to be used as a temporary palliative. The cost of applying such a method to a whole city is probably prohibitive, but there are important centres where any means of mitigating the nuisance would seem to be legitimate. Sir Oliver offers to show his method at work in Birmingham to any deputation of municipal or other engineers with a view to experiments being tried on an adequate scale. The necessary expenditure resolves itself into initial equipment and maintenance; the actual running expense being only occasional, and, moreover, quite insignificant compared with the power already expended in artificial illumination during daylight fog. Sir Oliver refrains from expressing an opinion as to whether it is worth while for any municipality to try the experiment; but, he adds, it is within the scope of the electrical engineering profession, and his assistants are competent to give the specific supervision and advice necessary to ensure its being tried properly, if any authority chose to attempt it.

Wireless Telegraph Notes.—In regard to communications from the Colonial Office recommending the Canadian Government, in common with other British self-governing States, to take over control of all wireless telegraph matters, it is understood that a bill will be introduced in the Canadian Parliament to give effect to the suggestion of the Imperial Government.

We are informed by the American De Forest Wireless Telegraph Co. that its development during 1904 has been satisfactory. The first event was the reporting of the naval operations around Port Arthur for *The Times*. New records were established, and distances up to 249 sea miles were covered with a 1kw. transmitter, using an antenna less than 100ft. in height. In America permanent communication was established between Buffalo and Cleveland, over 120 miles of frozen land and lake. Five operating stations were exhibited at St. Louis, one of these, the 300ft. observation tower, being used by two St. Louis newspapers. The long-distance station established new records in permanent communication with Chicago, 300 miles, and Kansas City, 280 miles; messages have also been sent to Cleveland, a distance of 505 miles over land. At the close of the exhibition this long-distance station was moved to East St. Louis. The American De Forest Company has now 18 stations fully equipped, and eight more in process of construction in the United States, not including the five long-distance stations which it is under contract for with the United States Navy. Of these much work has already been done at the Key West station, and the others will be equipped as rapidly as the navy erects the masts and station houses. Three of these navy stations will be of 33kw., and capable of operating over 1,000 miles. A similar station will be commenced before the end of 1905 at New Orleans and one in Galveston for operation with the Havana, Panama and Mexican ports. The Mallory Line boats plying between New York and Galveston have been equipped, and this service will be rapidly extended to vessels of other lines.

The *Patria* has stated that negotiations have been entered upon by the Italian Minister of Posts and Telegraphs and the British Postmaster-General with a view to establishing wireless telegraphic communication between the stations of Poldhu and Bari.

St. Catherine's Lighthouse.—St. Catherine's lighthouse, situated on the south coast of the Isle of Wight, has just been provided with the most powerful flashlight in this country, in accordance with the following notice, issued by Trinity House in March last:—"It is intended on or about September 22nd next to alter the character of the main light at St. Catherine's Lighthouse from one white flash every half minute to one white flash every five seconds—viz., flash 0·21 second, eclipse 4·79 seconds." *The Times* publishes some interesting particulars concerning the new light:—

> It is immensely more powerful than the old light, being of 15,000,000 c.p., as against 3,000,000 only with the old apparatus. The light from the new lens without the upper sections in position was exhibited on November 29th, it not being possible to fix the upper sections until the temporary apparatus was dismantled. This was accomplished on December 10th, and the full power of the complete lens was exhibited on that night. The flash is very intense, and must certainly be seen on the coast of France when the atmospheric conditions are favourable. Seen from the land there are three distinct beams of light revolving in view, one just on the point of disappearing behind the "blank" or shield, while the others stretch out their long arms across and pass rapidly over the waters of the English Channel. Viewed from the sea, the light is intensely white, but when the beam touches near objects it is seen to be made up of all the colours of the rainbow. The new lens is a fine piece of work by Messrs. Chance Bros., Birmingham, the whole of the revolving part floating in a trough of mercury, instead of being on rollers, which has hitherto been usual, about 816lb. of mercury being required to float it. The lens is rotated by a large clock driven by lead weights working in a solid drawn-steel tube placed in the service room below. A loud-tone gong is provided to sound when the weights are run down and when they are fully wound up. Hitherto chain has been used in lighthouses for suspending the weights, but in this case a fine steel cable, about ¼in. in diameter, has been adopted. The new subsidiary red light showing in the direction of the Needles is worked by reflection, a holophote being placed in the focal plane of the electric arc and the light projected on to a set of glass prisms; the rays are then bent down, as it were, and thrown on to a similar set of prisms about 20ft. below and bent again in a horizontal direction through a ruby plate-glass screen placed in a frame immediately in front of the lower set of prisms. A very powerful red fixed light is thus shown down Channel through an opening which has been cut in the solid masonry of the lighthouse tower. There is no alteration in the machinery in the engine room. The electric current is generated by old De Meritens magneto-electric machines running at 600 revs. per min., and driven by Robey compound steam engines of 50 B.H.P. There are duplicate sets in case of a breakdown. It is interesting to note that although the generating plant has been in use for 17 years there has never been a breakdown.

THE METROPOLITAN RAILWAY.

(*Continued from page 383.*)

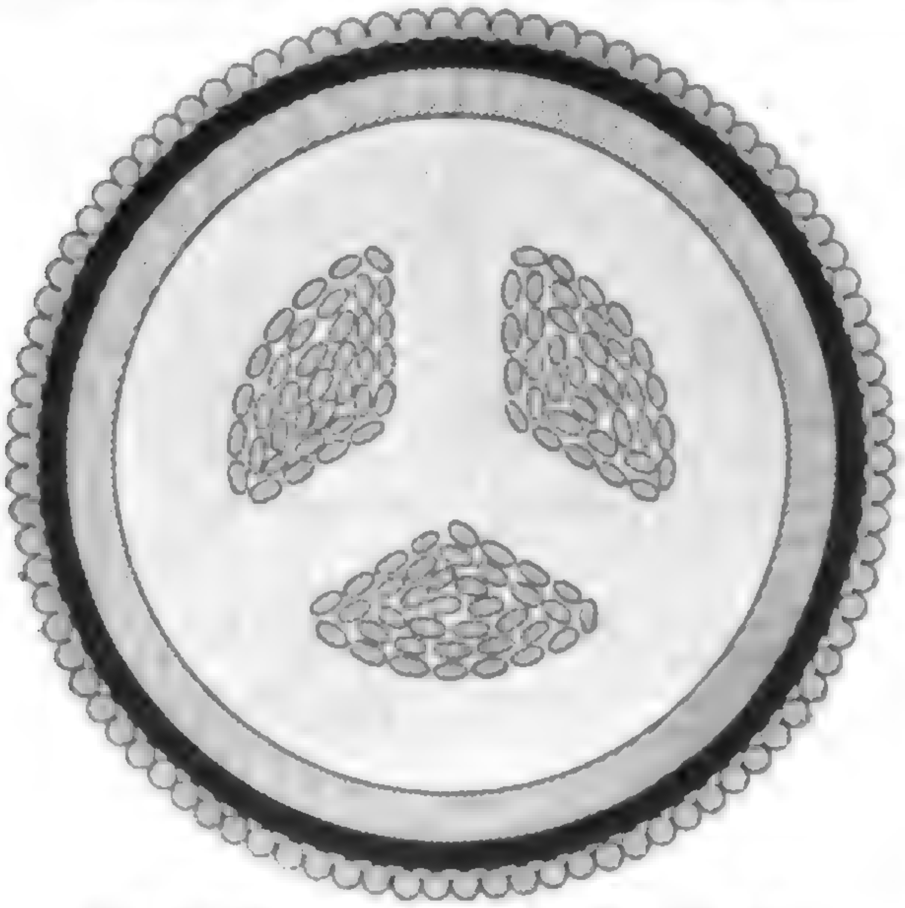

Fig. 15.—Section of E.H.T. Feeder. Full size.

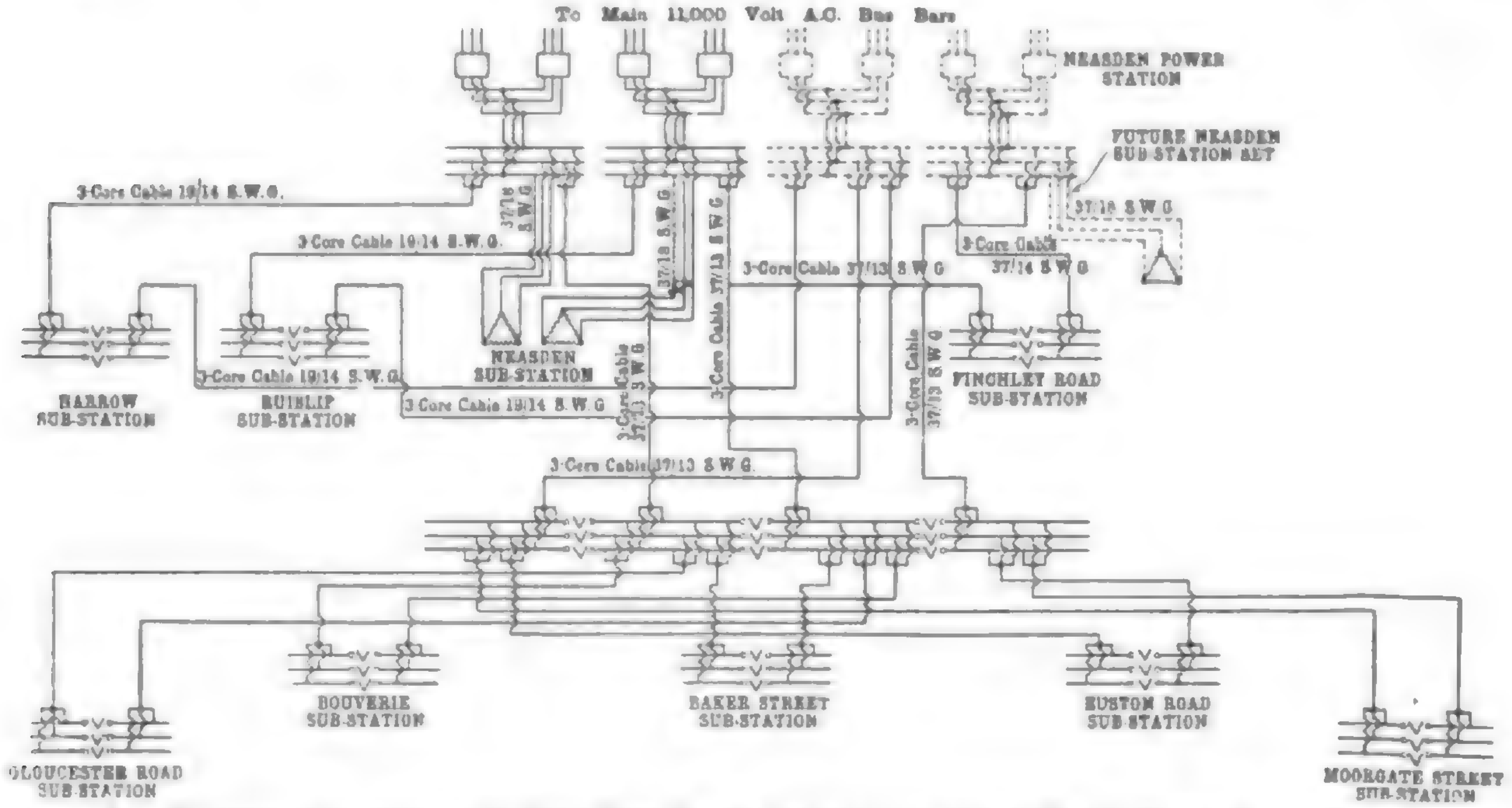
To Main 11,000 Volt A.C. Bus Bars
NEASDEN POWER STATION
FUTURE NEASDEN SUB-STATION SET
3-Core Cable 19/14 S.W.G.
3-Core Cable 19/14 S.W.G.
37/18 S.W.G.
37/18 S.W.G.
3-Core Cable 37/13 S.W.G.
3-Core Cable 37/13 S.W.G.
37/18 S.W.G.
3-Core Cable 37/14 S.W.G.
3-Core Cable 19/14 S.W.G.
3 Core Cable 19/14 S.W.G.
3-Core Cable 37/13 S.W.G.
3-Core Cable 37/13 S.W.G.
3-Core Cable 37/13 S.W.G.
HARROW SUB-STATION
RUISLIP SUB-STATION
NEASDEN SUB-STATION
FINCHLEY ROAD SUB-STATION
GLOUCESTER ROAD SUB-STATION
BOUVERIE SUB-STATION
BAKER STREET SUB-STATION
EUSTON ROAD SUB-STATION
MOORGATE STREET SUB-STATION

Fig. 16.—General Arrangement of Extra High-Tension Feeders from Neasden Power Station to Sub-stations.

The E.H.T. cables have been supplied and laid by the British Insulated & Helsby Cables (Ltd.), and consist of triple conductors, paper insulated and lead covered. The lead is covered by insulating material, and the whole cable is armoured by round galvanised 0·104 steel wires, the diameter of the finished cable being about 3in. Except in the tunnels, the cables are laid on the solid system in wooden troughs, being supported either on wooden bridge-pieces or on the iron bridge-pieces designed by Mr. Ruthven-Murray, and run in with pitch. At bridges, buildings and stations the cables are drawn into pipes. Nine cables leave the Neasden Power Station. Four of them run north to Harrow, two going into the sub-station there and two continuing on to the sub-station at Ickenham. The other five cables run south, one stops at Finchley-road sub-station, while another is interconnected there and then continues with the other three to Baker-street sub-station, two being carried on brackets in each tunnel. Four cables run west from Baker-street, two of them stopping at Bouverie-street sub-station and two continuing to Gloucester-road sub-station. There is a similar arrangement to the east of Baker-street, the sub-stations being situated at Euston-road and Moorgate-street. The cables in the tunnels are run on brackets except at stations, where they are drawn into pipes. The sizes and lengths of the E.H.T. cables are as follows: 9 miles of 0·15 sq. in., 14 miles of 0·20 sq. in., 24 miles of 0·25 sq. in. and 25 miles of 0·10 sq. in. All cables were tested at the works at 30,000 volts, and after being laid were again tested at 22,000 volts. They are finished off in the sub-stations in terminal boxes, supplied and fixed by the British Insulated & Helsby Cables (Ltd.).

Low-tension rubber cables are employed for connecting the sub-stations to the conductor rails. Similar cables are also used for connecting the conductor rails at crossings, &c., some being laid in troughs and some in ducts. This work, as well as all that in connection with the E.H.T. cables, was carried out by the British Insulated & Helsby Cables (Ltd.).

At the present time the sub-stations are not all completed, but ultimately there will be nine, which will come separately into use as occasion requires. Their equipment is as follows:—Ruislip, two 800kw. rotaries with transformers, &c.; Harrow, three; Finchley-road, four; Gloucester-road, three; Neasden, three; Praed street, three; and Baker-street, King's Cross and Moorgate-street, each three of 1,200kw. capacity.

When extensions become necessary, Baker-street, Harrow and Ruislip will each be allotted another rotary converter of similar size to those they now contain.

From the description of the cable work given above, it will be seen that Baker-street sub-station, when finished, will be highly important, as it will control all the Metropolitan Inner Circle traffic. As regards the transmission and distribution of power, the system upon which the railway is operated may now be regarded as a standard one. The 11,000 volt, three phase current is conducted to the sub-station and there transformed down, and changed to continuous current at approximately 600 volts by rotary converters. Though the sub-station equipments vary in size according to their position on the line and the load that they will have to carry, the plant is identical in type and as far as possible in arrangement, having all been designed and installed by the British Westinghouse Company. The two sizes of rotary converters employed, 800kw. and 1,200kw., have respectively 10 and 12 poles, and run at speeds of 400 and 333·3 revs. per min. The transformers used in connection with them are of 300kw. and 435kw. capacity per phase respectively, and are of the insulated self-cooling oil type.

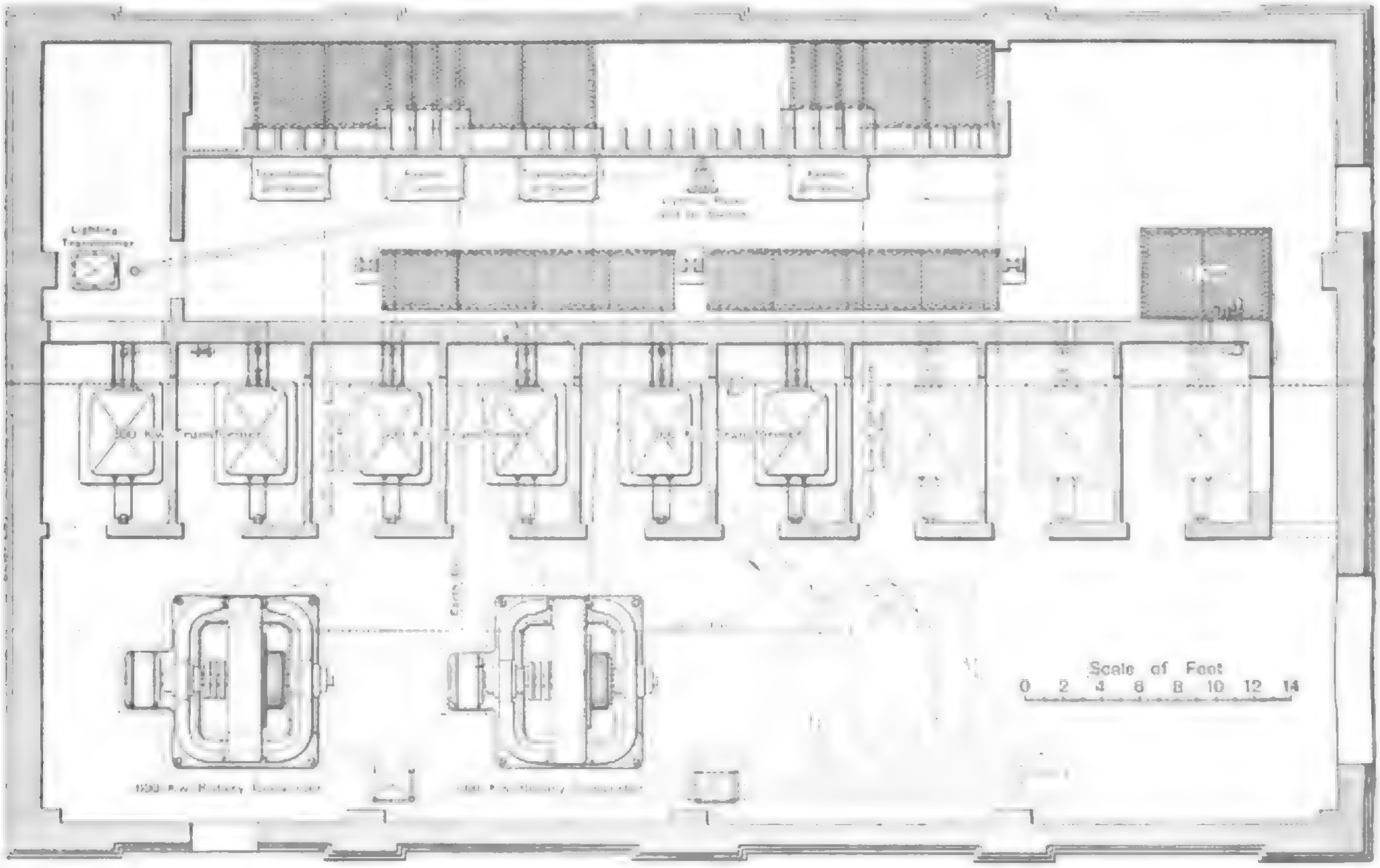
Lighting Transformer
300 Kw. Transformer
800 Kw. Rotary Converter
Scale of Feet
0 2 4 6 8 10 12 14

FIG. 17.—PLAN OF TYPICAL SUB-STATION.

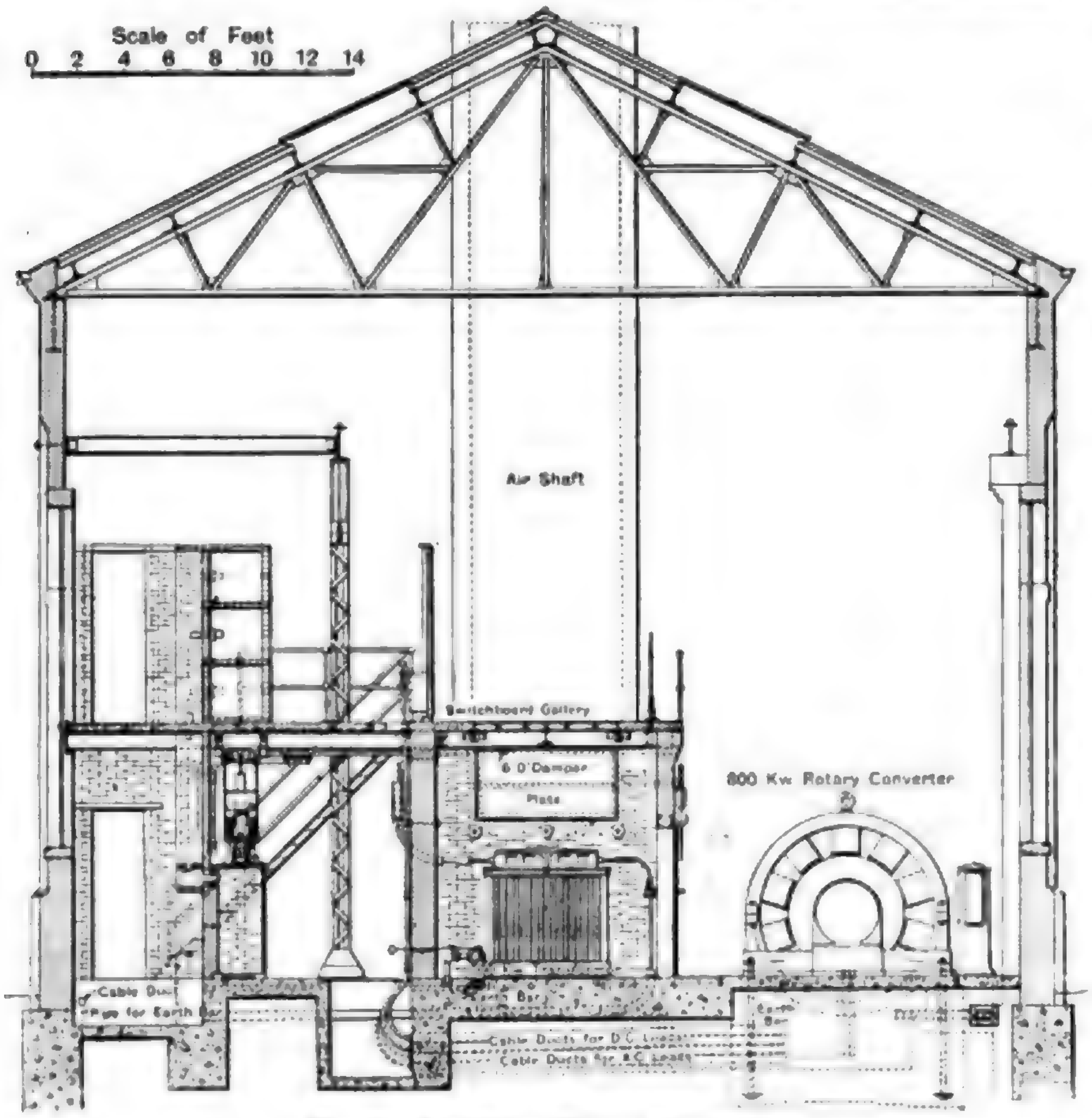
Scale of Feet
0 2 4 6 8 10 12 14
Air Shaft
Switchboard Gallery
6' 0" Damper Plate
800 Kw Rotary Converter
Cable Duct
Pipe for Earth Bar
Earth Bar
Cable Ducts for D.C. Leads
Cable Ducts for A.C. Leads

FIG. 18.—SECTION OF TYPICAL SUB-STATION.

A good idea of the general lay-out of the sub-stations is conveyed by Figs. 17 and 18. The rotaries occupy the ground floor, and in some cases a railway siding is brought right into the building in order to facilitate the erection and replacement of machinery. The switchboards, oil switches and transformer chambers take up by far the greatest space, and are arranged in the manner indicated in the drawings. Each transformer is placed centrally in a separate well-ventilated chamber with its high-tension side facing the door, and a large air shaft common to all the chambers provides for a through draught. The degree of ventilation may be varied by means of large damper plates shown in Fig. 18. These damper plates are suspended vertically on hinges, and may be opened or closed to any desired extent from the outside of the transformer chambers by means of counterweighted levers. There is one damper plate to each chamber. In the ceiling of the chambers, which is the floor of the upper gallery, large iron manholes are inserted to allow of the transformers being withdrawn if necessary; a hand power travelling crane being in most cases provided for this and other similar purposes. The entrance to each chamber may be closed by a rolling iron shutter. On the ground floor behind the transformer chamber is a passage containing the H.T. oil-break switches, and at the back of this are the cable ducts through which the 11,000-volt feeders enter the building and the track feeders leave it. The lightning arresters are situated here on the end of each cable in separate brick compartments. All the high-tension switches are hand operated through gearing by means of levers placed close to the edge of the upper gallery, and, in the case of those used in the rotary circuits, are provided with time limit relays, while automatic reverse current relays are installed with the feeder switches. Electrical tripping arrangements are placed both on the switchboard panels on the gallery, and on the main levers.

Each E.H.T. 'bus bar consists of a 3in. by ¼in. copper strip, and the three are situated vertically one above the other in separate brick chambers, directly over the oil switches. They are supported on substantial and effective insulators, and access is obtained to them through iron doors, which when closed render them inaccessible. The low-tension and operating switch gear is contained on several marble panels placed well in front of the 'bus bar chambers on the upper gallery. They are quite simple in electrical design. The first panel on the left contains sundry measuring instruments, synchroscopes, &c., the next three, the rotary converter alternating-current side starting, motoring, and switching gear. Following these are three panels for the continuous side of the rotaries containing circuit breakers, shunt regulating resistances, &c., next is the 11,000-volt feeder panel and finally four track feeder panels. The lighting of each sub-station is effected from a separate small transformer tapped off the 'bus bar coupling knife switches, mentioned later, and in addition an efficient gas supply is laid on to cope with the remote possibility of entire failure of the current. This latter point is an example of the great care and forethought that has been brought to bear on the design and construction of the sub-stations, where reliability has been made the essential feature, every possible accident or derangement apparently having been foreseen and provided for.

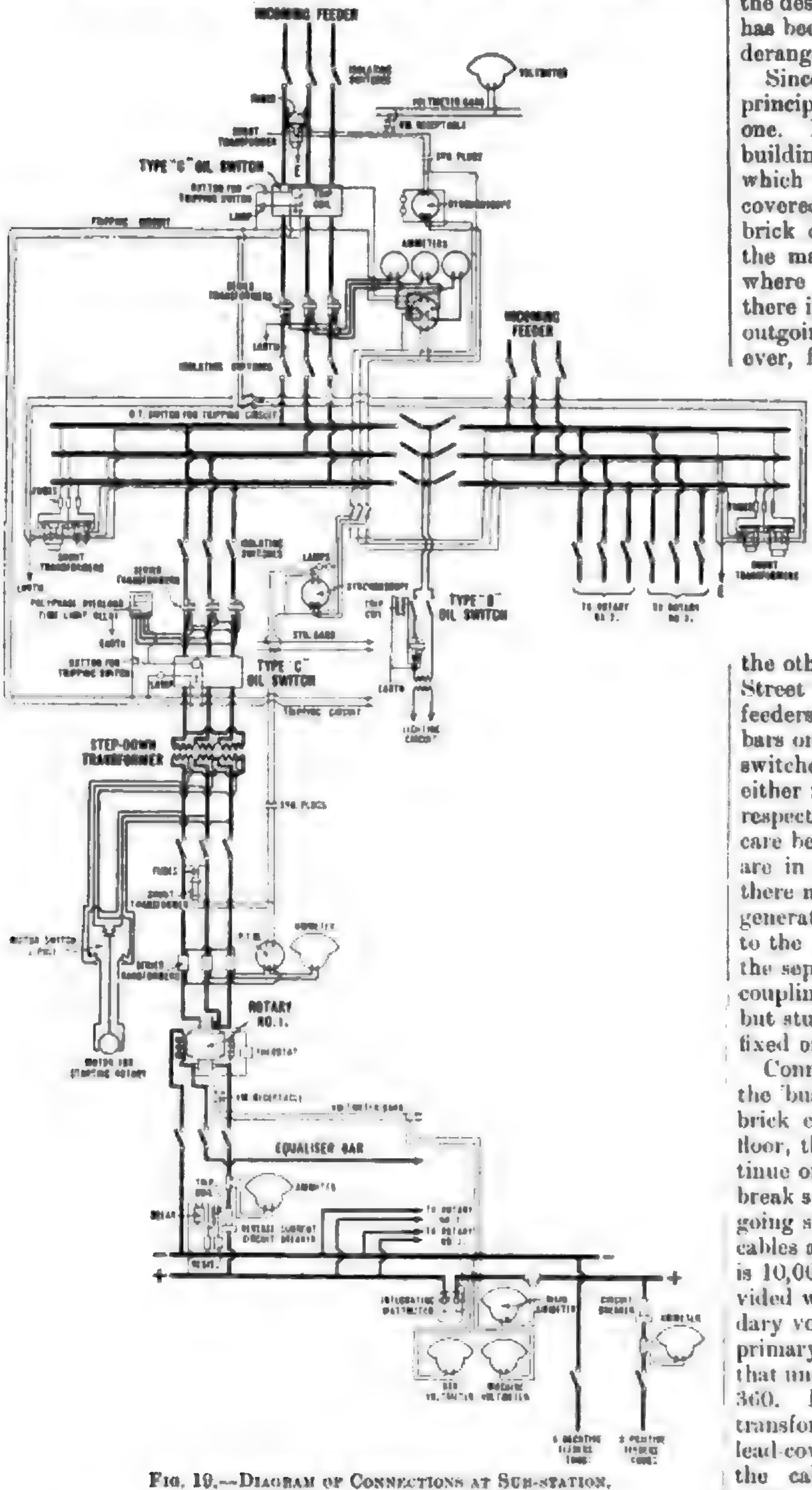
INCOMING FEEDER
ISOLATING SWITCHES
VOLTMETER
VOLTMETER BARS
FUSES
SHUNT TRANSFORMER
TYPE "B" OIL SWITCH
BUTTON FOR TRIPPING SWITCH
TRIP COIL
LAMP
TRIPPING CIRCUIT
SYNCHROSCOPE
AMMETERS
SERIES TRANSFORMERS
EARTH
ISOLATING SWITCHES
INCOMING FEEDER
O.T. SWITCH FOR TRIPPING CIRCUIT
FUSES
SHUNT TRANSFORMERS
EARTH
SERIES TRANSFORMERS
POLYPHASE OVERLOAD TIME LIMIT RELAY
EARTH
BUTTON FOR TRIPPING SWITCH
LAMP
ISOLATING SWITCHES
LAMPS
SYNCHROSCOPE
SYN. BARS
TYPE "C" OIL SWITCH
TRIP COIL
TYPE "B" OIL SWITCH
EARTH
LIGHTING CIRCUIT
TRIPPING CIRCUIT
TO ROTARY NO. 2.
TO ROTARY NO. 3.
SHUNT TRANSFORMERS
STEP-DOWN TRANSFORMER
SYN. PLUGS
FUSES
SHUNT TRANSFORMER
MOTOR SWITCH
SERIES TRANSFORMER
P.F.M.
AMMETER
ROTARY NO. 1.
MOTOR FOR STARTING ROTARY
RHEOSTAT
VOLTMETER BARS
EQUALISER BAR
TRIP COIL
AMMETER
REVERSE CURRENT CIRCUIT BREAKER
TO ROTARY NO. 2
TO ROTARY NO. 3.
INTEGRATING WATTMETER
BUS AMMETER
CIRCUIT BREAKER
AMMETER
BUS VOLTMETER
MACHINE VOLTMETER
2 NEGATIVE FEEDERS
2 POSITIVE FEEDERS

FIG. 19.—DIAGRAM OF CONNECTIONS AT SUB-STATION.

Since the arrangement of all sub-stations is the same in principle, it will suffice if we trace out the connections for one. Immediately the three-core E.H.T. feeder enters the building it is taken through a three-way dividing box, from which it emerges as three separate rubber-insulated asbestos-covered cables. These cables are carried vertically in separate brick compartments, passing through isolating switches and the main oil-break switch on their way to the floor above, where they are connected to the main 'bus bars. Thus far there is practically no difference from the arrangement of the outgoing feeders at the power station. It will be seen, however, from Fig. 19, which is a diagram of connections, that there is a conspicuous absence of group and selector switches, and hence of duplicate 'bus bars also. Notwithstanding this the 'bus bars are so arranged that they are, to all intents and purposes, in duplicate.

This desirable feature is effected (we are referring now to the Finchley-road sub-station) by means of coupling knife switches, which permit of the 'bus bars being divided in two distinct halves. To one of these halves is connected the feeder proper, and to the other a tapping from the feeder which supplies the Baker Street sub-station. If necessary, either (or both) of these feeders may be disconnected by its oil switch and half the 'bus bars only left alive. On the other hand, the coupling knife switches may be closed and the entire 'bus bars supplied from either feeder. Lastly, both feeders may be connected to their respective portions with the coupling knife switches closed, care being taken, however, to ascertain whether the feeders are in synchronism. Usually, of course, this will be so, but there may be occasions when the feeders are run on separate generators. From the coupling knife switches, wires are taken to the potential transformers situated in the basement and to the separate lighting panel. It should be observed that the coupling knife switches are not in the actual 'bus-bar chambers, but studs are taken through the wall, and they are, therefore, fixed on that side of the wall remote from the switchboard.

Connections are taken to the transformers from the back of the 'bus bar chambers, the cables being carried in separate brick compartments. After passing downward through the floor, they are broken by isolating switches. They then continue on through the series instrument transformers to the oil break switches of the stationary transformers. From the outgoing side of the oil switches, two paper-insulated lead-covered cables are provided for each phase. When the primary voltage is 10,000, the secondary is 328; but each transformer is provided with an additional winding, by means of which a secondary voltage of 427 can be obtained with 11,000 volts on the primary. As a matter of fact, however, they are so connected that under normal running conditions the secondary voltage is 360. Low-tension alternating current is taken from the transformers to the switchboard by means of paper-insulated lead-covered cables. Here knife switches are inserted in the cables, which are then connected to the slip rings of the rotaries. Middle tappings are taken off the secondaries of the transformers for the purpose of supplying the small induction motors which are coupled on the rotary shafts. A special starting switch is provided immediately under the three low-tension alternating-current knife switches for each machine. In starting up, the small induction motor is connected across the intermediate tapping, and when it has run up to its maximum speed for that voltage the starting switch is thrown on to the other contact, which operation cuts out the intermediate tapping and puts the full secondary voltage on to the induction motor. This, of course, increases the speed until the rotary approaches synchronism. Exact synchronous speed may be secured by means of a variable resistance in the shunt winding of the rotary. On the continuous-current side of the rotor is a return current cut-out together with two knife switches. The continuous-current 'bus bars are situated at the back of the switchboard, and are divided into two portions connected together through a recording wattmeter and an indicating ammeter. Thus by connecting the machine cables to one portion and taking the feeder cables from the other, the entire output of the sub-station is conveniently measured. Although an insulated return rail is provided, there is a switch on the board for connecting the negative 'bus bar to earth when necessary. From the Finchley-road sub-station there go out four positive track feeders, each of which is connected to the 'bus bar by means of a knife switch, through an ammeter. Two of these feeders supply current to the up and down lines to Neasden, and the other two to the up and down lines to Baker-street. Since the oil switches are mechanically operated by levers spaced out along the front of the switchboard gallery, there is no panel carrying remote control switches. Each track feeder consists of a 169/12 cable.

(To be concluded.)

THE NEW PATENTS ACT.

We may remind our readers that Sec. I. of the Patents Act of 1902 becomes operative on January 1st next. The history and Parliamentary proceedings relating to the Act of 1902, which takes the form of an amendment to the principal Patents Act of 1883, have been fully reported in our columns; and the new Act itself, as finally passed, will be found in *The Electrician*, Vol. L., p. 472. It may be well, however, to recapitulate briefly its chief points. First of all, the period of provisional protection is reduced from nine to six months. Then all "complete specifications" are to be examined as to novelty, but the search is to extend only to complete English specifications not more than 50 years old. A fee of £1 is to be levied for this search, but it must be borne in mind that the fact that the Patent Office examiners are unable to discover an anticipation does not in itself constitute a guarantee that the invention under examination is new. If anticipations to the specification submitted are found, the patentee is communicated with and may amend his specification to meet the objections of the Comptroller-General. Should this gentleman still hold the opinion that the specification, even in its amended form, was anticipated by a former patent, then he has the right to earmark the specification by a reference to the previous patents, which he believes anticipate the one under examination. This "reference" takes the form of a stereotyped official formula appended to the claims. An appeal against this decision may be made by the inventor to the law officer of the Crown. It will be understood, therefore, that the inventor is granted a patent in any case if he desires it, and this is one of the chief points of distinction between the new English Patent law and the American and German Patent laws, which provide that an application may be entirely rejected.

Mr. C. D. Abel, in a Paper recently read before the Society of Arts, denounced in unmistakable terms the American and German patent laws and demonstrated by actual cases what injustices may be done by incompetent examiners. From this point of view Mr. Abel thought the new English patent law a great improvement upon that of the other two countries mentioned; it would fairly satisfy the interests of the inventor while safeguarding at the same time those of the community. The one thing to be regretted was that it had taken the Patent Office authorities so long to adopt these regulations which had been proposed by him some 40 years ago. Mr. Abel very justly remarked that the new procedure could only be carried through in a thoroughly satisfactory manner if the best of examiners, and sufficient of them, were engaged by the Patent Office. He made some interesting comparisons between the average length of time which each of the examiners of the Patent Offices of the three countries in question could devote to the examination of a patent. The calculations are based on recent figures as to number of examiners, hours of work and number of patents, and it is stated that in the United States, Germany and England, the average time comes out at 10, 15 and 16 hours respectively. Apparently, the conditions in England are the most favourable to a thorough search, but the lecturer drew attention to the fact that, as a rule, the applications for English patents contain a very much greater amount of subject-matter than is the case with the applications in the United States or Germany. He, therefore, comes to the conclusion that the examining staff of the English Patent Office, as constituted at present, is inadequate to its duties. With regard to the system of classification, Mr. Abel gave the prize to the American system, which divides the subjects of invention into 235 classes. Yet Mr. Abel is not content even with this rather formidable-looking number of divisions, but advocates the adoption of a number of new classes, to be devoted to "machine elements." Every division of the examining staff should—according to the author—be supplied with a set of these new classes, which would have to be consulted for every specification.

Another suggestion of Mr. Abel was "to append a staff of competent officials to the Patent Office, whose duty it would be to travel about, both at home and abroad, collect common knowledge, forwarding it to the Patent Office to be there digested and classified and put in a useful form before the public."

Mr. Abel considered the right of the Comptroller-General to earmark a specification in the manner alluded to above, objectionable and he thought it would be better and more equitable to the patentee if the Comptroller would refer the public merely to the record of the proceedings in the matter. This point was criticised in the same sense by Sir Lloyd Wise in the discussion, while Mr. A. Siemens, the chairman of the meeting, agreed with the view which we have repeatedly expressed in these columns, that the partial investigation by the Patent Office as to the novelty of the invention will be of no marked benefit either to the patentee or the general public. If it causes a delay in the grant of the Patent and the publication of the complete specification, the resultant effect of the new Act will be to retard rather than to accelerate the progress of our industries.

A METHOD OF DESIGNING INDUCTION MOTORS.*

BY H. M. HOBART.

In the design of dynamo-electric machinery, the term "output coefficient" has been employed by Esson and by Kapp, and is generally denoted by the symbol ϕ.

$$\phi = W/(D^2 \times \lambda g \times R) \quad . \; . \; . \; . \; . \; . \; . \quad (1)$$

where W = rated output in watts; D = diameter at the "air-gap" in centimetres (for an induction motor, D is the diameter of the rotor); g = gross core length in centimetres; λg = active core length; R = rated speed in revolutions per minute. (In induction motor designing it is convenient to neglect the slip, and take for R the synchronous speed.)

The coefficient ϕ has been chiefly employed in the design of continuous-current dynamos and motors, and the writer has found it of extremely limited utility because commutation limits leads to a very wide range of attainable values, depending chiefly upon the rated speed, voltage and output. Similarly in alternating-current generators, the required voltage regulation imposes limitations. Where, however, as in the case of synchronous motors and induction motors, heating should generally be the limit of output, ϕ becomes very useful to the designer, and the attainable value is far more independent of the rated speed, voltage and output than in the case of commutating machinery and alternating-current generators.

In the writer's practice in designing three-phase squirrel-cage induction motors, he has found the attainable values of ϕ to range from 0·0009 at 10 H.P. to about 0·0018 at 1,000 H.P., thus only doubling in value for a 100 fold increase in output. It decreases slightly with increasing voltage, increasing periodicity and decreasing speed. But for the purposes of a broad survey of the factors of induction motor design, it will be taken as varying with the output alone, and in accordance with the curve of Fig 1.

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* Abstract of a Paper read before Section D of the St. Louis International Electrical Congress.

The present investigation will be limited to three-phase squirrel-cage induction motors, and the range of investigation is carried to 10,000 H.P., since the study of extremes will be generally admitted to be conducive to a clear comprehension of the factors involved. The writer has on other occasions shown that the importance of a small air-gap has been overestimated, and that it may, in fact, aside from its mechanical undesirability, be detrimental from the electromagnetic standpoint if carried to extremes.

In the present investigation, the air-gap will be determined from the following formula, except that in cases where this gives a value less than 0·10cm., the air-gap will be taken equal to 0·10cm.

$$\Delta = 0{\cdot}0006 \times \sqrt{D \times \lambda g \times V}$$

where V = peripheral speed of rotor in metres per second and Δ = radical depth of air-gap in centimetres.

T.W.C. denotes the *total works cost* in dollars, and the writer has found by examination of a large number of dynamo-electric machines built by many different manufacturers in several different countries, that

$$\text{T.W.C.} = K \times D \times (\lambda g + 0{\cdot}7\tau) \quad . \quad . \quad . \quad . \quad (2)$$

where τ is the polar pitch at the air-gap (*i.e.*, the circumference at the air-gap divided by the number of poles), and K is a factor to which fairly constant values may be assigned for any particular type of dynamo-electric machine.

For three-phase, squirrel-cage induction motors, K varies slowly from 0·15 in small motors, and it would approach 0·27 in a three-phase squirrel-cage motor of 10,000 H.P. capacity. In the present investigation K will be taken from the curve of Fig. 2. K may be designated the "Cost Coefficient."

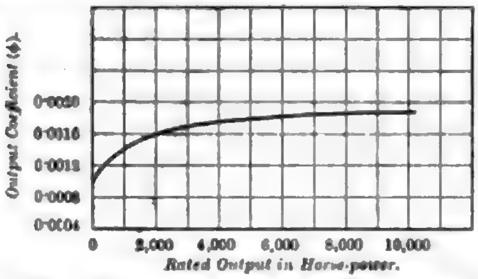

FIG. 1.—THE "OUTPUT COEFFICIENT" FOR THREE-PHASE SQUIRREL CAGE INDUCTION MOTORS.

Of all possible values of D and λg fulfilling equation (1) for a given value of ϕ, W and R, there is but one D and one λg which make the total works cost a minimum. By a brief calculation it will be readily seen that the equation $\lambda g = 2 \times 0{\cdot}7\tau = 1{\cdot}4\tau$ supplies the data corresponding to the minimum total works cost.* The author proposes to take this equation, in conjunction with a suitable value of the output coefficient ϕ, as the ultimate basis for the design of induction motors, and to show that throughout a great range of speeds and outputs, the design arrived at by this means is also a practical and sound design. The author has tested this method in many cases, and whilst it may occur that a careful examination leads to employing a different ratio of λg to τ, it must be said that the above method appears to him to afford by far the readiest means for obtaining a practical and economical design. It is quite natural that several other factors (which have not been considered in the cost formula) should affect the ratio of λg to τ, for instance, very high peripheral speeds would make it desirable, for mechanical reasons, to increase the ratio of λg to τ, whilst very low peripheral speeds would tend to make it preferable to decrease it for thermal reasons. It will also be seen that small variations from the ratio of λg to τ for the minimum cost generally increase the cost but slightly, and this fact must also be kept in mind. The dimensions of the design for minimum total works cost may be derived as follows:—

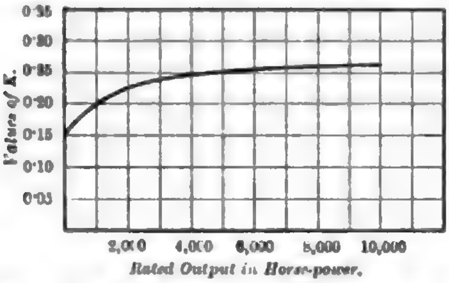

FIG. 2.—THE "COST COEFFICIENT" FOR THREE-PHASE SQUIRREL CAGE INDUCTION MOTORS.

We have the condition that $\lambda g = 1{\cdot}4\tau$ and $D^2\lambda g = W/(\phi \times R)$.

We deduce $1{\cdot}4\,D^2\tau = W/(\phi \times R)$.

If N = frequency in cycles per second, we have:

$$D = 120N\tau/(\pi R) = 38{\cdot}2N\tau/R,$$

and

$$1{\cdot}4 \times 1{,}460N_2\tau^3/R = W/(\phi \times R),$$

$$\therefore \tau^3 = 0{\cdot}00049 \times W \times R/(\phi \times N^2) \text{ and } \tau = 0{\cdot}079\sqrt[3]{\frac{W \times R}{\phi \times N}}$$

τ is independent of the value assumed for the "cost coefficient," K. W, R and N are in any case given, and ϕ is determined from the curve of Fig. 1. Thus we may readily determine τ for any given case, then λg (from $\lambda g = 1{\cdot}4$) and then D, and then the total works cost. In Tables I. and II. this is done for motors of 10 H.P., 100 H.P., 1,000 H.P., and 10,000 H.P., for 25 and 50 cycles per second and for a wide range of speeds (numbers of poles).

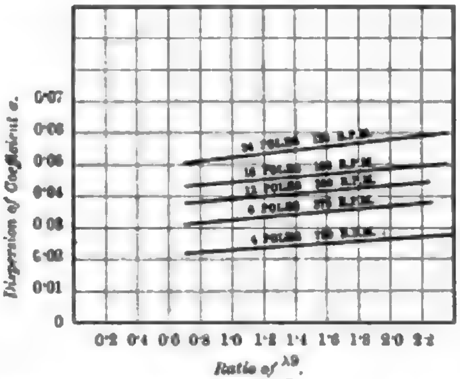

FIG. 3.—DISPERSION COEFFICIENTS FOR A 100 H.P. 25-CYCLE THREE-PHASE SQUIRREL CAGE MOTOR.

To set suitable limits to the scope of the present investigation, the author has entered up in the tables only those designs complying with the following three conditions:—

First Condition. Values of not less than 18cm. for the pole pitch, τ. With small values of τ only a small number of slots per pole can be taken, and this deleteriously affects the zig-zag dispersion, quite apart from the fact that with but few slots per pole the "dead points;" become more distinct. Nevertheless, 18cm. must by no means be taken as the smallest pole pitch which it is justifiable to employ in practice. In small motors still lower values of τ must be taken. *Second Condition.* The peripheral speed, V, shall not exceed 40 metres per second. *Third Condition.* No designs for speeds below 40 revs. per min. are considered, and even these low values are merely used to emphasize the tendencies in extreme cases.

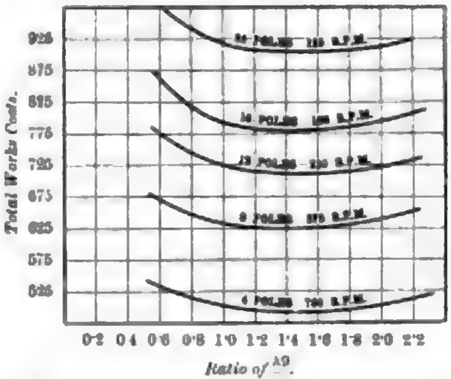

FIG. 4.—CURVES OF COST RELATION, 100 H.P. 25-CYCLE THREE-PHASE SQUIRREL CAGE MOTOR.

It may be well to go through the calculations for one case. We choose that of a 10 H.P., 12·5-cycle, four-pole motor. From the curve of Fig. 1 we find ϕ to be equal to 0·00092. $W = 7460$. $R = 875$. $N = 12{\cdot}5$. $\triangle = 0{\cdot}0000187 \times 7460\;0{\cdot}00092 = 0{\cdot}0385$cm.

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* Setting equation (1) in the form $\lambda g = W/(D^2R\phi)$, and letting $\tau = K'D$ and substituting these values in equation (2), we obtain

$$\text{T.W.C.} = K \times D \times \left(\frac{W}{D^2R\phi} + 0{\cdot}7K'D\right)$$

$$\text{or T.W.C.} = K \times \left(\frac{W}{DR\phi} + 0{\cdot}7K'D^2\right).$$

Differentiating and equating to zero, we obtain

$$-\frac{W}{D^2R\phi} + 2 \times 0{\cdot}7 \times K' \times D = 0,$$

or $-\lambda g + 2 \times 0{\cdot}7 \times \tau = 0$, or $\lambda g = 2 \times 0{\cdot}7\tau = 1{\cdot}4\tau$.

Table I. – *Constants for Three-Phase Squirrel Cage Induction Motors designed for Minimum Cost. 25 cycles per second.*

10 H.P.

4 pole.			
R =	750	H =	6·75
T =	$107	$\Delta \times$ H =	0·675
τ =	16·9	C =	9·5
λg =	23·7	C' =	1·42
D =	21·6	C'' =	0·75
V =	8·45	σ =	0·048
Δ =	0·10	cos ϕ =	0·913

100 H.P.

4 pole.				6 pole.				8 pole.			
R =	750	H =	14·25	R =	500	H =	12·5	R =	375	H =	11·4
T =	$493	$\Delta \times$ H =	1·72	T =	$567	$\Delta \times$ H =	1·49	T =	$625	$\Delta \times$ H =	1·37
τ =	35·7	C =	9·5	τ =	31·3	C =	9·5	τ =	28·4	C =	9·5
λg =	50	C' =	1·01	λg =	44	C' =	1·06	λg =	39·7	C' =	1·08
D =	45·4	C'' =	0·75	D =	59·4	C'' =	0·75	D =	72·3	C'' =	0·75
V =	17·8	σ =	0·024	V =	15·1	σ =	0·029	V =	14·2	σ =	0·034
Δ =	0·12	cos ϕ =	0·955	Δ =	0·12	cos ϕ =	0·945	Δ =	0·12	cos ϕ =	0·936

12 pole.				16 pole.				24 pole.			
R =	250	H =	9·9	R =	188	H =	9	R =	125	H =	7·89
T =	$710	$\Delta \times$ H =	1·21	T =	$785	$\Delta \times$ H =	1·09	T =	$900	$\Delta \times$ H =	0·95
τ =	24·8	C =	9·5	τ =	22·6	C =	9·5	τ =	19·7	C =	9·5
λg =	34·7	C' =	1·15	λg =	31·4	C' =	1·2	λg =	27·5	C' =	1·26
D =	94·7	C'' =	0·75	D =	115·1	C'' =	0·75	D =	150·5	C'' =	0·75
V =	12·5	σ =	0·040	V =	11·3	σ =	0·046	V =	9·8	σ =	0·055
Δ =	0·12	cos ϕ	0·925	Δ =	0·12	cos ϕ =	0·912	Δ =	0·12	cos ϕ =	0·900

1,000 H.P.

4 pole.				6 pole.				8 pole.			
R =	750	H =	27·2	R =	500	H =	23·7	R =	375	H =	21·6
T =	$2,450	$\Delta \times$ H =	8·6	T =	$2,820	$\Delta \times$ H =	7·6	T =	$3,140	$\Delta \times$ H =	6·9
τ =	68	C =	9·5	τ =	59·2	C =	9·5	τ =	51	C =	9·5
λg =	95·2	C' =	0·61	λg =	83	C' =	0·62	λg =	76	C' =	0·623
D =	86·5	C'' =	0·75	D =	113·5	C'' =	0·75	D =	138	C'' =	0·75
V =	34	σ =	0·020	V =	29·6	σ =	0·024	V =	27	σ =	0·026
Δ =	0·32	cos ϕ =	0·960	Δ =	0·32	cos ϕ =	0·956	Δ =	0·32	cos ϕ	0·957

12 pole.				16 pole.				24 pole.			
R =	250	H =	18·8	R =	188	H =	17·2	R =	125	H =	15
T =	$3,730	$\Delta \times$ H =	6·16	T =	$3,950	$\Delta \times$ H =	5·48	T =	$4,520	$\Delta \times$ H =	4·8
τ =	47	C =	9·5	τ =	42·8	C =	9·5	τ =	37·5	C =	9·5
λg =	66	C' =	0·625	λg =	60	C' =	0·625	λg =	52·5	C' =	0·63
D =	180	C'' =	0·75	D =	219	C'' =	0·75	D =	288	C'' =	0·75
V =	23·5	σ =	0·031	V =	21·4	σ =	0·033	V =	18·75	σ =	0·038
Δ =	0·32	cos ϕ	0·940	Δ =	0·32	cos ϕ =	0·934	Δ =	0·32	cos ϕ =	0·930

32 pole.				48 pole.				72 pole.			
R =	94	H =	13·6	R =	62·5	H =	11·85	R =	41·7	H =	10·4
T =	$4,950	$\Delta \times$ H =	4·3	T =	5,650	$\Delta \times$ H =	3·87	T =	$6,500	$\Delta \times$ H =	3·3
τ =	34	C =	9·5	τ =	29·7	C =	9·5	τ =	26	C =	9·5
λg =	47·5	C' =	0·64	λg =	41·5	C' =	0·66	λg =	36·4	C' =	0·72
D =	347	C'' =	0·75	D =	454	C'' =	0·75	D =	595	C'' =	0·75
V =	17	σ =	0·042	V =	15·8	σ =	0·052	V =	13	σ =	0·063
Δ =	0·32	cos ϕ =	0·923	Δ =	0·32	cos ϕ =	0·906	Δ =	0·32	cos ϕ =	0·890

10,000 H.P.

24 pole.				32 pole.				48 pole.			
R =	125	H =	29·6	R =	94	H =	26·8	R =	62·5	H =	23·4
T =	$24,100	$\Delta \times$ H =	26·4	T =	$26,500	$\Delta \times$ H =	23·7	T =	$29,400	$\Delta \times$ H =	20·7
τ =	74	C =	9·5	τ =	67	C =	9·5	τ =	58·6	C =	9·5
λg =	104	C' =	0·58	λg	94	C' =	0·58	λg =	82	C' =	0·585
D =	565	C'' =	0·75	D =	685	C'' =	0·75	D =	895	C'' =	0·75
V =	37	σ =	0·050	V =	33·5	σ =	0·055	V =	29·4	σ =	0·063
Δ =	0·88	cos ϕ =	0·910	Δ =	0·88	cos ϕ =	0·904	Δ =	0·88	cos ϕ =	0·890

72 pole.			
R =	41·7	H =	20·4
T =	$33,400	$\Delta \times$ H =	17·85
τ =	51	C =	9·5
λg =	71·5	C' =	0·59
D =	1,170	C'' =	0·75
V =	25·5	σ =	0·072
Δ =	0·88	cos ϕ =	0·875

Table II. – *Constants for Three-Phase Squirrel Cage Induction Motors designed for Minimum Cost. 50 cycles per second.*

100 H.P.

4 pole.				6 pole.				8 pole.			
R =	1,500	H =	11·4	R =	1,000	H =	9·9	R =	750	H =	9
T =	$315	$\Delta \times$ H =	1·37	T =	$362	$\Delta \times$ H =	1·21	T =	$392	$\Delta \times$ H =	[illegible]
τ =	28·5	C =	9·5	τ =	24·9	C =	9·5	τ =	22·5	C =	9·5
λg =	40	C' =	1·10	λg =	34·8	C' =	1·14	λg =	31·5	C' =	1·20
D =	36·4	C'' =	0·75	D =	47·6	C'' =	0·75	D =	57·2	C'' =	0·75
V =	28·5	σ =	0·031	V =	24·9	σ =	0·040	V =	22·5	σ =	0·046
Δ =	0·12	cos ϕ =	0·945	Δ =	0·12	cos ϕ =	0·928	Δ =	0·12	cos ϕ =	0·918

12 pole.				16 pole.			
R =	500	H =	7·9	R =	375	H =	7·2
T =	$457	$\Delta \times$ H =	0·97	T =	$497	$\Delta \times$ H =	0·875
τ =	19·8	C =	9·5	τ =	18	C =	9·5
λg =	27·7	C' =	1·26	λg =	25	C' =	1·30
D =	76	C'' =	0·75	D =	91·5	C'' =	0·75
V =	19·8	σ =	0·056	V =	18	σ =	0·063
Δ =	0·12	cos ϕ =	0·900	Δ =	0·12	cos ϕ =	0·890

1,000 H.P.

12 pole.				16 pole.				24 pole.			
R =	500	H =	15	R =	375	H =	13·6	R =	250	H =	11·85
T =	$2,240	$\Delta \times$ H =	4·8	T =	$2,490	$\Delta \times$ H =	4·38	T =	$2,890	$\Delta \times$ H =	3·75
τ =	37·5	C =	9·5	τ =	34	C =	9·5	τ =	297	C =	9·5
λg =	52·5	C' =	0·64	λg =	47·6	C' =	0·65	λg =	41·5	C' =	0·67
D =	14·4	C'' =	0·75	D =	174	C'' =	0·75	D =	227	C'' =	0·75
V =	37·5	σ =	0·039	V =	34	σ =	0·043	V =	29·7	σ =	0·051
Δ =	0·32	cos ϕ =	0·928	Δ =	0·32	cos ϕ =	0·920	Δ =	0·32	cos ϕ =	0·910

32 pole.				48 pole.				72 pole.			
R =	188	H =	10·8	R =	125	H =	9·45	R =	83·5	H =	9·25
T =	$3,120	$\Delta \times$ H =	3·43	T =	$3,590	$\Delta \times$ H =	3	T =	$4,120	$\Delta \times$ H =	[illegible]
τ =	27	C =	9·5	τ =	23·6	C =	9·5	τ =	20·7	C =	9·5
λg =	37·8	C' =	0·70	λg =	33	C' =	0·75	λg =	29	C' =	0·81
D =	275	C'' =	0·75	D =	361	C'' =	0·75	D =	473	C'' =	0·75
V =	27	σ =	0·059	V =	23·6	σ =	0·072	V =	20·7	σ =	0·090
Δ =	0·32	cos =	0·895	Δ =	0·32	cos ϕ =	0·875	Δ =	0·32	cos ϕ =	0·850

10,000 H.P.

108 pole.			
R =	55·2	H =	14·2
T =	$23,100	$\Delta \times$ H =	12·5
τ =	35·5	C =	9·5
λg =	49·6	C' =	0·70
D =	1,220	C'' =	0·75
V =	35·5	σ =	0·124
Δ =	0·88	cos ϕ =	0·800

As this is below the stipulated amount, Δ is taken equal to 0·1 cm.

$$\tau = 0{\cdot}079 \sqrt[3]{\frac{7{,}460 \times 375}{0{\cdot}00082 \times 156}} = 21{\cdot}0\text{cm.},$$

$\lambda g = 1{\cdot}4\tau = 29{\cdot}4$cm., $D = 4\tau/\pi = 26{\cdot}8$, $V = 2N\tau/100 = 5{\cdot}25$ metres per second.

K, the "cost coefficient" is found from the curve of Fig. 2, to be equal to 0·14.

$$T = 0{\cdot}14 \times 26{\cdot}8 \times (29{\cdot}4 + 0{\cdot}7 \times 21{\cdot}0) = \$165.$$

In the tables are also given values for the "dispersion coefficient," σ, the value of which is of great importance in induction motor design, and for the maximum value of the power factor, which is entered up as cos ϕ, according to customary conventions, although, of course, ϕ in this case is the angle of lag at the motor between terminal voltage and current, and has nothing to do with ϕ the output coefficient. In deducing σ, the method set forth on p. 805 of the *Electrical World and Engineer*, for April 30, 1904, has been employed. H, the average number of slots per pole for stator and rotor having been for simplicity's sake, taken equal to 0·4 τ, and this is a fair average working value for rough preliminary calculations, although, of course, the voltage and other considerations must be considered in the final design. It is further assumed that the slots are half-opened. The constants C, C' and C'', employed in the calculation of σ are defined in the article referred to. $\cos\phi = 1/(1+2\sigma)$.

One fact is very striking—namely, the lower minimum total works cost and the larger values of σ for motors for a high frequency. As the author has already pointed out, the "output coefficient ϕ" has been taken as depending only upon the brake horse-power. It would have been more correct and more in accordance with the present practice to take a slightly higher output coefficient for low frequencies This would have decreased the cost and slightly increased the dispersion coefficient (σ) of the low frequency, as compared with the high-frequency designs.

Figs. 3 and 4 show for the 100 H.P. 25 cycle designs the variation in the total works cost and in σ with variations in the ratio of λg to τ. It is evident from these curves that it is permissible to depart to a considerable extent from the ratio $\lambda g/\tau = 1{\cdot}4$, as the total works cost will not be increased by any prohibitive amount. On the other hand, we learn from Fig. 3, that the decrease in σ is very slight for a considerable decrease in $\lambda g/\tau$, and hence, so far as power-factor is concerned, one rapidly reaches undesirable dimensions in endeavouring to improve the power-factor. But, especially in small motors, one is for this and other reasons obliged to depart widely from the most favourable ratio, so far as regards minimum cost. In such cases considerably smaller values than the ratio $\lambda g/\tau = 1{\cdot}4$ are commonly employed. But for all medium sizes and large motors, the method here described affords a ready means of obtaining a good preliminary design.

THE COMBINATION OF DUST DESTRUCTORS AND ELECTRICITY WORKS ECONOMICALLY CONSIDERED.*

BY W. P. ADAMS.

(Concluded from page 391.)

Hackney.—As already stated, I have taken great pains to ascertain the actual coal consumed per unit generated at Fulham, but as no regular record is kept of the water consumption, it may perhaps be suggested that I have taken too high a figure in basing my calculations on 8lb. I am quite satisfied as to the correctness of this figure, but owing to the element of uncertainty, I turn with the greater pleasure to the Hackney records, for here the water is metered and the coal consumption ascertained. In addition to this, the figures of the water and coal consumption are quite exceptionable.

The electrical plant at Hackney consists of high-speed engines and direct-current generators, and an interesting feature is the 1,200 unit Tudor battery. The plant is run condensing, and 30lb. of water are used per unit generated. The average coal consumption is about 5lb. per unit generated. The Hughes & Stirling destructor consists of three four-cell groups, with a combustion chamber between each two pairs of cells. The combustion chambers lead direct to three Babcock boilers placed immediately behind the cells. The refuse is tipped into hoppers, from whence it is raised by elevators into three large bins above the cells; from these bins it is drawn as required and fed into the cells. The blast is provided by electrically driven fans, and is not heated.

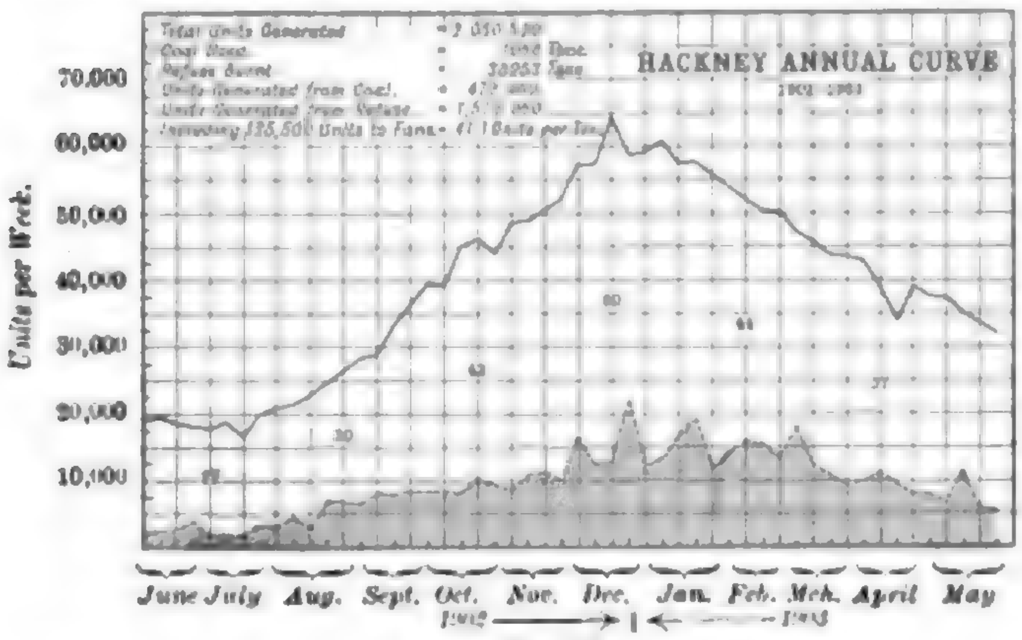

FIG. 11.

The annual curve (Fig. 11) is not dissimilar from the Fulham; a better value, however, is obtained in the summer, and the Fulham record of 53 units per ton throughout the week is beaten by the Hackney 60 units per ton. The units per ton throughout the year amount to 41·1, as against the Fulham 27·8. It should be observed that the curves cover the same period – namely, from June, 1902, to May, 1903. The coal in this and all the Hackney curves is plotted in at 5lb. per unit generated.

The chief interest lies in the Hackney day-load diagrams, for at present the day load is small and the peak value almost beyond belief. The method of burning the refuse differs slightly from that in use at Fulham, in that a varying number of cells is used when occasion requires. The refuse is, however, burnt uniformly, without any attempt to force the cells during the hours of the heavy load. The rate of burning per cell-hour varies very little. The cells are shut down early on Sunday morning, when the refuse which has been collected during the week is exhausted, and started again on Monday morning as soon as the new supply of refuse begins to come in. On November 6, 1902—a Thursday, which is closing day at Hackney—the whole output was carried on refuse steam (Fig. 12). The highest value on the peak lasting about two hours amounted to no less than 104·3 units per ton. The rate of burning is shown at the base of the diagram. Eight cells were burning from 12 to 8 a.m., 12 cells onwards to 10 p.m., and from 10 to 12 eight cells. Although the refuse was being burned steadily, the generating plant was shut down from 6 a.m. to 1 p.m. The three diagrams for December 16, 17 and 18, 1902, showed that the high value of 104 units per ton is not altogether exceptional, the average for the three days amounting to 102·1 units per ton. On each of these days the refuse was burnt uniformly throughout in 10 cells, and the generating plant was entirely shut down for four or five hours. The value obtained on December 17 of 105·8 units per ton on the peak load is the highest record which has come to my notice. I desire to repeat that these figures were obtained under ordinary working conditions, and without anyone being aware that such fine results were being realised until the curves had been drawn out. Given a sufficiently large load such as that obtained at Shoreditch, there really seems to be no reason why 100 units per ton should not be reached throughout the day.

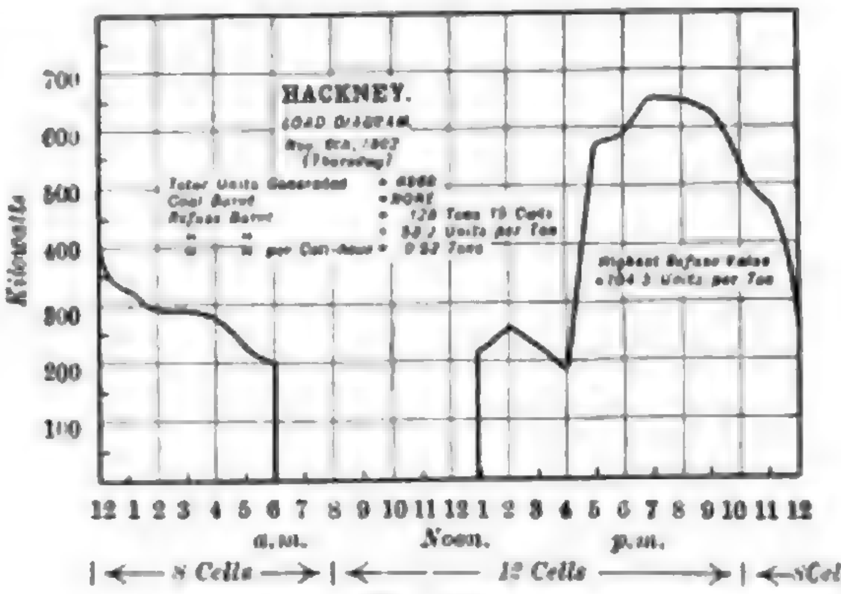

FIG. 12.

After observing the splendid value obtained on one of the Fulham curves, I naturally anticipated better results would be found at Hackney, and, comparing the relative water consumption, if 90 units per ton is obtained at Fulham, 120 or even more ought not to be an impossible figure at Hackney. Air leakages are, I believe, not unknown at these works, and may perhaps account for reduced efficiency.

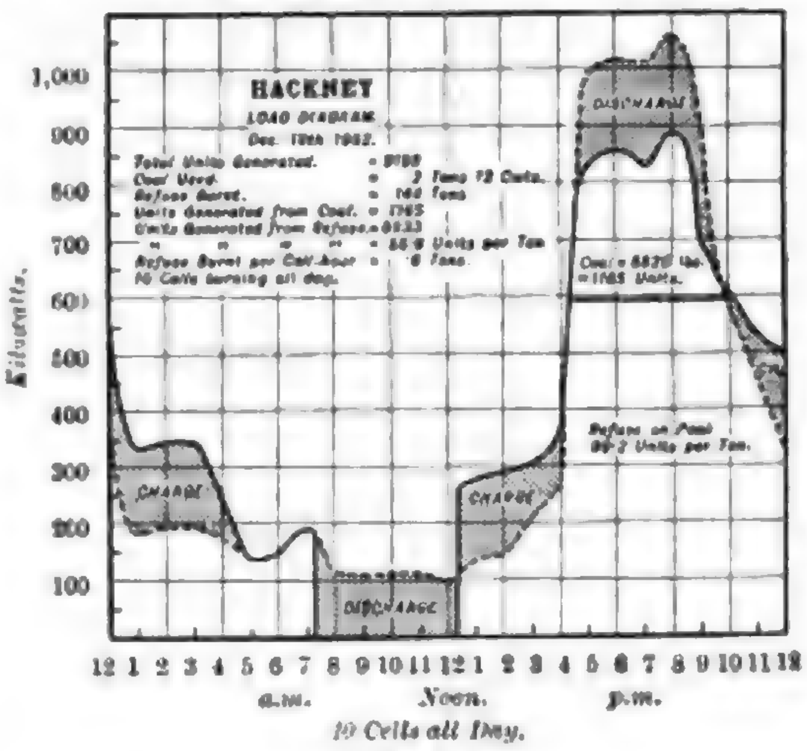

FIG. 13.

I have thought that a diagram showing the value of the large battery at Hackney might be useful. The diagram of December 18, 1902 (Fig. 13), gives the total load on the station, including feeder output. The solid line gives units generated, and the dotted line the station output. The battery charge and discharge is indicated by the shaded portions, on the top of the peak the average load taken is about 160kw. and the maximum 220kw.; roughly the discharge on the top of the peak represents 600 units, about half the nominal capacity of the battery. Had the full capacity of the battery been utilised the load carried on the peak would have been 250kw., and a very small quantity of coal would have been required. As it is the diagram shows that about 40 per cent of the coal which would be necessary without the battery has been saved.

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* Abstract of a Paper read before the Institution of Electrical Engineers Dec. 15.

A reference to Table B will show that for the year ending March, 1903, some 37 units per ton of refuse were generated after deducting the electricity used in the fan motors. As the average of steam-raising value is put at 1lb. per pound all the year round, and the water evaporated during the last financial year was only 0·54lb. per pound, it seems fairly safe to assume that an average figure of 64 units per ton will be obtained ultimately. Personally, I shall be surprised if in the course of a few years this figure is not considerably exceeded. In this connection it is not a little interesting to note that a value of 105 units per ton at 30lb. of water per unit means an evaporation of 1·4lb. of water per pound of refuse.

The destructor costs for the last financial year are high; the wages correspond curiously with those at Fulham, the clinker disposal formed a considerable item of expense, and as the destructor was running only 11 months during the year, the capital charges per ton were heavier than will be the case in future. The credit to the destructor for electricity is based on the coal cost, and is therefore absolutely fair. As in the case of Fulham, the difference between the destructor revenue and total costs—namely, 35·4d. per ton destroyed, is met by a credit from the Health Department. Owing to the Hackney destructor having a less favourable market for its steam, it does not seem likely it will earn a profit as will probably be the case at Fulham.

Bermondsey.—The smallest of the London combined stations has successfully completed a year of working. The returns, however, have not yet been published, and at the time of writing are not available. Mr. Vincent has, however, kindly placed at my disposal information which will prove of interest. The plant consists of high-speed vertical engines with direct-current generators; no use is made of the exhaust steam. The battery is small, being of only 240 units capacity. The Hughes & Stirling destructor consists of three pairs of cells with three Babcock boilers. A combustion chamber is provided between each pair, which leads into a flue at the back of the cells and so to the boilers. This arrangement is not quite so favourable as that at Hackney. The blast is provided by electrically driven fans, which only take 6 per cent. of the total quantity of electricity generated. In addition to supplying steam to the electric generators a supply is given to the adjoining baths and washhouses. The coal bill at the baths before the erection of the destructor was between £400 and £500 per annum; two stokers were also employed whose wages amounted to about £150 a year. The coal burnt at the electricity works was only 400 tons for the year; thus, altogether apart from the electricity works, a saving of about £600 less £380—the value of the coal—has been effected by the introduction of the destructor. It will thus be seen that the whole of the electricity generated may be credited to the refuse. After deducting the units used by fan motors, the very creditable figure of 29·8 units has been obtained per ton of refuse, a figure second only to Hackney. On the official test the fine value of 1·65lb. of water was obtained per pound of refuse, and, in view of the high calorific value of the Bermondsey refuse, Mr. Vincent anticipates that some 86 units per ton is the ultimate value of the refuse. The credit given to the destructor of 1d. per unit generated, or 1·09d. per unit sold, is undoubtedly high, but the works are unfavourably situated, the price of coal is high and condensing is impossible. Compared, therefore, with the average for the six uncombined London undertakings of 0·93d., the figure is not so extravagant as would appear at first sight. In view of the high coal value, the Bermondsey destructor should earn a substantial profit when the full heat value of the refuse is utilised.

Woolwich.—The combined electricity and destructor works here have so recently been added to the list of Metropolitan undertakings that returns for a year of working are not available. I am able, however, to give the result of an excellent test taken early this year. With a water consumption of 40lb. per unit generated, the fine figure of 100 units per ton was generated for two hours continuously. With the same economical plant as at Hackney this figure would have been 133 units per ton. If Mr. Mitchell can bring his water consumption down he may yet beat all records. The destructor is a Meldrum Bros. "Simplex."

PROVINCIAL UNDERTAKINGS.

Wimbledon.—From the figures given to me by Mr. Tomlinson Lee it is plain that these works should not be included in the list of combined undertakings. The joint works adjoin the sewage works, and the whole of the steam available from the refuse is used for sewage pumping and heating the hospital some 600yds. away from the works. The coal saved to the sewage works amounts to £900 a year, and Mr. Lee states that beyond what the destructor can do he provides coal-generated steam to the value of about £5 per annum in addition; this being so, the value of the steam in terms of possible units of electricity generated can only be estimated. On the basis of the present coal cost—namely, 0·9d. per unit sold—the units generated would amount to 300,000. From another source I understand that it has been estimated at 45 units per ton. Taking the former figure, 83 units per ton is a highly creditable performance, seeing that the refuse is burnt with pressed sewage sludge in the proportion of 1 ton of sludge to 2 tons of refuse. The large percentage of moisture and the very small percentage of combustible matter in sludge is well known. The furnaces are of the Beaman & Deas type, with Babcock boilers.

Grays.—Through the courtesy of Mr. Long and Mr. Arthur Preece I have been provided with very full information regarding these works, and although the quantity of refuse burnt is exceedingly small compared with the large works we have been considering, the results obtained are valuable. The generating plant is of the usual type, vertical high-speed engines with direct-current generators. The battery is a D.P. of 160 units capacity. The plant is run non-condensing. The destructor is a two-cell Meldrum Simplex, with a Lancashire boiler which is usually short. An economiser is in use, and also a regenerator in conjunction with steam blast. During 1902 the coal consumption per unit generated as ascertained by Mr. Long when the destructor has not been at work was 9lb. in the winter and 10lb. in the summer. The average for the year works out at 9·5lb. The total coal used during the year was 348 tons, a large proportion of which was used in getting up steam to assist the destructor for a short time every day. The resulting 15 units per ton of refuse is poor, but it is clear that as the load increases a better value will be obtained. Returns for the year ending March, 1903, have reached me, and a substantial improvement is already manifest. Allowing for the reduced consumption of 9lb. of coal per unit, the average units per ton of refuse is increased to 21. The ultimate valne with the plant working under more favourable conditions should reach 30 units per ton. In a small plant of this description burning between 2,000 and 3,000 tons per annum, the economical utilisation of the refuse becomes quite a special study, and the burning of coke breeze or coal in the destructor furnace to assist in the event of a shortage of refuse would probably prove more economical than getting up steam in an independent boiler. It is not possible to mix good fuel with the refuse, but with a little trouble a portion of the grate can be separately utilised. It is, I understand, now Mr. Long's practice to burn coke breeze in the furnace in this manner.

Gloucester.—The type of destructor in use in this town is that constructed by Messrs. Heenan & Froude. The plant is a comparatively small one, consisting of two cells only, with one Babcock boiler. An economiser is used, and also a regenerator in conjuncton with the fan blast, the fan being driven by electric motors. The engines are vertical high-speed condensing, the generators direct-current, and an E.P.S. battery of 440 units capacity is in use. In recording the returns for the year 1902-3, I have had difficulty in apportioning the units generated between coal and refuse; Mr. Bache, the engineer, informs me that the usual rate of burning is 1 ton per hour, but on the peak the rate is increased to from 25 cwt. to 28 cwt. He states that 100kw. to 120kw. was maintained for one hour. From 25 to 40 units per ton are obtained in summer and from 60 to 80 in winter. When all the refuse is burnt usefully, it is expected that an average of 86 units per ton will be obtained; at present the day load is small. In dividing the units generated for the year between the coal and refuse, I have had to assume that 15lb. of coal were burnt per unit generated. The refuse-generated units on this basis work out at one-third of the estimated total possible. Messrs. Heenan & Froude inform me that at present one-third of the refuse is burnt usefully.

Christchurch, N.Z.—One other plant I must mention briefly, as it has the distinction of being the only combined works outside the United Kingdom. The installation at Christchurch, New Zealand, has just completed its first year of working, and when the returns are published shortly, excellent results are promised. The electrical equipment is the usual high-speed direct-current type, but the battery is large, being half the size of that at Hackney—namely, 600 units. As an advocate of large batteries in combined works, I look forward with special interest to the publication of particulars, for the total capacity of the generators installed is only 200kw. The destructor is of the Beaman & Deas type, consisting of two pairs of cells and two Babcock boilers, erected by Messrs. Meldrum Bros. in 1902. 25 tons of refuse is destroyed between the hours of 8 a.m. and 10 p.m., giving ample steam for supplying the load during these hours and for charging the battery; the generators are shut down the rest of the day. The average evaporation is given at 2,000lb. of steam per ton of refuse.

Enough has already been said to show that under satisfactory conditions excellent results may be obtained from the combination of refuse destructors with electricity works. The installations at St. Helens and Shipley have been described by Mr. Highfield and Mr. Schofield respectively, and between 30 and 40 units per ton are obtained on the average. In a recent letter, Mr. Schofield informed me that he anticipates that some 50 units per ton will eventually be realised. At Partick, 29·6 units per ton were realised during last year, and it is anticipated that 37 units will ultimately be obtained. Although I have not obtained much data from Garston, the figures supplied show that some 50 to 60 units per ton are frequently obtained, and particulars of a test lasting 18 hours with the generating plant run non-condensing show an average of 82 units per ton, the water consumption being 50lb. per unit generated.

In endeavouring to secure good steam-raising results, it is desirable to maintain the temperature of the flues as uniformly as possible, and any device therefor which will render the shutting down of the plant for cleaning purposes unnecessary will be valuable. Particularly is this so in small plants, and the apparatus devised by Mr. Sillery, of Wrexham, is a step in the right direction. By means of this apparatus the dust destructor at Wrexham has been kept running for a whole year without a break. The maintenance of the temperature in the flues is important, not only from a steam-raising point of view, but also is desirable as tending to reduce the expenditure on repairs. The constant expansion and contraction of the brickwork owing to alternate heating and cooling is destructive.

As points deserving of careful attention, I have already referred to air leakages and the method of producing the blast. Both of these may be sources of large percentages of waste. Another point to which I have referred and which it may be well to emphasise, is the possible loss of efficiency due to long and badly-arranged flues. Mr. Price F. White, of Bangor, has been most kind in providing me with information concerning his plant, and in explanation of the poor results obtained calls my attention to the construction of the main flue. It is important to note that the destructor was added after the electricity works had been put down, and the main flue from the destructor to the boiler-house is long and built at a low level. The result is that the flue is very damp, and the greater part of the evaporation due to the destructor gases takes place *outside* the boiler. At times, Mr. White informs me, the flue is so full of water that the destructor has to be shut down.

A large proportion of total costs is often caused in disposing of the clinker. This matter is one requiring serious consideration, as if a satisfactory sale for this destructor bye-product can be secured, a heavy annual cost will be turned into a substantial profit. As an illustration of this I may point to the fact that at Fulham the cost of disposal of clinker amounted to £479. Mr. Fuller is making special efforts to dispose of his clinker profitably, and this year the loss will have disappeared and a profit have been secured instead. At Hackney, Mr. Robinson is not quite so successful, but he is now disposing of the clinker without cost. This will result in a saving of £750—no mean proportion of the total costs of destruction last year.

So long ago as 1892, Prof. George Forbes stated in a lecture before the Society of Arts that if the refuse then collected in Paddington were properly burnt and used in the most economical way, it should provide enough electricity to light one 8 c.p. lamp for two hours every night of the year per head of the population, which is the estimated amount of light demanded by the exigencies of modern civilisation. It is a great pleasure to me to take upon myself the vindication of Prof. Forbes as a prophet, for by the exercise of a small amount of scientific licence, I am able to demonstrate that in at least two Metropolitan boroughs this result will certainly be achieved within a few years. A 30-watt carbon lamp burning two hours per night throughout the year would absorb 22 units. A Nernst lamp giving the same light would burn, say, 11 units. The population of Fulham is 150,000, thus 1,650,000 units would be required; the ultimate value is estimated at 1,870,000 units. The population of Hackney is 230,000, the units required would amount to 2,530,000; the ultimate value of the Hackney refuse as estimated by Mr. Robinson is 2,486,000 units.

I will ask you to bear with me while I make a modest little calculation on my own responsibility. The annual collection of refuse in London amounts to approximately 1,250,000 tons; taking so low an average as 40 units per ton as its potential capacity for generating electricity, no less a sum than £200,000 per annum—taking the average coal cost of all the London undertakings—is being tipped on dust heaps, resolved into vapour and deliberately barged out to sea at heavy cost.

Conclusions.—As I am addressing engineers, I need summarise my conclusions but briefly.

1. The remarkable figures obtained in some undertakings as demonstrated in the series of curves I have had the privilege of laying before you, are evidence that great advances have been made in the problem of utilising waste heat from burning refuse in destructors since the pioneer works were started.

2. That these results still leave room for substantial improvement—(*a*) By closer attention to the details of construction of furnaces and flues and the general arrangement of the plant; (*b*) by improving the methods of handling and burning the refuse; (*c*) by careful utilisation of the steam generated and the adoption of an economical form of blast.

3. That, given suitable conditions, there is without doubt a substantial gain to be effected by the combination of electricity and destructor works; but owing to the variation in the calorific value of refuse in different localities, and to other special local considerations, every proposed case of combination needs to be considered on its merits by persons qualified to make an independent and intelligent inquiry.

4. That the various and in some cases crude methods in vogue of adjusting accounts between the two works need to be systematised, and that it is highly desirable that the results obtained be separated and recorded with accuracy, so as to give, so far as possible, a true record of the financial position of both works.

THE EFFECT OF VACUUM AND SUPERHEAT IN STEAM TURBINES.*

BY J. R. BIBBINS.

Much uncertainty seems to exist at the present time concerning the relative value of high vacuum and superheat. By the term relative is here meant, not a specific gain in steam consumption *per se*, but the net saving to the power station at the coal pile. A high vacuum permits the low-pressure section of the turbine rotor to move in a more rarefied atmosphere, while a high superheat serves to defer the "dew point" or beginning of condensation of steam during its expansion, thus eliminating to a large degree the detrimental effects of friction due to entrained moisture at high surface speeds. Figs. 1 and 2 show the effects of vacuum. In the former the test covers vacua from 0in. to 26·5in, the latter from 25in. to 28in. The drooping of the curve of steam consumption at the right (Fig. 1) clearly shows the relative advantages of the last few inches of vacuum. The curve "rate of increase per 1in. of

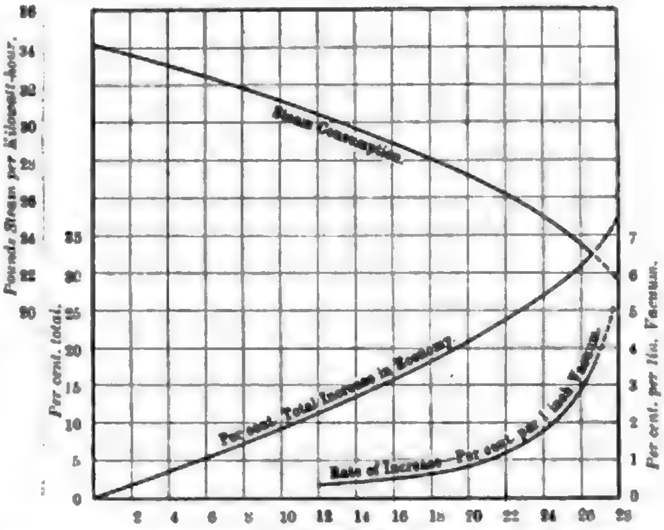

FIG. 1.—RELATION-VACUUM TO ECONOMY. 300kw. Parsons Turbine, Hulton Colliery. Full Load, no Superheat.

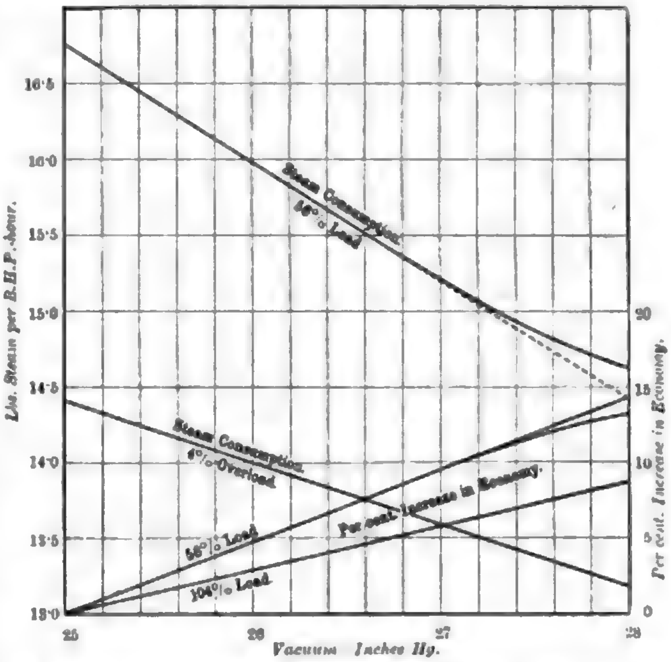

FIG. 2.—RELATION-VACUUM TO ECONOMY. Westinghouse-Parsons Turbine. No Superheat.

N.B.—Observations at 28in. taken from a subsequent test under same conditions.

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* From an article on "Steam Turbine Power Plants: Notes on their Equipment and Operation" in the *Street Railway Journal*.

vacuum" shows this still more clearly. With 21in. vacuum the gain is but 1 per cent. per inch, at 26½in. it is 3½ per cent., and at 28in. 5½ per cent., the last point being, however, estimated. A test upon a large Westinghouse-Pasons turbine between 25in. and 28in. is shown in Fig. 2. Here the benefit from vacuum at half load is considerably greater than at a slight overload—viz., 5 per cent. per 1in. in the one case and 3 per cent. in the other. The effect of superheat on economy is as striking as that of vacuum. In Fig. 3 the steam consumption was reduced 23 per cent.—from 16·45lb. to 12·66lb. per electrical horse-power at full load by raising the vacuum 3in. and superheat 140deg.

The series of tests upon a 400kw. turbine by Dan and Main give curves of slightly different character, but of close agreement. The relation is a direct proportion, and a uniform gain of 10 to 11 per cent. per 100deg. superheat is observed, this gain being practically the same at all loads, as the steam consumption lines are parallel (Fig. 4). From these curves and other data on Westinghouse-Parsons machines it is apparent that, although wide variations exist, in round numbers 100deg. superheat will ensure an increase in economy of about 10 per cent., and 1in. vacuum (between 25in. and 28in.) 3·5 to 4 per cent., depending somewhat upon the load.

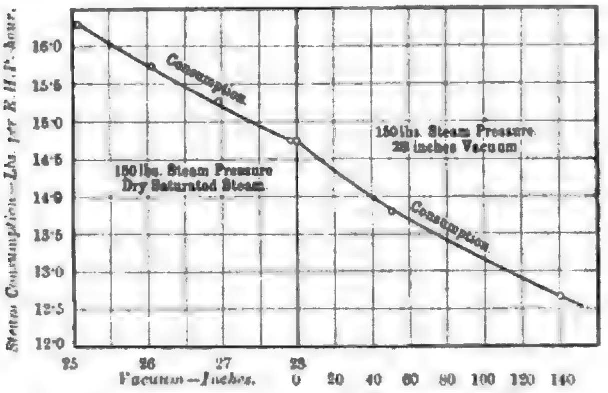

FIG. 3.—EFFECT OF VACUUM AND SUPERHEAT ON STEAM CONSUMPTION. 1,500kw. Turbine. Full Load.

Upon this assumption we may estimate the net saving resulting from the use of high vacuum. In Table I. three cases have been calculated embracing possible or typical conditions of service and cost of fuel. A 2,000kw. plant has been chosen, containing two 1,000kw. units. By raising the vacuum 2in.—from 26in. to 28in.—a saving in coal results, amounting to 3·5, 2·6 and 1·3 tons per day in the three respective cases. The extra cost of high vacuum condenser equipment will, however, be about $2 per kilowatt capacity, or $4,000. Deducting the interest and depreciation (12½ per cent.) on this investment from the fuel savings, a net saving is determined which represents an interest rate of 115, 27 and 3 per cent. respectively on the increased investment in high vacuum. The increased power requirements of the new equipment will presumably reduce these percentages by 1 to 5 per cent., according to the price at which power is charged; but the estimates, although largely tentative, certainly point to high vacuum as an excellent investment where high plant economy is imperative.

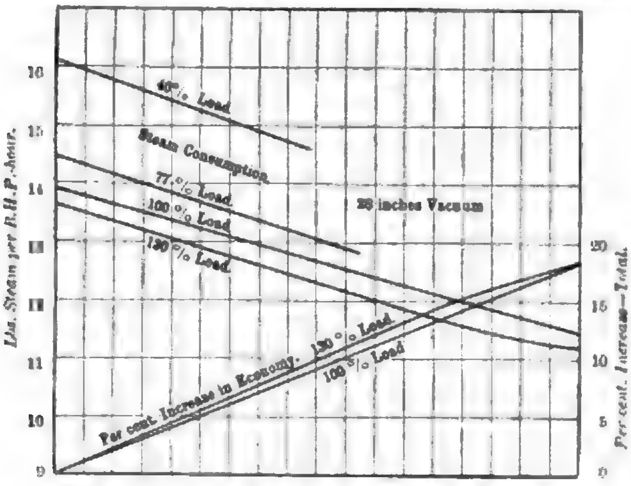

FIG. 4.—RELATION-SUPERHEAT TO ECONOMY. 400kw. Westinghouse-Parsons Turbine.

Table I.—*Relative Economy of High Vacuum.*

Case.	I.	II.	III.
Conditions of operation	Good coal, continuous service.	Med. coal, continuous service.	Poor coal, day service.
Capacity plant, kw.	2,000	2,000	2,000
Daily run, hours	24	24	10
Yearly run, days	365	300	300
Average load, kw.	1,500	1,000	1,000
Price coal, per ton (2,000lb.)	$4.00	$2.00	$1.00
Evaporation (actual), lbs.	9¼	8	7
Average economy, lbs. water per kw.-hr.	23	22	22
Raise vacuum, inches	26 to 28	26 to 28	26 to 28
Water saved per kw.-hour, lbs.	1·84	1·76	1·76
Water saved per day, lbs.	66,240	42,240	17,600
Coal saved per day, tons	3·49	2·64	1·26
Gross saving per day	$13·96	$5.28	$1.26
Gross saving per year	$5,095.00	$1,584.00	$378.00
Extra cost of condenser	$4,000.00	$4,000.00	$4,000.00
Interest 5%, depreciation 7½%	$500.00	$500.00	$500.00
Net saving per year	$4,585.00	$1,084.00	−$122.00
Net saving per year, capitalised at 5%	$91,900.00	$21,680.00	−$2,444.00
Net saving as interest on increased investment in 2in. extra vacuum	114·9%	27·1%	−3·05%

With superheated steam the same method of arriving at the net saving may be employed. At the present time the superheat usually specified in turbine plants ranges in the neighbourhood of 100°F., which is easily within the limits of various forms of apparatus suited for mounting within the boiler setting in the path of the flue gases. An increase in economy of 10 per cent. is thus effected, and at an investment cost of fully 25 per cent. less than that for the 2in. extra vacuum. The net saving should, therefore, be even greater. Superheat cannot, however, be obtained for nothing, and the net saving is evidently affected largely by the cost of heat supplied. In the case of the independent superheater this comprises fuel and stoking; in the case of the boiler superheater, the fuel value of heat delivered by the flue gases.

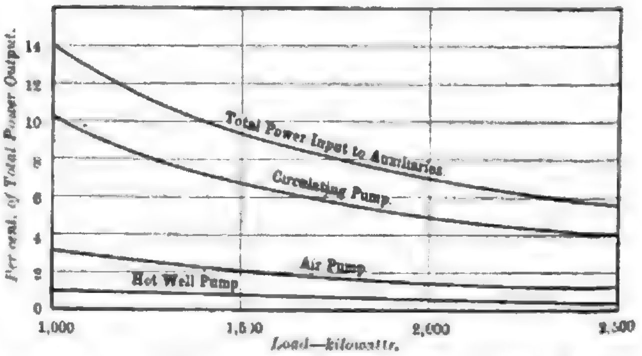

FIG. 5.—POWER CONSUMPTION OF AUXILIARIES. 2,000kw. Turbine.

Granted the beneficial effects of high vacuum, do the auxiliaries require excessive power to render them commercially impracticable? Fortunately, we are able to present results from two plants which throw some light upon the subject. At the Broad-street station of the Citizens' Light, Heat and Power Co., Johnstown, Pa., the condenser auxiliaries are driven from a single steam cylinder—that of the rotative air pump. By indicating this cylinder at normal speeds, the total power input was obtained as given in Table II.

Table II.—*Power Consumption of Auxiliaries.*

Load.		Vacuum.	H.P. auxiliaries.			Per cent. total power.		
E.H.P.	I.H.P.	Inches.	Steam. I.H.P.	To air. I.H.P.	To water I.H.P.	Steam cyl. Per cent	Air cyl Per cent.	To water. Per cent.
97·8	150·8	27·8	7·08	2·45	4·63	4·7	1·63	3·07
167·5	220·5	27·7	7·75	3·00	4·75	3·5	1·36	2·14
185·0	238·0	27·6	7·66	3·02	4·64	3·22	1·27	1·95
207·5	260·5	27·6	8·38	3·16	5·22	3·21	1·21	2·00
238·0	291·0	27·3	8·98	3·46	5·52	3·09	1·19	1·90
241·0	294·0	27·4	8·75	3·21	5·54	2·98	1·09	1·89
404·0	457·0	..	12·77	4·35	8·42	2·8	0·95	1·85
536·0	589·0	..	14·57	5·03	9·54	2·47	0·85	1·62

Although observed in indicated horse-power, the results were reduced to a basis of equality with turbine output in order to obtain commensurate percentages. At less than quarter load, the total power consumption was less than 5 per cent. of the station output, and it progressively decreased to 2½ per cent. at full load.

Similar observations casually made on a 2,000kw. Curtis turbine equipment at the Louisiana Purchase Exposition indicate the same relations. All auxiliaries are driven by constant-speed induction motors supplied from the high-tension 'bus bar through step down transformers. The curves, Fig. 5, are based upon observations varying from half to full load, and the power input is assumed constant for all loads, as this is approximately the case. It is probable that the percentages might be largely reduced were it possible to more closely proportion the speed of auxiliaries to the turbine load, as may be done in the Johnstown plant. The equipment is also labouring under unexpected high temperature of cooling water, frequently 85deg., which renders it difficult to obtain the high vacuum which could be held under normal conditions. The most important point is, however, well brought by the curves—viz., that the power consumption of turbine auxiliaries is moderate and constantly decreases with the load.

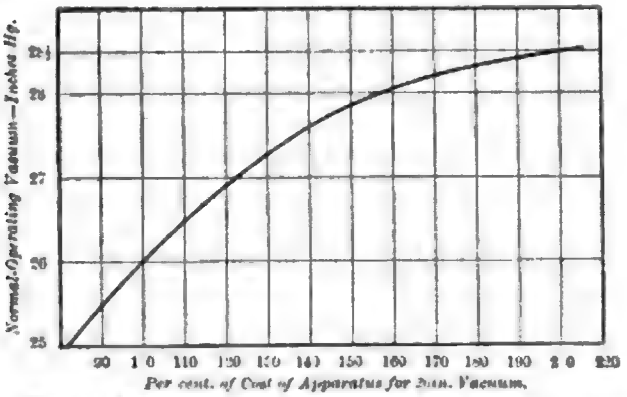

FIG. 6.—RELATIVE COST OF HIGH VACUUM CONDENSING APPARATUS. Comprising Surface Condensers, Dry Air Pumps, Circulating Pumps, Hot Well Pumps, Piping, Valves, &c.

The cost of high vacuum apparatus is not proportional to the vacuum, but increases much more rapidly, as shown in Fig. 6. Increasing the vacuum 1in. above 26in. increases the cost about one fourth, another 1in. raises it nearly one-third, and ½in. above 28in. about one-half of the cost at 26in. These estimates are, of course, averages, and intended to show relative, not specific, costs.

HIGH-TENSION SWITCH GEAR.*

BY L. ANDREWS.

Whilst the necessity of some type of remote control is generally recognised, considerable difference of opinion exists as to whether it is best to effect this operation electrically or mechanically. The multiplicity of small wires, the magnetic clutches, the numerous springs, and the push button, relay and commutator contacts all constitute weak points in electrical control, the reliability of which is dependent upon its weakest link. One argument that is sometimes used in favour of electrical control is that a large mechanically-operated three-phase switch cannot be closed sufficiently quickly for synchronising. Although this argument may apply when dealing with very large switches controlling 5,000kw. generators, such as are being used in some of the American stations, it certainly does not apply to 1,000kw. generators or under. The switches for these can be closed mechanically quite as quickly as an electrically-operated switch. Again, we are told that mechanically-operated switches must be tripped electrically, and since they are electrically controlled to this extent they might as well be operated electrically entirely. It must, however, be apparent to anyone who considers the question that merely to trip a switch that is closed by hand is a very simple problem compared to that of constructing a switch to be opened and closed electrically. Another advantage claimed for electrical control is that it enables the high-tension switches to be placed directly opposite the generators they control, whereas the operating keyboard can be compactly arranged in a very small space, but even this is a doubtful advantage. Think of the number of small wires that need to be run from each of these distant switches to the operating board for the ammeters, synchronisers, voltmeters, &c., and for operating the motors controlling the main switches. Even for a single-phase system the complication is appalling. Then, again, think of the length of high-tension 'bus bars required for this arrangement. On the whole, it seems much better practice to bring the main cables from the generators to one point of the building, at which centre all the high-tension switches are placed. In some cases it may be required to place the high-tension switches in a separate building so far removed from the engine room that mechanical control from an operating board fixed in the engine room would be extremely difficult. Electrical operation is certainly more satisfactory for controlling switches placed a long distance from the operating board.

This, however, raises another question. Is it necessary, or even advisable in all cases, to place the operating board in the engine room? It certainly has been the custom to fix the board in such a position that the switchboard attendant can obtain a full view of all the plant in the engine room; but is not this custom a relic of the days when generating stations were small and the switchboard attendant was also the engineer in charge of the shift? In all installations where the switchboard attendant's only duties are to manipulate the switches, there is much to be said in favour of placing him in a position where he will be guided in his operations solely by the reading of the indicating instruments, and will not have his attention distracted or his nerves unstrung by bursting steam pipes, broken connecting rods, armatures, flashing to pole-pieces, or any of the other exciting incidents that are liable to occur in the best regulated stations.

Another question upon which opinions differ at present is that of the necessity of separating the contacts of one phase from those of opposite phases in the main circuit breakers. Some engineers consider that if the circuit is broken under oil the contacts of all phases may be contained in one vessel. Others go to the opposite extreme, and divide each phase from adjacent phases by brick walls. In the former case there appears to be some risk that a slight arc started under oil may spread to the other phases, and so establish a short circuit across the 'bus bars. Complete isolation by brick walls, of course, provides a very perfect protection against short circuits between phases, but it introduces other difficulties. Two additional 4½in. brick walls must increase the width of the switch by at least 9in., and this is sometimes a serious objection; added to which placing the respective circuit breakers controlling each phase in such narrow and deep cells tends to increase the difficulties of getting at the back contacts and insulators for inspection and cleaning. The fact that the circuit breakers of each phase must be connected mechanically for simultaneous operation makes it difficult to withdraw one phase at a time. Both of the above difficulties can doubtless be overcome if it is really necessary. It appears, however, that all that is actually required is that the contacts of the different phases should be contained in separate oil tanks, the latter being insulated from the high-tension connections and from earth. The probability is that if this precaution is taken, and an arc is started in any one phase, it will not be maintained as the circuit will be broken on the other phases. Should it be maintained, however, on two phases simultaneously, it is probable that complete destruction of the switch is bound to follow, even if the precaution has been taken of separating the phases by brick walls.

It is no longer necessary to draw attention to the fact that neither fuses or excess current circuit breakers should be used between generators and the main 'bus bars, but that reverse current circuit breakers should be used in this position. The only danger now is that alternating current discriminating devices will be brought into disrepute through being misunderstood. There appears to be a very general idea that any device that tends to move in one direction when influenced by a forward current, and in the opposite direction under the influence of a reverse current, may be used as an alternating current discriminating relay. Experience has shown, however, that some of these devices are capable of behaving in a most unexpected manner under the abnormal conditions that are liable to arise when a serious break down on any part of the system occurs.

We sometimes find that engineers are a little uncertain as to whether discriminating cut outs or reverse current cut-outs should be used in certain positions. The following rule appears to apply to all cases. "Where current is fed into 'bus bars from a number of sources of supply connected in parallel, discriminating cut-outs only should be used. Where current leaves 'bus bars to supply a number of feeders, transformers, motors or distributors, excess current cut-outs only should be used."

We are often asked whether a discriminating cut-out should operate instantaneously or whether it should possess some time element. On the whole the advantages appear to be on the side of instantaneous action It is certainly desirable that a generator breaking down should be cut out of circuit with as little loss of time as possible, and with a reverse current of something less than the full-load current. If, however, the circuit breaker is fitted with a time-limit attachment there is a risk that its action may be so delayed as to allow the reverse current to exceed the normal current by 200 or 300 per cent. before the fault is isolated from the 'bus bars, and this may result in any synchronous apparatus connected at the time dropping out of step. Apparently the only argument in favour of a time-limit attachment is that a reverse current device without time element is liable to be tripped by the rush of sychronising current from one generator to another when machines are being paralleled.

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[*] Abstract of a Paper read before the Manchester Local Section of the Institution of Electrical Engineers on December 13.

and it is suggested that these momentary rushes are of such short duration that if the discriminating device is provided with some time-element attachment the cut-out will not be tripped by these momentary currents unless they are very severe. It should be pointed out, however, that these momentary currents are alternately generating and motoring currents. If, therefore, the discriminating device has any appreciable time element there is a risk that it may not be tripped by very heavy currents, as the pull will naturally be alternately in opposite directions; and, unless the device is free to operate instantaneously, the pull in one direction will counteract the pull in the opposite direction. As the period of oscillation is often less than a second it is obvious that if the time-element attachment prevents the cut-out operating in that time, it may fail to operate at all. The simplest way of dealing with this difficulty appears to be either to switch off the shunt-windings of the discriminating device at the moment of paralleling, thus rendering the device entirely inoperative or to greatly reduce the pressure across this winding when paralleling, thereby correspondingly increasing the reverse current required to operate the device.

High-tension fuses for controlling circuits carrying large currents are now being almost exclusively replaced by excess current circuit-breakers. The advantages of the latter are that, owing to the fact that the circuit can be broken under oil, there is much less danger of a destructive arc being started, and, further, the current at which an excess current circuit-breaker will operate can be determined with far greater accuracy than can the melting current of a fuse. One advantage of a fuse is that it naturally possesses a certain time element, whereas a circuit-breaker operates practically instantaneously, whatever the value of the excess current may be.

DISCUSSION.

The CHAIRMAN (Mr. Taite), in opening the discussion, pointed out that Mr. Andrews had given a very interesting demonstration of a subject which he had made peculiarly his own and had invited free criticism from members present. He hoped they would act on the invitation and make the discussion a very good one.

Mr. WOODBRIDGE thought a short-circuit such as he had often known to take place would demoralise any of the devices described. Engine-driven units in multiple would give out 8 or 10 times normal current under these conditions. The voltage would practically fall to zero, alternators would fall out of step and pull in again. This see-saw would throw anything out, as Mr. Andrews had unintentionally demonstrated when trying his switch with make-and-break current. He believed in solid connections to the 'bus bars. When the earthing of an armature constituting a short-circuit occurred, phase relation was no use owing to the reduction of the voltage to practically a straight line. He thought the most efficient reverse-current circuit-breaker was an intelligent attendant to switch out the faulty alternator. In a large New York station, containing units of 3,000kw. capacity, they had red and white pilot lamps to indicate the direction of the current if a reversal took place. The red lamp showed the attendant which alternator to switch out, and the arrangement had worked very well.

Mr. CLOTHIER said he had at present a poor opinion of reverse current devices. Mr. Andrews, in his 10 years' experience of these things, had shown them that what he had thought the correct thing from time to time was faulty and he would ask Mr. Andrews what would happen if a short-circuit took place on the 'bus bars? He endorsed the remarks of Mr. Woodbridge and was also in favour of solid connections.

Mr. ORTON said that Mr. Andrews' objections to electrical remote control were groundless and in large sizes it was necessary to operate switches by power, an attendant not having strength enough for mechanical operation—say, of a 4,000kw. set. Referring to the alleged complication it was well to state that only three small wires were necessary for the electrical operation of a set this size. He thought it preferable that the attendant should be able to hear and see what was going on, although away from main switches. With regard to separation of phases, he thought the matter depended largely on existing circumstances.

Mr. S. L. PEARCE (city electrical engineer, Manchester), agreed with Mr. Woodbridge that there was a good deal to be said in favour of solid connections between generators and 'bus bars. This was the system used on the Central London Railway, and he believed also at Glasgow and the Dublin Tramways. At the Central London Railway solid connections had worked well. On two occasions there had been serious short-circuits due to the generator losing its field. In the first case there was a total shut-down, and in the second the switchman succeeded in switching out the faulty machine. Whether solid connections could be used or not depended largely on the build of the machines. He asked what would be the result of a short-circuit on the 'bus bars with reverse-current circuit-breakers installed? Mr. Andrews would perhaps say the prime movers should pull up and the generators remain undamaged. In one of the Manchester stations there had been an occurrence of this kind. His experience in this case was that the armature was burnt out although the generator was provided with fuses which did not clear. Would Mr. Andrews give his views on whether overload or reverse circuit breakers were the most suitable for sub station synchronous motors operating in parallel on one set of high-tension 'bus bars.

Mr. COWAN mentioned that the chaotic conditions described by Mr. Woodbridge were of very rare occurrence.

Mr. W. S. TOPLIS referred to Mr. Andrews' statement that the American practice was to place isolating switches in 'bus bar cubicles. American practice was not to place these switches in the 'bus bar cubicles, but on the opposite side of the wall. He considered a partition necessary between phases with a grounded neutral. With reference to remarks on electrical remote control, he entirely agreed with Mr. Orton's remarks on the simplicity and ease of operation. Mr. Orton had pointed out that 4,000kw. switches could not be operated easily mechanically, and the same remarks applied to 1,000kw. switches, which might be equally heavy with high voltages.

In reply, Mr. ANDREWS admitted that he thought Messrs. Orton and Toplis were right in their remarks regarding electrical control of large-size switches.

Replying to Mr. Pearce, he thought reverse-current circuit breakers more important and more necessary in sub-stations on the low-tension side than anywhere else. As time was very short, he would reply further in writing.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Secondary Radium Rays.—A. S. Eve has investigated the secondary rays produced by the β and γ-rays of radium for the purpose of comparing the results with those obtained by Townsend in the case of secondary Röntgen rays. He finds that the secondary radiation from various substances follows approximately the same order as their densities. The coefficients of absorption of secondary radiation by various substances also follow roughly that order. Good radiators are therefore good absorbers. Neither the secondary radiations nor the coefficients of absorption are proportional to the densities. The secondary radiation does not come from the surface merely, but from a total depth varying from about 1·5mm. in the case of lead to about 3mm. for glass, aluminium or paper. It is mainly independent of the state of the surface. Almost the same amount of radiation is obtained from solid iron as from iron filings; from liquid and from solid paraffin; from ice and water; from paper, millboard, papier-maché, mahogany, pine and basswood. The theory which agrees most nearly with the results is that the secondary radiation set up in a thin layer is proportional to the density and to the rate of absorption of the primary rays.

[A. S. Eve, *Philosophical Magazine*, December, 1904.]

Electrolytic Detectors in the Bridge Method.—W. Nernst and F. Von Lerch use Schlömilch's electrolytic detector as a null instrument in a bridge combination on account of the ease with which it is constructed and the possibility of using a telephone. Two platinum electrodes polarised with 2 volts dip into a beaker filled with dilute sulphuric acid or potash. The anode is as small as possible, and consists of a platinum wire 0·02mm. thick melted into a glass tube and cut off close to its end. If a rapidly oscillating current is superimposed upon this cell, a rise in the current through the polarising circuit is noticed, and this can be easily observed by means of a telephone or galvanometer. The detector returns instantaneously to the zero, so that one hears a crack for every spark, and is therefore enabled to follow the interruptor in the telephone. The new detector is everywhere employed with advantage where it is a question of recording feeble but rapid oscillations. For it responds to gradually decreasing oscillations in a gradually decreasing manner. In this respect it differs markedly from the coherer, which either responds fully or not at all. The mode of action of the electrolytic coherer probably consists in a piercing of transition layers formed by polarisation. The apparatus works with great regularity, but it is necessary to work quickly and read the temperature accurately, as otherwise errors amounting to 2 per cent. may occur.

[Nernst and von Lerch, *Annalen der Physik*, No. 15, 1904.]

New Photographic Method for N-Rays.—H. Bordier has devised a method of registering N-rays which is not open to the objections urged against the spark method, and at the same time gets rid of the difficulties attending the ocular observation of the effect upon a fluorescent screen. The author uses a calcium sulphide screen, but instead of observing the increase of luminosity under the action of N-rays direct, he records it photographically by a prolonged exposure. On a thick piece of paper he drops two groups of collodion drops containing a little of the sulphide in suspension. These are allowed to dry and are kept in the dark overnight. The paper is then exposed for five or ten minutes to dull daylight, and is then placed, with the drops underneath, on a photographic plate enveloped in tissue paper. It is left in the dark for 24 hours, a source of N-rays, such as a file, being placed over one group of patches, and a piece of lead of the same weight and the same outline being placed over the other group. After this prolonged exposure the plate is developed. It shows a number of black patches corresponding to the drops, each surrounded by a halo. But in every case the halo surrounding the patches covered by the file is larger than that surrounding the patches covered by the lead. In another experiment, a cardboard box containing pieces of tempered steel was substituted for the file, and another box containing an equal weight of lead was substituted for the lead block. Exposure was made as before, and the plates were sent to the director of the photographic laboratory of Lyon University for measurement. His measurement showed that the patches produced under the steel had a diameter of 6·4mm. and a halo 11·7mm. in diameter. The other patches had an average diameter of 7·1mm. and a halo of 10·8mm. Therefore the patches exposed to the N-rays, although having a photographic image of smaller diameter, produced a wider halo. The author describes a further experiment, which is even more conclusive. A line of sulphide is traced on paper with a capillary tube containing the emulsion. After drying, the line is cut in two, and the halves are exposed to lead and tempered steel, as above. On developing, the image from the steel appears first, and its edge is shaded by a wider halo.

[H. Bordier, *Comptes Rendus*, December 5, 1904.]

Secondary Cathode Rays.—That the impact of electrons upon atoms tends to ionise those atoms by the detachment of electrons from them has been shown by a number of observers, among whom Stark has perhaps done most to elaborate in detail the theory of this action. P. Lenard has collected some further interesting material, in the discussion of which he shows that it is possible to detach the effects produced by primary cathode rays from those produced by the secondary ones to which they give rise. He accomplishes this by sending the primary rays through a diaphragm, behind which a phosphorescent screen is mounted parallel to the path of the rays, but out of their direct reach. When this phosphorescent screen is charged to several thousand volts, the rays are drawn aside, producing on the screen various patches, whose aspect varies with the voltage and the pressure of the gas. With a suitable distribution of the voltages it is possible to separate the direct rays from the slower secondary rays, which appear as a diffuse and much-deflected patch. The manner in which these rays are produced shows some striking analogies to ultra-violet light. This, like cathode rays, produces a conductivity in gases due to the liberation of electrons. It also discharges negatively electrified bodies, and the author shows in this connection that cathode rays impinging upon solids also cause them to emit secondary cathode rays of very low velocity. He believes that the discharging of solids and the conductivity of gases are equally due to these very slowly moving electrons. Like all other effects of cathode rays upon matter, the production of secondary rays is independent of the state of aggregation of the material. It is also independent of the orientation of the surfaces impinged upon. The so-called "reflection" of cathode rays is a complex phenomenon in which the field due to the reflecting body, the electric waves proceeding from it, and the secondary cathode rays each play an important part. The author's main object was to single out the effects due to the last of these elements.

[P. Lenard, *Annalen der Physik*, No. 13, 1904.]

Damping of Condenser Circuits.—A condenser circuit whose proper wave-length is sufficiently great in comparison with the length of the closing circuit, and whose plates are a sufficiently small distance apart, sends hardly any electric lines of force into the space outside. Therefore, according to Poynting's theorem, it radiates no Hertzian energy, and its damping is solely conditioned by the resistance of the whole circuit, which, if the wire is not too thin, consists practically in the resistance of the spark gap. P. Drude follows up this consideration, and deduces some rules of great importance to the practice of wireless telegraphy. For every condenser circuit there is a certain length of spark which gives a minimum damping. In the neighbourhood of that value the damping does not vary much with the length of the spark-gap, and however much the inductance and capacity may be varied, the damping can be brought to nearly the same value, if the supply of energy from the induction coil is not excessively large or small, and provided the condenser shows no hysteresis or brush discharges. By a careful adherence to these conditions, the author succeeded in reaching the extremely low value of 0·05 for the logarithmic decrement. The length of the spark gap was between 1mm. and 2mm., and the ratio C : L had the high value of 17. It was found essential, however, to attach the supply wires as near the spark-gap as possible, as was the uniform practice of Hertz himself. Righi's method of introducing spark-gaps in the supply circuit has to be avoided, at least when the sparks pass in air. An exciting condenser without hysteresis or brush discharges may be obtained by using metal plates in petroleum, and not connecting them by solid insulators. Zinc electrodes preserve the small damping factor for a considerable time, though a decrease of the damping is noticeable after every fresh cleaning. A Tesla coil can only be recommended for very small capacities. The integral effect of the exciting circuit in a resonating circuit increases at first with the sparking distance, and then decreases. It is considerably enhanced by increasing the supply of energy, which increases the partial discharges. The length of gap giving the greatest integral effect lies somewhat below the value which gives the minimum damping. If, therefore, a good resonance is aimed at rather than a far-carrying range, the spark-length must be slightly increased. If the energy supplied is small, the two critical spark-lengths are sensibly identical. The integral effect depends much more upon the spark-length than does the logarithmic decrement. That in wireless telegraphy much larger spark-lengths have been hitherto employed than those given by the author is due to the employment of the coherer, which reacts, not upon the integral effect, but upon the maximum amplitude. The author would not exceed 5mm. even with a capacity of 36,000 and a strong supply.

[P. Drude, *Annalen de Physik*, No. 14, 1904.]

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Maxwell's Theory and Wireless Telegraphy." Part I., Maxwell's Theory and Hertzian Oscillations. By H. Poincaré, translated by F. K. Vreeland. Part II., The Principles of Wireless Telegraphy, by F. K. Vreeland. (London: Archibald Constable & Co.) 10s. 6d.

"Electric Lighting." By F. B. Crocker. Vol. I.: The Generating Plant. 6th edition. (London: E. & F. N. Spon.) 12s. 6d.

"Elements of the Differential and Integral Calculus." By W. A. Granville. (New York and London: Ginn & Co.) 10s. 6d.

"A Technological and Scientific Dictionary." Part VII. Edited by G. F. Goodchild and C. F. Tweney. (London: Geo. Newnes.) 1s.

"Mathematische Einführung in die Elektronentheorie." By Dr. A. H. Bucherer. (Leipzig: B. G. Teubner.) 3.20m.

"Bau der Dampfturbinen." By A. Musil. (Leipzig: B. G. Teubner.) 8m.

"Experimentelle Elektrizitätslehre." By Dr. Hermann Starke. (Leipzig: B. G. Teubner.) 6m.

"The Dynamics of Particles and of Rigid, Elastic and Fluid Bodies." By A. G. Webster, Vol. II. of the "Mathematische Wissenschaften mit Einschluss ihrer Anwendungen" Series. (Leipzig: B. G. Teubner.) 14m.

"Die Tarife Schweizerischer Elektrizitätswerke für den Verkauf Elektrischer Energie." (Zurich: Fritz Amberger.) 3m.

"High Temperature Measurements." 2nd edition. By H. Le Chatelier and O. Boudouard. Translated by G. K. Burgess. (London: Chapman & Hall.) $3.

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"Annual Catalogue of the Colorado School of Mines." (Golden Colorado: Colorado School of Mines.)

"Fortschritte der Elektrotechnik." Vol. I. of 1904. Edited by Dr. Karl Strecker. (Berlin: Julius Springer.) 7m.

"L'Electricité a la Portée de Tout le Monde." By Georges Claude. 5th edition. (Paris: Vve. Ch. Dunod.) 7fr. 50c.

"Transactions of the American Institute of Electrical Engineers." December, 1904. (New York: The Institute.) $0·50.

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THE COMING PARLIAMENTARY SESSION.

Although slightly fewer in number than last year, the "electrical" Bills that have been deposited in the Private Bill Office for the Parliamentary Session of 1905 are of considerably greater interest than has been the case for two or three years. We conclude on another page our list of extracts taken from the Bills themselves and from them it is evident that two matters affecting London will receive very full consideration. These are the supply of electric power and the construction of tube railways in the metropolitan area. There are no less than eight Bills dealing with the supply of electricity "in bulk" in and around London, promoted by the following companies:—Metropolitan Electric Supply Co., Charing Cross and Strand Electricity Supply Corpn., County of London Electric Supply Co., Central Electric Supply Co., City of London Electric Lighting Co., North Metropolitan Electric Power Supply Co., East London and Lower Thames Electric Power Co., and the Administrative County of London and District Electric Power Co. The first six of these companies are already working electricity supply undertakings, and no new capital powers are asked for, the works contemplated under their Bills being merely regarded as extensions of their present undertakings. Further, the majority of them are not Parliamentary companies, so that any extra capital required may be raised under the Articles of Association without reference to Parliament. The Administrative County of London Co. and the East London and Lower Thames Co., if sanctioned, however, will be new Parliamentary companies, and their combined capital would be £9,000,000 with one-third borrowing powers. The former of these two schemes is influentially supported, judging by the list of subscribers, which includes Sir ANDREW NOBLE, Mr. A. F. YARROW, the Hon. W. H. ARMSTRONG, Mr. PHILIP WIGHAM RICHARDSON, Mr. ERIC HAMBRO, Mr. DOUGLAS VICKERS and Mr. G. F. MCCORQUODALE. The subscribers to the East London and Lower Thames scheme are less familiar in the electrical world, but this is no criterion of the quality of the financial evidence that may be produced before the Committees, which no doubt will be of the strongest in view of the failure of a similar measure last session on financial grounds.

The proposals of all eight Bills with regard to the area and method of supply are so similar that it is not unsafe to prophesy that they will all have to be sent to one Committee and a process of elimination put into operation which will result in the survival of the fittest. The ramifications of the Administrative County of London and District scheme involve a condition of competition which has never before existed in the electric supply industry. The promoters of this scheme have scheduled such an extensive area that none of the other promotions can avoid clashing with it, and, in addition, the new Company proposes to compete with a large number of municipalities and companies in and around London owning electricity supply undertakings. The nature of the opposition to these various schemes, when the Committee stage is reached, may be indicated by the fact that both the Administrative County of London Co. and the Metropolitan Electric Supply Co. seek powers to distribute electricity, in detail as well as "in bulk" and for power purposes, in districts where undertakings owned both by companies and local authorities are already in operation. No power company has yet been granted such powers; we expressed our views upon this matter at the time of the publication of the notices in November. Whilst maintaining the opinions then stated we can only once more plead for a speedy revision of the Electric Lighting Acts which will define in a clear manner whether an electric supply undertaking carrying out its duties in an honest and satisfactory manner according to its statutory obligations should not be allowed undisturbed possession as the "authorised distributors." In London, outside the City area, the majority of the electric supply undertakings are in the hands of the borough councils, and it is serious for the local finances that money should have to be spent continually in protecting their businesses in the way that so many of the London boroughs will have to do this year. The question of whether competition between power companies for the "bulk" supply of electrical energy over any particular area is desirable or not is unlikely to involve such important issues, and in each case might fairly be dealt with on its merits without the sacrifice of any interests.

Outside the metropolis, the Shropshire & Worcestershire Electric Power Co. seeks an extension of area with a change of name, whilst the South Wales Electrical Power Distribution Co. wishes to absorb the Carmarthenshire Electric Power Co., which was authorised in 1903, the purchase price being £1,000 in cash and £18,000 in shares. All the power Bills this year take powers to effect transfers of Electric Lighting Provisional Orders. In the original power Acts no specific provision was made for this, with the result that last year many of the companies had to promote special Bills in Parliament to confer such powers upon them, a policy which has been followed by others this session. Another precaution taken by the power Bills this year, and one which is also included in many of the municipal Bills, is the right to supply electricity "in bulk" to authorised distributors outside the promoters' areas. In this way the boundary trouble, to which reference has frequently been made, will be to a large extent avoided. But this is a matter which should also be dealt with in a revision of the Electric Lighting Acts, and should not be left to be the subject of legislation in private Bills. In many cases, however, these proposals will set up a direct competition with the large power companies.

In the traction Bills, London again claims first attention, the amount of capital which it is proposed to raise for the construction of new tube railways being no less than £17,550,000, exclusive of borrowing powers. As all the proposals, however, are to a large extent competitive, the final amount sanctioned will probably be not greater than one-third this sum. As we have already pointed out, moreover, much depends upon the attitude of Parliament respecting the Bills should the report of the Royal Commission on London Traffic not be presented before the Committee stage is reached next March. There are three proposals to build lines from Hammersmith via Piccadilly to the Strand and City, two schemes for the construction of railways from the City to Walthamstow, Chingford and Waltham, whilst the line proposed by the Hammersmith, City, and North-East London Railway Co., after reaching the City, will continue on to Tottenham and Palmer's Green, in addition to the Waltham branch just referred to. Mr. ARNOLD F. HILLS, of the Thames Ironworks, who has already spent many thousands of pounds in promoting an electric railway to the north-east of London, is again interested in one of the proposals—viz., the Hammersmith, City and North-East London Railway. The proceedings in connection with these bills, if they reach the Committee stage, will be a repetition of what took place in 1902, it being noteworthy that each Bill includes a time-limit for the substantial commencement of works, a provision that the Board of Trade shall approve of the permanent way, tunnels, platforms, stairs, lifts, rolling stock, lighting, ventilation, &c., and also that all plans shall be submitted to the Board—proposals which were first inserted in tube railway Bills in 1902. Unless these provisions are included in a railway Bill the Board of Trade has no jurisdiction, except in a few comparatively unimportant details, such as the insufficiency of staff, incompleteness of the permanent way, &c.

Tramway Bills are fairly numerous, and one that will meet with strong opposition is the annual proposal of the London County Council to continue its tramways from the south side of Westminster Bridge, along the Victoria Embankment so as to join up with those on the south side of Blackfriars Bridge. The Bill of the Blackpool, St. Anne's and Lytham Tramways Co. for reciprocal running powers over the Blackpool Corporation tramways may conceivably be unopposed, the two parties arriving at an agreement in view of the Newcastle Bill last Session and the reversal of opinion on this question since. Birmingham, after being in the toils of the companies for many years, has prepared an ambitious municipal tramway scheme which will involve an expenditure of over £1,000,000, whilst many other provincial corporations seek extensions of lines. A somewhat unusual condition is contained in the Gosport and Fareham Tramways Bill, promoted by the Portsmouth Street Tramways Co.—viz., that if the new lines are not completed within five years there shall be a penalty of £50 per day. The other proposals in the tramway measures are not of special interest.

The municipal "omnibus" Bills, as usual, contain powers of a very wide character, most of which, however, have already been granted to other municipalities. Provision as to the supply of electricity to persons possessing independent plants, and the exemption of electric fittings supplied on the hire-purchase system from distress, are now common features of these measures. A good number of proposals are made, however, to wire and fit up premises for electric supply, but in only one case is it specifically laid down that the work shall be done through a contractor—viz., in the Ealing Bill. The London County Council (General Powers) Bill, Part XV. seeks to make it lawful for Metropolitan Borough Councils to expend money upon the wiring of premises for electrical supply, and although the words "and to enter into and make agreements in connection therewith" may be intended to convey that the work is to be given to a contractor, we fear that this will hardly be sufficiently binding or definite for the London wiring contractors, and considerable opposition will surely be offered. This Bill, if passed, will also authorise the money to be spent for such purposes to be borrowed under the Electric Lighting Acts.

Amongst the miscellaneous applications may be mentioned a large power-gas scheme for the Esk Valley in Scotland, Bills for the transfer of the University College, Sheffield, and University College, London, to the Sheffield University and the University of London respectively, and a proposal for an electro-pneumatic parcel despatch system in London. The session would appear to give promise of several useful private Bills being sanctioned, the satisfaction to be derived from which would be considerably increased if the very necessary general reforms in electric supply and traction legislation which have been so continually postponed were at last given effect to by the Government.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

The Testing of Continuous-current Machines. By C. Kinzbrunner. (London: Harper & Bros.) 1904. 6s.

Die Prüfung von Gleichstrommaschinen. By C. Kinzbrunner. (Berlin: J. Springer.) 1904. 9m.

This publication, the English and German editions of which are practically identical, gives a clear account of the way in which continuous-current machines are tested, and contains also much information on the testing instruments and apparatus themselves. After some sound general remarks relating to the carrying out of the tests and to the treatment and construction of the appliances used, the author describes a number of auxiliaries, such as switches, fuses, resistances, starters, regulators and measuring instruments, a large percentage of which are also illustrated. The various ways in which the apparatus and instruments may be connected up to the motors are indicated by clear diagrams. We notice in this connection that one diagram shows the starting rheostat connected up to a shunt motor in such a way that the "kick" of the shunt is not taken up by the resistances when the motor is switched off. Although the author dwells briefly upon this point and also gives the proper diagram, the importance of this detail has hardly been insisted upon sufficiently, and it might be advisable in a future edition to omit the faulty diagram altogether. The main part of the book deals successively with resistance tests, insulation tests, the determination of the various no-load and load characteristics, the leakage coefficients of the magnetic circuit, efficiencies and temperature rises.

In the chapter on the determination of leakage coefficients, mention is made of the bismuth spiral for carrying out magnetic measurements. Bismuth has the property of changing its resistance with the varying density of the field in which it is placed, and this metal is, therefore, suitable for carrying out absolute magnetic measurements. As this application of bismuth does not seem to be known as widely as it might be, although it is 20 years old, a reference to it in this review may help to bring it before those interested. Various ways of separating the different losses which occur in continuous-current machines are dealt with at some length by Mr. Kinzbrunner. The book also contains a reproduction of definitions and rules adopted by the American Institute of Electrical Engineers with reference to continuous-current practice, some notes on practical testing and some specimen test sheets. The book may be recommended to students and engineers who require to know how the testing of continuous-current motors and generators is done in practice.

The Management of Electric Tramways and Light Railways. By W. R. Bowker. (London: E. & F. N. Spon, Ltd.) 9s. net.

Mr. Bowker may be called a worker in mosaic, this book, like the last of his we reviewed, being largely composed of lengthy quotations from divers authors. Unfortunately, the design lacks consistency and the cement between the pieces is rough.

For instance, the author holds strong opinions on the question of advertisements on cars. On pp. 196 and 197 he says:—

> There is not a substantial argument which can be used against advertising in the cars. The chief complaint, which is heard from time to time, is that some passengers offer objections to travelling in cars with advertisements therein. What commonsense reasons these complaining people can offer to explain themselves the author has never been able to fathom, and their case can be cast aside as being one of imaginary grievances.

But on page 202 he says:—

> The author does not believe in any advertisements in any shape or form being fixed to the outside of the cars, or being fixed inside so that they can be seen from the outside, as in his opinion such advertisements do spoil the general pleasing appearance of the car.

In short, the artistic feelings of the passenger (who pays) are to be "cast aside," but those of the man outside are to be fully respected (since the author shares them) whatever sacrifice of revenue they demand.

On the burning question of running powers the inconsistencies are perhaps more pronounced. Thus on p. 278 we find:

> In his [the author's] opinion it is not a wise and foresighted policy to allow running powers over each others lines, except on an amalgamation basis.

On p. 281—

> There is no doubt but that the "interchange of traffic" with "running powers" over each others lines, within certain confined and mutually interested areas, is an excellent arrangement as regards traffic organisation.

And on p. 283—

> There is no doubt whatever but that "running powers" over each others system is the proper order of things: and I am greatly in favour and strongly advocate "through working and running," but it should be left to "mutual agreement" and not "compulsory."

There are some reprints of articles, opinions and reports that it may be useful to have in a collected form, treating of, for example, season tickets, depreciation, light railways in rural districts, the carriage of goods on tramways and light railways. These form the best part of the book, or we may say the gems of the mosaic; but neither by themselves nor in their arrangement do they justify the title, the professed purpose or the price of the book.

Electric Lighting for the Inexperienced. By Hubert Walter. (London: Edward Arnold.) 1904. The Wallet Series. 1s. in paper, 2s. in cloth.

This small book is intended as a guide to the ordinary householder who is about to adopt electric light in his house. It suggests how a dressing-table should be lighted so that the mistress of the house may be enabled to see her back hair and the master may have his chin sufficiently illuminated for a comfortable shave. The nursery should be fitted with counterweight pendants, not brackets, as the former "'give' if you hit them with any missile, and are thus less likely to break." In the difficult problem of lighting a dining room, however, the author is rather at a loss, and lamely invokes the assistance of wax candles for the dining-table. The explanation of the functions of the switch, fuse, distributing board, cord-grip, shade carrier, &c., will doubtless be useful to the uninitiated, but the author is not always quite safe himself in highly technical matters. For instance:—

> A volt (which rhymes with "jolt") is a unit of electric force or energy. No unprofessional person need trouble about its scientific definition. The reader may safely think of it as a unit of pressure, in the same way as he thinks of a pound when he says that a boiler works at 150lb. or 200lb. to the square inch. Just as a pipe or boiler is made to stand a certain steam pressure in pounds, so a wire or lamp is made to stand a certain electric pressure in volts.

The consumer is not afforded much assistance in the checking of his quarterly bill for electric supply. An electricity meter, he is told, is to be read like a gas meter, but "sometimes the meter is made to record a less number than the actual units, and then the reading is multiplied by a 'constant' quantity to make it right." We fear that this will leave the average consumer rather fogged. No attempt is made to explain the maximum demand system of charging:—

> Some companies charge the same amount—say, 5d. a unit—for any number of units. Others charge, perhaps, 6d. for a certain number of units, and allow a rebate on anything over that number. There are various ways of doing it, but in any case the consumer will be expected to pay once a quarter.

Electro-technology. By W. Brown and R. G. Allen. (Dublin: Sealy, Bryers & Walker.) 5s.

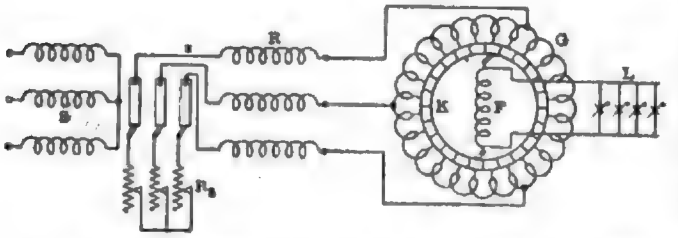
Yet another text-book for students makes its appearance. Unlike many of its forerunners, the present volume is devoted exclusively to laboratory work, and is of no use to any but those actually engaged in such work. As an adjunct to the small leaflets usually given out to students it is excellent, but it is questionable whether many will consider it worth 5s. The illustrations are indifferent, and, if the book reaches a second edition, some general improvemements might well be made.

The Conductometer and Electrical Conductivity. By ROLLO APPLEYARD. (London: Alabaster, Gatehouse & Co.). 1s. 6d.

Mr. Appleyard's brochure consists mainly of a description of his patented conductometer, of its design, and of its virtues. The author gives, besides, in some 16 pages, his views on the matter of the establishment of the 100 per cent. conductivity copper standard. He suggests a normal value for the resistance of the foot-grain, and calculates therefrom a table of resistance per pound-nautical-mile at different percentage conductivities. This table might prove useful to cable manufacturers.

Der Kaskadenumformer. By E. ARNOLD and J. L. LA COUR. (Stuttgart: F. Enke.) 1904. 1·20m.

Some time ago brief descriptions were published in the technical press with regard to an entirely new type of electric machine for converting alternating current to continuous current and vice versa, the invention of Herren Bragstad and La Cour. Messrs. Arnold and La Cour's book elucidates in a clear and practical manner the principle, theory and design of this new converter, and it will be read with interest and profit by designers of converting machinery. The book also contains several numerical examples, some records of tests on an actual machine and a number of illustrations which help to render the subject quite clear. It may be remarked that the book—in agreeable contrast to other publications by the learned authors—tackles the subject in a way which may easily be followed by the busy designer who lacks the time to study intricate vector diagrams and high mathematics. The converting set consists of an induction motor directly coupled to a continuous-current dynamo, the armatures of the two machines being also electrically connected, as is indicated by the illustration. This diagram applies to a three-phase continuous-current converter. S is the stator winding of the induction motor and, although shown connected in star fashion, there is, of course, no reason why it should not be connected in delta. R represents the secondary of the induction motor, connected to which are, as shown, the windings of the continuous-current armature. R_2 is the starting resistance of the induction motor.



The principle of working will best be understood by a simple example. Let us assume that both machines possess an equal number of poles, and that the speed of the set is half that of the primary synchronous speed. Obviously, then, the frequency of the current in the rotor of the induction motor is only half that which corresponds to synchronism. The current engendered in the rotor flows through the continuous-current armature and produces in it a rotating field. If the connections are such that the direction of this field is opposed to the direction of rotation of the converter shaft, then this rotating field will be stationary in space. It follows, thus, that such a machine behaves like a synchronous motor. Since the speed of the induction motor corresponds to only half of the synchronous speed, it is seen that only half of the energy supplied electrically to the induction motor is converted into mechanical energy and transmitted as such through the shaft. The other half is transmitted by induction from the stator to the rotor, whence it passes directly on to the commutator of the continuous-current dynamo. Rotor and armature, therefore, work in parallel on to the same commutator. The authors consider the cases where the stator winding is single-phase and polyphase, and they also deal with various rotor windings, ranging from a three-phase winding up to a 12-phase winding. Much is said in a general way regarding the reduced cost and weight of material of this new design as compared with the cost and weight of ordinary rotary converters and motor generators, and it is therefore to be regretted that the authors did not quote specific figures to show what the exact gain may be in actual cases.

HIGH-FREQUENCY TELEPHONE CIRCUIT TESTS.*

BY DR. A. E. KENNELLY.
(Harvard University.)

In land-line telegraphy it has for many years been a custom to test the circuits periodically by applying a steady assigned voltage to their sending ends, and measuring the strengths of current received to ground at their distant ends through a milliammeter or equivalent apparatus. The object of this Paper is to describe certain apparatus constructed for the purpose of measuring the alternating-current strength, at telephonic frequencies, received at the distant end of a telephone circuit, with a definite E.M.F. impressed on the sending end. The apparatus, therefore, is one which enables that routine test to be made for telephone circuits which has so long been well known for telegraph circuits.

The receiving instrument in such a test should either have negligible impedance or an impedance of magnitude similar to that of an ordinary receiving apparatus. There is no difficulty in producing an electrodynamometer of sufficient sensibility to enable a telephonic current strength to be measured under laboratory conditions, but such an apparatus has relatively large inductance, and at a frequency of 1,000 ∼, such inductance develops 6,283 ohms reactance per henry. The device selected for the purpose (with Prof. Fessenden's permission) was the "solid barretter" used in the Fessenden system of wireless telegraphy. This consists of a minute loop of very fine platinum wire or filament. Out of several sizes of platinum filament tried, the size which gave the best results has a diameter of about 1·7 microns (1·7 μ=0·0017mm.=0·000067) and a length of about 1·5mm. (0·06). The resistance of this filament is about 40 ohms per millimeter, or 1,000 ohms per inch, at room temperatures. Such a filament has a cross-section of 2·27 × 10^{-8} sq. cm. (3·5 × 10^{-9} sq. in.), and a volume of 3·4 × 10^{-9} cubic cm. With the specific gravity of 17·5 for platinum, the mass of the filament would be 6 × 10^{-8} gramme, and with the specific heat of 0·0323 for platinum, 1 erg of heat, accumulated in such a filament, would suffice to raise its temperature 12·3°C.

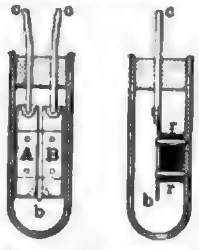


FIG. 1.—FRONT AND SIDE ELEVATION OF BARRETTER.

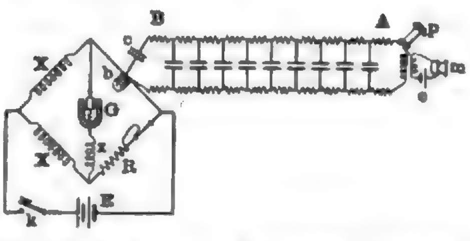


FIG. 2.—CONNECTIONS OF LABORATORY BARRETTER TESTS.

To produce a platinum filament of such dimensions, the Fessenden device is seen in Fig. 1. A and B are two brass strips (25mm. × 6mm. × 0·7mm.), pinned, side by side, to a hard-rubber supporting block, *rr*. Copper connecting wires, *c*, *c*, are soldered on above. A short v-loop of silver wire, *b*, is soldered as a bridge at the lower ends. This silver wire has a diameter of about 0·075mm. (3 mils), and has a central filament of platinum running through it, like the wick within a candle. The point of the silver v is dipped below the surface of strong nitric acid for a few minutes, and with the aid of a current of some milliamperes from a voltaic cell the silver is rapidly dissolved away, leaving the platinum filament intact. The process is watched under a microscope, and stopped when the estimated right length of platinum filament has been exposed. The barretter is then protected from injury by being enclosed in a short glass test-tube containing air at the ordinary atmospheric pressure.

In one of the Fessenden systems of wireless telegraphy, a barretter of this kind is connected between the receiving air-wire and the ground. The passage of the feeble electromagnetic waves through the apparatus generates in the filament a small amount of joulean heat, and the sudden small change in the temperature of the filament produces a correspondingly sudden small change in its resistance.

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* Abstract of a Paper read before Section G of the St. Louis Congress.

By means of a telephone connected in a local circuit through the barretter, the sudden fluctuations of resistance due to the passage of electromagnetic waves produce audible signals.

In adapting the Fessenden barretter to the telephonic circuit test, the arrangement of Fig. 2 was employed. Here the barretter b is made one arm of an *inductive* Wheatstone bridge. X, X, are two similar coils of low temperature-coefficient resistance wire, wound upon closed magnetic circuits of steel wire, so as to have each 500 ohms resistance, and a relatively large reactance. A smaller reactance coil, x, of low resistance, of copper-wire winding, was included in the galvanometer branch. The galvanometer G is a wall-pattern d'Arsonval reflecting galvanometer of 620 ohms resistance, with a telescope and a scale at about half-meter distance from the mirror. No attempts were made to secure extraordinary sensitiveness, and 1mm. of deflection in the telescope represented approximately 10^{-8} ampere. The testing battery consisted of two storage cells (4.0 volts total E.M.F.) The platinum filament in the barretter had a length of about 5mm., a diameter of 3μ, and a resistance of about 125 ohms at ordinary temperatures. Under these conditions a steady battery current of about 6 milliamperes passed through the barretter, raising its temperature some 25°C. A balance at R, aided by a slide wire, r, was secured at about 135 ohms.

If feeble alternating currents are sent through the barretter, superposed upon the steady testing current, they are practically confined to the arm b of the bridge by the reactances X, X, x, and heat the filament above the temperature due to the testing current. It may be shown that for *small* alternating currents, the change in the resistance of the barretter is proportional to the square of the strength of the superposed alternating current.*

As shown in Fig. 2, the barretter b was connected at the receiving end of an artificial telephone cable lent by the American Telephone and Telegraph Co. This artificial cable has a conductor-resistance of 2,820 ohms, and a capacity of 1·92mfd. at 15°C. Its cr time constant was, therefore, 0·0054 second. The cable represents 32 loop miles of standard underground cable of No. 19 B and S copper wire (88 ohms and 0·060mfd. per loop mile). The electrical length of this artificial cable could be adjusted to even miles. With the condenser c short-circuited, and a balance in R of 130 ohms, loud singing into the transmitter at A, operated by one storage cell, or two volts, produced a distinct deflection on the galvanometer G, representing a received current strength of nearly 100 microamperes, over the 32 miles of cable. This length represents the limit of "easy commercial" telephonic conversation. As the length of artificial cable in circuit was reduced, the strength of the received current increased, roughly as the inverse square of the length.

It was found practically impossible to obtain steady readings of the current strength received through the barretter either over different lengths, or even over one and the same length, of the artificial cable, owing to variations in the transmitting apparatus, including the singer. The galvanometer showed that the intensity of the note delivered by the singer could not be steadily sustained for even a few seconds. Moreover, the difference in the effective current at the receiver due to variation in the distance between the lips and the transmitter was very remarkable. The current received, when the lips of the singer were only a few centimetres from the transmitter, was only a small fraction of that received when the lips almost touched the transmitter cone. It was evident, therefore, that the conditions of sound production at the transmitter would have to be standardised if consistent and reproducible measurements were to be secured.

A short standard organ pipe was lent for this purpose by Prof. W. C. Sabine of the Jefferson Physical Laboratory. This pipe sang a fairly pure note of C = 512 ∼. It was connected by an electromagnetically controlled valve to a small air-holder, which, descending under a constant imposed weight, maintained a nearly constant amplitude of sound at the lips for half a minute at a time. By setting this pipe immediately facing the transmitter, and at a carefully maintained distance therefrom, fairly consistent measurements of alternating-current strength were obtained with different lengths of cable in circuit. The results are indicated in the curve, Fig. 3. It will be seen that the received-current strengths are roughly proportional to the inverse squares of the lengths of the cable, the inductance of which was negligible. The received current varied from 0·13 milliampere at 32 miles to 1·16 milliamperes at 13 miles. The dotted line represents the calculated values, taking E = 1·74 volts. It will be seen that there is a rough agreement between the observed and computed current strengths. The sources of the discrepancy between them were not, however, investigated.

It is evident that the sensibility of the test depends upon the smallness of the filament's diameter, so that it may become heated by a feebler alternating current, and also upon the minimum increase in resistance that can be accurately determined by the Wheatstone bridge. With three-micron wire this was about $\frac{1}{100}$ of 1 per cent. This represented the effect of a telephonic current strength of 23 microamperes. With 1·7 micro wire in air, the limit was reduced to about seven microamperes, and with the same 1·7 micron wire *in vacuo*, to three or four microamperes.

Although such degrees of sensitiveness are attainable under laboratory conditions, and might suffice for measuring telephonic conversation currents at the receiving end of long circuits, yet the reflecting galvanometer is quite unsuited for routine tests at the switchboard. Any galvanometer that can at present be used under switchboard conditions is much more limited in sensibility. If, however, the limit of resistance change to be detected is increased from $\frac{1}{100}$th of 1 per cent. to $\frac{1}{10}$th of 1 per cent., the minimum measureable telephonic current strength becomes about $\frac{1}{2}$ milliampere, with 1·7 micron wire in air. This current strength can be supplied over the longest commercial telephone circuits if an effective impressed alternating E.M.F. of about 25 volts be substituted, at the sending end, for the transmitter. That is to say, routine tests using switchboard instruments become quite practicable if a standard 25-volt alternator of telephonic frequency can be applied at the sending end of each circuit to be tested.

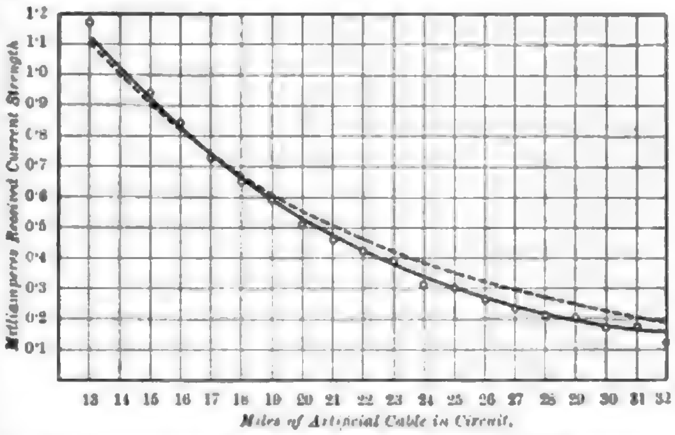

FIG. 3.—CURVE SHOWING RECEIVED CURRENT STRENGTHS AT EACH SUCCESSIVE MILE LENGTH OF ARTIFICIAL CABLE BETWEEN 13 AND 32 MILES.

Dotted line gives computed curve for constant E.M.F. impressed = 1·74 volts effective.

In order to adapt the apparatus in this manner for switchboard use, a Weston milliammeter, in series with the barretter, was substituted for the reflecting galvanometer and Wheatstone bridge.

The connections of the switchboard apparatus are indicated in Fig. 4, where b is the barretter, with a 2-mfd. condenser in its circuit, to stop the testing current, supplied by the dry cell c, from flowing around the telephone circuit; x is a reactance coil to stop the telephone current from being diverted through the Weston milliammeter m, which gives a full-scale reading of 10 milliamperes over 100 divisions of $\frac{1}{10}$th milliampere each. The dry cell c has an E.M.F. of 1·45 volts, and an internal resistance of less than 1 ohm. The resistance of the local circuit is adjusted, with the aid of the rheostat r, until the full deflection of 10 milliamperes is obtained. This requires 145 ohms in the circuit, of which about 120 are in the barretter, at working temperature, 8·5 in the reactance coil x, 4 in the milliammeter and the remainder, or 12·5, in the dry cell and rheostat r.

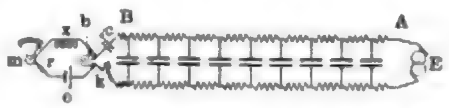

FIG. 4.—BARRETTER AND MILLIAMMETER AT RECEIVING END OF CIRCUIT OPERATED BY ALTERNATOR.

Pressing the key k allows alternating current from the source E to pass through the barretter, thereby heating it, increasing its resistance, and temporarily reducing the current in the local circuit. Each division of the milliammeter scale represents 1 per cent. of the testing current, and $\frac{1}{10}$th of a division or 0·1 per cent. can be readily estimated. A convenient strength of alternating current is one which will reduce the testing current 1 per cent., or one scale division. The action is very prompt and dead-beat, so that the needle's deviation follows at once upon the movement of the key. It may be shown, that the strength of the received alternating current is equal to the square root of the needle's deviation in scale divisions, on pressing the key, multiplied by an instrument-constant, depending on the barretter.* Thus in the actual instrument one division of deviation from the full-scale reading represents 1·4 milliamperes of superposed alternating current, with shunt multiplier of unity.

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* This proof is given in an appendix to the original Paper.—[ED. *E.*]

* This proof is given in an appendix to the original Paper.—[ED. *E.*]

The source of standard alternating E.M.F. E employed with the switchboard testing set was a small 12-pole inductor alternator, weighing about 2kg., and originally designed for a very different purpose. When belt driven, this little machine could readily deliver a few milliamperes at a frequency of 1,200 ∼, and when directly connected to a small motor, 600 ∼. The rotor consisted of a laminated inductor cylinder with grooves and polar projections. Owing to the peculiar magnetic actions set up during operation, the frequency delivered was very impure. Thus, when running at a speed corresponding to the principal frequency of 1,200 ∼, there was a prominent undertone frequency of 600 ∼, in addition to overtones of 1,800, 2,400 and higher orders. Moreover, the pressure regulation of this little alternator was very defective, the voltage at terminals varying greatly with the nature and impedance of the circuit to which it was applied. Consequently, although this was the only convenient source of telephonic-frequency E.M.F. available, yet it left much room for improvement. An ideal source of alternating current for these tests should be simple, reliable, consume little power, having constant frequency and terminal E.M.F. with a pure sine-wave.

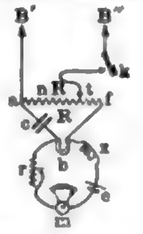


Fig. 5.—Connections of Barretter High-frequency Milliammeter for Telephone Circuits.

Since the 1·7 micron wire melts at approximately 14 milliamperes in air at ordinary pressure (about 2·5 milliamperes *in vacuo*), and the steady testing current is 10 milliamperes, the barretter must be protected from alternating currents of more than 3 or 4 milliamperes. It becomes desirable, therefore, to protect the barretter by an adjustable shunt, as shown in Fig. 5. Here R is a resistance of 2,000 ohms, permanently bridged across the barretter *b* and 2mfd. condenser *c*. By shifting the contact *t* to points distant *n*R ohms from *a*, where *n* = 1, ½, ⅓, ¼, ⅕, &c., successively, the multiplying power of the shunt is made 1, 2, 3, 4, 5, &c., on the principle of the Ayrton universal shunt.

The actual connections employed differ only from those of Fig. 5 by the insertion of compensating resistances in the wire *kt*, so as to keep the impedance of the apparatus constant under all conditions, and about equal to that of an ordinary telephone receiving apparatus at the testing frequency. In the case considered, the frequency selected was 600 ∼, and the constant impedance, including barretter, condenser and universal shunt, 529 ohms. The full connections are given in Fig. 6.

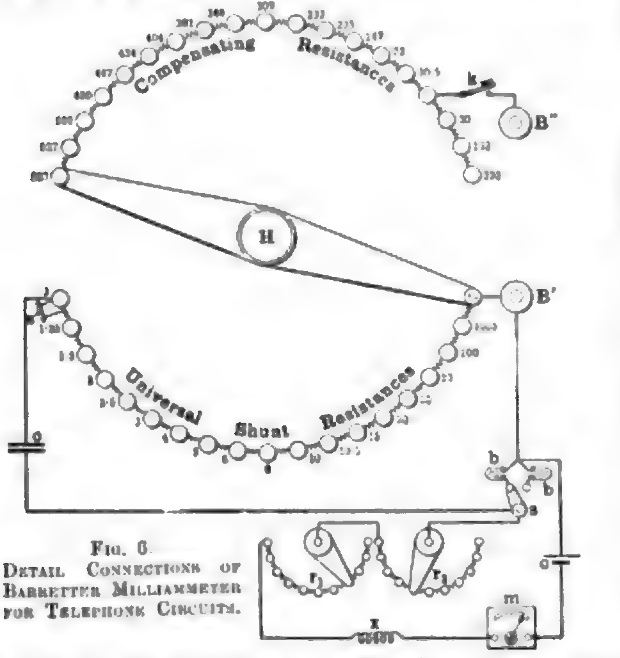


Fig. 6.
Detail Connections of Barretter Milliammeter for Telephone Circuits.

B' B" are the line terminals, connected to the telephone circuit under test, at its receiving end. H is a double-ended ratchet switch, bridging diametrically across the two semicircular rows of contacts. The upper contacts are separated by the compensating resistances. The lower contacts belong to the universal shunt. In the position shown, the barretter *b* and condenser *c* are entirely short-circuited, or shunted with a multiplying-power *a*; while the impedance of the apparatus, between line binding posts, is 529 ohms, when the key *k* is depressed. On turning the handle H clockwise from this initial position, the multiplying power of the shunt is gradually reduced to 1, in 18 steps. By this means the instrument has a theoretical range of measurement from 0·5 milliampere to 1,000 milliamperes.

Two barretters, *b*, *b*, are installed, under the control of the switch *s*, one for working and the other for reserve in case of accidental fusing. The adjustable rheostats r_1, r_2 of ½ ohm and 5 ohm steps respectively enable the testing current from the dry cell *e* to be kept constant at 10 milliamperes, except at such moments when the key *k* is depressed. The barretter receiving apparatus was constructed by the International Instrument Co. of Cambridge for the engineering department of the American Telephone and Telegraph Co.

The process of testing a circuit with this apparatus consists in applying the required voltage and frequency of alternating E.M.F. at the sending end of the circuit, connecting the receiving ends to the line terminals B', B", adjusting the steady testing current to the precise value of 10 milliamperes, pressing the testing key with the left hand, and turning the handle of the universal switch with the right hand from point to point by ratchet until a suitable small deviation of the needle is observed with the magnifying glass on the milliammeter scale. The square root of this deflection times the shunt multiplying power, times the instrument constant, gives the effective alternating current in milliamperes received through the 529 ohms impedance in the instrument. From this current, and the applied effective E.M.F., the receiving-end impedance follows at once by Ohm's law. If the impressed E.M.F. is pure, or simply harmonic, this observed receiving-end impedance can be compared with its computed value, for the frequency employed. If the E.M.F. is a complex harmonic, the observed receiving end impedance can be compared with that similarly observed on varying lengths of artificial standard underground cable. The comparison will show whether the circuit under test is in satisfactory telephonic condition.

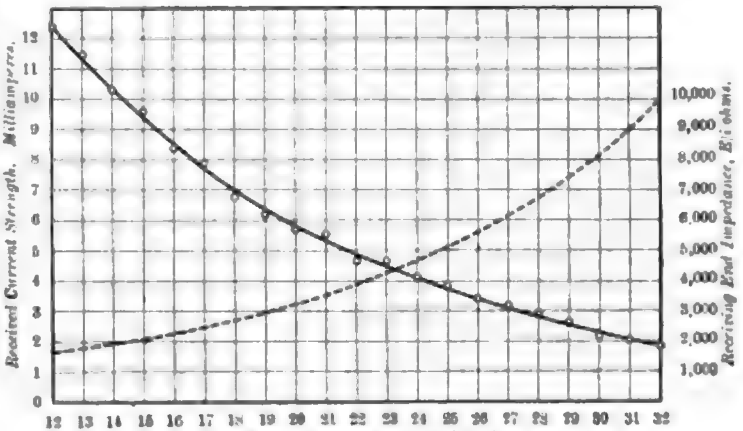


Fig. 7.

Full line—Received current strengths over successive lengths of artificial standard cable.

Dotted line—Receiving end impedance of successive lengths of artificial standard cable. Including Barretter apparatus. Frequency 800 ∼.

The curves of Fig. 7 show the current-strengths received with this apparatus through successive lengths of the artificial standard underground cable above described, and also the corresponding receiving-end impedance. In this case the E.M.F. E had a magnitude of from 18 to 20 volts, varying with the length of the circuit, and the frequency was 800 ∼ with components of 480 ∼ and upper harmonics. It will be seen that the received current strength increased from 1·85 milliamperes at 32 miles to 12·85 milliamperes at 12 miles, and the receiving-end impedance from 1,650 ohms at 12 miles to 10,000 ohms at 32 miles, with the particular frequencies used. With lower frequencies these impedances would ordinarily be less, and with higher frequencies greater.

The following table gives a few measurements made with the apparatus over various looped circuits, the inductor alternator and the barretter receiving apparatus being in the same room, near the switchboard. The frequency was 600 ∼ (with 300 ∼ and other harmonics):

Length of circuit loop. Miles.	Wires. Gauge.	Applied E.M.F. Volts.	Received current.			Receiving end impedance. Ohms.
			Deflection divs.	Shunt.	Milli-amp.	
470	8 B.W.G.	5·9	0·5	1·0	0·99	5,960
470	8 B.W.G.	25·0	1·0	3·0	4·20	5,950
470 + 1 mile ar. cable.	8 B.W.G.	26·0	0·8	3·0	3·75	6,925
" " " "	..	..	1·2	2·5	3·84	6,760
235 + 235 } 470	{ 8 B.W.G. 12 N.B.S.G. }	24·0	1·0	1·0	1·4	17,150
235 + 235 } 470	{ 12 N.B.S.G. 8 B.W.G. }	30·0	1·2	1·0	1·53	19,600
470	12 N.B.S.G.	30·0	0·1	1·0	0·442	67,800
25	Art. cable.	28·0	0·8	3·0	3·75	7,470
26	Art. cable	28·0	0·65	3·0	3·376	8,280

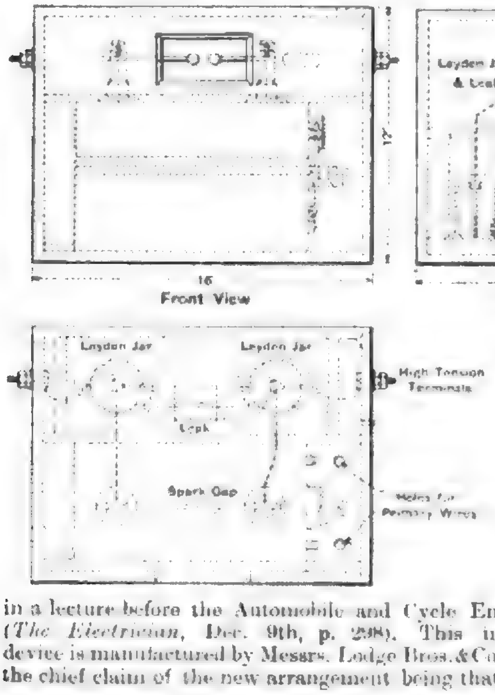
The engineering department of the American Telephone & Telegraph Co. has made a series of tests with the apparatus from day to day, on a loop of open-wire circuit from Boston to Bedford, N.Y., and return, with a view to ascertaining the variations which might occur in repeating the received-current test on the same circuit day after day under conditions kept as nearly the same as possible. Owing to the fact that no high-frequency alternator has been available of sufficiently good regulation to afford a constant impressed voltage from day to day, the impressed voltage at the sending end had to be observed simultaneously with the current at the receiving end. The observations are tabulated below. It will be seen that the receiving-end impedance varied from 10,600 ohms to 13,000 ohms, being affected apparently by the insulation of the circuit.

Table I.

Date.	Impressed voltage.	Barreter number	Insulation of circuit meg.-miles.	Shunt multiplier.	Deflection.	Receiving end impedance ohms.
July 22	33·85	7	6·67	1·25	2·0	12,800
22	33·85	9	6·67	1·25	1·9	13,100
26	30·78	7	9·85	1·25	1·8	12,200
26	30·78	9	9·85	1·25	1·6	13,000
27	30·78	7	8·53	1·25	1·9	11,900
27	30·78	9	8·53	1·25	1·7	12,600
28	30·78	7	5·14	1·25	1·8	12,200
28	30·78	9	5·14	1·25	1·7	12,600
29	30·78	7	13·26	1·25	1·8	12,200
29	30·78	9	13·26	1·25	1·7	12,600
Aug. 5	30·16	7	8·93	1·25	1·7	12,300
5	30·16	9	8·93	1·25	1·8	12,000
8	29·54	7	5·43	1·25	1·7	12,100
[illegible]	29·54	9	5·43	1·25	1·7	12,100
10	30·78	7	2·35	1·25	1·8	12,200
10	30·78	9	2·35	1·25	1·7	12,600
11	30·16	7	[illegible]·53	1·25	2·0	11,400
11	30·16	9	8·53	1·25	1·7	12,300
12	30·78	7	6·93	1·25	2·0	11,600
12	30·78	9	6·93	1·25	1·9	11,900
14	30·78	7	0·63	1·25	2·4	10,600
14	30·78	9	0·63	1·25	2·1	11,300
17	33·24	7	12·08	1·25	2·1	12,200
17	33·24	9	12·08	1·25	2·0	12,500

Circuit tests of loop of 384 miles of two No. 12 N.B.S.G. copper overhead wires (plus underground wires in Boston city limits). Resistance per loop mile, 10·5 ohms. Capacity per loop mile, 0·008mfd. Inductance per loop-mile, 3·66 millihenrys. Insulation as above. Frequency about 300.

THE LODGE ELECTRIC IGNITER FOR INTERNAL COMBUSTION ENGINES.



LODGE ELECTRIC IGNITER FOR INTERNAL COMBUSTION ENGINES.

We are now able to give some further particulars of the Lodge electric igniter for gas engines, which was referred to by Sir O. Lodge in a lecture before the Automobile and Cycle Engineers' Institute (*The Electrician*, Dec. 9th, p. 298). This improved ignition device is manufactured by Messrs. Lodge Bros. & Co. of Birmingham, the chief claim of the new arrangement being that the firing of the explosive charge is rendered quite positive and independent of leaks due to moisture or soot at the sparking plug. The figure shows the general arrangement of the apparatus, whose constituent parts are an induction coil, two Leyden jars, a leak and a spark-gap. The primary of the induction coil is fed from an 8-volt secondary battery, the current being given a pulsating character by a trembler or any other suitable device. It will be seen from the drawing that the secondary of the high-tension induction coil is connected up to the outer coatings of two Leyden jars, the inners of which are connected to the adjustable spark-gap. This spark-gap is an auxiliary device for producing well-defined disruptions, and must not be confused with the working spark-gap within the engine cylinder. The last-named spark-gap is connected directly to the two high-tension terminals of the induction coil, one of the connections being usually formed by the bed-plate of the engine. In order that the Leyden jars may be charged it is necessary to have some form of leak between the outside coatings of the jars. This leak must be of sufficient value to allow the jars to charge rapidly and yet not diminish the volume of the spark in the cylinder by allowing the discharge current to pass through it. In the case of the gas-engine igniter a special form of liquid resistance is used, which offers a fairly good path to the charging current, but offers a large resistance to the oscillating discharge. The jars have a capacity of the order of 0·0001mfd.

PHYSICAL SOCIETY.

At a meeting of the Physical Society held at the Central Technical College, on December 9th, Dr. R. T. Glazebrook, F.R.S., President, in the chair, a Paper on

"A High Frequency Alternator"

was read by Mr. W. DUDDELL. The author described and showed in action a high-frequency alternator which he had constructed in 1900 for some experiments on the resistance of the electric arc, and with which frequencies up to 120,000 ∾ per second had been obtained. The alternator consists of an inductor, built up out of ferrotype plate, having V-shaped notches cut in its edge so as to have flat-topped teeth. Surrounding the indicator is a laminated ring having two inwardly projecting poles, the clearance between these and the teeth of the inductor, which formed the air-gap, being less than 0·1mm. The ring is wound so that a direct current flowing round the winding tends to produce lines of force from one pole to the other through the inductor. The number of lines of force varies from a maximum when the teeth of the inductor are opposite the poles, to a minimum when the poles are in front of the spaces. This variation in the total number of lines of force produces alternating E.M.F.s in any winding either on the pole-pieces or on the ring itself; the movement of the inductor through the distance between two consecutive teeth producing one complete period. One winding on the ring could serve to carry both the direct field-current which magnetises the ring and the alternating current produced. In practice, owing to the great importance of any self-induction in the alternate-current circuit, it was found advisable at high frequencies to use separate windings for the two currents. At the highest frequencies the best results were obtained with coils having a few turns of wire fixed right on the tips of the poles. The alternator is driven by means of a figure-of-eight belt drive from two phosphor-bronze discs. Each of these discs is belted to a double-grooved pulley fixed on the shaft of a direct-current driving motor. With this method of drive the inductor was run for several months at speeds between 30,000 and 40,000 revs. per min., and the spindle of the inductor alone could be easily run at 60,000 revs. per min. Using inductors having 30, 60, 90 and 204 teeth, the author obtains small alternating currents having frequencies from a few hundred periods per second up to 120,000 ∾ per second. An illustration will perhaps convey some idea of how high a frequency of 120,000 ∾ per second really is. In plotting curves for ordinary frequencies of 50 to 100 ∾ per second a scale often adopted is 10in. for 100 ∾. If it were attempted to plot a curve up to 120,000 ∾ per second to this scale, the curve paper would require to be 120,000in., or nearly *one-fifth of a mile long*. Many difficulties were encountered with the centrifugal forces on the driving belt, and the author finally obtained the best results with a spliced cotton cord. Working drawings of the alternator, characteristic curves and its wave-form are given in the Paper. During the construction of the alternator bicycle wheels were used to drive it, and curves are given showing the very large power taken to drive these wheels owing to air friction. A table is given of all the high-frequency alternators which have come to the author's knowledge, and he would be glad to receive any missing data or data of other machines to include in the table before it is finally printed.

Dr. J. A. FLEMING said he had felt surprised on hearing about Mr. Duddell's alternator that he had been able to reach any such frequency as 120,000 ∾ per second. It spoke highly of the excellent mechanical means employed. On the other hand, as far as its use in wireless telegraphy was concerned, it was no use to speak of a machine even if it gave this frequency, corresponding to a wave 1¼ miles in length, if the output of the machine were only a few watts. If it were 150 H.P. it might be different. The difficulty with most high-frequency alternators was the magnetic leakage. Dr. Fleming then described some of the devices adopted by Tesla for obviating this defect. Many of the high-frequency alternators made had their power over-estimated. Hitherto the frequency reached had been only about 10,000 ∿ per second. A machine of this last frequency would be no particular assistance in wireless telegraphy. Such machines were, however, very useful for research and demonstration purposes.

Prof. W. E. Ayrton gave an "Exhibition of Experiments to show the Retardation of the Signalling Current on 3,500 miles of the Pacific Cable between Vancouver and Fanning Island." The experiments were performed upon a cable electrically equivalent to the portion of the Pacific cable between Vancouver and Fanning Island, the product of the capacity (in mfds.) and the resistance (in ohms) being nine millions. Three dead-beat galvometers were employed to indicate the current at the beginning, in the middle and at the end of the cable. It was shown that upon applying an E.M.F. at one end of the cable the current at that end was enormously greater than its steady value, and that one-fifth of a second elapsed before any indications of current were shown at the far end of the cable. By that time the current at the sending end was 8·7 times its steady value, and after two-fifths of a second it had fallen to 2·3 times its steady value. In about five seconds the current became steady.

The electrical laboratories of the college were open to the inspection of Fellows, a special feature being an exhibition of Ayrton-Mather galvanometers (showing the evolution of the present commercial instruments from the earliest types, constructed in the college), universal shunts and electrostatic instruments.

BILLS IN PARLIAMENT NEXT SESSION.

We conclude below particulars of the bills of electrical interest which have been deposited in the Private Bill Office. Last week we gave the electric lighting and power bills and the combined electric supply and traction bills.

Traction Bills.

Baker-street & Waterloo Railway Co. seek further powers with regard to the purchase of additional lands, an extension of time for the compulsory purchase of lands authorised in previous acts, and an extension of time for the construction of subways, &c., thereon.

Edgware & Hampstead Railway Co. ask for a three years' extension of time for the completion of works under Act of 1902 and a similar extension of time for the compulsory purchase of lands under the 1902 Act. Abandonment of certain portions of the authorised railway is proposed, and powers to deviate vertically and laterally are also included.

Great Northern, Piccadilly & Brompton Railway (No. 1) Bill gives power to raise additional capital and to build a line from the Holborn station to Waterloo via Kingsway. Line is to be completed within five years, and interest to be paid out of capital during construction at rate of 3 per cent. per annum.

Great Northern, Piccadilly & Brompton Railway (No. 2) Bill extends the company's line from its western terminus via Kensington, along the same route as that scheduled by the Central London Railway to the City and thence to Aldgate. Twin tunnel construction will be adopted throughout, and the line is in no place to be less than 28ft. below the surface. Intercommunication with other railways so far as stations, subways, &c., is concerned, is provided for. Provision is also made for approval by the Board of Trade of the permanent way, tunnels, platforms, stairways, lifts and other communication; rolling stock, lighting and ventilation. Intercommunication by through booking is proposed with the London United Tramways Co., and other agreements are proposed. Additional capital to the extent of £4,200,000, with one-third borrowing powers, is to be raised, and 3 per cent. interest out of capital during construction is to be paid.

Coventry Electric Tramways Co. ask for an extension of time for the construction of certain tramways authorised in 1903.

The Wemyss Tramways Bill gives Mr. R. G. E. Wemyss, of Wemyss Castle, power to construct certain tramways in Kirkcaldy in the County of Fife and to take lands for generating station. The lines would be purchasable by the Kirkcaldy Corporation at the expiry of five years and at the end of every subsequent period of five years. The tramways to be completed within five years. Agreements with local authorities may be entered into for the supply of electricity, or the lines may be transferred to a company.

Central London Railway Co. wish to extend their line from Shepherd's Bush down to Hammersmith and thence via Kensington, the Strand, and Fleet-street to Liverpool-street, joining up with the terminus of the existing railway at the Bank. The majority of the line will be in separate tunnels for up and down traffic, as on the present railway, but a certain portion of the double track at the Shepherd's Bush end will be in one tunnel. The usual powers to deviate laterally and vertically are taken. Elaborate provision is made in the bill for the protection of property and especially public buildings. Line to be completed within five years of the passing of the act. Capital powers £3,150,000 share capital and one-third borrowing powers. Interest out of capital during construction at the rate of 3 per cent.

Charing Cross, Euston and Hampstead Railway Bill confers further powers in respect of lands and authorises agreements with other railway companies as to use of stations, subways, lifts, &c.

Birmingham Corporation General Powers Bill includes proposals to construct a large network of new electric tramways, the reconstruction of existing tramways for electrical working and the purchase of land for generating station, tramway depots, &c. It is proposed to borrow £295,530 for the construction of the new tramways, repayable in 30 years; £554,820 for the reconstruction of existing tramways, repayable in 30 years, and £202,200 for land for generating station, tramway depots, &c., repayable in 60 years.

Blackpool, St. Anne's and Lytham Tramways Co. seek reciprocal running powers over the Blackpool Corporation tramways, the terms and conditions to be determined by an arbitrator if no agreement is come to.

Glasgow Corporation (Tramway Consolidation Provisional Order) propose to consolidate their various tramway powers, which date as far back as 1870. New lines are also proposed.

Paisley District Tramways Co. in a Scottish Provisional Order wish to construct additional tramways, to run omnibuses and raise £50,000 additional capital. The bill also seeks to increase the period of purchase of the new lines from 21 years to 40 years, purchase to then take place upon the terms of the Tramway Act of 1870. Authority is also sought to enter into agreements for running powers with the Glasgow Corporation or any other body possessing tramways.

London County Council (Tramways) Bill again proposes the continuation of the existing tramways from the terminus on the southern side of Westminster Bridge over the bridge, along Victoria Embankment and over Blackfriars Bridge, making a junction with the existing lines there. New tramways are also proposed in the Brockley and Crystal Palace districts. Certain short lengths of tramways authorised last year it is proposed to abandon, and an extension of time is asked for in respect of other lines authorised in 1900. The period for construction of the new lines is put at seven years. Power to work the Vauxhall Bridge tramways, authorised in 1896, electrically is also sought.

London United Tramways Co. seek extensions of time for tramways in Malden and Coombe authorised in 1901 for two years from Aug. 17, 1905, tramways sanctioned by 1902 Act for two years from Aug. 8, 1905, and for the purchase of land in Hammersmith under 1902 Act two years' extension from Aug. 8, 1905.

Whitechapel and Bow Railway Co. wish to raise additional capital and to enter into agreements with the Underground Electric Railways Co. of London.

Buenos Ayres Grand National Tramways Co. seek to confirm an agreement for the amalgamation of the Buenos Ayres Grand National Tramways Co. and the Buenos Ayres New Tramway Co., to increase and rearrange the capital, deal with the arrears of dividend on the preference shares of the Grand National Tramways Co., and modify the rights of the preference shareholders and holders of debentures and debenture stock issued by both companies.

Liverpool Corporation Tramways Bill provides for the incorporation of previous powers and the construction of new tramways in Liverpool and Bootle. New lines to be completed in five years.

Gosport & Fareham Tramways Bill, promoted by the Portsmouth Street Tramways Co., proposes the construction of additional tramways in Gosport and Alverstoke and an extension of time for the already authorised tramways. New lines to be completed within five years under penalty of £50 per diem. Powers are also taken to run omnibuses and to abandon certain already authorised lines.

Colchester & Southend Light Railways Co.'s Bill provides for the working of the lines of the company by electricity.

South Lancashire Tramways Co.'s Bill seeks an extension of time for the compulsory acquisition of certain lands under acts of 1900 and 1901 and the abandonment of certain authorised tramways. A scheme is also proposed for the consolidation of the shares of the company with the absorption of the South Lancashire Electric Power & Traction Co. Power to arrange for the purchase of the various portions of the company's undertakings by the local authorities at varying dates is asked for, and also power to take a transfer of other undertakings.

Swansea Corporation Bill provides for the acquisition of the tramway undertaking of the Swansea Tramways & Improvements Co. by notice within six months of Feb. 28, 1906, or within six months of the expiration of every subsequent seven years. The purchase is to be made under sec. 43 of the Tramways Act, 1870, and the Corporation may re-lease the undertaking to the company. These provisions would have the effect of repealing certain sections of the Company's Act of 1882. Power is also taken to borrow sufficient sums to conclude the purchase, such sums to be repaid within 60 years.

Hammersmith, City and North-East London Railway Bill seeks power to incorporate the Hammersmith, City and North London Railway Co. for the construction of a deep level tube railway from Hammersmith, via Kensington, the Strand and the City, to Shoreditch, with branches from there to Walthamstow on the one hand, and Palmer's Green via Tottenham on the other. The promoters are Arnold F. Hill, David Urquhart and James Westfield, who are also to be the first directors, with four others to be nominated. The capital of the company will be £7,200,000 in £10 shares, with the usual one-third borrowing power. As in the case of the other tube railways, the Board of Trade is to inspect the permanent way, tunnels, platforms, stairs, lifts, rolling stock, lighting and ventilation. The line is to be completed in five years and a substantial commencement made within 12 months of the passing of the act. The statutory fare is placed at 2d. per mile or part of a mile for passengers, no goods being carried. Powers are taken to arrange for through bookings with the Middlesex County Council tramways, and working agreements with other companies as well as agreements for the supply of electricity. Interest out of capital will be paid during construction at the rate of 3 per cent.

North-East London Railway Bill seeks to incorporate the North-East London Railway Co. for the construction of a tube railway starting at a point near the Monument station of the District Railway Co. on to High-street, Shoreditch, and thence via Walthamstow, Leyton, Chingford to Cheshunt. The capital of the company will be £3,000,000 in £10 shares and one-third borrowing power. The directors are the Hon. Reginald Parker, J. H. Buxton, C. J. E. Stuart and R. F. Collinge. Land for generating stations is scheduled in Hackney and Leyton, and all work is to be approved by the Board of Trade, as in the case of the other tube railway bills. The works are to be completed within five years. The statutory fare for a first-class passenger is 3d. per mile, and for a third-class passenger 1d. per mile, any passenger travelling less than 3 miles being charged for 3 miles. Powers are also taken to enter into agreements with regard to the supply of electrical energy. Interest out of capital during construction will be paid at the rate of 3 per cent.

Nottingham Corporation seeks to construct new tramways and to supply them with electrical energy from the existing generating stations. Periods for completion vary from two to five years. Omnibuses may be run, but if electrical energy is to be used the motive power must be contained within the omnibus. Borrowing powers, £5,700, repayable in 30 years. Powers are also taken to supply electrical energy in bulk outside the city boundaries.

Rhondda Urban District Council ask for an extension of time for three years from July 31, 1909, for the construction of tramways already authorised, and an extension of five years from 1902 for the compulsory acquisition of land authorised under the Council's Act of 1902.

Blackpool Corporation proposes to construct additional tramways along the Lytham-road, the period for completion being placed at two years. Agreements are also to be entered into with the Blackpool, St. Anne's and Lytham Tramways Co. for the construction of certain lines authorised to the company in 1901. It is also proposed to take general powers for entering into agreements for working tramways outside the borough.

Metropolitan Railway Co.'s Bill provides for the amalgamation of the undertaking of the Harrow and Uxbridge Railway Co., the consolidation of the convertible preference stocks and other financial adjustments.

Metropolitan Electric Tramways Bill authorises agreements between the company and the various local authorities for the purpose of modifying existing powers, and agreements between the company and the North Metropolitan Electric Power Supply Co. for a supply of electrical energy. The bill also provides for an extension of the period of purchase of the tramways in Edmonton and Wood Green, and also for making arrangements to defer the date of purchase generally.

Tyneside Tramways & Tramroads Co. seeks further capital powers.

Miscellaneous Bills.

Esk Valley Power Gas Co.'s Bill authorises the incorporation of a company, with a capital of £450,000 in £10 shares, for the supply of power gas in portions of the county of Midlothian. Land is scheduled for four power stations.

Channel Ferry, Railway & Quay (Dover) Bill takes powers, inter alia, to erect electric generating stations, but the specific object of this is not mentioned.

London County Council (General Powers) Bill deals, in part XV., with the question of electric wiring. It provides that it shall be lawful for metropolitan Borough Councils authorised to supply electric energy to expend money upon the wiring and fitting up of premises for electrical supply, and to enter into and make agreements in connection therewith. The money to be spent for such purposes is to be borrowed as if for the purposes of the Electric Lighting Acts as amended by the London Government Act of 1899.

Sheffield University (Transfer) Bill provides for dissolving University College, Sheffield, and the transfer of all properties and liabilities to the Sheffield University.

University College (Transfer) Bill provides for transferring University College to the University of London.

Medway & Thames Canal Co.'s Bill asks for an extension of time for three years from July 31, 1907, in which to carry out the works authorised in 1902. Electric haulage and lighting is proposed.

Electro-Pneumatic Tube System.—A proposal to lay down a system of pneumatic tubes for the conveyance of postal matter and parcels in London. Electric motors placed at various parts of the system are to drive the air compressors. Sir John Wolfe Barry and Col. R. E. B. Crompton are the consulting engineers.

Street Indicator for Tramcars.—According to the *Street Railway Review* of Chicago, a device to indicate the names of the street to the car passengers will be tried by the Cleveland Electric Railway Co. It is about the size of the fare indicator, and is placed in the forward end of the car. On the face of the dial are printed the names of the streets on the line in consecutive order, while below are numbers corresponding to the distance the given street is from the starting point of the cars. As the cars run along, a rod projecting from the top of the car strikes, just before it reaches every block, a weight suspended from one of the trolley suspension wires. This blow to the rod causes it to fly back, releasing a spring which moves the indicator point forward to the name of the next street. The indicator is set for a round trip and can be regulated by the conductor.

ON BATTERIES WITH REVERSIBLE BOOSTERS.*

BY C. TURNBULL.

A good booster should fulfil the following requirements:—

1. When required, it should work so as to keep the load on the generator approximately steady. This will be needed when the demand for current is approximately equal to the output of the generator. In this case, however, when a very heavy demand is made on the feeders, both generator and battery current should rise to meet it, so that the utmost power of the combination will be available. If this be not arranged, it will often be found that a heavy load will blow first one circuit breaker and then the other, although the combined maximum power of the battery and generator would have been sufficient to meet the demand had the booster been arranged to allow the generator output to increase along with the battery's output. (2) It should be possible to vary the apportionment of the load between the battery and generator. In a slack time the battery should do very little. Also, if the traction peak should correspond with the lighting peak, then it may be desirable to let the battery take an extra load to relieve the boilers for the time being. (3) On a slack day with occasional peaks, the battery and booster combination should be arranged to respond to the peaks only, and otherwise do practically nothing, so as not to overcharge the battery. Sometimes the booster may be cut out altogether, and the battery may then with advantage be used to float on the line to meet any occasional rush of current. (4) For periods of very light load, the booster and battery should be arranged to go on to the 'bus bars without any generator. In this case the booster should be arranged to compound up to counteract the drop of volts in the battery.

I might point out that a booster worked by the feeder currents only will not fulfil these requirements, as such a combination will tend to take the load off the generator when the battery is fully charged, while it will be sluggish and unresponsive when the battery is down at all in volts.

The actual work done by the cells when working with a reversible booster is very little. For although the curve of charge and discharge looks large enough in importance when it is examined on the recording ammeter chart, still the peaks integrate to very little. We, therefore, want a cell which will do with very heavy discharges, and also with considerable charges, but that does not necessarily have a large low-rate capacity. Durability is more important than efficiency. As a matter of fact, it is well known that a cell which receives charges and discharges at short intervals has an extraordinarily high efficiency, and a slight reduction in this, if it gave increased durability, would not matter. I have been informed by one of our leading accumulator firms that a cell to meet those requirements can be made and maintained at about half the ordinary price if it be asked for, and I hope that such will be on the market in the near future.

It is a great advantage to have the cell boxes large enough to allow of the addition of more plates. This enables the size of the battery to be kept down, as it is easy to increase its capacity. If, however, more plates are added, then it is not desirable simply to put the new plates in parallel with the old ones. Old plates should be taken from some of the cells to make up the additional number required in the other cells, and the cells thus depleted should be made up entirely with new plates. The space at the side is useful in assisting the much-desired circulation of the acid. It also enables the cells to be inspected by an inspection lamp on an L-shaped stick. This lamp put under the plates shines upwards and shows any shorts clearly. The space at the bottom of the cells should be ample, about 6in. or so, so as to obviate frequent cleaning.

The possible variation of cell voltage is from 1·8 to 2·7 volts per cell, the last figure being obtained with the fortnightly overcharge, which makers recommend to be given to the cells. In ordinary working the variation is from 1·9 to 2·5 volts. Provided that the booster is arranged to prevent the current from coming back on to the generator, the number of cells may be varied considerably. I think, however, that 250 cells is a suitable number where the 'bus-bar pressure is between 500 and 550 volts. If fewer cells be used, a good deal of work is thrown upon the booster to pump the current out of them, and if more cells are installed there is a danger of the current coming back on to the generator if they be floated on the line without the booster when fully charged.

The advice is sometimes given that the booster should be worked so that the battery is charged every night at shutting-down time. This is impracticable without an undue amount of attention. The most practicable way that I have found is as follows: During the morning, when the generator is started up, there is usually a slack time, so that it can be arranged that the battery is mainly charging. The battery attendant should be in the battery room now, and he should go round and see that every cell gasses up at the same time. He should watch the battery when it is gassing, and at the same time top up any cells with water if necessary. The water can be put in by a long glass tube, about 1½in. in diameter, with a bell mouth. This will enable the water to be put in at the bottom, and it can be stirred about and well mixed with the acid. The amount of gassing and volts per cell necessary on the daily charge should be determined by the battery makers, whose assistance should be freely requisitioned at first start up. When the cells are full up the attendant should inform the engine-room staff, so that the booster can be regulated, so that the battery can be discharged for a time rather than charged. When a little current has been run off, the adjustment can be made so that charge and discharge are about equal or as needed. This method of working the battery needs a minimum of attention, and will be found very satisfactory in practice. Once a fortnight—if required by the makers—an extra charge can be put in, which will bring the voltage up to 2·6 or 2·7 per cell. This should be done at a quiet time, when the charge can be put in fairly steadily. Condensed water from a boiler is not always suitable for filling up accumulator cells, as it may contain boiler compounds or iron. Rain water is often too impure. I think that a simple distiller could, however, be made by using a gas jet under a boiler. The steam would go through a worm, and would be cooled by water in a tank. After the worm had gone through this tank it would go through a second tank. The boiler and the two tanks would be connected by a pipe so that the water would stand in the same level in all. This would cause the boiler to be automatically fed with hot water. A tap could run into the last tank to keep up the level, and also to provide cooling water.

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* Abstract of a Paper read before the Newcastle Local Section of the Institution of Electrical Engineers on December 12th.

Too much light in a battery room is bad, as it renders cell inspection difficult. The room should be rather dark, with good artificial lighting. The wiring may be done on insulators. At intervals lamps should be provided on long flexes of 3/25 wire for looking into the cells from above. Hooks should be provided to hang these lamps on when not in use. I have found acid-resisting paint liable to chip off a concrete ceiling, but wood varnished with acid-resisting varnish has stood better. The ventilation should be good, but of a nature to prevent fly and dust from coming in too freely.

The milking booster should be run off the lighting circuit so as not to be shut off if the main circuit breaker of the traction generator is blown. It is a debatable point as to how the leads should be run for milking up the cells. Perhaps the best way is to run them under the grating on the floor, being supported on insulators. The flexible leads can be connected by means of screwed plug handles. A small switchboard can be fixed in one end of the room, or possibly in a small room provided for the purpose. Where the cells are on two floors the switchboard should be provided with one pair of switch fuses only, to connect either the upstairs leads or the downstairs leads on to the 'bus bars. The use of a single pair of switch fuses prevents any attempt to milk up two parts of the battery at once, as, of course, only one pair of flexible leads is kept in a room. The booster can be put in a convenient place, but the regulation of its volts can be done from the battery room. The booster may also be arranged to provide heavy currents for meter-testing purposes. The board should have a polarised ammeter and a voltmeter with paralleling and other stops on the switchboard. The grating for the battery-room floor can be made of rough wood dipped into melted pitch. This makes quite a cheap and satisfactory arrangement.

The breakers of the booster-motor and battery should be on the live side, but most of the rest of the instruments on the board may be on the earth side. The motor breaker should be arranged to shut off the battery current, if it comes out, so that the booster may not race owing to the battery current running through it. On the other hand, it is desirable to have the breakers arranged so that the blowing of the battery breaker does not stop the motor.

The abomination of several shunts in series—one for the ammeter, one for the recorder and one for the integrators—should be avoided. One shunt should do for the lot, or if two in series be used, then the instrument having the heaviest drop should come off the combined resistance of the two shunts. In this latter case the two shunts in series should be soldered together, so that the combined resistance could not be affected by bad contact.

The following is an abstract of the discussion which took place in connection with the above Paper:—

Mr. KIDMAN asked Mr. Turnbull whether his battery was specially designed for traction work, as battery-makers usually discouraged frequent small discharges and charges, as would be the case with a battery on a traction load working in parallel with a steam generator. He did not agree with any switches being placed in the battery room, not even lighting switches, and all wiring for lighting should be lead-covered, and the fittings ought to be acid-proof.

Mr. VESEY BROWN preferred hand regulation for lighting work; this also allowed the end cells to be fully charged. He had tried, unsuccessfully, to impress on manufacturers the necessity of having a 6in. clearance at the bottom of the plates to allow for sediment. In a battery room he had known ordinary rubber-covered wires lasting for 11 years, but lampholders occasionally fell off or caused short-circuits. He thought the Aron battery meter preferable to the motor type.

Mr. TURNBULL, replying to the discussion, agreed that it was not advisable to have switches in battery rooms. The objection to Aron meters was that the pawl in reversing sometimes slipped a notch, thus introducing an error into the readings.

CORRESPONDENCE.

ENGINEERING AND COMMERCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was engaged in the supervising and directing of a test on an 8,000 H.P. synchronous motor during the small hours of the day, and having a few minutes to spare I took up *The Electrician* of November 18th, in which you reprint Mr. James Swinburne's address to the students of the Institution of Electrical Engineers, entitled "Some Difficulties in Getting On." The early hour of the day, the strenuous work which had yet to be accomplished by my assistants and myself after we had been working for almost 24 hours continually, all this "unpaid-for" devotion did not harmonise with Mr. Swinburne's advice to the students—to take "a money view of everything." The address began to interest me, and I read it carefully, taking pains to keep it from my assistants for fear that they might take a "money view of the situation" and refuse to stay working in their clothes for another 12 hours needed to finish the tests on this largest of electric motors in the world.

Mr. Swinburne's address is entitled "Some Difficulties in Getting On." If this address were delivered to a heterogeneous class of students, not only of engineering, but of law, and of medicine, and of all other branches of human knowledge that can be studied at our colleges, the address might have been very much to the point. It is undoubtedly true that if you want to get on in the world you had better not study engineering or any other scientific pursuit. If Mr. Swinburne objects to the use of the word "scientific" let me say that knowledge is by no means desirable for getting on, and that I hold strongly that the adage attributed to Bacon, that "knowledge is power," requires emphatic qualification.

"Knowledge is power" in the hands of him who can wield it and put it to any use he pleases, but in the hands of most people knowledge is not power, because it controls them, and it is their master while it should be their servant.

When Mr. Swinburne states that "the business man comes out far away above the engineer. He employs the engineer; the scientific man is his servant," Mr. Swinburne is stating merely a matter of fact for which he is in no way responsible. This is a law of the social cosmos against which no amount of railing will avail. This is not due so much to the fact that young men's education nowadays consists more or less in the study of "Aztec Metempiries," it is due to the fact that both the average student and the average teacher are very average men. Education is given to the boy of very average intelligence by a teacher of very average intelligence, and hence the quality of the knowledge and of the teaching is very average, too. So that, even if knowledge *were* power, *that knowledge* which is taught need not be power at all.

Why is it, then, that the engineer is employed by the business man and not vice versa? The reason is obvious to anyone, although he will be better able to appreciate it if he has read and digested Mill's "Political Economy." It is a fact that capital is the mother of all labour, and that the engineer who wishes to market his ability needs capital, and plenty of it, to turn his ability to account. Shops in which machinery of any kind can be built are expensive, and weekly pay-rolls want to be met, and for all these things the engineer goes to the capitalist, and on account of these things he is the capitalist's servant and the capitalist is his master. This, again, is a fact derived from the laws of Nature for which the engineer is in no way responsible. "To him who hath shall be given," and as the capitalist can wait for years without starving, the engineer, whose only capital is his brains, wants to live, and therefore has to make a bargain with the capitalist to accept his services. This law of Nature which has made capital the mother of all labour, has placed the engineer where he is to-day. The business man without capital is in no better position than the engineer; on the contrary, his position is less enviable, as good business ability is not so rare as good engineering ability, which statement is proved by the fact which Mr. Swinburne can obtain by a study of the social conditions in the United States, that the business man without capital is paid less than the engineer without capital.

When Mr. Swinburne says that "a man's earnings is a rough test of his value to the world," I fear that Mr. Swinburne is making a statement which he learned in the study of "Aztec Metempiries." Money making is an art just as engineering or medicine is an art. The aim of a great engineer consists in engineering achievement of a high order. The aim of a great surgeon consists in surgical work of a high order. The aim of the money maker consists in making money of a high order. The standard of measure of greatness in the three professions is different, and hence it is illogical to apply the standard of money making to these three professions, as money making is only an incentive to the first two professions, and the aim of the third profession.

When Mr. Swinburne says, "Our leading consulting engineers do not spend a large portion of their lives plotting curves, counting electrons, or even making anything more than arithmetical calculations," I only have to say that—paraphrasing Mr. Swinburne's remark that "electric installation work is merely a sort of electric plumbing"—consulting engineering is mostly jobbing of electric apparatus. The commercial engineer is likely to be neither a first-class engineer nor a first-class money maker. He is average all the way through, average in intellect, average in engineering, average in money making. The money maker of ability will consider him a tyro in money making; the engineer of ability will consider him a tyro in engineering.

Again quoting Mr. Swinburne, he says "the engineer will remain in the middle position as long as he takes the middle view and considers engineering as something superior to money considerations, and as long as he looks down on business and commercial methods." Mr. Swinburne here forgets that as soon as the engineer emerges from the position thus outlined for him, he becomes a business man with an engineer's education. But who is going to do the engineering for him after he has entered into the commercial side of engineering? Somebody has to do the engineering work, and to him Mr. Swinburne's criticism will always apply. I have no patience with that cant which we fortunately do not hear so much of now-a-days as we did some 15 years ago, disparaging the commercial side of engineering work. It is necessary just as much as the purely engineering work is, and to whichsoever a man is best fitted, he should devote himself. But it is due to just such addresses as Mr. Swinburne's that engineering work of enormous commercial value is not duly appreciated by the business man with whom rests the fixing of the compensation for such work. Even engineering work of a very high order is generally under-paid. I do not mean by engineering work of a very high order merely, for instance, designing ability; I mean by it exceptional ability in designing apparatus which is commercial, and executive ability to direct the large number of assistants who are always needed in large manufacturing concerns.

The men who get on in the world are never of the common run. It seems to me that the hardships of the successful men who are engaged in professions requiring study and knowledge like engineering, law and medicine, are greater than the struggles of the business man, for the simple reason that the tools of the successful business man consist in capital, which is easily convertible into the commodities of life.

The work of the engineer is very much like that of the soldier. The soldiers in the army are numerous, the officers are few, the generals still fewer. Money is not the aim of the soldier, of the officer, of the general. The officer who fell in the relief of Lucknow would have made more money if he had stayed in Cheapside running a grocery.

There is much good in Mr. Swinburne's address, but much that is apt to misdirect the young man's mind. In positions requiring engineering ability, we need engineers and not commercial men, and if a man feels in him the faculty for making money, let him turn his ability into the channels of money making, and not into the channels of engineering. He will be more successful in money making than he will in engineering.
—Yours, &c., B. A. BEHREND,

Chief Engineer, The Bullock Electric Mfg. Co.

Cincinnati, Ohio, Dec. 12.

CABLE LAYING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Men in the actual fight of work will agree that in various ways knowledge and laboratory research (for more knowledge) are in advance of practical requirements, but that in apparently the simplest matters decisive knowledge is wanting. I think most men in practice will admit that the question of mains is one of these apparently simple matters. We all remember the fable of the fox who had a great many tricks, but the hounds caught him. We have a great many tricks of mains laying: among them all have we the *one* right way? Like a great many other things this is a matter which must be submitted to the test of time. I have been laying mains for the last 15 years, and I have (in a small way) had much difficulty and loss. I have had—(*a*) bare copper in a conduit; (*b*) Fowler Waring cable; (*c*) lead-covered diatrine laid solid in bitumen in wooden boxing, and (*d*) indiarubber lead-covered services.

It will be remembered that in the early days lead covering was supposed to sufficiently protect a cable from the moisture of the ground. I have one item of experience which I think is very valuable. Fourteen or fifteen years ago, when laying services, we took the precaution of surrounding them with a good thickness of sand wetted with coal tar, and these services have never given any trouble. Lead-covered cables laid "solid" in bitumen have given much trouble. I am just after having to deal with a feeder in a street, an operation which at this time of year is annoying both to the public and to ourselves. It may be said the cables were improperly laid and the bitumen was "burnt." Well, but I have made some private inquiries, and other men have had similar troubles. The feeder which has just been dealt with was made of three separate lead-covered cables laid in one boxing. We took it all up, and in the parts which had not shown faults on examination I found numbers of fine annular cracks or joints in the lead sheathing. Bitumen does not adhere to lead, and, in my view, there is a continuous joint between the whole surface of the sheathing and the surrounding bitumen, which is available for damp to distribute itself if it can reach this joint from the outside. Well, it may be said that it cannot reach it; I think it can, and I know that it has in the case of my feeders. It is a nice notion that bitumen flows and makes good a momentary crack produced by sudden shock or vibration; but suppose there is water present, or even saturated air, does this not penetrate some distance at a crack? And if there are successive vibrations, the tendency will be for the same crack to repeatedly form, resulting in the destruction of the cable. Then we have the various modes of preventing the cable sinking so as to lie on the bottom of the troughing.

Now, (*a*) coal tar does adhere to the lead covering; (*b*) the cable has no tendency to sink through tarred sand; (*c*) tarred sand does not appear to tend to crack definitely under vibratory shocks; (*d*) the material is cheap, and a good large quantity of it can be afforded to surround the cable. Any old services which we now disturb I find to be firmly fixed in a coherent mass of somewhat flexible *tar concrete*, which does not easily break off from the lead.

There is a property of wet sand to shrink and compress which appears to have received insufficient attention. It furnishes the reason why the common plaster (plasterer's coarse stuff) of our walls does not crack on drying as mud would crack. This is a phenomenon of what is called surface tension. The effect is to draw the grains of sand together more powerfully than they could be forced together by outside pressure. Let anyone take a measure of dry sand—say, in a ¼lb. cocoa tin—and then wet it, it will be found to shrink in bulk, and it will no longer fill the tin. In like manner, the tarred sand compresses about the mains, the interstitial tar is retained by the attractions of the particles, and it is more fluid (less likely to crack to let water in) than bitumen.

I give this experience freely without any suggestion of patent. I should very much like to have, either by letters to your journal or addressed to myself, practical suggestions on this question of mains and the laying of them. There are, no doubt, books, but, as a rule, the men who know from their own work have not time to write text books.—Yours, &c., JAMES PERRY, M.Inst.C.E.

Galway, Dec. 24.

LEGAL INTELLIGENCE.

Bournemouth and Poole Tramway Arbitration.

AWARD.

In the arbitration, between the Poole and District Electric Traction Co. and Bournemouth Corporation, the Umpire (Mr. Justice Lawrence), after reciting the terms of the agreement which the arbitrators were asked to interpret, has made the following award:—

That the Corporation do pay to the company as consideration for the said sale and purchase, and in full satisfaction of all the several sums above mentioned, the sum of £112,000.

And I further award and adjudge that the Corporation do pay to the company the costs of and incidental to the reference, and the costs of this award.

And I direct that if the company shall in the first instance pay the costs of this award that the Corporation shall repay to the company the sum so paid.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Hanley Corporation require an electrical engineer to take entire charge and management of their electricity undertaking. Salary £300, rising, by annual increments of £10, to £350 per annum. Applications to the town clerk (Mr. Arthur Challinor) by Jan. 10. See advertisement.

A general manager is required for Newcastle-upon-Tyne Corporation's electric tramways. Salary £700, with increases of £50 per annum to £800. Applications by Jan. 7.

The Council of Victoria University, Manchester, propose to appoint a professor of engineering. Total income not less than £1,000 per annum during the first three years. Applications by Feb. 15.

Mr. E. Kilburn Scott, A.M.Inst.C.E., M.I.E.E., has been appointed P. N. Russell lecturer in electrical engineering at Sydney University at a salary of £500 per annum, with permission to carry on consulting work. Mr. Scott is a native of Leeds, and he received his training as a mechanical engineer with R. Kilburn & Sons and John Fowler & Co. For 15 years he has held responsible positions with W. T. Goolden & Co., the Brush Co., the Electric Construction Co. and Johnson & Phillips. For some time Mr. Scott represented in the United Kingdom and the Colonies the Cie. Internationale d'Electricité of Liége, and left that company to undertake some original electric furnace work in Norway. In recent years Mr. Kilburn Scott has been engaged in advising on the details of the Bath tramways power house, the power transmission at 10,000 volts and three-phase equipment for the railway being built by the North Wales Power & Traction Co. and on the Sunderland & District Tramways. For the last five years he has been lecturer to the senior electrical engineering students at Northampton Institute, Clerkenwell. His Paper on "Coal-cutting Machinery" was awarded a premium by the Institution of Civil Engineers.

The Secretary of State for India has now sanctioned the appointment of an electrical adviser to the Government of India at a commencing salary of £70 per month, rising to £110. Private practice will be allowed, but not for municipalities or district boards. Mr. J. W. Meares, M.I.E.E., F.R.A.S., hitherto electrical adviser to the Government of Bengal, will, doubtless, be promoted to the newly-created position.

Mr. A. T. Smith, A.M.I.E.E., chief assistant electrical engineer to Bury Corporation, has been appointed borough electrical engineer at Leigh, Lancs.

Acton District Council have appointed Mr. J. H. Chick of Horsham, senior charge engineer at £130 per annum. Mr. H. E. Taylor of Folkestone has been appointed clerk to the department.

Mr. J. W. Turner has been appointed chief assistant electrical engineer at Huddersfield.

Personal.—Mr. A. J. Lawson, M.Inst.C.E., having tendered his resignation in September last as chief electrical engineer to the British Electric Traction Co. and its associated undertakings, which position he has held for the past three years, terminates his connection at the end of the present year. He will, we are informed, continue to practise as a consulting engineer at 4, Adelphi-terrace, Strand, London, W.C.

Mr. E. Garside has resigned his positions of designer and works manager with Messrs. Lionel Robinson & Co. and has arranged to join the board of Engineering Instruments (Ltd.) as managing director.

Appointment Wanted.—An experienced telegraph engineer, who is now completing a Government contract in Tropical Africa, desires an engagement for construction and maintenance of land or mixed land and cable lines or reorganisation work. See an advertisement.

EDUCATIONAL.

King's College (London).—The Lent term commences on Monday, Jan. 9. There are also evening classes for civil, mechanical and electrical engineering, workshop practice, drawing, metallurgy, mathematics, physics and all science subjects. Prospectuses, &c., from the secretary.

Birkbeck College.—The new term begins on Jan. 9. Systematic courses of instruction (lectures and laboratory) are given in science and engineering for the University of London degrees. Evening classes are also held in practical geometry, building and machine construction, steam, theoretical and applied mechanics, &c. Further information can be obtained from the Principal.

Willesden Polytechnic.—The additions to the Willesden Polytechnic were formally opened by Sir Wm. Anson, M.P., last week.

Sir William said that polytechnics marked in some sense what, he hoped, was gradually becoming the modern view of education—namely, that it was a composite thing, every part of which rested on some other part. The great local authorities had full power to act on that view. The lesser authorities by combining with them could share that power. He suggested that employers should allow the boys in their service time to attend institutions like the Willesden Polytechnic.

Brighton Technical School.—Sir Wm. White, K.C.B., late Director of Naval Construction, opened the new engineering department of Brighton Technical School last week.

Sir William appealed to the Town Council to be liberal in its grants of scholarships to the school. It was education of that character, he said, that was needed to meet the competition that was forced upon this country. That was the way in which in America and Germany competition was being met. If municipal authorities in England, in taking charge of technical education, would but be generous they would never regret it, and the ratepayers who provided the money would be proud of the fact that they had helped on the cause of education in this country.

Aberdeen.—A draft agreement with the National Telephone Co. as to the laying of underground wires by the company has been prepared by the Finance and Streets and Roads committee for approval by the Council.

Acton.—It is announced that supply of electric current will be available in January.

Argentina.—Strikes of employés of the Compania Alemaña Transatlantica de Electricidad, the Buenos Ayres and Belgrano Tramway Co. and the Co-operative Telephone Co., have recently taken place, but in the case of the tramway company the Minister of Marine lent 300 men, enabling the company to continue working on all their routes.

Mr. E. Danvers has designed what is claimed to be the first surface contact system constructed in the country. This line is 800 metres (about ½ mile) in length and is situated on the wharf of the River Plate Fresh Meat Co. at Campana. There are 3 miles of overhead trolley tramways around the works, but the use of the overhead system was found impracticable on the wharf.

Barbados.—The railway and telephone systems on this West Indian island are under the control of private companies. There is no electricity supply either for lighting, power or traction in the colony, but there is on foot a project to start a company to operate electric tramways and to introduce the electric light.

Barking.—It was announced at the meeting of the Council last week that application had been made for sanction to a further loan of £8,500 for extensions to mains, plant, &c.

Bradford.—The Electricity committee of Bradford Chamber of Trade report that they have drawn up a memorial to the Corporation Electricity committee requesting the adoption of a sliding scale of charges for electric lighting, and asking that, instead of giving the consumer free lamps, the committee should allow a small discount.

Last week a deputation from Bradford (the chairman of the Electricity committee, Ald. Robinson), Ald. Peel, Councillors Thomas and Rogerson, the City electrical engineer and manager (Mr. A. S. Blackman), and the tramways manager (Mr. Spencer) visited Dublin for the purpose of inspecting the new three-phase plant erected there.

Bradford Corporation are about to expend some £50,000 or £60,000 in extending and improving their existing electricity works, which is on continuous-current system. The chairman of the Dublin Lighting committee (Councillor J. Irwin) and the City electrical engineer (Mr. Mark Ruddle) conducted the deputation over the Fleet-street distributing station, the Pigeon House generating station, and several of the transformer sub-stations. It is reported that the members, who had previously visited the works at Newcastle-on-Tyne and Erith, had been confirmed by their Dublin trip in their decision to adopt the three-phase system for lighting and power, instead of making a further extension on the continuous-current system.

British Guiana.—At Georgetown the Demerara Electric Co. have supplied current since 1890, and there was on Oct. 31 last the equivalent of 25,000 8 c.p. lamps connected. There are 1,100 consumers on the company's books.

The Demerara Electric Co also own 10 miles of electric tramway built to 4ft. 8½in. gauge, which has been working since 1900.

The telephone system is in the Government's hands, and there were at Oct. 31 200 subscribers.

Chelsea (London).—An inquiry has been held here into the application of the Council for sanction to a loan for new baths, including £2,600 for independent electric lighting plant.

The consulting engineer (Mr. A. G. Hansard) stated that, in his opinion, it would pay the Council to generate their own electric current for lighting the baths and the Town Hall.

In opposition to this view, the chief engineer of the Chelsea Electricity Supply Co. (Mr. Percy Still) said his company were the largest ratepayers in the parish, and they objected to the loan on the ground that it would be a waste of public money. His company had offered very reasonable terms for a supply from their mains.

On the basis of an annual consumption of 25,000 units, Mr. Hansard estimated a saving of £76 a year, but admitted that that figure was arrived at without providing for depreciation.

Colchester.—A new 500 H.P. generating set was started on the 21st inst. At present there is the equivalent of over 30,000 8 c.p. lamps connected to the mains.

Deduction from Wages.—Messrs. F. & A. F. Higg, builders, were recently summoned at the South-Western (London) Police Court by two of their bricklayers, who sought to recover certain sums deducted from their wages. To check their workmen and to see that they were in daily attendance, defendants instituted a system by which each man was required as he passed into the works to take a ticket, identified by a number, and place it in a box for reference. Defendants held that employés who neglected these conditions forfeited all claims unless they reported themselves at once to the responsible official. It was not denied that complainants actually worked, but, as they failed to observe the regulations, payment was withheld. The magistrate thought it unreasonable to refuse payment when work was actually done, and he made an order for payment of the amounts claimed, with costs.

Dunfermline.—Mr. W. B. Sayers, of Glasgow, has submitted a preliminary report upon electricity supply, and recommends the Council to take supply in bulk and act as distributors themselves. Fresh negotiations are therefore to be opened with the Fife Electric Power Co.

East Barnet Valley.—For some time the Council have been negotiating with two companies for the transfer of their provisional electric lighting order 1899, and for the supply of electricity in the district, but it has now been discovered that the Council cannot carry out the proposed transfer.

The Board of Trade have offered, in order to give the Council a further opportunity of considering their position, to defer revoking the order until March 31 next. The communication also referred to the suggested arrangement with the North Metropolitan Electrical Power Supply Co. to take electricity in bulk, and the board stated that they were not aware under what authority the company could enter into such arrangement. The order did not contain any provision which would enable the Council to transfer any of their powers, duties and liabilities thereunder.

After discussing the situation the Council appointed, on the recommendation of the Lighting committee, the chairman, and Crs Bowden, Plowright and Stutters as a sub-committee to continue the negotiations with the North Metropolitan Co.

Egypt.—Beyond the already existing electric tramways and electric lighting in Cairo and Alexandria, there are at present no important schemes of electric power transmission in Egypt, both lighting and power plants in the other towns (where such exist) being on a quite small scale. Great developments, however, of electrical enterprise may be expected in the future when the Government is in a position financially to turn its attention to the best method of supplying power to the numerous pumping stations, whose economical working forms an important item in the prosperity of the country. Practically, whatever electrical work is going on in Egypt is being carried out by the Siemens-Schuckert Co., and it is pointed out by a correspondent that to obtain a sure footing in Egypt, British firms must employ capable agents well acquainted with French, Italian and Arabic.

Electricity in Mining.—At the meeting of the Giant Mines of Rhodesia (Ltd.) on Wednesday, the chairman (Mr. H. D. Boyle) said arrangements were being made for issuing 45,000 shares to provide funds for (among other things) electric light and power plant.

Exhibitions.—A small exhibit of students' work will be open free up to Dec. 31, between 10 a.m. and 5 p.m. at the London County Council School of Photo-Engraving and Lithography, Bolt-court, Fleet-street, London, E.C.

It is announced that, as the result of negotiations for additional space at the Liège Exhibition, 1905, Mr. T. Cope, the British Commissioner-General for the Exhibition, 54, Great Tower-street, London, E.C., is now in a position to receive further applications for space for the display of machinery in motion.

Fire.—The stores and workshop of Messrs. Hunter and Jack, electrical engineers, Glasgow, were burnt out on Wednesday morning.

Gloucester.—The chairman of the Tramways committee (Mr. R. Fream) gave details of the cost of tramway construction at the meeting of the Corporation on Wednesday.

Track construction cost £68,537. 18s. 2d., less cost of wood blocks (£6,000); overhead equipment, feeder pillars, cables, &c., cost £12,967. 12s. 4d.; cars and rolling stock £13,212, depot buildings £5,736, provisional order £1,358. 16s. 7d., engineers' fees, &c., £2,695. 14s. 6d., tools and miscellaneous expenses £2,401. 13s. Total £101,000. The purchase of the horse tramways cost £26,310, less £3,445 for re-sales. The county portion of the system had cost £16,154. 16s. 3d., the gross total expenditure of the entire undertaking being £140,020. 1s., or within about £20 of the estimate made by Mr. Fream in November, 1903.

Gosport.—The erecting of the power house and the construction of the permanent way of the Gosport-Fareham tramway of the Provincial Tramways Co. are approaching completion.

Halifax.—In the omnibus bill of the Corporation power is sought to borrow £47,220 additional for electric tramways and £10,600 for the electricity department.

Huddersfield.—Sanction has been obtained to a loan of £4,300 for giving a supply of electricity in Golcar. A special sub-committee has been appointed to deal with the development of motive power.

Ilford.—A profit of over £4,000 was made on the Council's tramways last year, there being, with £3,000 profit previously made, about £7,000 available for disposal. At last week's Council meeting Mr. Bailey proposed that £2,000 be devoted to relief of rates. The matter was referred to the Tramways committee for report.

India.—Alterations and extensions have recently been made to the Darjeeling water-power electricity works. The new plant includes a 200 H.P. General Electric (London) turbo-generator. A new channel for conducting water to the turbines has (according to "Indian Engineering,") been made from the Barbhutra Jhora, crossing a gorge on a suspension bridge made up of the old material of an old telpher line. Supply will be taken from a new tank of 80,000 cubic ft. capacity, so that, despite the large amount of sediment always found in hill streams, the turbines will be sure of a clean supply. As there will be no additional running charges, it is anticipated that the extra capital expenditure will be remunerative, especially as the tea gardens in the neighbourhood are likely to drive their factories by electricity. One garden has already decided to do so. There is now the equivalent of 5,000 8 c.p. lamps connected to the mains. The charge for current is 4 annas (4d.) per unit for lighting and 2 annas for power. The population of the district for which the municipality hold a licence isabout 50,000, and there are at present 78 consumers on the books of the department.

Japan.—During the current month of December the Tokyo Electric Railway Co. will open a line built to 4ft. 6in. gauge, and consisting of 15 miles of double track, for which the contractors were Messrs. Dick, Kerr & Co. The line is on the overhead trolley system, with vestibule single-deck cars. The service commences with 180 motor cars.

The Japanese Government own the telephone system throughout Japan. The service has been established since 1890. There are 45 exchanges in all, employing 63 male and 25 female clerks, and 115 male and 1,722 female operators. The number of subscribers at the end of November, 1904, was 35,265. The telephone department has 2,537 miles of bare wire, 201 miles of aerial cable, 169 miles of underground cable and 3·58 nauts of submarine cable employed in the service. The charge to subscribers varies somewhat according to the size of the town, being 48 yen per annum in some of the smaller towns and 66 yen in Tokyo and Osaka, the middle charge of 54 yen being made in Yokohama, Kobe, Kyoto and Nagoya. The call office fee is 5 sen for a conversation not exceeding five minutes, with an additional 5 sen for each additional five minutes' conversation within town limits and 10 sen for five minutes' conversation to subscribers outside the town area, with 10 sen additional for each five minutes' further conversation. The charge for inter-urban communication up to a distance of 5 ri (12·5 miles) is 20 sen per five minutes' conversation, up to 25 ri (62·5 miles) 25 sen, and for each ri beyond 25 1 sen per five minutes' conversation.

Kingston-on-Thames.—London United Tramways (Ltd.), have notified the Council that they will shortly commence constructing tramways in the district.

Lancaster.—The Tramways committee are considering the question of the adoption of a parcels system on the municipal electric tramways.

Leeds.—The work of constructing the Kirkstall to Horsforth tramway route has been commenced, and the line, which is estimated to cost about £25,000, will, it is expected, be finished next summer.

Leicester.—The Groby-road section of the Corporation electric tramways, opened last Thursday, practically completes the scheme, communication now being established with all parts of the town.

London County Council.—A report of the Highways committee presented to the Council last week dealt as follows with the subject of the construction of tramways in Archway-road, Highgate, N.:—

The Council, on May 5, 1903, decided to adopt the overhead trolley system for the tramways along Archway-road, between the Archway Tavern and the county boundary at Highgate Archway which, when constructed, will form part of a through route to Finchley and Whetstone. The committee are in communication with Middlesex County Council with a view to some temporary arrangement being made for working the lines in connection with the Middlesex light railways, pending the reconstruction of the portion of the Council's (Northern) tramways with which the Archway-road lines will be connected ultimately. The local authority concerned in this matter (Islington Borough Council) has intimated that it is prepared, subject to certain conditions, to give its consent (required by sec. 23 of the Electrical Power Act) to the use of overhead electric traction on the lines.

The committee recommended that plans, &c., be submitted for the Islington Council's approval, and this was agreed to.

London County Council Tramways.—Experiments are to be made on the Tooting route with a roof-covered car 9in. less in height than those employed on other routes so as to permit of the cars passing under the railway bridges at Clapham and Balham. An alternative solution of the difficulty—viz., the raising of the bridges—is to be reported upon shortly by the Highways committee.

Malta.—On Sept. 30 there was the equivalent of 18,200 8 c.p. lamps (including 32 H.P. for motors) connected to the Government's electricity undertaking 155 consumers connected. A correspondent informs us that incandescent lamps and small fittings, fans, &c., for ship work, bells and telephones, are in fair demand in Malta.

Military Engineering.—"The Times" states that a new electrical school on a considerable scale is being built in connection with the School of Military Engineering at Chatham.

Municipal Telephony.—On Wednesday the Hull Telephone committee instructed the manager (Mr. T. Holme) to prepare specifications for increasing the number of lines in the city from 2,000 to 3,000. Direct inter-communication has been established with the National Telephone Co.'s system at Hessle.

New Zealand.—The municipal authorities of Gore (Otago) have 92 consumers connected to their electricity supply undertaking out of a population of 3,000. The demand for current has justified extensions to the works, and these extensions were opened recently. Electric power is now used for pumping in connection with the town water supply.

At Christchurch the Municipal Tramway Board will open an electric tramway service in April next, consisting of 31 miles of single and 4 miles of double track on a 4ft. 8in. gauge. The whole of the installation has been carried out by the New Zealand Electrical Construction Co. Vestibule double-deck cars will be used, 31 motors, seven locomotives and 60 trailers being employed at the start.

Since 1899 Stratford (N.Z.) has been supplied with electric current by the Stratford Electric Supply Co., and there are now 258 consumers on the mains. The alternators employed are each driven by twin turbines and work in parallel.

Wellington has been supplied since 1891 with electric current by the City of Wellington Electric Light & Power Co., which now has 2,900 consumers on its books. There is the equivalent of 94,000 8 c.p. lamps connected, including 598 H.P. in motors. 890 20 c.p. incandescents and 83 15-amp. arcs are employed in the public lighting. The charge for current is 8d. and 5d. per unit for lighting and 3d. for power.

The local authorities of New Plymouth have recently let a contract to the Brush Co. for the electric light of the town.

At Inglewood (Taranaki) a three-phase plant is being erected to light the town by a local company, of which Mr. W. E. Richardson is the managing director.

The town of Te Arola (Auckland) has just let a contract to Messrs. Stenart & Fenn, of Auckland, to light the town by electricity.

The Hawera County Electric Co., which commenced supply in September last to a population of 4,000, has already 36 consumers and is supplying current to Hawera (distant 6½ miles from the generating station), Normanby (2½), Skaiawa (3) and Manaia (7 miles). The streets of Hawera are lighted by 60 50 c.p. incandescents from sunset to sunrise at a charge of £3. 6s. 8d. per lamp per annum.

The Auckland Electric Tramways Co. have now 35 miles of tramways working 4ft. 8½in. gauge. These lines were reconstructed from horse traction to the overhead system, the electrical equipment being carried out by Messrs. J. G. White & Co. Three types of passenger cars are used—(1) closed cars, (2) combination cars, and (3) double deckers.

A correspondent informs us that no firm in New Zealand stocks H D. copper wire, and that whatever is required is obtained from home, except small quantities which are bought in Australia at 1s. 1d. per pound.

Newquay.—Preliminary arrangements have been made for the erection of electricity works in this town and negotiations for the purchase of a site are in an advanced state.

Oldham.—An inquiry was held here last week into the application of the Corporation to borrow £48,114 for electricity supply extensions. A period of 30 years was asked for the loan, to which there was some opposition.

The Inspector (Mr. H. Ross Hooper) intimated that, as a very large portion of the amount asked for was for expenditure which had already been incurred, he would require detailed particulars as to how the expense had been incurred and the necessity for it. He saw that an extra £11,838 had been incurred on the Greenhill station, £2,937 on extra routes and £17,184 on mains. Then there was an application for the anticipated expenditure for the next three years of £15,000, £300 for tools at Greenhill station and £850 for Greenhill-street East, and he took it that neither of the last two items had been expended.

The Borough Electrical Engineer (Mr. S. Wilmott Newington) said that only a small portion of the £15,000 had been expended on mains.

The Town Clerk (Mr. J. Armstrong) supplied figures showing the assets and liabilities of the Corporation to March 25 last, which showed a surplus of over £1,000,000.

The Inspector: On what value are your assets based?

The Town Clerk: The actual outlay. He proceeded to give statistics of the rapid progress made by the electricity undertaking. There was no charge on the rates, but, on the contrary, there had been a contribution made to the rates.

In reply to the Inspector, Mr Armstrong said that they had a depreciation account, and Mr. Newington also said no plant had been scrapped. They had had the meters repaired.

The Town Clerk said that in 1895 they supplied 86,000 units, and that the output had now risen to over three millions. The number of consumers had increased from 55 in 1895 to 676 last year, and the number of 8 c.p. lamps connected had increased from 6,000 to 68,000 last year. The total length of distributing mains laid was over 24,000 yds. £11,000 was the amount over-expended at Greenhill, and the amount previously sanctioned was £152,000. 5s. 10d.

The Inspector said then they had exceeded the estimates at Greenhill works by £11,938. There had been a saving of £1,000 on engineering, but there had been excesses in architectural work of £6,477 and in additions of £5,848.

A ratepayer referred to the large amount which was being paid to the clerk of works, who still remained on though the work was finished.

Another ratepayer questioned an item amounting to £565, and asked whether it was right that the cost of photographs, souvenirs, &c., which were included, should come out of the Corporation funds? A considerable sum had been expended on pictures of certain gentlemen. There had also been a number of gold watches, silver brooches and other expensive things given away, and he would like to know where the money was coming from.

The Inspector said those matters were entirely new to him, and he would want details. There were, in fact, so many details required which could not be supplied offhand, that it would be necessary to adjourn the inquiry.

Mr Bayne (on behalf of the Master Cotton Spinners' and Engineering Associations) remarked upon the absence of any provision for depreciation, and contended that the ratepayers could not know their financial position if depreciation was not taken into account. After 20 years' wear and tear machinery was not as good as new, and 5 per cent. would not be too much depreciation to allow for that. It might be argued that the Corporation were paying interest on loans and also providing a sinking fund, and there would be no depreciation, but the loans were to be repaid not within the life of the machinery. There was another objection to the loan and that was that 3½ per cent. interest was now being paid by the Corporation. 3½ per cent. meant £1,660 per year, or another 1d. rate.

Mr. J. Dodd, chairman of Messrs. Platt Bros., Oldham, said his firm were the largest ratepayers in Oldham, paying £8,000 yearly. The engineering trade was a very important one to Oldham, and upon it the population largely depended. They objected because the expenditure was being carried too far, and had a prejudicial effect upon the engineering industry. It was hardly possible to give an accurate idea of the position of the undertaking without accounting for depreciation. The shareholders of a company could call upon the board of directors to give an account of their doings, but it was different with the ratepayer.

Mr S. Buckley (Messrs. Buckley & Taylor, Ltd., engineers) said he had been a member of the Corporation for many years. They were not doing justice to themselves in allowing the expenditure to continue, particularly in regard to obtaining money without knowing what it was for. On the question of depreciation he thought this should be taken into account.

Mr. E. Travis, vice-president of the Oldham Master Cotton Spinners' Association, Mr. Jones, representing the Lancashire and Yorkshire Railway Co. and Mr. Owen, of the Oldham, Ashton & Guide Bridge and Great Central Railway Co., also objected.

The Inspector asked how the Corporation had obtained money without the sanction of the Local Government Board.

The Borough Accountant: By overdraft.

Has the interest been paid and the sinking fund been met?—Yes.

Do you mean after paying the overdraft?—No.

The Inspector remarked that the Corporation had borrowed and had paid interest, but had made no provision for sinking fund or depreciation of the works for which such added expenditure had been incurred.

The inquiry was adjourned sine die.

Panama.—A company has been established at Panama, but registered in New Jersey, with a capital of £40,000, the object being to erect a generating station to supply the city with electric light and power, and to manufacture and supply ice, which is an important commodity.

Penrith.—An inquiry was held here last week into the application of the District Council to borrow £6,000 for electricity supply. There was some opposition by ratepayers.

Perth.—On Wednesday the Electricity committee received from the Secretary for Scotland sanction to a loan for providing additional plant at the electricity works to supply energy to the projected electric tramways.

Plymouth.—Some time ago the Council granted permission to the National Telephone Co. to place its wires underground, but stipulated that in the event of the company reducing its charges in other towns of similar or larger size it should concede the same privilege to its Plymouth subscribers. Recently the company has (it is alleged) made concessions to subscribers in some of the large towns, which Plymouth Corporation claims to have the effect of giving such towns better terms than those which Plymouth enjoys, and they have requested the company to place Plymouth subscribers on an equality. The company deny that the concessions granted to other towns have reduced the charges in those places below the Plymouth tariff. Correspondence is proceeding.

Poole.—The Council have decided to withhold their consent to a proposal of a company to construct a light railway between Bournemouth and Swanage, which would cross the entrance to Poole Harbour over a conveyor suspension bridge.

Poplar (London).—Mr. D. M. Macleod (chief assistant electrical engineer) is to be granted £10. 10s. for extra services rendered during the period the post of borough electrical engineer was vacant.

Complaints have been made of the Belgian cement supplied to the electricity department, and English cement is to be supplied in future.

Presentations.—The staff of the electricity department of the Woolwich Borough Council recently presented a gold albert to Mr. J. J. Lightfoot prior to his present appointment with the County of London Electric Supply Co.

Sergt.-Major Rook, senior non-commissioned officer of the Chelmsford detachment of the Electrical Engineers Volunteers, recently retired from the service, and last week a farewell smoking concert was given in his honour, when he was presented with a silver cigarette case and match box and a gold-mounted cigarette holder in silver case. Responding to the toast of his health, Mr. Rook said that since he had been in charge of the detachment it had doubled its numbers, and he believed was now the strongest outside London.

Rating of Telephone Lines.—The National Telephone Co.'s subscribers' lines in London were assessed at no less than £30,000 at the last valuation, while the lines of the Post Office service make no contribution to local rates. In a circular just issued by London County Council in view of the forthcoming quinquennial revaluation of property in London, the Council suggests that this is inequitable.

Rhodesia.—The Buluwayo Waterworks Co., owners of the electricity works at Buluwayo, have supplied electric current since 1898, and have now the equivalent of 13,000 8 c.p. lamps connected to their mains. There are 600 consumers, and the supply is from overhead conductors. The price per kilowatt-hour for current is 2s. There is as yet no power supply available from these works.

The Government of Southern Rhodesia own the telegraph system in that part of the world, which comprises 5,777 miles of wire and 2,728 poles. The charge for the inland service is 1d. per word, with a minimum of 1s.

The Government of Southern Rhodesia also own the telephone service, which is worked from Salisbury. There are now five exchanges, and at Nov. 30 there were 800 subscribers at a charge of £12. 12s. per annum for a service not exceeding 1 mile distance from the exchange. The call office fee is 6d. Females are employed exclusively as operators.

Rubber.—An interesting report by Mr. W. H. Johnson on the subject of rubber cultivation, exports, &c., from the Gold Coast and Sierre Leone has recently been issued. The report shows that since 1880, when the first shipments of rubber from the Gold Coast were made, the increase in values of this commodity has ranged from £1 in 1882 to £555,731 sterling in 1899, the value of this exported produce in 1903 being £196,500.

From Sierre Leone the exports of rubber have decreased since 1896 to a very large extent, the values in 1896 being £79,196 compared with £9,258 in 1903. It is urged that European capital can alone save the rubber industry of Sierra Leone from an early death.

Sheffield.—The traffic receipts of the Corporation tramways for the past year amounted to £235,939, against £228,743. 17s. 10d. last year.

It is reported that the electric light department received during the present year applications for current for motors to the extent of 1,150 H.P.

Ship Lighting Contracts.—It is announced that Messrs. W. C. Martin & Co., of Glasgow and London, have secured the contract for the electric lighting of the 30 new steamers building for passenger traffic on the Thames for the London County Council. The firm have also secured a contract for the lighting of a passenger steamer building for the General Steam Navigation Co., and for the lighting of two steamers building for Messrs. Charles Barrie & Son. A further order has been placed for four steamers building for the Danish Russian Steamship Co.

The new Allan line turbine steamer "Virginian" is supplied with electric lighting plant and is also fitted with Marconi wireless telegraph apparatus.

Show Lighting.—The electric lighting of the Automobile Exhibition at Olympia (London) will comprise over 100 2,000 c.p. arc lamps and 20,000 incandescent lamps for stand lighting, &c.

South Africa.—At Pietermaritzburg the Natal Government Railways Department have supplied electric current since May, 1903, and at Dec. 31, 1904, the equivalent 8 c.p. lamp connections numbered 5,000, including 130 H.P. for motors. The works were established to meet the requirements of the railways, but the service has been extended to Government House and to the P.W.D. yard, 3 miles from the power station, where a number of machine tools are driven electrically.

At Krugersdorp the Lancaster Gold Mining Co. are supplying current to three mines aggregating 900 H.P. in motors, besides a considerable lighting load. The charge for current for lighting is 9d. per kilowatt-hour and 3½d. for power. A correspondent notifies us that enclosed switches for underground work are a big demand, but it is found difficult to obtain any switch which will stand the rough usage of the mines. What is required, he urges, is a switch so made that contacts can be easily refitted and in a damp proof case. The working parts of such switches as are obtainable on the spot are not made strong enough.

On Nov. 2, 1904, Maritzburg municipality opened the tramways which have been constructed on a 4ft. 8½in. gauge. There is one mile of double track and six miles of single track on the overhead system. Six motor cars are already on the service and six further are on order. Current for the tramways is taken from the Corporation's electricity department.

At Durban, where the supply of electric current has been given since August, 1897, there are now 2,581 consumers on the Corporation's books. Of those 2,441 take current for lighting and 140 for power. The total plant at Durban is 101,666 8 c.p. lamps, and there is the equivalent of 140,998 8 c.p. connected, including 1,016 H.P. in motors. There is no gas supply at Durban, and the charge for current for lighting is 8d. per unit less 15 per cent. above 500 units and for power 2d. per unit, plus £5 per horse-power per annum.

At Kimberley the De Beers Consolidated Mines (Ltd.), who have supplied current since November, 1903, have the equivalent of 53,000 8 c.p. lamps connected out of a total plant capacity of 100,000. There is no gas in this district, and the charge for current for lighting is 6d. and for power 3d. per unit. There are 600 consumers on the company's books.

Southend-on-Sea.—Last week the Council decided to invite tenders for the erection of a refuse destructor and to apply for sanction to a loan of £10,000.

Spain.—The projected electric railway between Malaga and Velez-Malaga, which has been under consideration for some time past, appears to be on the eve of realisation. The capital will, it is stated, be chiefly Canadian and Belgian, and the active work of construction is about to be commenced. The line will be chiefly used for freight traffic, but a passenger service will also be run. Another electric line to Coni, a small town 30 miles south-west of Malaga, is, it is stated, also contemplated by the same group of promoters.

Electricity supply has been available at Beasain (Guipuzcoa) since September last, the mains being overhead bare copper. The power house is situate 9km. from the main switchboard. The receiving station is situate in the extensive waggon works of the Soc. Espa. de Construccion Metalicas-Beasain. Water-power plant is employed in the generation of current.

Recently one of the chiefs of the Spanish Telegraph Department retired by age limit, with a satisfactory pension and in a contrite spirit. The official issued a valedictory address to his distressed staff in which the following appeared :—

> On the termination of my official life I bid farewell to my chiefs, companions and subaltern asking them to excuse the faults I may have committed during my career, and I offer myself unconditionally to one and all.

Many hard words have been said of Spanish Government officials, but it cannot now truthfully be urged against them that they are not fully cognisant of their shortcomings.

Steam Superheating Apparatus.—Manufacturers in the United States of steam superheating apparatus recently requested the Department of Commerce and Labour to obtain particulars relating to the use of steam superheating apparatus in Europe, and these particulars have now been prepared and a summary issued. The scope of the Department's inquiries is shown by the following interrogatories and instructions :—

1. Are there now in force any restrictions or regulations regarding the installation or operation of steam superheating apparatus? If so, send copies, if procurable

2. Are there now in force any restrictions or regulations regarding the installation or operation of steam superheating apparatus made wholly or in part of cast iron?

3. Do such restrictions or regulations, if existing, refer to steam superheating apparatus operated in connection with the gases from fuel burnt under boilers, or operated with their own furnaces?

Replies to these interrogatories were received from Austria, Germany, (including Prussia, Bavaria and Saxony), Italy, Norway and Sweden, and the United Kingdom, and may be summarised as under:

Austria.—Practically no regulations.

Germany.—Prussia: Para. 25 of the Imperial Industrial Code applies and Para. 3 of the General Police Code also has particular application to this point. This latter para. is as follows:—

"It must be possible to shut off at will the gases of combustion from the superheating device, even when it is located in one of the flues of the boiler. It must be possible to shut off the steam supply from the superheater. . . . When it is to be feared that condensed water may collect in a superheater thus closed and cut out of action, the evaporation of which may produce dangerous tension when the superheater is again brought into operation, the superheater must be provided with a steam safety valve and, at its lowest part, with a discharge valve for the escape of water. . . . All devices for controlling the working of the superheater must, so far as practicable, be within reach of the fireman. These precautions having been fulfilled, no objection is raised to the use of cast-iron superheaters in boiler rooms."

Bavaria.—The general regulations regarding steam boilers apply to steam superheating in Bavaria, but it is pointed out that the Association of German Engineers delegates a member to investigate new inventions, and recently, Dr. Otto Berner was deputed to examine different types of steam heating apparatus, and a treatise has recently been published on the subject.

Saxony.—Herr Morgenstein in 1902 published a work on the law governing steam boilers in Saxony, and this is the book of reference used by the Government officials, in whose hands the regulation of the installation of steam power rests. These officials have, under the Saxon laws, a wide discretion in controlling installations of steam superheating plant in Saxony, where the use of cast iron is prohibited in all boiler parts exposed to fire. The regulations include notification to the police authorities that boilers or similar plant is to be erected, the use to which such plant is to be applied, the class of engine, particulars of the tests to which the boiler has been subjected and the class of fuel that is to be used. A fine up to 300m. is imposed upon persons erecting an industrial plant without licence. The regulations are otherwise very stringent also.

Italy.—In this country there are no legal restrictions or regulations regarding the installation and working of steam superheating apparatus for marine use, but for plants established on land article 10 of the Law of Public Safety, 1888, applies, and is as follows:—

"The use of cast iron and of sheet copper is prohibited for the portions exposed to the fire, exception being made of copper tubing of less than 10cm. (3·9in.) in diameter.

"It is not permitted to use castings or brass plates for parts exposed to the fire, excepting tubes of brass of less than 10cm. (3·9in.) in diameter, and for boilers of a special character, such as may be designated by the law. In this class are the multitubular inexplosible boilers of Belleville, Field, Babcock & Wilcox, Steinmuller, &c.

"The use of cast metal is permitted for the steam dome, boiler heads, manhole lid, mud collectors, economisers and similar apparatus, such as is not surrounded by the wall and is not touched by the fire, and whose diameter is not above 70cm. (27·6in.)"

Sweden and Norway.—In Norway no permanent regulations regarding the installation or operation of steam heating apparatus exist, supervision of such plants being left to the police authorities, to whom drawings and specifications of all intended installations of this character must be submitted for approval before the work is begun. The work of periodical inspection of such plant is also carried out by the police department. In Sweden there are no regulations regarding steam superheating apparatus, but factory inspectors appointed by the Government have full control over the installation of all high-pressure steam apparatus.

The report concludes with a brief review of the regulations obtaining in the United Kingdom and the chief engineer of (1) London County Council; (2) Boiler Assurance Co.; (3) Manchester Steam Users' Association and (4) Lloyds (for marine work) have contributed their views on the subject.

Timber for Telegraph Poles.—A report has been presented to the New Zealand General Assembly containing observations of the telegraph inspectors in that country with regard to the durability of New Zealand timbers for telegraph poles. The two timbers which have the highest merits in this respect are totara and silver pine, but the fact that the latter is obtainable in no longer lengths than 20ft. renders it less useful than the former, and all things taken into consideration the postal telegraph department of New Zealand gives the preference to totara, and this timber is now being almost exclusively used for the purpose in New Zealand, the life of a pole of this timber being regarded as high as 30 years in the ground. It is found, however, that totara is a weak timber for strain-resisting, and, unless very large, is liable to snap in a gale of wind.

Theatre Lighting.—The contract for the electric lighting installation at the new Lyceum Theatre, London, W.C., has been carried out by the National Electric Construction Co. There are over 3,000 lights, and the fixtures, which are of a highly artistic character, were supplied by the General Electric Co. Messrs. Bolton, Fane & Co. supplied the ornamental brass and ironwork.

Messrs. Bolton, Fane & Co. have just completed an electric lighting installation at the Surrey Theatre, London, S.E., where about 3,000 lights are employed.

Telegraph Enterprise in Spain.—It is anticipated that the Spanish Government will during 1905 lay a submarine telegraph cable between Barcelona, Palma and Mahon (Balearic Islands), the necessary expenditure having been provided for in the general estimates, which have, however, yet to be approved by the Cortes. It is said that the Balearic Islanders are keen on the project.

Tonyrefail.—The electricity works of the local electric light company were opened on Tuesday.

West Hartlepool.—An inquiry was held here last week into the application of the Council for permission to borrow, among other sums, £13,861 for electric lighting extensions.

The Town Clerk (Mr. Hudson Simpson) said the loan was required owing to the estimated number of consumers being largely exceeded, current being now supplied to the equivalent of 53,076 8 c.p. lamps, compared with 8,300 lamps in 1900. After paying all charges and repaying instalment of principal, the charge upon the rates was only £560, and they expected that there would shortly be no charge at all.

The chairman of the Electric Lighting committee (Ald. Macfarlane) stated that since the works were opened there had been an increasing demand for current. The total amount sanctioned for electric lighting to the end of March was £62,342, and the expenditure to date was £73,198, of which £8,000 had been repaid. £2,300 was being asked for in anticipation of future requirements.

Protest was made on behalf of the local ratepayers' association against the Council spending money in excess of that sanctioned.

The Inspector (Mr. M. K. North) said there was no doubt the Local Government Board objected to loans being expended before sanctioned, and they also objected to excess loans.

Westcliff-on-Sea.—The new marine drive and esplanade to be opened in January are to be lighted by electric arc lamps.

Workhouse Lighting.—Ormskirk Guardians have applied for sanction to a loan of £4,000 for an electric lighting installation at the workhouse.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Guardians of *Whitechapel* (London) Union invite tenders for the electric lighting of section 2 of the infirmary. Specifications from the clerk (Mr. F. J. Tootell), and technical information from the consulting engineers (the Electrical Standardizing, Testing and Training Institution), 8 and 10, Charing Cross-road, W.C. Tenders to the Guardians' Offices, 74, Vallance-road, N.E., by noon Jan. 10. See also advertisement.

Johannesburg Municipal Council invite tenders for Vignoles rails, fishplates, angle steel guard-rails, bolts, nuts, coach-screws, and dog-spikes. Specifications, &c., may be seen after Dec. 30 at the offices of the consulting engineers (Messrs. Mordey & Dawbarn), 82, Victoria-st., Westminster, S.W., to whom tenders by noon Jan. 26. See also advertisement.

The Municipal Council of *Johannesburg* is prepared to receive tenders for 100 electric tramcars, two electric water cars, one 5-ton travelling crane, one electric car traversor and various workshop tools, including erection at Johannesburg, to specification No. 10 of the consulting engineers (Messrs. Mordey & Dawbarn, 82, Victoria-street, London, S.W.). The specification may be seen after Jan. 7 at the Council's offices, Johannesburg, and at Messrs. Mordey & Dawbarn's offices, where tenders are to be sent by March 6. See also advertisement.

The Directors of the *Great Western Railway Co.* invite tenders for the supply and delivery of the following material required in connection with the electrical equipment of the Hammersmith and City Railway, &c.: Steel conductor rails, cast-iron and steel ramps and fastenings; porcelain insulating supports and their fastenings for conductor rails; copper bonds, insulated cable connections, cable terminals, bonding presses and accessories for connecting up connector rails. Tenders to the Secretary, Paddington Station, London, W., by Jan. 3.

The Directors of the *South London Electric Supply Corpn. (Ltd.)* invite tenders for supply and erection at their works, Bengeworth-road, Loughborough Junction, London, S.E., of one 750kw. steam alternator and pipe connections and sundry iron work. Tenders to the secretary (Mr. H. H. Boyer), by noon Jan. 16.

The Public Health committee of *Belfast* Corporation invite tenders for supply and erection at the new infectious diseases hospital, Purdysburn, of steam boilers, &c.; heating of pavilions and administrative block; electric light installation, including engine, dynamos, &c. Tenders to the town clerk (Sir Samuel Black) by 11 a.m. Jan. 12.

Bradford Guardians require tenders by Jan. 16 for electrical engineers' work in two new hospitals.

Stockport Corporation require tenders by Jan. 9 for supply of steel girder tram rails, tie bars, fish plates and anchor joints.

The *Metropolitan Asylums Board* require tenders by 10 a.m., Jan. 4, for the installation of fire alarms at Northern Hospital.

The Société Générale des Tramways de Madrid et d'Espagne have made application for a concession for an electric tramway in *Madrid* to extend the existing Northern Madrid tramways. Tenders will be adjudicated on Feb. 25, should any offer reach the Spanish Government more favourable than that from the Société Générale. The "Madrid Gazette" of Dec. 20 contains further particulars.

Further tenders are also invited for a 10 years' concession for the electric lighting of *Plasencia*, Spain, which will be adjudicated on Jan. 28. The "Madrid Gazette" of Dec. 24 contains further particulars.

TENDERS RECEIVED AND ACCEPTED.

Kingston-on-Thames Council received five tenders for the supply of ½ mile of high-tension armoured cable, and that of Siemens Brothers & Co. was accepted at £174. The tender of W. T. Henley's Co. was accepted for ½ mile of 5 ampere and ½ mile of 20 ampere twin-service cable at £115.

Leeds Corporation have accepted the tender of the Leeds Steel Works for supply of 850 tons of steel rails at £5. 7s. 6d. a ton. The contract for the supply of two 1,000kw. turbo-alternators has been let to the British Thomson-Houston Co.

Wimshurst, Hollick & Co. have secured a contract for the supply of an electric crane at the Southend Corporation's loading pier for £415.

Bury and District Joint Hospital Boards have accepted the tender of Mr. A. Halliwell for wiring the verandah at the Florence Nightingale Hospital.

Exeter Corporation have accepted the tender of Hodges Bros. for the equipment of the workshop at the new electricity works for £112.

Stoke-on-Trent Guardians have accepted the tender of Teeton & Meadows for electric lighting extensions at the workhouse at £451. 15s.

Southampton Education committee have accepted the tender of Shalders & Davis for wiring Portswood School at £175.

BUSINESS NOTICE.

Messrs. J. T. Mayfield and T. Champness (trading as J. T. Mayfield & Co.), electrical engineers, 63 and 63A, Cannon-street, London, E.C., have dissolved partnership. Debts by Mr. Mayfield.

LIQUIDATIONS, &c.

The gross liabilities of the Motor Manufacturing Co. (Ltd.) are £41,425. 18s. 6d., of which £11,004. 19s. 10d. are expected to rank, with an estimated surplus in assets of £20,775. 4s. 10d. As regards shareholders, a deficiency of £42,453. 15s. 2d. is disclosed.

Claims against the Rhyl and Prestatyn Light Railway Co. (Ltd.) must be sent by Feb. 4 to Mr. W. Webb, 46, Queen Victoria-street, London, E.C.

Electric Fittings for Sale.—Messrs. J. G. Statter & Co., Cornwall-buildings, Birmingham, are offering for sale a large stock of Admiralty, Post Office and other standard pattern lampholders, ceiling roses, tumbler switches, &c., all suitable for 220-volt circuits. See advertisement.

Old P.O. Stores Sale.—Tenders are invited for the purchase of about 450 tons of gutta-percha, 75 tons of copper, a quantity of other metals, gutta-percha-covered copper wire, tools, lamp tops, &c. Forms of tender from Controller of Stores department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders by 10 a.m. Jan. 18.

Premises to Let.—A factory in Pentonville (3,000 super. ft.) is to be let. Applications to Mr. H. Holme, 472-4, Caledonian-road, London, N. See advertisement.

Willing's "Press Guide."—We have so regularly commended this excellent guide to the world's Press that in acknowledging the receipt of the 32nd annual issue we have little to add, except that, so far as we have been able to check the entries, we find the book has been brought thoroughly up to date. It is certainly the best shillingsworth of this class of literature published. Willing's "Press Guide," for 1905, is obtainable at 125, Strand, W.C., and 162, Piccadilly, W., London.

Catalogues, &c.—A new sheet list of E.P.S. moting cells is just issued, including particulars of the "Epsco" 4-volt ignition cell.

Beaumonts Limited, of Brinksway, Stockport, have ready a new catalogue of "Rapid" pumps for all descriptions of work. The list is especially strong in centrifugal pumps.

Calendars, Diaries, &c.—The always-welcome desk pad, calendar and memoranda (interleaved blotting) which is sent out by the Electrical Power Storage Co., 4, Great Winchester-street, London, E.C., is to hand, and contains all the useful features of its predecessors. There can be no better form of advertisement for the E.P.S. Company's manufactures, for the pad has the particular merit of keeping the company's goods before the user during the whole year.

The Hart Accumulator Co., Marshgate-lane, Stratford, London, E., also send out a useful blotting pad, of which we have to acknowledge receipt of a copy.

An excellent use has been made of Whitaker's Almanack for 1905 by the British Electric Transformer Co., of Hayes, Middlesex, from whom we have to acknowledge the receipt of a copy of this useful publication handsomely bound and containing illustrations and particulars of the company's manufactures, and a list of the numerous electricity undertakings and others to whom British electric transformers have been supplied.

Messrs. W. T. Glover & Co. for the third year issue a tear-off sheet almanack, which combines the instructive with the useful. A number of examples of Cockney wit *à la* Mr. Dooley are interspersed with a number of excellent portraits of station engineers and illustrations of cable laying and other work incidental to electrical engineering. Messrs. Glover's own poet has been on the war-path too. Altogether the Glover calendar for 1905 is equal to any of its predecessors.

Messrs. John Knox & Co., of 210, Upper Thames-street, London, E.C., forward a neat hanging pad calendar, upon which is illustrated a few of the infinite variety of engineers' tools, contractors' plant, and other goods supplied by this firm.

With the season's compliments Messrs. Dorman & Smith are sending out a smoker's companion as an advertising device, which the smoker, at any rate, will find useful.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Dec. 21 to 23, with the ports of destination:—

Africa—Cape Town, £13; Delagoa Bay, £49; Durban, £1,704 (including £1,539 telegraph material); East London, £56. *Argentina*—Buenos Ayres, £25. ***Australasia***—Brisbane, £76; Christchurch, £14; Sydney, £456; Townsville, £115. *Brazil*—Rio Janeiro, £39. *Canada*—Hamilton, £11. *Ceylon*—Colombo, £223. *Channel Islands*, £180. *Chili*—Antofagasta, £230 (telegraph apparatus). *China*—Shanghai, £46. *Egypt*—Suakim, £2,404 (including £1,380 telegraph material and instruments). *Germany*—Hamburg, £95 (telegraph material). *Holland*—Amsterdam, £16. *Hong Kong*, £62. *India*—Bombay, £59; Calcutta, £1,158; Madras, £34. *Russia*—St. Petersburg, £658 (including £440 telegraph instruments). *Straits Settlements*—Penang, £124; Singapore, £70. *Surinam*, £16. Total (for three days), £7,933, against £26,849 in eight days last year (Dec. 23 to 30).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

November 12, 1904.

24,538 B. Thomas and G. Thomas. Manchester. Fuses.
24,539 B. Thomas and G. Thomas. Manchester. Automatic switches.
24,560 H. Frankel. Electric testing clip. (Date applied for, Dec. 2, 1903, date of application in U.S.)*
24,569 O. H. Baldwin. Supply of current to electric vehicles.
24,572 Marquis Albert de Dion and G. Bouton. Electric igniters for internal combustion engines. (Date applied for, Aug. 16, 1904, date of application in France.)*
24,573 A. F. Batchelder. Dynamo-electric machines. (Date applied for, Nov. 12, 1903, date of application in U.S.)*

November 14, 1904.

24,599 J. Devitt and C. Maskrey. Manchester. Guards for incandescent lamps.
24,604 W. E. Sumpner. Sevenoaks. Power-factor indicators.
24,605 W. E. Sumpner. Sevenoaks. Wattmeters.
24,618 W. M. Martin. Cornwall. X-ray obstructing material.
24,620 I. H. Parsons and A. E. J. Ball. Leicester. Electric clocks.
24,627 J. Mauger. Subscriber's call devices for telephone exchange.
24,632 A. Eckstein and E. Parker. Manchester. Electrically operated switches.
24,634 R. C. Wetherell. Transmission of signals to a travelling locomotive from stationary contacts on a permanent way.
24,660 G. A. Walker. Electric lamps or fittings.
24,663 I. G. Waterman. Electrical valve controlling systems.*
24,675 R. B. Ransford (American Electric Brake Co., U.S.). Electric brakes for vehicles.*

24,689 R. N. J. Rosslie. Storage batteries. (Date applied for, Nov. 16, 1903, date of application in France.)*
24,692 A. Grammont. Ascertaining the power-factor in alternating-current systems. (Date applied for, Nov. 24, 1903, date of application in France.)*
24,698 B.T.-H. Co. (G.E. Co., U.S.). Switches.
24,699, 24,700 and 24,701 B.T.-H. Co. (G.E. Co., U.S.). Electric motor control and apparatus therefor.

November 15, 1904.

24,706 W. T. Jones. Hengoed. Illuminating arrangement for examining inside of enclosed motors or semi-enclosed motors.
24,708 C. W. G. Little. Beckenham. Control of electric vehicles.
24,715 J. W. Lea and J. Hall. Birmingham. Electric globe lamps.*
24,722 W. Whittaker. Burnley. Electric tramcars and lifeguards.*
24,743 H. F. Schmidt. Electrical timekeeper and alarm-clock.
24,769 Nalder Bros. & Thompson, F. H. Nalder and O Cox. Commutators.
24,770 O. Imray (F. S. Payne, U.S.). Electric signalling devices.*
24,788 W. R. Whitney. Arc lamps. (Date applied for, Nov. 16, date of application in U.S.)*
24,798 J. H. Lamprey. Apparatus for production of ozone.

November 16, 1904.

24,828 W. F. Mason. Manchester. Raising and lowering arc lamps.
24,831 E. Rothwell. Manshester. Actuating points in electric tramway systems.
24,850 J. A. Fleming. Instruments for detecting and measuring alternating currents.
24,852 G. I. King. Metallic passenger cars. (Date applied for, June 9, 1904, date of application in U.S.)*
24,857 C. A. A. Capito. Electricity meters.
24,873 J. Brockie. Regulating arc lamps.
24,874 B.T.-H. Co. (G.E. Co., U.S.). Alternating-current generators.
24,875 B.T.-H. Co. (G.E. Co., U.S.). Controlling apparatus for electric motors.
24,876 B.T.-H. Co. (G.E. Co., U.S.). Electromagnetic speed changing and reversing devices.
24,900 A. L. Davis. Electric brakes or interrupters.

November 17, 1904.

24,918 A. C. Hyde. Manufacture of leading-in wires for incandescent lamps or other vessels requiring leading in wires with gas-tight joints.
24,927 A. Marshall. Switches for electric railways and tramways.
24,951 T. Cooke and J. R. Cooke. Medical electric and magnetic appliance.*
25,010 Westdeutsche Thomasphosphat-Werke Gesellschaft mit Beschränkter Haftung. Producing nitric acid by aid of electricity. (Date applied for, Oct. 19, 1904, date of application in Germany.)*
25,026 and 25,027 B.T.-H. Co. (G.E. Co., U.S.). Electric switch operating mechanism.

November 18, 1904.

25,029 T. Moore. Leeds. Potentiometer apparatus for localising faults.
25,041 W. Keren. Trolley heads for overhead wire system.
25,072 J. R. Craig, Jun. Glasgow. Terminals for main and other switches.
25,078 R. Aron (Continental Hardware & Cycle Co.) (L. Boulez, France.) Electric ignition devices.*
25,095 E. W. Jungner. Accumulators.*
25,105 H. G. Prested. Device for the poles of a circuit.*
25,106 H. G. Prested. Regulating current through an electric lighting circuit.*
25,112 H. H. Lake (C. A. Gould, U.S.). Electric light systems.*
25,114 J. M. de la Croix and H. F. Joll. Accumulators.*
25,128 N. Manga. Fireproof, acid-proof and electrically-insulating material.*
25,129 W. P. Thompson (Levi Stamm and E. D. Lewis, U.S.). Liverpool. Electric braking apparatus.

November 19, 1904.

25,171 J. Scott. Liverpool. Electric light baths and like appliances.
25,172 S. T. Webster. Liverpool. Dynamo-electric machinery.
23,175 G. Higginbotham. Manchester. Electrical apparatus for timing the speed of vehicles over measured distances.
25,181 C. P. J. Fitzsimon. Dublin. Electric lamps.
25,189 R. Starke. Composition for electrical conduits.
25,191 G. Magini. Application of a coherer to any electric transmission by means of conductors for any distance, for telegraphic, telephonic, signalling bell or other systems.
25,196 B.T.-H. Co. (G.E. Co., U.S.). Improving the power-factor of alternating-current circuits.
25,218 D. Perret. Enclosed electro magnet. (Date applied for, March 12, 1904, date of application in Switzerland.)*
25,219 and 25,220 L. Wilson. Protective systems for electric distribution lines. (Date applied for, Nov. 20.1903, date of application in U.S.)

November 21, 1904.

25,235 J. T. Taylor and W. Lawson. Yorks. Ignition plugs.
25,243 H. B. Stocks. Manchester. "Party line" system of telephones.
25,248 W. C. Priestley and B. Holroyd. Leeds. Electric ignition apparatus for internal combustion engines.
25,249 E. Talbot and D. Mondey. Sheffield. Electric switches for the ignition circuits of multiple cylinder explosion motors.
25,265 A. J. Boult. (Accumulatoren und Electricitats werke-Act.-Ges. vormals W. A. Boese & Co., Germany). Accumulator electrodes.
25,276 B.T.-H. Co., (G.E. Co., U.S.) Vapour electric lamps, rectifiers and the like.
25,282 Siemens & Halske Akt. Ges. Electrode for apparatus producing radiant electrical energy. (Date applied for Nov. 24, 1903, date of application in Germany.)*

November 22, 1904.

25,329 W. C. Fisher. Ealing. Electrical measuring instruments.
25,331 J. Hargreaves. Lancashire. Treating contents of electrolytic cells.
25,370 J. H. Lee and A. E. R. Bottone. Telephony.
25,376 H. Csanyi, E. Klupathy and G. von Barczay. Batteries.
25,378 H. H. Lake (Electro Radiation Co., U.S.). Electric air-gap condensers for high-frequency currents.
25,382 H. H. Lake (Electro Radiation Co., U.S.). Rotary spark-gap apparatus for use with high-frequency currents.
25,336 T. von Zweigberg. Single-phase commutation motors.
25,406 P. C. Hewitt. Amplifying variation of energy in electric circuits.

November 23, 1904.

25,444 W. Thomas. Shropshire. Fire-alarm.
25,458 Veritys Limited and A. E. Gott. Birmingham. Electromagnetic circuit-breakers.
25,463 E. S. W. Moore and S. Bourne. Wolverhampton. Brush-holders.
25,464 E. K. E. Vollrath. Manchester. Automatic fire-alarm.*
25,478 W. H. James. Maidenhead. Detachable service fuse box, single and double pole.
25,492 L. M. McBride. Trolley for electric cars.
25,498 A. Wiseman. Birmingham. Gear wheels for high-speed cars.
25,504 R. H. Derry. Oscillating magneto sparking plug.
25,519 T. C. Dafforn. Incandescent candle lamps.*
25,524 O. Imray (J. Denham, Cape Town). Electric lighting of railway carriages and the like.

November 24, 1904.

25,592 C. F. Hunter. Switches.*
25,608 C. Hulsmeyer. Hertzian wave projecting and receiving apparatus for locating position of distant metal objects.*
25,610 F. W. Howorth (G. O. Squier, U.S.). Wireless telegraphy.
25,620 A. M. Taylor. Apparatus for controlling or/and supplying current for power and light on consumers' premises during certain periods.
25,625 H. Leitner. Facilitating control of accumulator cells.
25,630 B.T.-H. Co. (G.E. Co., U.S.). Systems of control for electrically operated doors.
25,631 B.T.-H. Co. (G.E. Co., U.S.). Circuit-breakers.
25,632 B.T.-H. Co. (G.E. Co., U.S.). Electricity meters.
25,633 B.T.-H. Co. (G.E. Co., U.S.). Reverse current relays.
25,634 B.T.-H. Co. (G.E. Co., U.S.). Seals for vacuum tubes.
25,635 B.T.-H. Co. (G.E. Co., U.S.). Attachments for trolley poles.
25,636 B.T.-H. Co. (H. S. Meyer and B. Hopps.). Electric power transmitting mechanism.
25,637, 25,638 and 25,639 J. S. Stone. Space telegraphy. (Date applied for, Nov. 24, 1903, date of application in U.S.)*
25,640, 25,641, 25,642, 25,643, 25,644, 25,645, 25,646 and 25,647. J. S. Stone. Space telegraphy. (Date applied for, Nov. 25, 1903, date of application in U.S.)*

November 25, 1904.

25,648 W. B. Spurrier. Newport. Glow lamp and combined reflector or shade.
25,682 L. S. Andersson. Arc lamps. (Date applied for, Nov. 30, 1903, date of application in Sweden.)*
25,689 O. Schott. Germany. Mercury and like vapour lamps.
25,693 W. Way. Insulated chairs for current-conducting rails.
25,708 L. Kamm. Electric projecting lamps chiefly for enlarging.
25,729 and 25,730 B.T.-H. Co. (G.E. Co., U.S.). Dynamo-electric machines.
25,735 T. Coningham. Contact makers or breakers for sparking devices.

November, 26, 1904.

25,764 B.T.-H. Co. (G. E. Co., U.S.). Electric motor controllers.
25,781 L. C. Ingram, S. R. Cohen and B. R. Cohen. Electric igniting apparatus for explosion engines.
25,784 H. Leitner and R. N. Lucas. Means for regulating circuits.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

23,853 Du Bois and Reason Mfg. Co. Mercury electrolytic apparatus specially applicable to electricity meters and electric switches.
23,948 Conaty. Electric tramcars.
24,023 Bastian. Arc lamps, mercury vapour lamps, or the like.
24,065 Gamble. Memorandum, &c., for use in connection with telephones.
24,083 Rees. Electrical apparatus for propelling vehicles, launches, &c.
24,129 Zani. Structure of alternators.
24,144 Junggren. Electrically-controlled valves. (Date applied for, Nov. 15, 1902.)
24,235 Davy. Arc lamps.
24,701 Howell. Multiplication of electric force for machinery of all kinds.
25,020 Staunton. Automatically governing electric motors.
25,074 Case and Reason Mfg. Co. Rebate indicators.
25,322 Mathews & Hoghton. Resistances.
25,858 B.T.-H. Co. (G.E. Co., U.S.). Windings for dynamo-electric machines.
26,427 Eckstein and Angold. Electromagnetic controlling gear for arc lamps, circuit-breakers and like automatic mechanism.
26,856 Crompton & Co. (Ltd.) and Harris. Electric circuit breaker mechanism.
26,954 Moffatt. Mechanical device applied to cages of electric lifts.
27,069 Cardell. Operating points on electric tramways, railways, &c.
27,722 Hunt and Sandycroft Foundry Co. Alternating-current induction motors.
28,030 Rimington. Electricity meters.
28,543 Walker. Insulation of the linings of metal tubes.
28,580 Gaiffe. Transformers for high-frequency circuits.
28,601 Bowell and Pearson Fire Alarm. Automatic fire-alarm systems.
28,607 Baily. Fuse holders, fuse boxes &c.

Google

1904.

319 Field. Cables.
330 Lackie and Calderwood. Fuses.
351 Griffiths and Bedell. Safety device for vehicles propelled by electric traction on the stud contact system.
1,036 d'Arsonval. Spark extinguishing apparatus for high frequency circuits.
1,354 Le Tall (Cooper Hewitt Electric Co.). Gas or vapour electric apparatus.
1,609 Napier-Clavering. Adjustably suspending electric lamps.
2,347 Starke. Composition for electrical conduits.
2,458 Ault. Brush holders. (Date applied for, Jan. 31, 1903.)
2,512 Groves. Joint boxes.
2,829 Schwabe. Electric lighting appliances more especially for theatres.
2,855 White. Printing telegraph receivers.
3,169 Cash. Suspension chain for electroliers, &c.
4,062 Scialpi. Arc lamp.
4,918 Carter Hall and Parsons. Automatic circuit-breaking appliances for trolley-wire systems.
8,373 Page. Arrangement for using house electric bells for electro-medical purposes.
9,215 Wilson. Switches for electric time-recording devices. (Date applied for, April 21, 1903.)
11,405 Pounsford and Love. Automatic switch for intermittent lighting of electric lamps.
12,615 Katz. Thermo-electric piles.
13,483 Schnelle. Electrical separation of granular material. (Date applied for, June 15, 1903.)
14,523 Fairweather (American Electric Telephone Co.). Telephone systems.
14,568 Siemens Schuckert Werke G.m.b.H. Arrangements of cables working with high voltage. (Date applied for, June 29, 1903.)
15 551 Wilhelmi. Prevention of fires caused by short circuits.
15,869 Siemens Brothers & Co. (Siemens & Halske A.-G.). Electrically-operating railway points.
16,569 Drowns. Directories for telephones. (Date applied for, Jan 29, 1904.)
16,871 Underhill. Receiving telegraph instruments.
17,160 Clements. Chain for suspending electroliers.
17,166 Flichtner. Gas or vapour electric apparatus. (Date applied for, Aug. 10, 1903.)
18,181 Roussell and King. Telegraph transmitters.
18,322 Pieper and L'Hoest. System of electric lighting for railway trains.
18,385 Hornicke. Indicating device for electrical fire-alarms.
18,429 Hawxhurst. Selective telephone call mechanism.
18,827 Kloppenstein and Kloppenstein. Electric temperature signalling device.
18,908 Kelly. Electric time-recording mechanism and apparatus.
18.919 Middleton and Middleton. Terminal or coupling for electric cables.
18,991 Thomas. Systems of electrical distribution. (Date applied for, Sept. 4, 1903.)
19,232 Blondel. Arc lamps. (Date applied for, Sept. 9, 1903.)
19,265 Hornicke. Electrical fire-alarms.
19,334 Reiss and Klemm. Electric fans. (Date applied for, Oct. 12, 1903).
19,561 Honnette and Gebhardt. Trolleys for electric tramways.
19,883 Eisemann. Electric igniters for explosion engines.
19,998 Elebo. Current collecting devices. (Date applied for, Sept. 26, 1903.)
19,999 Fortescue. Electrical transformers. (Date applied for, Sept. 30, 1903.)
20,001 Lincoln. Systems of electrical distribution. (Date applied for, Sept. 30, 1903.)
20,007 Romain and d'Auguesvives. Supports for incandescent lamps.
20,070 Bohy. Magnetised board for teaching purposes.
20,105 Pinching and Walton. Electrical signalling apparatus for fire-calls, &c.
20,134 Klinkenberg. Controlling apparatus for electric motors for lifts.
20,277 Abel (Siemens & Halske A.G.). Incandescent bodies for glow lamps.
20,278 Hunter and Warren. Switch.
20,791 Betmann and Zapf. Supporting electrical conductors.
20,824 Thomson (Gesellschaft fur Drahtlose Telegraphie m.b.H.). Wireless telegraphy systems.
20.975 Boult (Ad. Wagner S. Brechtel & Co.). Incandescent lamps.
21,648 James and West. Trolley heads.
21,664 Houghton. Light and heat baths.

NEW COMPANIES, LIENS REGISTERED, &c.

NEW COMPANIES.

W. W. BAMFORD (LTD.) (82,727).—Reg. Nov. 30, capital £2,000 in £1 shares, to carry on the business of electrical, mechanical, consulting and practical engineers, manufacturers of and dealers in electric, telegraphic, telephonic and other apparatus and appliances, makers of steam, hydraulic or other engines, meters, dynamos, fuse boxes, cutouts and other appliances, dealers in vulcanised bitumen, damp course cloth, box and sealing compounds, bitumen lapping and tapes, wires, cables, wood and other troughing and bridges, &c. Reg. office, Deepwater Pier, Northfleet, Kent.

INVICTA MOTOR ACCESSORIES CO (LTD.)—Reg. Nov. 28, capital £1,000 in £1 shares, to acquire business of electrical engineers and motor ignition manufacturers carried on by Brandes & Co. and to trade as electricians, motor and motor part manufacturers, motor car, motor boat and launch builders, &c. First directors, L. Vanlaetham, O. C. Perkins and F. Johnstone. Reg. office, 68, St. John-street, Coventry.

MANCHESTER & MILFORD ENGINEERING CO. (LTD.) (82,990.)—Reg. Dec. 22, capital £10,000 in £1 shares, to carry on business of mechanical engineers, tramcar, motor-car, locomotive and rolling stock manufacturers, makers of signalling apparatus, telegraphs, telephones, &c., manufacturers of railway sleepers, boiler makers, electrical engineers, manufacturers of all kinds of electrical plant, &c. Reg. office, 22, Conduit-place, Paddington, London, W.

NEW BRITISH ELECTRIC SUPPLY CO. (LTD.) (82,971.)—Reg. Dec. 21, capital £2,000 in £1 shares, to acquire business of electrical manufacturers recently carried on by the New British Engineering Co. (Ltd.), to adopt an agreement with Messrs. Bergtheil and Young, and to carry on the business of electrical and mechanical engineers, suppliers of electricity, manufacturers of and dealers in all kinds of electric and other appliances, &c. First directors, A. Bergtheil, H. W. Young and E. Bergtheil.

HERBERT PLUMPTON (LTD.) (82,986.)—Reg. Dec. 22, capital £6,000 in £1 shares, to acquire business carried on at Warrington by Herbert Plumpton, and to carry on the business of tool manufacturers, engineers, wire-drawers, iron and brass founders, electrical engineers, electric cable manufacturers, coppersmiths, electricians, suppliers of electricity, &c. First directors, H. Plumpton, W. A. S. Clatworthy (nominee of H. Plumpton) and J. W. Hayward and W. Fletcher (nominees of G. Artingstall & Co.). Reg. office, Samuel-street, Warrington.

JOHN W. SUTCLIFFE & CO. (LTD.) (82,989.)—Reg. Dec. 23, capital £5,000 in £1 shares, to acquire business carried on as Hans Neumann & Co., to adopt an agreement with A. Pelteschn, to act as manufacturers' agents, to trade in electrical and general supplies and to carry on the business of electrical and general engineers, &c. The subscribers are J. W. Sutcliffe, electrical engineer, A. J. Mardlin, electrician, P. G. Burgess, electrician, W. E. Von der Muhll, H. Grob, F. G. Crossland and E. J. Nettleton. First directors, J. Pelteschn, J. W. Sutcliffe and W. von der Muhll.

TRAMWAYS DEVELOPMENT CO. (LTD.) (82,953.)—Reg. Dec. 20, capital £100 in £1 shares, to own tramways, railways, omnibuses and vans, and to equip, maintain and work same by electrical or other power.

MORTGAGES AND CHARGES.

ERNEST SCOTT AND MOUNTAIN (LTD.)—Trust deed dated Nov. 28, 1904, to secure £50,000 debenture stock, has been registered. Property charged, certain land in Coulthard's-lane, Gateshead, and company's other assets, present and future, including uncalled capital. Trustees, W. Scott, N. C. Cookson and J. T. Middleton.

LIVERPOOL ELECTRIC CABLE CO. (LTD.)—A memorandum of satisfaction in full of a mortgage dated July 29, 1902, securing not more than £8,000, has been filed.

SCOTTISH HOUSE TO HOUSE ELECTRICITY CO. (LTD.)—A charge on company's undertaking and property, present and future, including uncalled capital, dated Dec. 15, 1904, to secure £750, has been registered. Holders, County of London Electric Supply Co.

CITY NOTES.

MEMORANDA (Dec. 29).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 28$\frac{1}{4}$d. per oz. Consols 88$\frac{1}{16}$—88$\frac{3}{16}$ for money, 88$\frac{1}{4}$—88$\frac{3}{8}$ for account; 2$\frac{1}{2}$ per cent. annuities 87$\frac{1}{4}$—87$\frac{3}{4}$. Consols Pay Day, Jan. 5. Stocks and Shares Continuation Days, Jan. 11 and 25; Ticket Days, Jan. 12 and 27; Pay Days, Dec. 30 and Jan. 13; Mining Share Carry-over Days, Jan. 10 and 24.

BLACKPOOL ELECTRIC TRAMWAYS (SOUTH) (LTD.)—A special meeting of the debenture holders was held on Thursday last week to consider a scheme for writing off 20 per cent. of the debenture stock and asking sanction to pay 3$\frac{1}{2}$ per cent. interest on the stock instead of 5 per cent. on the balance for the next 11 years; at the end of that period, if the company achieved the success anticipated, the sum written off the debentures was to be reinstated, and the difference between 3$\frac{1}{2}$ per cent. and 5 per cent. paid on the whole stock. After discussion, Messrs. P. Musgrave (Bolton), A. M. Sing (Liverpool) and J. Wilson (Liverpool) were appointed to associate with the trustees (Mr. J. S. Harmood Banner and Ald. J. Heap) as a committee "to consult as to the best course to be taken in the interest of the stockholders." The committee was empowered to raise £10,000 to meet immediate requirements, &c. Consideration of the financial scheme was postponed.

BRITISH ELECTRIC TRACTION CO. (LTD.) The interim report states that the directors have not of late undertaken new obligations of any magnitude, and the policy of restricting capital commitments as far as possible for the present has enabled them to reduce considerably administration expenses, whilst some promising schemes are kept in reserve to be dealt with when monetary conditions are more favourable. There has been an increase in the aggregate traffic receipts of the associated companies, although, owing to the general depression in trade during the year, the increase has not been as large as was anticipated. It is hoped, with the expected revival in trade, that there will be a further improvement in traffic receipts and in the income from the company's investments, which last year yielded £136,238. The usual interim dividend at the rate of 6 per cent. per annum has been declared on the ordinary shares for the six months to Sept. 30 last.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Dec. 24	1,147	− 28	30	42,881	+ 5,687
Airdrie	„ 16	172	...	45	9,019	...
Ayr Corporation	„ 21	157	+ 5	32	10,638	+ 501
Barnsley	„ 16	147	+ 7	50	9,414	− 548
Barrow	„ 16	179	...	45	8,200	...
Bath Electric Trams, Ltd.	„ 21	546	...	41	22,250	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	„ 23	1,026	− 88	...	...	...
Birmingham Corporation	„ 24	382	...	51	15,510	...
Birmingham Tramways Co.	„ 24	5,550	+ 861	25	135,388	...
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	„ 22	276	− 4	39	48,175	+ 5,966
Blackpool and Fleetwood	„ 24	182	− 44	26	21,019	+ 241
Blackp'l, St. Anne's & Lytham	„ 22	121	− 14	¶18	971	− 110
Bolton Corporation	„ 25	1,036	+ 156	39	71,599	+ 296
Bournemouth Corporation	„ 21	557	− 16	‡38	42,179	+ 2,047
Bradford Corporation	...	...	...	...	...	...
Brighton Corporation	„ 25	852	− 20	38	39,548	+ 3,266
Brisbane Tramways	...	...	...	...	...	...
Bristol Trams & Carriage	„ 23	5,076	− 189	20	156,701	+ 1,462
Buenos Ayres & Belgrano	Nov. 27	2,215	− 862	6	19,126	+ 20
Burnley Corporation	Dec. 24	954	− 25	12	12,988	+ 2,241
Burton Corporation	„ 25	262	− 67	¶38	13,172	...
Calcutta Tramways Co.	„ 24	a13,016	+ a2,641	21	a964,494	+ a103,531
Camborne-Redruth	„ 26	157	− 7	8	891	− 214
Cardiff Corporation	...	...	...	...	...	...
Carlisle Tramways Co.	„ 24	174	− 31	51	10,015	+ 185
Central London Railway	„ 24	7,744	+ 1,882	25	161,169	+ 1,077
Chatham & Dist. Lt. Rys.	„ 22	496	− 125	51	29,577	+ 1,966
City & South London Rly.	„ 25	3,707	+ 786	26	69,065	− 1,636
Colchester Corporation	„ 19	167	...	...	...	...
Cork Electric Trams Co.	„ 22	446	− 56	51	23,765	− 2,516
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	„ 16	447	− 13	50	26,401	+ 3,214
Dover Corporation	„ 24	192	+ 15	39	8,534	− 101
Dublin & Lucan Railway	„ 23	165	+ 9	26	3,100	+ 1
Dublin Southern District	„ 23	631	− 9	§25	127,506	− 2,399
Dublin United	„ 23	4,152	− 189			
Dudley—Stourbridge	„ 16	734	+ 6	50	48,182	+ 1,466
Dundee Corporation	„ 21	816	− 15	¶30	56,114	+ 45
East Ham Council	„ 21	528	− 20	35	27,011	+ 1,429
Gateshead & Dist. Trams	„ 16	667	− 1	50	45,135	+ 1,844
Glasgow Corporation	„ 24	11,067	+ 570	†30	436,596	+ 20,263
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	„ 16	176	− 27	50	12,420	+ 364
Gt. Northern & City Rly.	„ 24	1,661	...	45	47,559	...
Greenock & Port Glasgow	„ 16	447	+ 16	50	23,715	+ 1,418
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	„ 16	288	− 9	50	14,579	+ 1,010
Huddersfield	...	...	...	...	...	...
Hull Corporation	„ 24	2,221	− 26	38	84,012	+ 10,457
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	„ 21	87	− 33	12	1,350	− 215
Ipswich Corporation	„ 24	346	− 124	38	16,080	...
Isle of Thanet Co.	„ 21	260	− 15	12	10,229	− 525
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	„ 16	93	− 3	50	6,261	+ 2
Kirkcaldy Corporation	„ 21	104	− 9	51	11,491	...
Lanarkshire Trams Co.	„ 23	607	+ 67	51	33,109	+ 19,815
Leeds Corporation	„ 24	6,265	− 541	39	225,793	+ 12,497
Leicester Corporation	„ 21	1,761	...	33	47,671	...
Liverpool Corporation	„ 17	10,121	+ 368	51	522,698	+ 14,045
Liverpool Overhead Rly.	„ 25	1,485	66	†26	40,107	− 7,315
London County Council	...	...	...	...	...	...
Lowestoft	„ 21	140	...	...	...	...
Maidstone Corporation	„ 22	93	...	23	3,350	...
Manchester Corporation	„ 24	11,403	− 602	38	467,465	+ 18,979
Mersey Railway	„ 24	2,138	+ 599	25	87,872	+ 8,843
Merthyr	„ 16	170	− 7	50	10,000	+ 27
Metropolitan Elec. Trams	„ 23	1,779	+ 400	26	46,601	+ 18,647
Middleton	„ 16	217	+ 9	50	16,110	+ 375
Nelson Corporation	„ 24	103	+ 28	30	4,613	+ 1,216
Newcastle-on-Tyne Corp.	„ 24	3,671	− 831	26	91,845	+ 5,050
Newport (Mon.)	...	...	...	...	...	...
Oldham, Ashton & Hyde	„ 16	451	− 14	50	27,273	− 1,113
Oldham Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams	„ 23	1,328	− 101	51	66,202	+ 6,891
Peterborough	„ 16	108	− 4	50	7,396	− 251
Poole and District	„ 16	203	− 6	40	15,026	+ 16
Portsmouth Corporation	...	...	...	...	...	...
Potteries	„ 16	1,759	+ 20	50	86,016	+ 6,113
Reading Corporation	„ 22	581	− 32	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	„ 16	20	− 4	50	6,915	− 17
Salford Corporation	„ 26	3,710	− 374	38	157,018	+ 7,604
Sheerness	„ 14	66	+ 6	50	8,191	− 403
Sheffield Corporation	„ 25	4,465	− 107	‡39	152,436	+ 8,591
Southampton Corp'ation	„ 22	909	− 69	38	37,739	− 2,424
Southend Corporation	„ 21	227	+ 5	38	14,193	+ 1,415
Southport Tramways	„ 16	219	− 1	50	16,009	+ 436
S. Staffordshire Trams.	„ 16	645	− 30	50	58,021	− 2,279
Stockport Corporation	„ 23	320	− 45	38	21,604	+ 7,915
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	„ 16	450	+ 3	50	26,888	+ 921
Taunton Trams	„ 16	39	− 6	50	2,090	− 314
Tynemouth and District	„ 16	169	− 11	50	14,411	− 164
Tyneside Trams Co.	„ 21	330	+ 53	51	19,049	+ 3,200
Wallasey District Council	„ 25	688	− 5	¶38	29,075	+ 1,848
Walsall	„ 24	475	...	50	26,400	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	„ 22	1,012	...	43	40,778	...
Weston-super-Mare	„ 14	25	+ 5	51	6,214	+ 297
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	„ 16	357	+ 12	50	13,380	− 25
Worcester	„ 16	240	+ 130	41	14,095	+ 7,010
Wrexham	„ 16	98	− 17	50	5,407	− 996
Yorkshire Woollen District	„ 16	478	+ 55	50	28,978	+ 8,938

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days.

COMPAGNIE GENERALE DE TRACTION (PARIS.)—The Seine Tribunal of Commerce have authorised this company going into voluntary liquidation.

DELAGOA BAY DEVELOPMENT CORPN. (LTD.)—At the meeting last week the chairman (Mr. J. C. A. Henderson) said that for the present the receipts did not balance expenses, but that was to a certain extent unavoidable in a new country, and especially in a country where electric tramways were comparatively new. They had got nearly 8 miles of track, 12 passenger cars, two freight cars and a water car for cleaning the track and watering the streets. Doubtless better results would be obtained if they were able to run separate cars for Asiatics and coloured people; but they had not sufficient rolling stock to do that, and at the present stage could not incur the necessary capital expenditure. The estimate for the cost of the tramway had been considerably exceeded, partly owing to the heavy cost of macadamising roads. Lately they had received suggestions that the line be extended so as to join the railway, and there was no doubt that that would be a great advantage. In a growing place like Lourenço Marques considerable revenue could be derived from the sale of power, but that would, except to a small extent, mean adding to their present plant at the works.

DOLTER ELECTRIC TRACTION (LTD.)—At the meeting last week the chairman (Mr. H. N. Lubbock) moved the adoption of the directors' report, which stated that Parliamentary sanction had been obtained to the company's application for powers to lay the Dolter system in Torquay. The French Dolter Company had recently laid an experimental line in Dresden, and they were informed that that line was showing excellent results. The chairman said that the directors were now negotiating the financial arrangements, and the scheme when settled would be put before the shareholders.

EDMUNDSONS ELECTRICITY CORPORATION (LTD.)—The directors have declared an interim dividend of 5 per cent. per annum on the ordinary shares for the half year ended Sept. 30.

INDUSTRIAL STORAGE BATTERY SYNDICATE (LTD.)—At an extraordinary meeting on Wednesday it was decided to go into voluntary liquidation, and the secretary (Mr. W. W. Futcher) was appointed liquidator.

RAWORTH'S TRACTION PATENTS (LTD.)—Letters of allotment for the recent issue of capital were posted on the 23rd inst. The company commences business with orders for 65 cars.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee have appointed Jan. 12 a special settling day in a further issue of 5,000 £5 fully paid 4½ per cent. cumulative preference shares of *W. T. Henley's Telegraph Works Co. (Ltd.)*, and have ordered the same to be quoted.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., Dec. 28.	Rate per Cent. Yielded.	Dividend Due.	Business, 6 Days to Dec. 27. Highest.	Business, 6 Days to Dec. 27. Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	3/0	Anglo-Argentine Ord. Shares	7¼–7¾	4 0 6	Ap, Oc	7⁷⁄₁₆	7⅜
5	[illegible]	Do. 5% Cum. Pref.	5½–5¾	4 11 0	..	5⅝	5½
St.	6%	Do. Permanent 6% Deb. Stock	143 –146	4 2 9	..	..	..
St.	6%	Auckland Elec. Trams 5% Deb. (red.)	106 –107	4 15 3	..	..	..
10	6%	Barcelona Tramways Ord.	11 –11½	2 12 2	..	11½	11⅛
10	5 0	Do. 5% Cum. Pref.	9½–10	5 0 0	..	9⅞	9¾
St.	4½%	Do. 4½% Deb. Stock (red.)	95 –100	4 10 0	..	..	..
100	5%	Do. 5 per Cent. Debs.	98 –101	4 19 6	..	..	..
5	..	Brisbane Electric Trams. Invest Ord.	1½–2	..	..	..	..
	4/6	Do. 5 per Cent. Cum. Pref.	3¾–4¼	5 17 5	..	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	96 –100	4 11 9	..	..	..
St.	6%	British Columbia Elec. Rlwy Def. Ord.	100 –106	5 15 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	100 –103	4 17 2	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½–10¾	4 13 0	..	..	..
0	4½%	Do. 4½ per Cent. 1st Mort. Dbs	102½–104½	4 6 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 –101	4 11 0	..	..	..
5	1/0	Buenos Ayres and Belgrano Ord.	3⅛–3⅜	5 16 6	..	3⅜	3¼
5	2/0	Do. 6 per Cent. "A" Cm. Pref	4⅝–4⅞	5 4 4	..	..	..
5	3/0	Do. "B"	5⅜–5⅝	5 11 6	..	..	..
St.	5%	Do. 5 per Cent. Debs.	106 –108	4 12 8	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	103 –106	4 15 9	..	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	96 –99	5 2 6	..	..	..
5	3 0	Calcutta Tramways	8¼–8¾	5 13 2	..	8½	8
100	4½%	Do 4½% 1st Deb. Stock (red.)	108 –110	4 3 3	..	..	..
1	1/0	Cape Electric Tram Shares	1⅛–1¼	6 5 0	..	1¼	1⅛
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red.)	101 –104	4 16 5	..	..	..
St.	..	Madras Elec. Trams 5% Deb. Stk.	103 –106	..	Ja, Jul	..	..
100	5%	Montreal St. Ry. St'g 5% Mort Debs. (1908)	100 –103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922).	103 –106	4 5 9	..	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	103 –106	4 16 9	..	..	..
		ELECTRICITY SUPPLY.					
5	2/0	Calcutta Electric Supply Ord.	8 –8½	4 5 0	..	8⅛	8
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 –93	5 7 6	..	..	..
10	..	Havana Electricity Co. Shares	9½–10½	..	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	¾–1¼	..	..	..	..
1	..	Rand Electric	1¹⁄₁₆–1³⁄₁₆	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	100 –102	4 8 9	Ap, Oc	..	..

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* In calculating the yield, allowance has been made for accrued interest but *not* for redemption.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., Dec. 28	Rate per Cent. Yield.	Dividend Due.	Business, 6 Days to Dec. 18. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.		High-est.	Low-est.
1	..	Bath Elec. Trams Pref. Ord.	½—¾	..	..	..	..
1	..	Do. 5% Cum. Pref.	1⅛—1⁵⁄₁₆	..	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19 —20	4 0 0	Feb, Aug	..	..
10	6%	† Do. Cum. Pref. (fully paid)	10 —10½	5 16 3	..	..	..
St.	4%	† Do. 4 per Cent. Debs.	103 —105	3 14 0	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	9¾—10¼	5 17 3	..	10¼	10
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾—11⅛	5 8 7	Feb, Aug	11	10¾
St.	5%	Do. 5 per Cent. Perpetual Debs	117 —119	4 4 3	..	119	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	96 —97	4 12 10	..	96½	96¼
St.	4%	Central London Ordinary Stock	90 —92	4 6 11	June, Dec	91½	90½
St.	4%	Do. 4 per Cent. Pref. Stock	101 —103	3 17 9	..	102	..
St.	4%	Do. Deferred Stock	84 —86	4 13 6	..	..	..
100	4%	Do. 4 per Cent. Debs.	108 —110	3 13 4	..	108½	..
5	2/6	City of Birmingham Trams 5% Cm. Prf.	4½—4¾	4 17 6	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	45½—46½	4 16 0	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 —125	4 0 3	Feb, Aug	..	..
St.	5%	Do. (1896)	117 —120	4 3 6	..	..	..
St.	5%	Do. (1901)	116 —119	4 4 10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 —107	3 14 9	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13 —14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	—	..	..
10	2 0½	Gt. Northern & City Rly. Prf. Ord. (4%)	6—6½	..	—	6⅛	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8½—9½	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19 —20	4 0 0	Mar, Sept	..	..
10	6%	‡†Do. 6 per Cent. Pref.	15 —15½	3 18 6	Mar, Sept	..	..
St.	4½%	‡†Do. 4½ per Cent. Debs.	110 —112	4 0 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 7 3	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3¼—3¾	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10½—10¾	4 12 0	..	..	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 —105	3 17 4	..	..	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10 —13	..	—	..	..
1	..	Metropolitan Electric Trams Def	⅜—⅝	..	—	½	..
1	0/6	Do. 5% Cum. Pref.	⅞—1	5 0 0	—	..	..
St.	13/7	Do. 4½ Deb. Stock	104 —106	4 6 7	..	105	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—1½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —102	4 8 3	—	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	—
..	6%	Underground Elec. Rys. Co. of London	57 —58	5 2 0	..	..	..
St.	3%	Waterloo and City Ord.	88 —90	3 7 0	June, Dec	..	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	100 —103	3 19 3	Jan, July	..	..
10	..	Amazon Telegraph	1 —1½	..	Jn, Dec ..	..	..
St.	12/6	Anglo-American	16 —16½	4 12 2	F,My,Ag,N	16⅛	15⅞
St.	25/0	Do. Preferred	103½—104½	4 19 6	F,My,Ag,N	104	103
St.	2/0	Do. Deferred	11½—12½	6 16 0	F,My Ag,N	12½	12
100	8%	Commercial Cable Capital Stock	178 —180	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93 —96	4 4 4	Jn Ap,Jy,O	..	..
10	5/0	Cuba Submarine Ord.	8½—9½	5 3 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16½—17½	5 14 3	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3½—3¾	5 11 9	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7¾—8¼	6 1 3	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	102%—104%	4 8 6	Jan, July	..	..
20	8/0	Direct United States Cable	10¾—11	5 9 1	Ja,Ap,Jy,O	10⅞	.
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	101 —103	4 9 3	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	135 —138	5 3 8	Ja,Ap,Jy,O	137	135
St.	17/6	Do. 3½ per Cent. Pref. Stock	88 —90	3 18 0	Ja Ap,Jy,O	89½	88½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —107	3 14 9	May, Nov	..	..
10	2/6	Eastern Extension	13½—14	5 0 0	Ja,Ap,Jy,O	13⅞	13½
St.	4%	Do. 4 per Cent. Deb. Stock	106 —108	3 14 3	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1900	101 —103	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 6	May, Nov	101	..
10	5/0	Great Northern (of Copenhagen)	28½—29½	5 2 9	Jan, July	29⅛	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	101 —103	4 9 2	June, Dec	..	..
25	12/6	Indo-European	44½—45½	5 7 8	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	98 —100	4 0 0	June, Dec	..	—
10	4/0	West African Telegraph Shares	7½—7¾	6 9 2	—	..	..
2½	..	West Coast of America	½—¾	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	98 —100	4 0 6	Jan, July	..	..
10	..	West India and Panama	½ —¾	..	May, Nov	..	..
10	7/0	Do. 6 1st Pref. (x 7 - on act. of arrears	7½—8½	7 17 6	May, Nov	..	..
10	—	Do. 6 per Cent. 2nd Pref.	6½—7½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	102½—104½	4 16 11	Jan, July	..	..
10	3/0	‡ Western Telegraph	13½—14	5 0 0	Mr,Jn,O,D	13⅞	..
100	5%	* Do. 5% Debs. (2nd Series, 1900)	103 —105	4 17 9	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	103 —104	3 16 11	—	..	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid)	5½—6	5 16 8	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	¾—1⅛	..	..	..	..
St.	6%	National Co. Pref. Stock	108 —109	5 10 1	..	108½	107½
St.	6%	Do. Def. Stock	101 —102	4 18 0	..	100	..
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	15 —16	4 0 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12 —13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅛—5⅜	4 11 9	Feb, Aug	5⅜	5¼
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 —99	3 12 3	June, Dec	98½	98
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103½—105½	3 17 2	..	105	..
..	5/0	Do. Do. Prov. Certs, 35% to be pd.	67½—68½	..	..	..	..
1	0/7½	Oriental	1—1⅛	5 18 6	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼—1⅜	4 16 0	..	..	..
5	5/0	United River Plate	6½—6¾	5 16 6	July......	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 16 5	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	105 —108	4 15 8	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	—	..	.
10	2/0	Globe Telegraph and Trust	10½—11½	5 4 9	Ja Ap,Jy O	10¾	10¼
10	3/0	Do. 6 per Cent. Pref.	14 —14½	4 3 9	Ja Ap,Jy,O	14	..
100	6%	Submarine Cables Trust (Cert.)	130 —133	4 16 4	April, Oct	..	..

Share.	Last Dividend.	Name.	Price Wed., Dec. 28.	Rate per Cent. Yield.	Dividend Due.	Business, 6 Days to Dec. 18. Highest.	Lowest.
		ELECTRICITY SUPPLY.		£ s. d.		High-est.	Low-est.
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12 — 13	6 3 1	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10	4 10 0	..	9½	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104 —106	4 5 9	—	..	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5¼—5¾	3 9 7	..	5½	..
St.	4½%	Do. Do. 1st Debs	101 —104	4 7 0	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 5 1	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	104 — 107	3 14 9	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8½—8¾	4 11 6	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5⅜—5⅝	3 17 5	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 —103	3 17 8	..	101½	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	5 —5½	4 0 9	—	..	..
5	2/3	Do. Do. (1903)	5 —5½	..	..	5¼	..
5	2/3	Chelsea Electric Supply Ord.	6½—7	4 2 2	March ..	6¾	6½
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109 —111	4 1 9	Jn, Dec ..	..	..
10	6/0	City of London Electric Lighting Ord.	10¾—11¼	4 9 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13½—14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 —127	4 5 0	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	103 —105	4 6 4	..	104½	..
10	4/0	County of London Elec. Supply Ord.	9 —9½	4 4 2	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —12½	4 16 0	Mar, Sept	12½	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 —110	4 3 3	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 —103	4 7 5	..	..	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	102 —105	4 7 0	—	102½	—
5	3/0	Hove Electric Lighting Ord.	7½—8	3 6 3	..	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	100 —102	4 8 9	..	101½	.
5	5/0	Kensington & Knightsbridge Ord	13½—15	4 12 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 0	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —104	3 17 3	—	..	..
3	..	London Electric Supply Ord.	2¼—2¾	..	—	.	..
5	3/0	Do. 6 per Cent. Pref.	5¾—6¼	5 2 3	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 —97	4 2 6	Mr,Jn,S,D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	16¾—17¼	5 4 4	April, Oct	17⅛	16⅞
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½—5¾	4 0 0	Jan. July	5⅝	.
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	113 —117	3 18 0	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 —99	3 10 6	..	98½	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	93 —96	4 18 0	..	..	—
10	5½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	11½—12½	5 12 0	Feb, Aug	..	..
5	8%	Newcastle Elec. Supply Ord.	8⅛—8⅜	4 17 6	Feb, Aug	..	..
5	6%	Do. 5 per Cent. Non. Cum. Pref.	6¼—6½	4 0 0	Feb, Aug	..	..
1	2	Northern Counties Elec. Sup. 17/- paid	15/6—16/9	3 6 8	Mar, Sep	..	..
10	6/0	Notting Hill Electric Ord.	14½—15	4 0 0	March....	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	101 —103	3 18 2	..	..	..
5	2/6	Oxford Electric Ord.	4¾—5¼	5 2 2	March ..	.	..
St.	4%	Do. 4% Deb. Stock	99 —101	4 0 0	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	13½—14½	5 1 9	Feb, Aug	14⅛	..
5	3/6	Do. 7 per Cent. Pref.	8½—9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	99 —101	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2½—3½	6 3 1	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83 —87	4 12 6	..	..	..
5	3/0	South London Electric Supply Ord.	4½—4¾	3 8 8	—	..	..
1	..	South Metrop'n Elec. Lt. & Power Ord.	½—¾	..	—	..	..
1	0/8½	Do. 7% Cum. Pref.	1½—1⅞	4 16 9	—	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. Accm.)	107 —110	4 2 3	—	108	..
5	2/6	Urban Electric Supply Ord.	4⅞—5⅛	4 18 9	..	5⅛	5
5	2/6	Do. 6% Cum. Pref.	6 —6½	4 17 7	..	6⅛	..
St.	..	Do. 4½% 1st Mort. Deb.	104 —106	..	..	104½	104¼
5	6/6	Westminster Electric Supply Ord.	12½—13½	5 1 11	Mar, Sept	.	..
5	3/6	Do. 5 per Cent. Cum. Pref.	6½—6¾	3 14 0	—	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	½—¾	5 14 2	..	..	..
1	..	Aron Elec. Meter 6% Cum. Pref.	⅞—1⅛	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6½—6¾	6 19 2	July, Feb	6⅝	..
5	3/0	Do. 6 per Cent. Pref.	5½—6¼	5 4 4	Jan, July	5¾	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —105	4 6 3	—	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	100 —102	4 8 6	—	..	..
5	3/0	British Westinghouse 6% Pref.	2½—2¾	..	—	2⅝	2½
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	88 —90	4 10 8	..	..	..
2	..	Brush Electrical Engineering	½—¾	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½—1¾	7 7 6	Mar, Sept	.	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	93 —96	4 14 6	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	69 —73	6 7 6	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	9½—10	6 5 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 15 3	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	105 —107	4 6 0	Nov, May	106	105½
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1½—1¾	4 13 9	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	96 —98	4 13 4	..	..	..
1	0/1½	Chadburn's (Ship) Telegraph Ord.	⅛—1½	5 17 6	..	..	..
2	1/6	Crompton and Co. (Nos. 1 to 64,000)	1¾—2	3 15 1	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	94 —99	5 3 7	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	7½—8½	6 1 3	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	6½—6¾	5 4 4	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	107—109	4 4 6	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	78 —83	4 17 9	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 —84	6 0 6	..	..	..
5	4/0	Edmundson's Elec. Corp. Ord.	6½—6¾	5 9 10	H'lf-yearly	6½	.
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 16 0	—	6⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	107 —109	4 4 0	..	..	..
2	1/7½	Electric Construction Co.	1½—1¾	6 3 0	July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2½—2¾	5 12 5	July	2½	.
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98 —100	4 0 6	Jan, July	..	.
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	80 —85	5 8 8	—	..	.
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10	5 0 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	61 —66	4 3 4	..	[illegible]	[illegible]
5	5/0	Henley's Telegraph Works Ord.	10½—10¾	6 10 3	Feb, Aug	10½	.
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4 3 9	Feb, Aug	..	.
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	110 —112	4 0 10	Feb, Aug	.	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	15 —16	6 5 0	Feb, Aug	15½	..
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 6	Mar, Sept	.	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11 —11½	4 7 0	Mar, Sept	.	..
12	22/0	Telegraph Construction & Mainten'ce.	38 —40	5 18 6	Mar, July	38½	38
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	103 —105	3 17 0	Jan, July	..	..
5	—	Willans and Robinson Ord.	1 —2	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2 —3	—	Apr, Oct	..	—
..	4%	Do. 4 per Cent. 1st Mort. Debs.	74 —79	5 1 3	May Nov	..	..

In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote them

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NOTES.

WE trust that our readers will welcome the book on Electricity Meters, the publication of which, in serial form, is commenced in this issue of *The Electrician*. Excellent volumes have been published on supply stations and their equipment, and there are also some good books dealing with distributing networks, but the important subject of electricity meters has hitherto not been accorded the attention it deserves. Mr. C. H. W. GERHARDI, the author of the book we are publishing, is head of the meter department of one of the largest electricity supply companies in London, and he writes from experience. Without divulging too much of the contents of the succeeding instalments of the serial, we may say that they are essentially of a practical nature, and cannot fail to be of service to supply station distribution engineers.

THE progress of the electrical industry in the Colonies, to which attention is drawn in our leading article this week, is emphasised by the résumé which we give on another page of the provisions of the "South Australian Tramways Electric Traction Act, 1904." We recommend a perusal of this article to electrical manufacturers and contractors in this country. From this it will be seen that the electrification of some 70 miles of horse tramways is to be put in hand at once under less onerous conditions than usually apply in this country, and an opportunity is thus afforded once again to home firms to falsify the impression that they are slack in developing British electrical interests in the Colonies.

THE Postmaster-General has made provisional arrangements with the Marconi International Marine Communication Co. for the acceptance at telegraph offices in the United Kingdom of prepaid messages for transmission from wireless stations on the coast to ships at sea. The arrangement came into operation on January 1st. A charge of 6½d. per word is made, with a minimum of 6s. 6d. for each telegram.

WE are able to give the following particulars of the arrangements, supplementary to what has already appeared in the daily newspapers. At present, the service is confined to Atlantic liners. Contrary to the general impression, messages cannot be sent to the ships through the medium of the Post Office during the whole voyage across the Atlantic, but practically only so long as the ships are near the English or Irish coast. At each post office there is a table giving the list of sailings, and the times up to which telegrams can be received for transmission through six wireless telegraph stations operated by the Company. These stations are at the North Foreland, Niton (Isle of Wight) and the Lizard, on the English Coast, and the other three at Rosslare, Crookhaven and Malin Head on the Irish Coast. They are not fitted with sending apparatus of the same power as at Poldhu, and therefore the distance to which they will carry is limited. Telegrams may be accepted at post offices after the times scheduled for passing these points, but no guarantee of delivery is given, and the messages are sent wholely at the senders' risk.

TWENTY-FIVE Atlantic liners fitted with apparatus for receiving these messages sail this month. Six of these are of the Cunard line, and pass within range of the Rosslare and Crookhaven stations on their way to and from Liverpool. Three of the Compagnie Générale Transatlantique steamers from Havre come into touch with the Lizard station. Eight belong to the American line, those coming from Antwerp being accessible at the North Foreland, Niton and the Lizard, while those that start from Southampton can be communicated with from the last two of these stations. The two Norddeutscher Lloyd boats sailing during the month can be signalled from all three of these Channel stations, and the same applies to two steamers each of the Hamburg-American and Holland-American lines, and the "Minnetonka," of the Atlantic Transport Co., which sails from London on January 19th. The "Parisian" of the Allan line, which is also on the list, sailed from Liverpool yesterday, and can be communicated with via Malin Head up to 9 a.m. to-day (Friday); this steamer does not pass the other two Irish stations.

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We understand from the Marconi Company that arrangements may possibly be concluded in the near future for transmission of such messages via Poldhu, which would mean that communication could be maintained with the steamers for a considerable part of the passage to and from America, as is now done in the case of those which publish a "wireless" newspaper on board. Even for this last purpose, however, the messages are not all received by each ship directly from Poldhu, we believe; some messages are re-transmitted by ships in intermediate positions at sea.

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Reviewing the action of the Post Office in granting these facilities to a company we think that the Department has done wisely to give the system a trial on a practical basis. By the terms of the Wireless Telegraphy Act, there can be no suggestion that the company is in any sense granted a monopoly of this method of communication, and the Act also serves as a safeguard should the service be in any way detrimental to the interests of the Navy, the coast communications of the Trinity Board or the War Office. Moreover, it has been definitely announced that the present agreement is provisional. In some quarters it is held that the service—which in deference to the interests of the public should certainly be provided—ought to be carried out by the Post Office itself, but we think that in the present experimental state of the wireless telegraph industry it would not be wise to discourage private enterprise. We wish the new service every success, and trust that there will soon be equally useful developments in similar directions, for communication between ships and shore stations is the field in which wireless telegraphy should prove of the greatest utility to mankind.

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We publish elsewhere in this issue our annual list of patents of an electrical nature which expire during 1905. Two only of these are in the nature of master patents—viz., that covering the Dickinson swivelling trolley and trolley pole and the patent describing the much-discussed Ward-Leonard system of traction. The combination of electric with pneumatic and hydraulic means for controlling the switch-gear and signalling apparatus of railways forms the subject of patent No. 2,443 granted to Mr. George Westinghouse and Mr. J. G. L. Schreuder, which expires this year together with two other patents for railway signalling apparatus by Mr. I. A. Timmis and Mr. Edward Tyer. A system of ships' telegraphs devised by Messrs. S. Evershed and A. E. G. Richards and a patent for an improvement in the Higgins type-printer are also in the list. Electro-chemical subjects are touched upon in Mr. T. L. Willson's patent, No. 4,757, which covers a certain construction of electric furnace, and in patent No. 19,775, granted to Dr. August Breuer for diaphragms of porous cement.

A Noteworthy patent in connection with dynamo design which expires this year is No. 16,572, which covers Mr. W. B. Sayers' well-known arrangement for improving the commutation of continuous-current machines. This device, which received an enthusiastic reception at the Institution of Electrical Engineers in 1893 has not been adopted as widely as was expected at the time, owing, no doubt, to the fact that in the meanwhile simpler methods for preventing sparking have been found. If only for Mr. Sayers' sake, it must be regretted that the development of the continuous-current turbo-generator has been so slow. Transformer design is represented by Mr. W. M. Mordey's well-known patent No. 12,960, which describes his method of dimensioning transformer stampings, by means of which the whole of the sheets, from which these stampings are punched, is utilised. Three Weston patents have run their allotted span. Two relate to moving coil measuring instruments of a pattern not much in use in this country, in which the current sucks a coil into an annular space formed by the two poles of a permanent magnet; rotatory movement is given to the coil and pointer by providing the spindle of the coil with a number of steep threads which engage with a fixed nut. Mr. Weston's third patent covers the construction of his well-known cadmium standard cell. An expiring Hartmann and Braun patent describes a number of arrangements for mechanically magnifying the movements of the working wire in hot-wire measuring instruments. Mr. W. Deckert's patent (No. 21,565), which expires this year, refers to microphones in which the grains are prevented from "packing" by tufts of fibrous material. Patent No. 22,304, granted to Prof. S. P. Thompson, relates to the artificial distribution of inductance over long-distance telegraph and telephone lines, more or less on the Oliver Heaviside principle, as described by the Professor in his Chicago Paper of 1893. Last, but not least, we must record the expiry in November of Mr. Druitt Halpin's patent for his system of thermal storage, the true value of which has only been appreciated during the last few years.

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In a recent issue of *The Times*, reference was made to a suggestion for a new means of telegraphic communication between the United States on the one hand and Siberia, Japan, China, the Philippines, Manchuria, Corea, and also with the Continent of Europe, on the other. In view of the considerable extension of telegraph lines which has, within the last two or three years, taken place between the United States and Alaska, and in the latter territory itself, it is suggested that the United States Government should continue its lines in Alaska from Nome to Cape Prince of Wales, and establish a wireless system at the latter place connecting with a station at East Cape, the nearest point on the Siberian side. If this were done, the North-Eastern Siberian Company might build an overland line across North-Eastern Siberia, 1,500 miles in length, for which it holds a concession from the Russian Government, communicating with a line on the Siberian Railway. Before the successful completion of the Atlantic cable, this route was suggested, with a cable across the Bering Strait, but was not proceeded with. Looking at the map the scheme appears to be a tempting one, considering that the distance between Alaska and Siberia is only 57 nauts, but when it is considered that such a line could create no new sources of traffic, and that a great part of the line would be on the edge of the Arctic Circle in a region of constant fog and snow, and through most sparsely-inhabited countries, it will be seen that the cost of erection and difficulties of maintenance and working would be very great. It is impossible to believe that such a line could compete in cheapness, reliability, speed or accuracy with the cable lines now connecting the United States almost directly to the countries with which it is proposed to afford communication by the new route.

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THIS view is confirmed by a letter published in yesterday's *Times* from Mr. MARK J. KELLY, F.R.G.S., who was a member of the expedition sent in 1866 to establish the line originally proposed. He fully confirms the impossibility of maintaining such a land line owing to the rigours of the climate, and mentions that he himself lost two fingers by frost-bite.

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THERE is an interesting letter in our Correspondence columns from Messrs. Siemens and Halske, who comment on an article which we published concerning the fixation of nitrogen from the air. Generally speaking, nitrogen can only be fixed effectively at high temperatures, and, in consequence of this, electrical methods are evidently indicated. Direct fixation by burning the nitrogen of the air has been practised in the Bradley process, the outcome of which commercially is still awaited. Fixation of nitrogen by calcium carbide with the formation of calcium cyanamide has been known for some time and promises well. Now it has been realised that potential calcium carbide will serve. Instead of the actual substance, a mixture of lime and carbon is heated in a resistance furnace and air is passed over it. The operation is rational and its success turns on the output. Messrs. Siemens and Halske would do a service by treating this side of the question.

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Personal.—According to the *Electrical World* of New York, Prof. Harris J. Ryan has resigned his professorship in Sibley College, Cornell University, to accept a call to the head of the Department of Electrical Engineering of Stanford University, Palo Alto, Cal. Prof. A. S. McAllister, assistant professor of electrical engineering at the same university, has also resigned his position in order to enter on editorial work in New York.

Cable Interruptions and Repairs.

	Date of Interruption.		Date of Repair.
Cayenne—Pinheiros	Aug. 18, 1902	..	—
Beissi-Issa (Yemen)—Camaran	Oct. 22, 1902	..	—
Tarifa—Tangier	Jan. 18, 1904	..	—
Cayenne—Paramaribo	July 18, 1904	..	—
Sitka—Valdez (Alaska).......	Nov. 11, 1904	..	—
Trinidad—Demerara	Dec. 20, 1904	..	—
Assab—Perim..............	Dec. 26, 1904	..	—
St. Vincent—San Thiago....	Dec. 27, 1904	..	Jan. 4, 1905
Bathurst—Sierra Leone	Dec. 27, 1904	..	Dec. 30, 1904
Cap Haytien—Puerto Plata ..	Dec. 27, 1904	..	—
Gibraltar—Tangier	Dec. 28, 1904	..	Jan. 3, 1905

Accident on the Central London Railway.—At about 11 o'clock on Wednesday morning, whilst an empty train was being shunted at the Bank station of the Central London Railway, the motor car left the rails and blocked the line. In consequence of this no further service between the British Museum station (the next shunting place) and the Bank was possible until about four o'clock in the afternoon. Fortunately the heaviest part of the morning traffic was over at the time of the accident. There was no interruption in the service between the British Museum station and Shepherd's Bush throughout the day.

Electric Traction in Japan.—On Friday last week a special train consisting of 42 waggons left Messrs. Dick, Kerr & Co.'s Preston Works, carrying 250 tons of electrical machinery for shipment in connection with that firm's contract for the complete equipment of the Tokyo Denki Totsudo Kabushiki Co.'s Tramways. This tramway system when finished will cover over 60 miles of line, and operate some 250 cars. The complete installation is being carried out by Messrs. Dick, Kerr & Co., under the supervision of a staff of their engineers, and it is surprising to learn that the only effect the war has had on the progress of the work is in connection with the transportation of the machinery from Yokohama to Tokyo, the railway being congested with war material.

Arc Lamps for the New Underground Railways.—We learn that the Underground Electric Railways Co. of London have placed an order with the Sir Hiram Electrical & Engineering Co. for a large number of Maxim direct-current traction circuit arc lamps. These lamps are to burn five in series on 550 volts direct-current, and are provided with self-contained line and substitutional resistances and automatic cut-out and an isolating switch by which one lamp can be trimmed or examined while the other four are burning. The mechanism chamber is completely separate from the resistance, and the overall length of the lamp is only 28in. A full trim of carbon (12in. 12mm. top and 5in. 12mm. bottom) lasts 90 hours with single enclosure globe, and the carbon left in the top holder is just long enough for the bottom holder for re-trimming. The isolating switch is operated by means of a key inserted through a watertight self-replacing latch in the case.

Compensated Series Motor.—In order to be able to remove the magnetising winding of an alternating-current compensated series motor without disturbing the neutralising coil, Mr. B. G. Lamme, according to the *Electrical World* of New York, proposes to place the neutralising conductors in slots cut in the face of the projecting poles of the stator. One half of the neutralising conductors in each pole-piece are connected to the neutralising conductors of the adjacent half of the next pole-piece by means of end portions bent outward in a plane parallel to the end of the motor and then around the adjacent space between the pole-pieces. This construction, for which an American patent was granted November 22, 1904, permits of locating the magnetising coils quite close to the pole tips, which tends to reduce the magnetic leakage around the coils and thereby to improve the operating characteristics of the machine.

The Cost of Electric Drilling in Mines.—According to Mr. G. E. Walsh, in the *Engineering and Mining Journal* of New York, electric drills have been driven at the mines of the Consolidated Cariboo Hydraulic Co. at Bullion, British Columbia, for some time by direct-current portable 1·5 H.P. motors, and also by 2 H.P. motors. Three drills averaged 312ft. of holes in 10 hours through solid rock. The cost of current was $2·25, and lubricants 35 cents. The drillmen's wages were $4 per shift, with a helper at $2; a blacksmith at $4, and a helper at $2 must be added. The total cost of running the drills for 10 hours amounted, therefore, to $31·55. Compared with hand-drilling, there was a saving of about $50. The power at the above place was generated by steam engines, and the results cannot be considered as an indication of the highest efficiency attainable. A more satisfactory test of electric drills was made for the purpose of determining the consumption of power without reference to wages. Under this test, which was extensive enough to give good averages, an 86in. hole, 2in. in diameter, was drilled in 19·08 minutes. The total consumption was 940 watt-hours, or 131 watt-hours per foot. The cost was 10 cents per kilowatt-hour, which, at the rate of 131 watts per foot drilled, would bring the cost down to 1·31 cents per foot. The minimum cost of drilling with steam or compressed air is about 10 cents per foot.

The Andrew Carnegie Research Scholarship.—A research scholarship or scholarships, founded by Mr. Andrew Carnegie, who has presented to the Iron and Steel Institute sixty four $1,000 Pittsburg, Bessemer and Lake Erie Railroad Co. 5 per cent. debenture bonds for the purpose, will be awarded annually irrespective of sex or nationality, on the recommendation of the Council of the Institute. Candidates, who must be under 35 years of age, must apply on a special form before the end of February to the secretary of the Institute. The object of this scheme of scholarships is not to facilitate ordinary collegiate studies, but to enable students, who have passed through a college curriculum or have been trained in industrial establishments, to conduct researches in the metallurgy of iron and steel and allied subjects, with the view of aiding its advance or its application to industry. There is no restriction as to the place of research which may be selected, whether university, technical school or works, provided it be properly equipped for the prosecution of metallurgical investigations. The appointment to a scholarship is for one year, but the Council may at their discretion renew the scholarship for a further period instead of proceeding to a new election. The results of the research are to be communicated to the Iron and Steel Institute in the form of a Paper to be submitted to the annual general meeting of members, and if the Council consider the Paper to be of sufficient merit, the Andrew Carnegie Gold Medal shall be awarded to its author. Should the Paper in any year not be of sufficient merit, the medal will not be awarded in that year.

The Measurement of Vacuum.—In a Paper on this subject read by Mr. C. Turnbull before the Newcastle Local Section of the Institution of Electrical Engineers on December 18th the author drew attention to the fact that the vacuum gauge in common use measured the difference between the condenser pressure and the atmospheric pressure. It was, therefore, necessary to read the barometer as well as the vacuum gauge to get at the true result. Thus, with a vacuum gauge at 25in. and the barometer at 30in., the actual pressure of the condenser was 5in., and this 5in. was the only quantity that really concerned us. The lower the barometer, the better would be the actual vacuum, although the vacuum gauge would show a worse result. What we required, then, was an instrument which would fulfil the following requirements: (1) It must show the actual pressure in the condenser quite independently of the pressure of the atmosphere; (2) it must be quite accurate in its readings, and not liable to go wrong. The first requirement would be met by an ordinary Bourdon gauge with an exhausted tube (or a similar arrangement to that used in the aneroid barometer), but with the case of the instrument connected to the condenser. Another and perhaps better way was to make use of the ordinary mercury barometer, but to connect the open end of the U-tube, not to the atmosphere, but to the exhaust. When the mercury rose 4in. in the tube it meant that there was a pressure in the condenser which had an effect upon the back of the piston of a reciprocating engine as if the piston were lifting a layer of mercury 4in. deep. For most purposes a 10in. tube was quite long enough, for this would show a vacuum as low as 20in. The instrument could therefore be made in a neat and cheap form. The idea was not new, of course, but so far as he knew it had not come into common use. Messrs. Risely, Thornton and Orde took part in the discussion which followed. On the whole the idea was welcomed, but the opinion was expressed by the first and third speakers that leakages of air might interfere with the accuracy of the readings. In reply, the author confessed that he could not see how air leakages could take place. The apparatus had been working for some time, and had given very good results so far.

Bursting Tests of 4ft. Flywheels.—In a Paper presented recently to the American Society of Mechanical Engineers, Mr. C. H. Benjamin discussed the results of some bursting tests of flywheels. The following contains the gist of his Paper: The first wheel to be experimented on was a well-proportioned cast-iron pulley, such as is used on shafting for transmitting power. This pulley No. 1 was 48in. in diameter, had six arms and weighed 194lb. The rim was whole and was 8½in. wide and about ⅝in. thick, finished on the outside. The arms were elliptical in section, 3¼in. by 1 1/16in. at the hub, and 2in. by ¾in. at the rim. On the whole the wheel was well designed and showed no signs of shrinkage strains. It had, however, been balanced in the customary manner by riveting a cast-iron washer inside the rim at the lighter side, and this proved its undoing. The combination of a thin place in the rim, a rivet hole and a heavy mass of cast iron is enough to wreck any wheel. It was necessary to still further weigh this side by winding lead wire around the arm just inside the rim. As has been shown by previous experiments on whole-rim wheels of cast-iron, a bursting speed of 400ft. per second may reasonably be expected. The circumference of a 4ft. wheel being about 12½ft., such a wheel should burst at about 1,920 revs. per min. The pulley in question burst at 1,100 revs. per min., as recorded by a tachometer connected to the driving shaft. The balance weight weighed 3½lb. and its centre was approximately 23in. from the axis of rotation. At 1,100 revs. per min. the centrifugal force of the balance weight alone would be 2,760lb. Add this radial pressure at a weak point between the arms to that due to the weight of the rim itself, and the low bursting speed is easily accounted for. The linear speed of the rim at rupture was 230ft. per second. As 100ft. per second is considered the limit for belt speed, this pulley would have a working factor of safety of $(2{\cdot}3)^2$ or 5·3. Wheel No. 2 was a cast-iron pulley of the same general style and dimensions as No. 1, but with a split hub and rim. The balance weight was present here as in the former case, but was obliged to yield the palm to its rival, the flanged joint. The wheel had been cast in one piece, as is usual in such cases, with cavities cored at the joints of rim and hub. After finishing it had been broken apart by wedges, making a fracture joint. The flanges, being located midway between the arms and bolted at some little distance inside the rim, were in the worst possible position to withstand the bending action due to centrifugal force, and their own weight only aggravated the difficulty. The flanges weighed, with their bolts, 7¼lb. This wheel burst at less than 700 revs per min., the tachometer not recording below this speed. The speed was probably about 600 revs. per min. At this speed the centrifugal force of the flanges on one side would have been 1,680lb. At 600 revs. per min. the linear speed of rim would be only 125ft. per second. At the very common belt speed of 4,500ft. per minute the factor of safety would be but 2·8, which is altogether too low, considering the nature of the material and the shocks to which a pulley may be exposed.

New York Power Schemes.—Mr. P. S. Sheardown read a Paper, "A Description of Electric Light and Power Schemes in New York, with Special Reference to the Waterside Station of the New York Edison Company," before the Dublin Local Section of the Institution of Electrical Engineers, on Thursday, December 8th. After referring historically, geographically, and statistically to the development of New York, the author described the Waterside generating station at some length. A complete description of this station appeared in *The Electrician* about two years ago (Vol. XLIX., pp. 741, 819, 899). A few features of recent date were, however, alluded to by Mr. Sheardown:—

It was intended originally to instal at the Waterside station 16 steam engines of the vertical marine type, three-crank, with one high and two low-pressure cylinders. The development of the steam turbine in the larger units has made it seem desirable to modify these plans somewhat, and 11 only are so far erected. The balance of the equipment will consist of turbines and their auxiliary apparatus. Turbines of the Curtis type, manufactured by the General Electric Co., each having a capacity of 5,000kw., are now in course of erection, and will be in service in time to assist this winter. The first turbine is of the two-stage type, with eight rows of revolving blades and six rows of guide blades, divided equally between the stages. The second and third turbines will be of the four-stage variety, having four sets of expanding nozzles and four revolving units, each unit containing two lines of blades, with one line of guide blades between them. In the first type the steam is partially expanded at the first set of nozzles, flows through the four revolving blades and three guide blades of the first wheel, and the expansion is then finished in the nozzles between the stages. The steam then passes through the four revolving blades and three guide blades of the second stage into the exhaust chamber in the base of the turbine, and from there passes into the condenser, standing beside the turbine and of about the same height.

For all the company's generating stations the maximum load on Manhattan Island during 1903 was 359,460 amperes, which at the average station pressure of 140 volts equalled 50,000kw. The output of the generating stations on Manhattan Island during 1903 aggregated 131,000,000kw.-hours. The ratio of maximum load to connected installation was 36·6 per cent., a percentage which has been decreasing from year to year with increased concentration in the generation of current and greater diversity in the purposes for which it has been employed.

The average load on the Waterside station for the maximum day of 1903 (December 24th) was 21,535kw., a load-factor of 56 per cent. of the 24-hour capacity; the average for the month of December was 18,059kw., 47 per cent. of the capacity. Current is supplied through more than 42,000 meters to installations aggregating 1,507,342 incandescent lamps, 19,896 arc lamps, 85,072 H.P. in motors and 2,000kw. in customers' storage batteries, heating, and cooking appliances and experimental apparatus. Of the arc lamps, 8,126 are supplied for the municipality. The aggregate of these installations is the equivalent of 2,955,214 lamps of 16 c.p., each averaging 50 watts.

To the smaller customers current is sold under a retail contract, in which the maximum price is 15 cents a kilowatt-hour, falling as the average use of the installation increases; thus it is 10 cents for the third and fourth hours of average use, 7½ cents for the fifth and sixth hours, and 5 cents a kilowatt-hour for all use in excess of six hours daily. The larger installations are supplied under wholesale contracts, which, through the medium of guarantees, ensuring a relatively large consumption of current, offer marked reductions from the prices of the retail schedule. Thus, on what is known as the wholesale "A" form, a customer guarantees a monthly use of current amounting to 2,000 kilowatt-hours, and a daily average use of the installation of two hours, for 10 months of the year, and the maximum price is reduced to 10 cents a kilowatt-hour. For all current in excess of four hours' daily average use of the installation, the price is reduced to 5 cents a kilowatt-hour. There is also a second wholesale form of contract, which deals with customers taking a still larger quantity of power; and there is a third form of wholesale contract, which was developed in order to get on to the supply mains of many of the huge blocks and buildings which have hitherto been supplied with current by their own private lighting plant. This schedule is for customers taking supplies of from 10,000 units per month for 12 months in the year, when the maximum charge is 5 cents per unit, which is reduced to 3 cents per unit for current in excess of 50,000 units per month per year. For these wholesale contracts the consumer has to supply space free for the installation of a high-tension sub-station by the company. The latter requires that all retail customers shall permit it to supply incandescent lamps, including them within the price for current. The wholesale customers in the private plant class, however, have the option of purchasing incandescent lamps either from the company or elsewhere, and when this option is exercised a special reduction of 1 cent per kilowatt-hour is made.

Large Searchlight.—In the *Electrical World* of New York there recently appeared a description of a huge searchlight erected on the roof of the building occupied by the Lewis Publishing Co. The searchlight was built by the General Electric Co. (U.S.A.). By reason of its excellent position the full effects of its strength are obtained. Situated in the dome of the office building, it is 135ft. above the ground. The building, however, occupies a point considerably higher than the city and the surrounding country, so that the light is more than 300ft. above the city proper. When projected at an angle of about 30deg., in which position the beam of light is seen at the greatest distance, the ray is reported to have been discerned at points 300 miles from St. Louis. The strength of the light is such that, when thrown on the outlying city of Clayton, 3 miles distant, no difficulty is experienced in reading a newspaper by its light. The lamp itself is 84in. in diameter, and the parabolic mirror behind the arc measures 80in. This mirror, which is of foreign make, in itself entailed an expense of about one-third of the total cost of the lamp. The carbons are set horizontal or parallel to the ray of light, the negative carbon being placed nearest the reflector. With this position of the carbons the intense light from the crater of the positive carbon is thrown directly into the reflector. The crater at times assumes a depth of 2½in. or 3in. A cored carbon, 2¼in. in diameter, is employed for the positive, and the negative is solid, having a diameter of 1¾in. The current, changing somewhat with the length of the arc, varies from 300 to 350 amperes. Because of the purity of the carbons employed very little hissing is present, but the intensity of the heat is such that there is a constant flaming, the flame rising several inches above the carbons. To avoid rising temperature in the lamp, liberal ventilation is obtained by openings at the top. By this means the temperature is kept down to such a point that the hand can be placed on any point of the exterior of the lamp. Opposite the arc numerous openings fitted with ruby glass are provided, through which the operator may observe the condition of the arc when making adjustments. By means of several devices the arc may be adjusted to any position. Its position relative to the mirror may be changed by a crank projecting from the front. By so doing the rays may be diverged or concentrated as may be desired. An attempt to concentrate too intensely results in a crossing of the rays, which is readily distinguishable by a lessened diameter of the beam of light at the point of crossing. The mechanism of the lamp is so arranged that the beam may be thrown in any direction. It may be revolved completely on its base or may be swung upon its supporting trunnions for raising or depressing the beam. As the lamp is delicately balanced, these movements may be accomplished by hand, and for operating in this manner convenient handles are provided. Through a series of gears adjustments of direction may be made more delicately by two cranks at the base, one for horizontal and one for vertical motions. It is, however, customary to provide large searchlights with means for control from a distance. This light has been supplied with such a system of electric control. Two small motors, one for vertical, the other for horizontal movements, are placed in the base, together with resistances, gearing and other mechanism. The motors are operated by means of a controller, which can be placed in any convenient position within the radius of the 200ft. of connecting cable. A lever projecting from the top of the controller, by the proper movement, gives any direction of motion desired. Connections are so made that the movement of the lamp corresponds to the position of the lever; that is, when the lever is thrown counter clockwise the lamp revolves in a similar direction, if the lever be thrown down the light is depressed, &c. By a diagonal movement of the controller handle both motors may be made to operate simultaneously and the lamp be given a diagonal or a combination of vertical and horizontal motions. An increasing pressure on the controller handle gives three speeds, either in a vertical or a horizontal direction. In the construction of the building special provisions were made for the accommodation of the lamp. It occupies the centre of the copper dome-shaped roof. Beneath it is steel framework, into which it is lowered when not in use. When so lowered the trap doors above are closed and the exterior of the building presents no evidence of its existence.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

TUESDAY, January 10th.

INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW LOCAL SECTION.

8 p.m. Meeting at 207, Bath-street. Paper to be read: "Street Lighting by Electric Arc Lamps," by H. B. Maxwell.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m Ordinary Meeting, when Sir William White, F.R.S., will deliver an Address on "The Recent Visit to the United States and Canada."

WEDNESDAY, January 11th.

INSTITUTION OF CIVIL ENGINEERS.

3.30 p.m. Ordinary Meeting, when Sir William White will repeat his Address on "The Recent Visit to the United States and Canada.

THURSDAY, January 12th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when the conclusion of the discussion on Mr. W. P. Adams' Paper: "The Combination of Dust Destructors and Electricity Works Economically Considered," will be taken. Time permitting, the following Paper will also be read: "Fuel Economy in Steam Power Plants," by W. H. Booth and J. B. C. Kershaw.

INSTITUTION OF ELECTRICAL ENGINEERS: DUBLIN LOCAL SECTION.

8 p.m. Meeting at the Royal College of Science. The discussion on Mr. P. S. Sheardown's Paper: "New York Electric Power Stations," will be concluded, and the following Paper read: "Note on a Peculiar Fault on a 200-volt Lighting Circuit in the City of Dublin," by A. B. Porte.

FRIDAY, January 13th.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER STUDENT'S SECTION.

7:30 p.m. Meeting in the Municipal School of Technology. Paper to be read: "Electric Heating," by A. E. Jephson.

TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

8 p.m. Meeting at the Society of Arts. Paper to be read: "Overhead Equipment," by H. M. Sayers.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel, when Prof. Vivian B. Lewes will deliver a lecture, illustrated by lantern slides, and experiments on: "The Theory of the Incandescent Mantle."

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

8 p.m. Meeting at 25, Great George-street, Westminster. Mr. James Swinburne will deliver a lecture on: "Theory of Electricity and Magnetism." Sir Guilford L. Molesworth, the President, will occupy the Chair, and members of all classes are invited to attend.

ELECTRICITY METERS.*

BY C. H. W. GERHARDI.

The work imposed on an electricity meter is perhaps the hardest that is put upon any electrical machine. It is erected, probably in a cellar and kept there for four or five years or longer without receiving any attention, except an examination of the reading once a quarter by the meter reader. It is further expected to be accurate on all speeds from zero to the speed corresponding to its full load, and, should it become inaccurate to an extent of 5 or 6 per cent., it is liable to be looked upon as a terrible offender (particularly by the consumer if the inaccuracy be against him).

It is sometimes put forward that the accuracy of a clock or watch remains good for many years, and therefore why should not a meter be made to have the same accuracy? The work of a clock, however, is very different. It works at a uniform speed with a strong power to drive it, whereas in a meter the power for driving is kept down as low as possible and is generally very small.

Electrical meters, or more correctly, electrical integrating meters, may be divided into two classes. They are (1) Watt-hour meters, and (2) Ampere-hour meters. Those of the first class register, or should register, the true energy supplied through them. Mathematically they find the value of $\int_{t_0}^{t_1} CV\,dt$, where C and V are the various values of the current and pressure between the times t_0 and t_1; in the case of alternating-current meters C and V are the virtual amperes and volts respectively, and the expression under the integral must be multiplied by the "power-factor" of the circuit. For the second class the integral becomes $\int_{t_0}^{t_1} C\,dt$ the pressure being assumed constant at the "declared pressure." If this declared pressure is not kept, then with an ampere-hour meter the number of Board of Trade units for which the consumer would be charged would be too high or too low, according as to whether the supply had been at lower or higher pressure than the "declared."

Ampere-hour meters possess the advantage of simplicity of connections, as they are inserted in one main only, whereas watt-hour meters either require both mains to be taken into the meter, or one only, and a tapping from the other to supply the current for the shunt winding.

Ampere-hour meters are only suitable for one kind of current, but several watt-hour meters have been put on the market which are equally suitable for alternating and continuous-current circuits without any mechanical alteration, and in some cases without special calibration. This—although not an important feature to suppliers of current who generate only one kind, and do not propose to change their supply in future to another kind—is a distinct advantage in more ways than one to those who supply both alternating and continuous current, or to those who intend to change the supply from alternating to continuous or vice versa. Meters form a large item in capital outlay, and the wholesale "scrapping" of a certain make owing to its unsuitability for working on the new supply would mean a great expense.

Another point, although by no means so important, is the number of meters in stock, which would be consequently increased. Many sizes of meters have to be stocked, and it is very desirable to keep down the stock—which is idle capital—as much as possible. In order to avoid delay in supplying meters from the test room for erection, it is always necessary to have a stock in all sizes tested. There must of necessity also be several which are untested; and after the undertaking has been running some time, a further stock, composed of defective meters brought in from time to time from circuit, which cannot always be repaired at a moment's notice, will also swell the stock. In a large electric lighting company with some thousands of meters, there must necessarily be a number constantly being returned from the above cause, as also on account of consumers increasing their lamp connection. It is worth while to overhaul or at any rate to inspect carefully all meters that have been returned to the testing department after having been out on circuit for some time.

Meters may also be classified according to the principle upon which they work, thus: Clock meters, electrolytic meters, motor meters. Clock meters form the smallest class, there being practically only two examples in commercial use at the present day. They either depend on the difference of the rates of two separate clocks (such difference being caused by the energy passed through them), as in the Aron meter, or on the rate of oscillation of the escapement wheel (caused by the current) as in the Mordey-Fricker meter.

Electrolytic meters, as their name implies, depend for their action on electrolysis. Water is decomposed into its gases, or copper is transferred from one copper plate to another, both being in a solution of copper; or mercury is precipitated out of a solution of a mercurous salt. This class is confined to continuous-current circuits up to the present, although attempts have been made to produce electrolytic meters for alternating working, but without success.

Motor meters form by far the largest class. In these a small but definite fraction of the total energy which they are to measure is used to work a motor to which is attached a train of wheels for recording the number of revolutions of the motor. The speed being made proportional to the energy passed, the indices on the train may be made to indicate directly the kilowatt-hours taken by the consumer.

Probably the most advantageous classification for the purpose of description, however, is to divide meters up according to the work for which they are suitable, thus:—

(1) Meters suitable for alternating-current supply,

(2) Meters suitable for continuous-current supply,

(3) Meters equally suitable for both alternating and continuous-current supply,

and in this way it is proposed to describe them.

ALTERNATING-CURRENT METERS.

Meters suitable for use on alternating-current circuits only mostly depend for their working on motion being produced by alternating magnetic fields acting on a disc or cylinder of metal. They comprise the following four principal parts: (1) A registering train, (2) the moving portion, or rotor, (3) a driving combination, composed of an iron core with series and shunt coils, (4) a Foucault brake.

The registering train gears with a worm or pinion on the main spindle, and thus records the number of turns made by the moving part; a definite ratio is fixed between the first dial and the main spindle, so that the readings of the dials may be made equivalent to the number of Board of Trade units transmitted. The moving portion consists of a flat disc or bell of copper or aluminium, forming the armature, supported by a vertical spindle through its centre which rests upon a jewelled footstep bearing, and is held in position by a small bearing at its upper end. In this type of meter the mechanical friction may be kept low owing to the lightness of the moving portion, and to the absence of the necessity for commutation. This, coupled with the ease by which the acceleration can be prevented above the desired amount by means of the eddy-current brake, avoids the necessity of any mechanical contact with the moving part, with the exception of its top and bottom bearings and the point where the motion is transmitted to the registering train. The action of all meters of this class is the same, the differences between the various types being those of design, construction and workmanship.

The motor is in reality a two-phase asynchronous motor, capable of being worked on a single-phase two-wire circuit, a torque being produced by a magnetic field which varies in intensity, and alters in position continually, acting on the fields set up by eddy curents which are generated in the armature by the impressed field.

The shifting, or rotating, field is really the resultant of two fields, one of which is due to the main coil or coils through which the current consumed by the lamps or other apparatus passes and the other to the shunt current. The main coils are of low resistance and few turns, and are as non-inductive as it is possible to make them, consequently the current is practically in phase with the pressure if the load be incandescent lamps or other non-inductive load. The shunt circuit is made as inductive as possible, so that the current through it lags nearly 90deg. behind the impressed voltage, and consequently by almost the same amount behind the main current.

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* From a forthcoming book to be published by "The Electrician" Printing and Publishing Co. All rights are reserved.

In order that an induction watt-hour meter may be a true energy meter on loads of varying power factor, and especially on very inductive loads, it is necessary for the fluxes due to the main and pressure coils to be in exact quadrature. As the main current is bound to have a slight lag, passing as it does through a coil, and, as also the shunt current cannot be made to lag 90deg. behind the impressed volts (for the shunt coil must have some resistance) the meter, although capable of being made to register non-inductive loads accurately, would register too little if used on circuits of power factor less than unity, if made without any compensating device. Its armature would cease to move at all on a load, the power factor of which was equal to the cosine of the angle of lag between the main and shunt currents, and it would rotate backwards, giving a negative value for the consumption on highly-inductive circuits in which the power-factor was less than the above value. It is not, however, essential that the currents in the shunt and main coils be displaced in phase by 90deg. so long as the magnetic fluxes are so displaced. Certain devices are, therefore, introduced in order to obtain this end, so that the final result is that a resultant flux is produced which is in quadrature with the one not acted upon by the compensating device. Under such conditions the torque exerted upon the disc is proportional to the cosine of the angle of the lag of the main current, and is also proportional to the product of shunt and series fluxes, which, in their turn, are proportional to the currents causing them; consequently, the torque varies directly as the true power transmitted, or as C × V × cos ϕ, C and V being the virtual current and voltage.

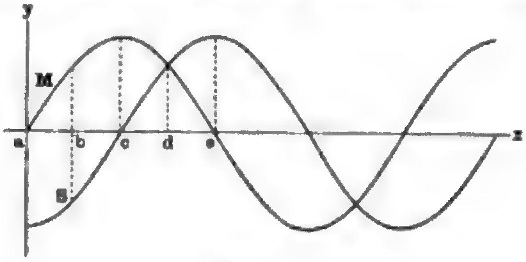

Fig. 1.

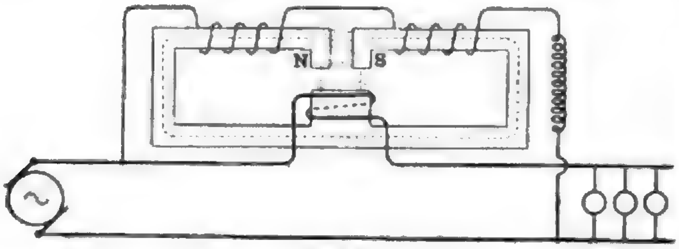

Fig. 2.

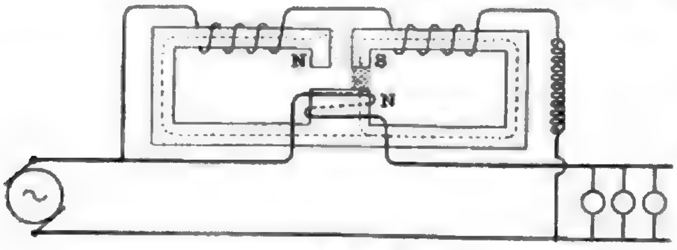

Fig. 3.

In order that the shunt current may be proportional to the impressed voltage, it is necessary that the iron be not too highly magnetised.

The two fluxes at 90deg. displacement may be imagined to combine into one resultant flux which acts on the disc or armature, and the way in which this flux alters in position may be followed by analysing the conditions which exist at different times during one period. Thus, if the two curves M and S represent the two fluxes (Fig. 1), due to the main and shunt currents respectively, and if diagrams be drawn of the stationary portion of the motor indicating the polarity of the iron circuit at certain instants, it is easy to see how the resultant flux shifts, and how, together with the fluxes due to the eddy currents generated by it in the disc, the necessary torque is obtained.

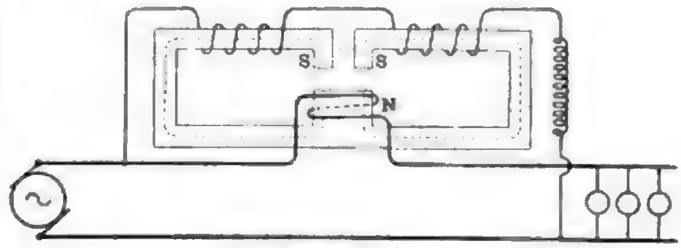

Fig. 4.

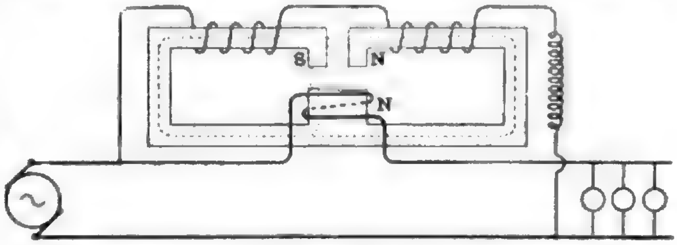

Fig. 5.

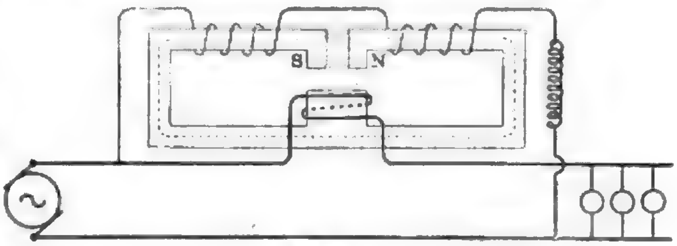

Fig. 6.

The two curves are represented at a phase displacement of 90deg., corresponding to the condition of non-inductive load. The flux above *ax* is considered positive, and below *ax* negative. Starting at a time, *a*, when the series flux is zero, the shunt flux is at a negative maximum, and the iron circuit (Fig. 2) is magnetised as a ring, the left-hand pole being a north and the right-hand one a south; the lower vertical limb is not magnetised at this moment, so that the flux passes across the vertical air-gap, as indicated by the dotted lines, and there is only a slight leakage across the horizontal air-gap. At the time *b* (Fig. 3) the shunt flux is still negative, but the main flux is rising in a positive sense, thus the polarities of the upper poles are still the same, but the vertical limb now has a flux in it, the upper end being a north pole; therefore at this instant there is a flux in the horizontal air-gap between the right-hand pole and the pole of the vertical limb as well as across the vertical air-gap. By the time *c* is reached (Fig. 4) the shunt flux has decreased to zero, and the main flux is spread across the horizontal air-gap, the two upper poles being south and the lower one north, and there is only a slight leakage across the vertical air-gap. At time *d* (Fig. 5) the shunt flux has risen, so that the left-hand pole is south and the right hand one north, the flux in the vertical limb still remaining, although diminished in strength, so that the flux in the horizontal air-gap has now shifted to the left and is between the left hand and lower poles and also between the two top poles. Coming to *e* (Fig. 6), which is the time of one alternation or half a period, the main flux has become zero, the shunt flux being a positive maximum; consequently the flux passes through the vertical air-gap as at time *a*, but in the opposite direction, the left-hand pole now being south and the right north.

For the other half period the same changes take place, the only difference being that the polarities are the reverse at the corresponding intervals of time, the flux still passing from right to left. These same changes take place during each period, so that the effect is that the flux in the horizontal air-gap gradually changes from zero to maximum, starting on the right and finishing at zero on the left, alternation by alternation.

(To be continued.)

ELECTRIC LIGHTING AT THE NEW LYCEUM.

In the rebuilt Lyceum Theatre, which was opened last Saturday, there is an electrical installation of about 2,000 lights. The stage, as well as the auditorium, is lighted electrically, the work having been carried out to the design and specification of Mr. Thomas J. Digby, the consulting electrical engineer. There are two sources of supply. The Metropolitan Electric Supply Co.'s mains supply at 200 volts, and the Charing Cross and Strand Electricity Supply Corpn. are at the same pressure, but on the three-wire system. The circuits are divided between the two sources of supply, and there are change-over switches on each service. 100 amperes (taken from the Charing Cross Company) are required for the cinematograph lantern, which, it may be mentioned, is contained in a room of special fire-proof construction.

We illustrate some of the fine fittings, all of which have been supplied by the General Electric Co., who designed and manufactured them (at their Birmingham works) to the approval of the architect, Mr. Bertie Crewe. In designing these the company were confronted by the difficult problem of lighting the theatre efficiently with decorative fittings that would naturally harmonise with the general decorations, without spoiling the effect of the delicate details in which they were to be set. Each fitting had been carefully designed, first, to fulfil its necessary function of lighting the space; second, for illuminating the decorations satisfactorily; third, for completing this scheme of decoration, and for this purpose a free rendering of the Louis Quinze period was adopted by means of which the fixtures were kept light and graceful in contour, while adhering to the characteristic style of the period.

The main ceiling of the auditorium is lighted by 20 nine-light electroliers, as Fig. 1; the circle fronts and round the stalls by brackets, as Fig. 4; the box fronts are lighted by means of cupids holding small arms similar to Fig. 4; the circle fronts by five-light clusters, as Fig. 2; the foyer by handsome candelabras, as shown in Fig. 3, supported on pillars; and the grand staircase by two nine-light standards, Fig. 5.

All the wiring work was carried out by the National Electric Construction Co. in record time. This firm only put in an appearance on the job on October 24th, the building being even then not far enough advanced to make a good start; but the work was completed and passed by the London County Council on December 30th, the theatre being opened on the following day. Solid-drawn screwed barrel (supplied by Messrs. Isaac Griffiths & Sons) is employed throughout, except in the dressing rooms, which are wired in casing. Henley cable of the 2,500 megohm grade has been used and Moy switchboards. The illuminated ex t notices are by the Electrical and General Engineering Co., and the outside arcs are of the "Excello" flame pattern, supplied by the Union Electric Co. These lamps make a fine display at the main entrance, and are also fitted all round the outside of the building. It may also be mentioned that electric motors are employed for the ventilating arrangements, a 15 H.P. motor driving a fan and a 3 H.P. motor being used for working the pumps.

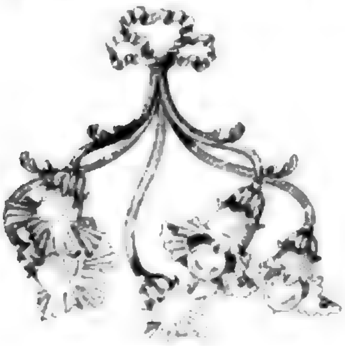

Fig. 2.

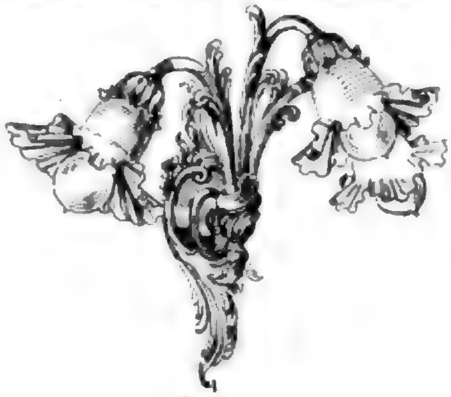

Fig. 4.

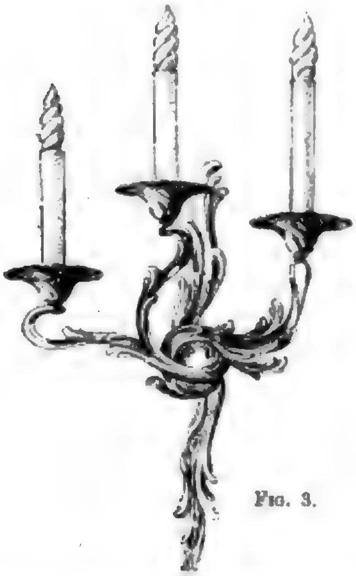

Fig. 3.

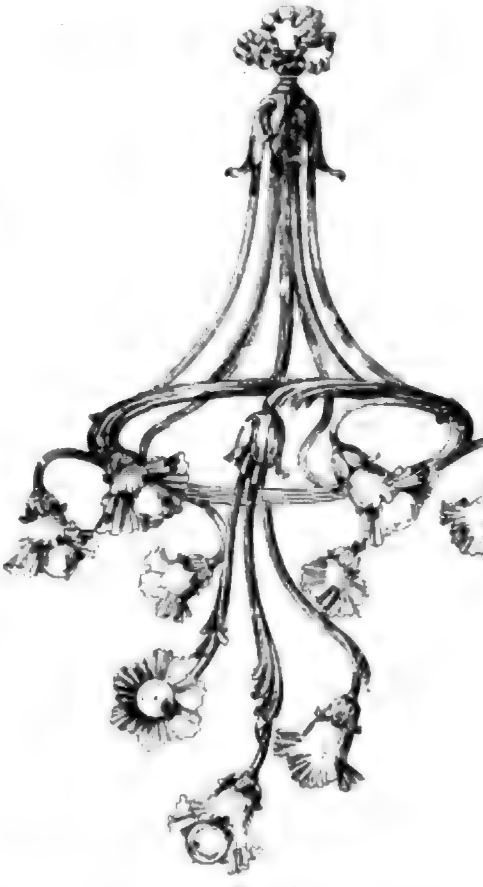

Fig. 1.

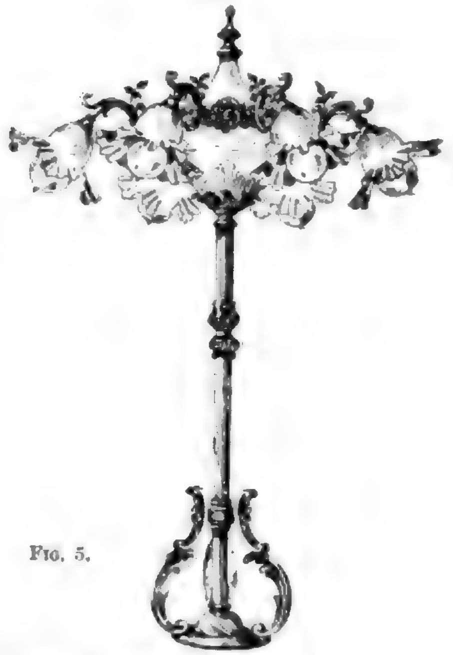

Fig. 5.

THE AMSTERDAM-HAARLEM TRAMWAYS SYSTEM.

About five years ago the first electric tramway in Holland was constructed in the city of Haarlem by a local Dutch company. This system included a belt line about the city of Haarlem, with two suburban branches, one running north to Bloemendal, a thriving residential suburb, and the other west about 5 miles to Zandvoort, an important seaside resort for the people both of Haarlem and of Amsterdam.

Haarlem itself is a pleasant residential city of 65,000 inhabitants, where many of the business men of Amsterdam live. The distance between the boundaries of the two cities is 10 miles. It appeared to a number of people that an electric line connecting the two would be a paying enterprise, and several years ago a concession was granted for such a line. but the route was rather roundabout, and finally the Holland Steam Railway Co. secured control and prevented the construction of the line. In 1901, however, Messrs. Anderhagen & Neumeyer, of Amsterdam, took the preliminary steps towards securing a new concession over the direct Government high road connecting the two cities and running parallel with the steam railway. The essential conditions of this concession for the construction of a double-track line on each side of the Government high road were :—

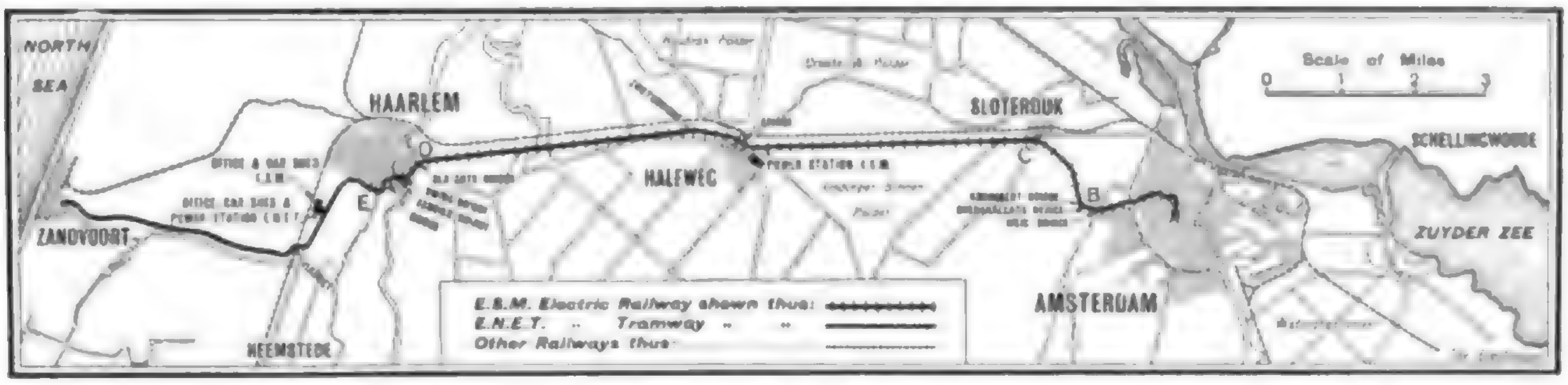

FIG. 1.—MAP OF ROUTE.

1. That the concessionaire was required to sheet pile the sides of the road (which is bordered by a canal on one side and a ditch on the other), in order to secure the necessary width and stability, and to carry out the whole of the works with the least possible interference with the regular use of the road.
2. That the period of the concession was for 50 years from December 31, 1902.
3. That all construction plans of every nature were required to be submitted for Government approval.
4. That the period allowed for the construction was two years.
5. That the speed allowed for the cars was to be regulated by the Secretary of State, and the speed actually permitted was 35km. per hour. The Secretary of State was also empowered to fix the maximum fares, but it was generally understood that the maximum fares allowed should be equal to those of the steam line.
6. That at the expiration of the concession the Government will take over, without compensation, all the property of the company located on Government lands. There are a large number of minor provisions regarding protection of working men as to hours of labour, accident insurance, pensions, &c., and others as to the protection of the various water boards, drainage boards, telegraph companies, railways, &c.

In addition to this concession for the use of the government high road it was necessary to obtain an entrance into Amsterdam, and to do this satisfactorily the concessionaires obtained options on a private right of way for about two miles from the government road to the Amsterdam city limits, at a point near the terminus of one of the Amsterdam corporation tramway lines. In obtaining this private right of way the option was made to include a strip of land for the whole distance wide enough to permit of a row of building lots on each side of the road being laid out and sold. On this section the tramway is built in a purely private right of way in the centre of the road with a paved driveway on each side, and outside of this driveway the usual footpath and building lots are arranged. Running powers were then secured over the tramways of Amsterdam, then in process of electrification, for a distance of about 1 mile from the city limits to the corner of the Spui and the Kalverstraat, the centre of the office and retail business districts of Amsterdam. The gauge of the Amsterdam city lines being standard and the gauge called for by the new concession being 1 metre, it was necessary to lay a third rail for the greater part of this distance where the lines are common to permit through running of cars over the corporation route, this work being carried out by the corporation at cost and a percentage. This was made more expensive by the fact that a large swing bridge had to be constructed to permit the through running of the cars, and this was done principally at the expense of the concessionaires. In addition to paying for this bridge and construction the concessionaires agreed to pay 40 per cent. of the fares which the town would have charged within the city limits on the basis of its own rates, and also to repay the actual cost plus 10 per cent. expended by the corporation for repairs and maintenance of the tracks used by the concessionaires, and, further, to pay for power within the city and taken from the city's trolley wire at a rate of not less than 0·9d. per car mile. The period of this contract is the same as that of the concession on the Government road. It will be noted that the conditions are most stringent and that a net profit on the running in the city of Amsterdam cannot be expected ; but, on the other hand, the distance within the city is a very short one (1·4 mile in a total run of 12), and to secure the satisfactory terminal facilities these concessions were necessary.

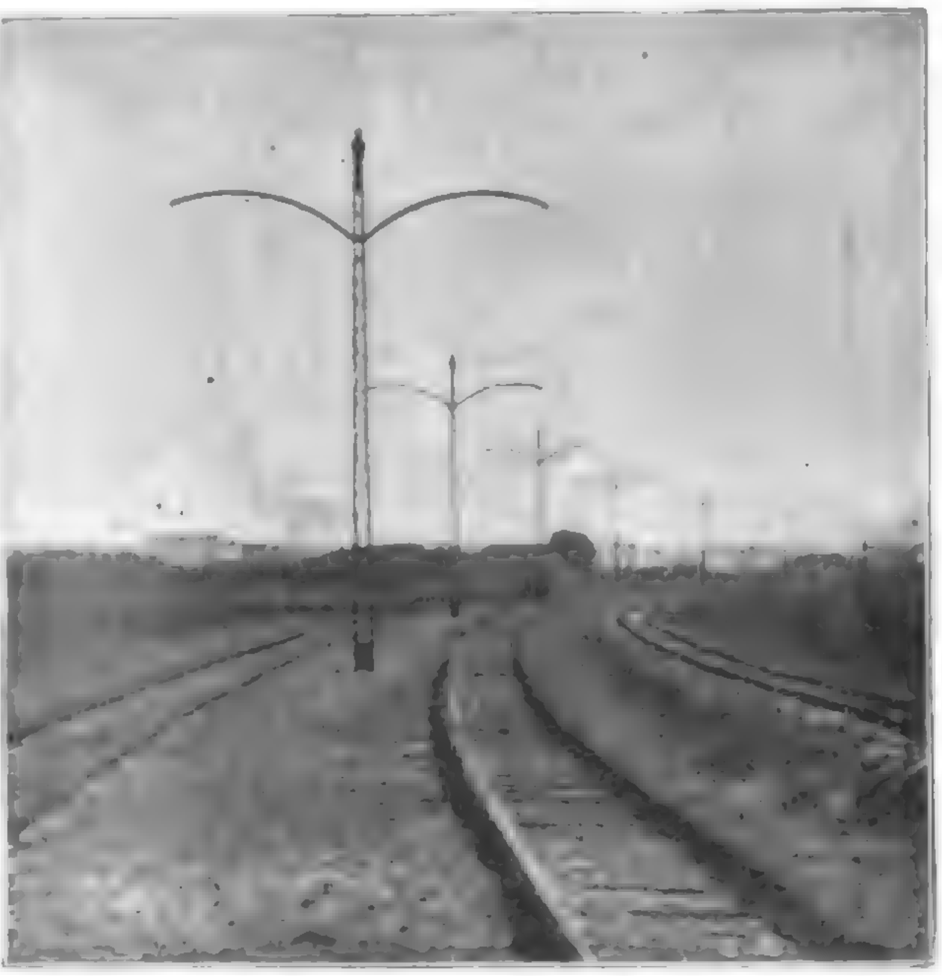

FIG. 2. CENTRE POLE EQUIPMENT ON PRIVATE RIGHT OF WAY.

Messrs. Anderhagen & Neumeyer then secured an agreement with the Corporation of Haarlem permitting the construction of about $1\frac{1}{2}$ miles of lines within that city, to give the company a satisfactory terminus at its eastern end. The Haarlem concession is also for a period of 50 years, and is without unusual features, except that the concessionaires are required to pay large amounts for the renewal of bridges and similar works in the city of Haarlem. When all the concession arrangements above outlined were completed, local permits obtained, &c., the matter was presented to an American syndicate headed by Mr. H. J. Pierce, of Buffalo, who, after full investigation, decided to take the matter up and build and operate the proposed line. The Electric Railway Co. of Amsterdam—a Dutch corporation—was organised to take over the concessions and build the line. All the shares of this company were subscribed and fully paid for in cash by the Netherlands Tramways Co. of New Jersey, the American syndicate above mentioned. The debentures of an amount equal to the amount of shares—viz., 3,000,000 guilders—were purchased outright by the well-known Amsterdam banking firm of H. Oyens and Sons.

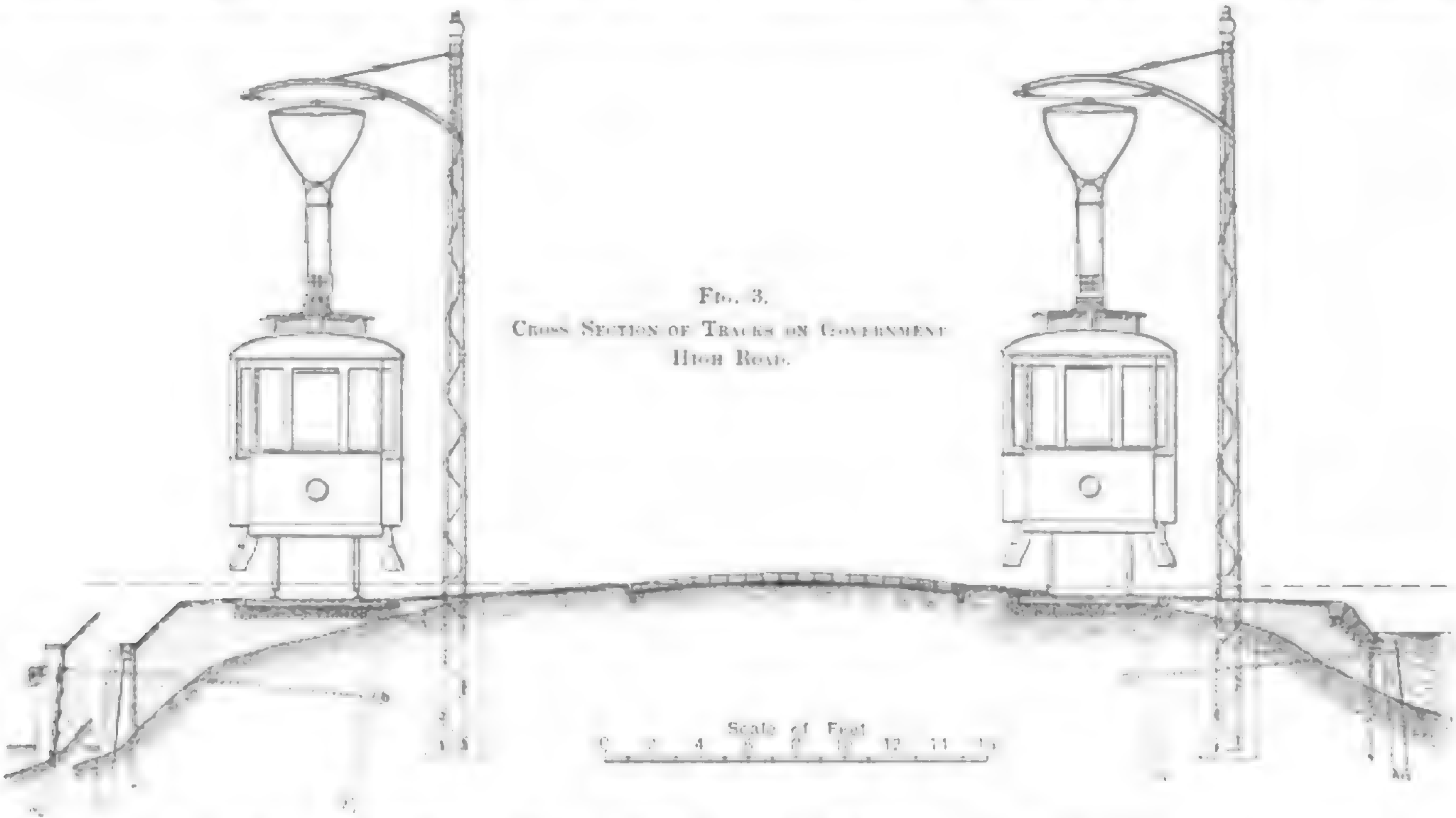

Fig. 3.
Cross Section of Tracks on Government High Road.

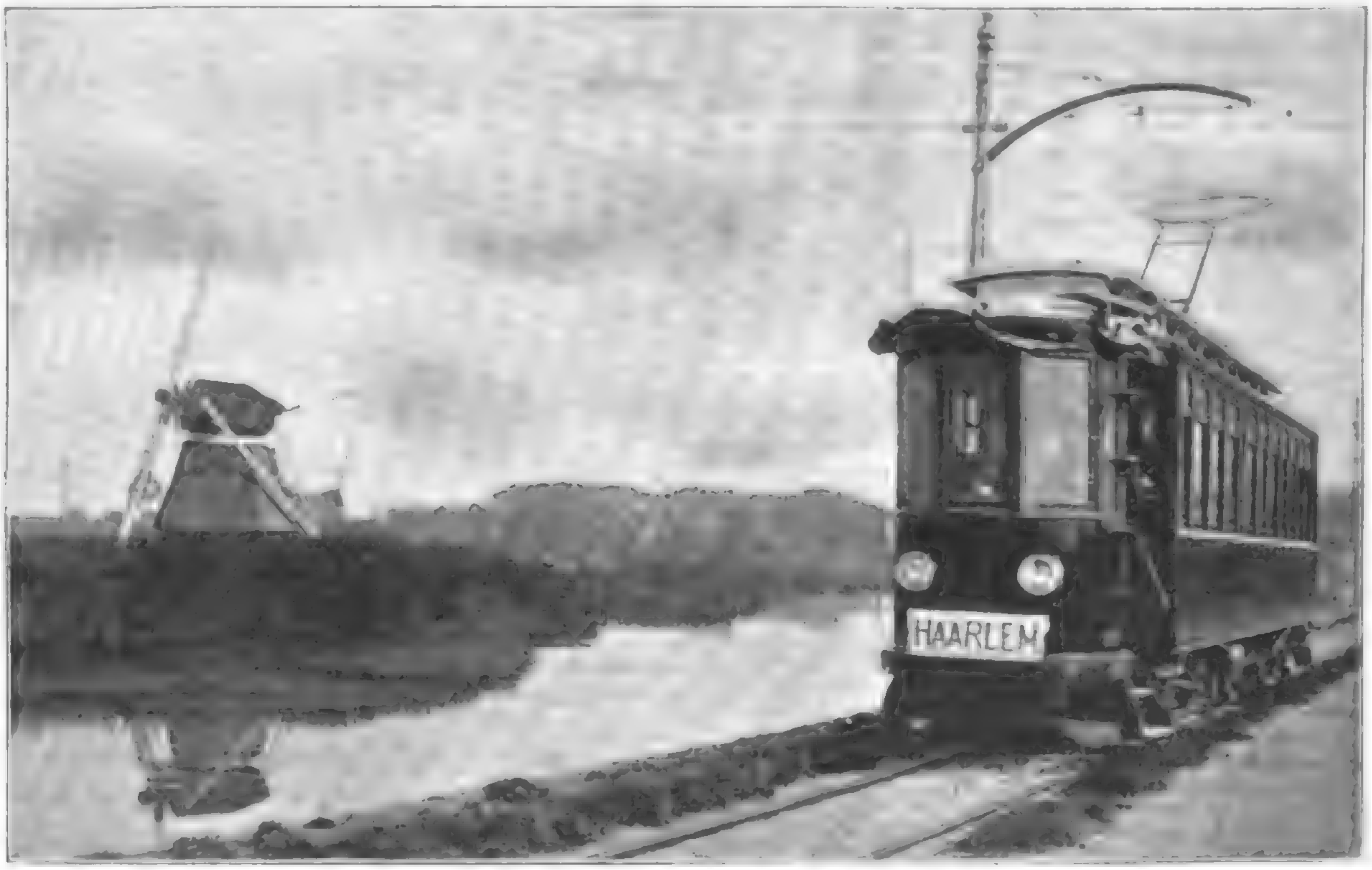

Fig. 4.—View of Track Running Parallel with Canal.

The Netherlands Tramways Co. decided that in order to secure more satisfactory terminal facilities in Haarlem and to secure satisfactory through running arrangements between Amsterdam and Zandvoort, the seaside resort above mentioned, the local Haarlem tramway company, which had been in operation then for two years, and known as the First Netherlands Electric Tramways, generally abbreviated to E.N.E.T., should be purchased outright. This was carried out, and practically all of the shares of the E.N.E.T. passed into the hands of the Netherlands Tramways Co. of New Jersey, and for all practical purposes of operation they are consolidated and to be considered as a single system. Contracts were then entered into with Messrs. J. G. White & Co. (Ltd.), of London, for the complete design and construction of all the works required, including the permanent way, overhead equipment, power station, car shed, shops, office buildings, bridges, &c., for the Amsterdam–Haarlem inter-urban line and the reconstruction and additions required by the E.N.E.T. This reconstruction included the double tracking of the line running to Zandvoort, increase of offices and car sheds and increase in capacity of power station. This contract was entered into January 1, 1903, and the operation of the completed system was commenced in October, 1904. It was the intention to commence operation in the spring of 1904, but the works were delayed owing to the failure of the Corporation of Amsterdam to complete bridges and the delay in getting the approval of the municipality of Haarlem.

From the terminus at Spui to "B" on the map (Fig. 1) the lines are within the city of Amsterdam. Over the greater portion of this route the line follows the existing tram line of the municipality, and on such portions the third rail was laid. All the work on this section was done by the city of Amsterdam and the cost charged to the inter-urban line. The bridge at point "B," which is known as Kostverloren Vaart, was also constructed by the municipality and charged to the railway company. It was built and designed by the Haarlem Machine Co., and is what is generally known as the bascule type of swing bridge. It is operated electrically, but is not easily adaptable for an overhead construction; therefore the cars run across it by momentum. There is no difficulty in this, notwithstanding the fact that there is a considerable ascending grade and a sharp curve on the Amsterdam approach. Current for working the tramcars on the Amsterdam side of the bridge and also for working the bridge is furnished by the Corporation of Amsterdam, though there is a cable connection made under the canal so that the current furnished by the railway company to the bridge on the west side can be switched on in case of failure of the Amsterdam current.

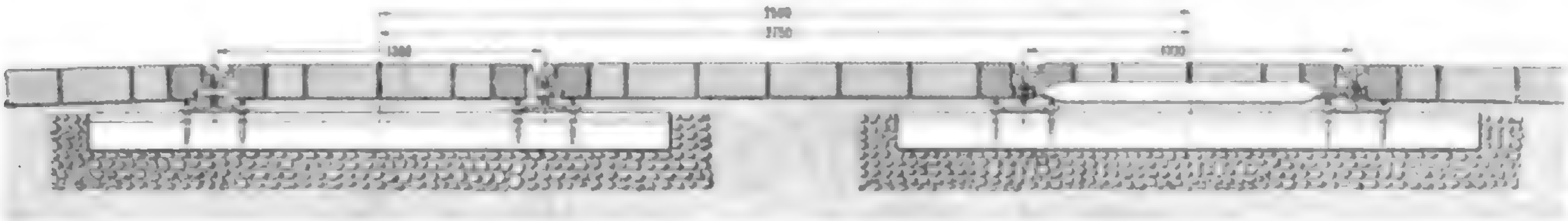

FIG. 5.—CROSS SECTION SHOWING TRACK CONSTRUCTION.

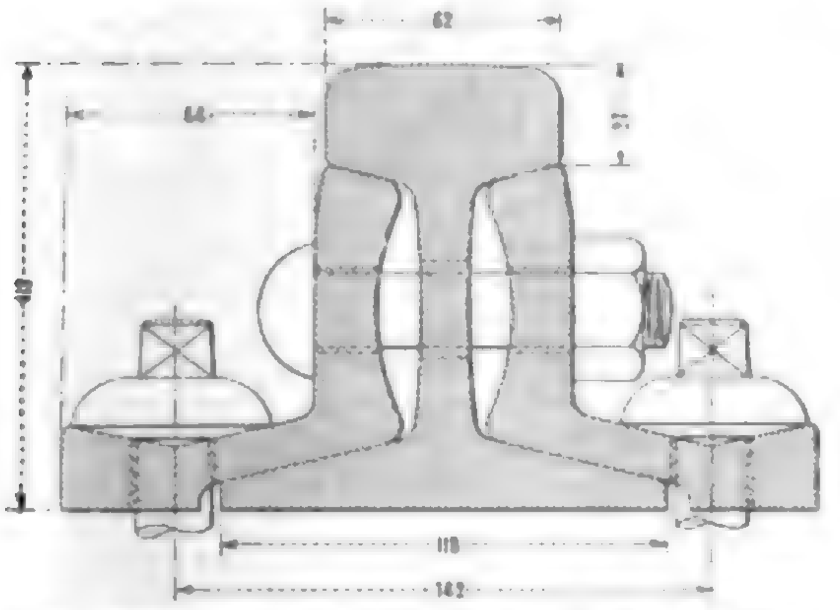

FIG. 6.—CROSS SECTION OF RAIL USED ON GOVERNMENT HIGH ROAD AND PRIVATE RIGHT OF WAY.

The bridge itself is 12 metres span, 12 metres wide, has 876 piles to the foundations, 176 cubic metres of other timber, 1,250 cubic metres of brickwork, 100 cubic metres of granite, and 220 tons of steel. From the point "B," or the bridge in question, to "C," the line runs over what is known as the private right-of-way, the length of which is 2,444 metres. The cross-section of the road over the greater portion of this part of the route is 22ft. from building line to building line, and in the centre a strip 8 metres wide is left for tramway tracks with centre pole construction (Fig. 2). The average surface of the was 1·60 metres below the Amsterdam datum, and the height of the finished road is 0·70 metres above, making a fill of 2·30 metres. The total fill was 160,000 cubic metres, and the total amount of sand brought on the work to make this fill was 280,000 cubic metres. There was, therefore, used on the work 120,000 cubic metres more than shown on the embankment. This is due to the bad soil, the additional amount of sand sinking into the ground. The sand was brought in scows for a distance of 20km. from the work; it was unloaded from the canal by means of elevators into trucks and hauled by engines on the work.

On this section two steel bridges and one wooden had to be built. The steel bridges have a span of 5 metres and a width of 12 metres. These bridges took 440 piles with 72 cubic metres of additional timber, 310 cubic metres of brickwork, 20 cubic metres of granite and 20 tons of steel. There were also used on the private right of way for the approaches 500 piles and 100 cubic metres of other timber. At the village of Sloterdyk the line joins what is called the government high road, between Amsterdam and Haarlem. On the north side of this road is a canal running the whole length, except through the village of Halfweg. On the south side of the high road is a ditch. The ground over this distance is what is known in Holland as "Polder land," and is below the canal level. It is divided by ditches, generally running in a north-easterly and south-westerly direction. These ditches lead to various points, where windmills are placed to pump the water from the low level up into the canals. The land is of a boggy, peaty nature, and is used wholly for grazing purposes.

On the north or canal side of the high road the distance from centre to centre of the piling is 1·25 metres. The piles are of heavy kolders or hellens (special piles), about 22cm. at the top and 18cm. diameter at the point. Their length is 5 metres. A purlin 13cm. by 20cm. of squared pine is carried along the total length of the piling, which is bolted with a 16mm. bolt, with a washer 6mm. thick and 70mm. diameter. These bolts are made with square heads countersunk into the wood. Behind the purlin a row of planks 6cm. thick, 2·50 metres long, or as much longer as is shown on the cross-sections (Fig. 3) are driven in; each plank is 28cm. by 30cm. wide, the jointing of them being of fishmouth construction, and each is fixed on the purlin with three spikes 15cm. long. The planks are driven in perfectly vertical, and the joints are of a good workmanlike fit. At the back of every other pile two anchor piles of circular section are driven in; these are 3 metres long, 13cm. diameter

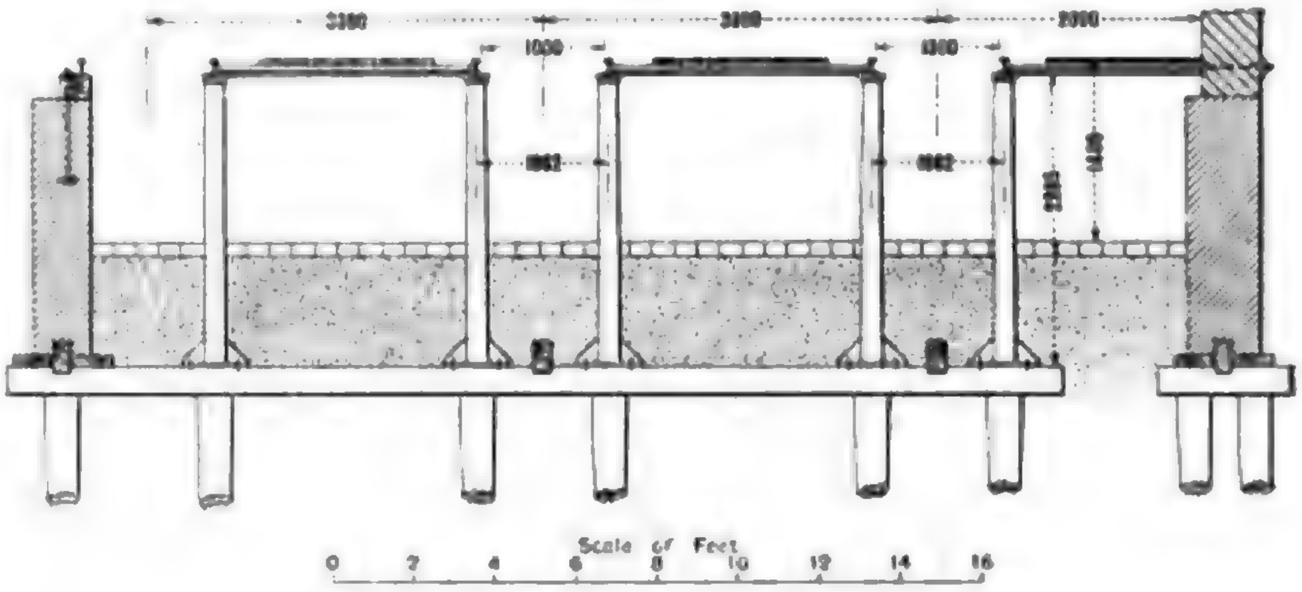

FIG. 7.—PIT CONSTRUCTION IN CAR SHED.

ground, at the head and 10cm. diameter at the point. Behind these anchor piles, which are 60cm. between centres, there is an anchor plate made of wood 80cm. long and 13cm. by 15cm. These anchor plates are joined to the sheet piles by 25mm. round iron rods 3·80 metres long, provided with the necessary threads, nuts and washers. The end of the anchor is bent round the piles and fixed with a staple, and the thread for the iron anchor rods is of sufficient length to allow for the drawing up of the piling.

On the south side of the government road the piles are of roughly-dressed fir-wood, 6 metres long, 22cm. diameter at the head and 18cm. diameter at the point; the distance between their centres is 1·10 metre and each is creosoted. The back of this piling is shuttered with boards, 5cm. thick, of creosoted pine, and the joints in the shuttering are covered with a strip of timber 2cm. by 10cm. Each plank is fixed on the pile with three spikes 13cm. long. This shuttering is made at such a depth that the bottom is 10cm. below the summer level of water, and at the bottom is a purlin 8cm. by 18cm., behind which is a row of fir planks, 6cm. thick, with fishmouth construction, extending to a depth of at least 3 metres. The heads of the piles are covered with a creosoted pine plate, 5cm. by 28cm., securely fixed on. The purlin is fixed on each pile with a 16mm. bolt, with washer, 6mm. thick and 70mm. diameter. For anchoring every alternate pile two anchor piles of creosoted pine, 3·50 metres long and having a diameter of 13cm. at the head and 10cm. at the point, are driven in. Behind these piles are anchor plates, 13cm. by 15cm. 0·80 metre long, which are connected with the purlin by a 25mm. round iron rod, 4 metres long, and provided with thread, nuts and washers.

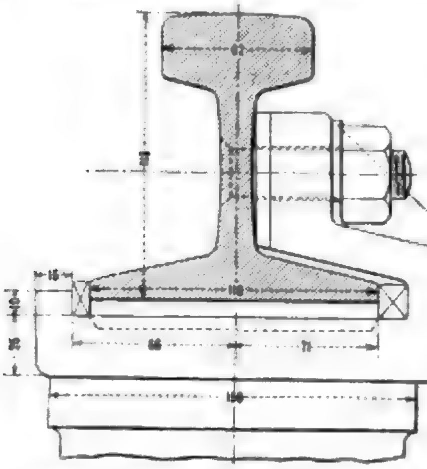

Fig. 8.—Method of Securing Rail to Top of Column in Car Shed.

Behind the sheet piling spoken of above, the filling has been carried out according to the cross-sections. Before commencing the sand filling, the turf was carefully taken up and stacked on the side, and the subsoil and other material was well cleared away. The filling has been done with pure sand in level layers and well rammed down. In this filling a space 15cm. deep and 2 metres wide was left under the bottom of the sleepers; this space is filled in up to the bottom of the sleepers with pure coarse gravelly sand (Fig 5). At the south side, where the height of the slopes is more than 60cm. above the top of the sheet piling, these slopes are built up with sods in graduated layers; the remaining slopes and the surface of the filling, as far as the sleepers, are covered with either sods or turf, 10cm. thick. Where turf is used, grass seed has been sown. The adjoining roads and approaches are filled up over their full width, and the grades of the approaches are at least 1 in 40. The surface of such roads and approaches is metalled in a similar manner to that employed previously.

The slopes in the canal side above the sheet piling are covered with basalt. For this purpose a layer of broken bricks 12cm. thick is laid on the sand filling and on this the basalt is placed, 20cm. to 25cm. thick, with a slope of 1 in 1. The pitching is well joined together and the joints filled in with small pieces of basalt, the top part being covered with sods. The broken bricks are not of smaller size than half a brick and not inferior in quality to hard brick. The basalt is as regular in shape as possible and at the top not smaller than 22cm. in diameter. Creosoting has been done under high pressure, each cubic metre of timber containing 200 litres of creosote. All ironwork is well cleaned off and painted with two coats of red lead. All wood of the sheet piling on the south side is painted with three coats of carbolineum.

The paving of the high road was practically relaid for the entire length, to the stipulated datum level of Amsterdam, and the amount of work involved may be seen from the following figures, which give the amount of material used:—20,500 uncreosoted and 23,000 creosoted piles; 2,700 cubic metres uncreosoted and 1,900 cubic metres creosoted timber; 160 tons of iron for tie-rods; 5,000 tons of basalt for protecting slopes; 75,200 cubic metres sand filling; 31,600 sq. metres of brick paving; 9,600 cubic metres of dredging; 1,700 metres of fencing and 74 gateways and approaches to farms and houses on the south side.

When the work was at its height on the entire line, there were employed 2,360 labourers, two steam locomotives, one electric locomotive, 31 steam pile drivers, three steam spouters, one steam crane, 60 hand pile-drivers, one steam bucket rigger and 165 flat boats and scows. The permanent way along the government high road and also along the private right-of-way is practically a steam railway construction. The rails are of Vignole or "T" section, weighing 70lb. per yard, and are the standard of the American Society of Civil Engineers for that weight (Fig. 6). They rest directly on sleepers spaced 76cm. centre to centre, except at the joints, where they are 50cm. and the joints are staggered. The sleepers are creosoted Norway pine, 23cm. by 11·5cm., the upper edges being bevelled. Screw bolts fasten the rails to the sleepers, and double concealed bonds are placed at each joint. The length of route along the canal is 13,417 metres.

At the village of Halfweg, which, as its name indicates, is situated approximately halfway between Amsterdam and Haarlem, the line crosses two canals. Over these bridges were built specially for the purposes of the tramway. One bridge has four spans, each 15 metres, and the other two spans of the same length. There were used in the construction of these bridges 295 piles of 15 metres average length, and 295 cubic metres of other timber, 280 cubic metres of brickwork, 25 cubic metres of granite and 150 tons of steel. Through the village of Halfweg there are two sections of single line. These short sections are controlled by an automatic electric signalling device of the Siemens-Schuckert Co. At what is called the "Amsterdam Gate," marked "D" on the map, the line enters the city of Haarlem. The terminus in Haarlem at point "E" coincides with the terminus of the Zandvoort line, belonging to the E.N.E.T. system, and the construction in Haarlem is all grooved girder rail. The rails weigh 84lb. to the yard; they rest directly on the sleepers, spaced 74cm. centre to centre, except at the joint, where they are 56cm. Similar sleepers are used as for the Vignole track. In Haarlem it was necessary to reconstruct a swing bridge, to rebuild three other bridges entirely, and to construct a new bridge for the tram line only at the Amsterdam Gate, point "D." A new car-shed was constructed alongside the existing power station of the E.N.E.T. The pit construction in car-shed tracks was made by cast-iron columns, which carry the rail directly (Figs. 7 & 8). These columns at the other end have flanged bases resting on the pile foundations. Their length is 2·20 metres, and the depth of the pit in the clear is 1·40 metre. From centre to centre of the columns the distance is 2 metres. The rail bridges this distance without any additional support. This construction gives the minimum of obstruction in the pits, and is simplicity itself.

(To be continued.)

Long Electric Railway.—Reference is made in a recent number of the *Street Railway Journal*, of New York, to the completion of the electric railway between New Haven and Wallingford, Conn., closing the last link in the line between New York and Boston. The distance from the Grand Central station in New York to the Park-street station, Boston, is 254 miles. The fare is $2.85, and the time required to make the trip is 20 hours.

ELECTRIC DRIVING OF TEXTILE MILLS.*

BY W. B. WOODHOUSE.

The reasons for the slow rate of adoption of the use of electrical machinery in textile factories in this country are not far to seek. The first is the lack of accurate knowledge as to the results to be obtained from electrical driving; the second, the absence, until recently, of a public supply of electrical energy at a reasonable price. The object of this paper is to state, briefly, the advantages of electrical driving, and to show that a clear knowledge of the advantages will modify very considerably the prevalent ideas as to the relative cost of driving by individual steam plants, and by motors, taking a supply from the mains of a power company or electricity works. That the advantages are truly existent may be realised from the extent of the adoption of electrical driving in other countries. On the Continent it is largely used in the woollen, cotton and silk industries; in the United States, at the census of 1900, over 140,000 H.P. of electrical machinery was in use in cotton mills alone, and a considerable proportion are supplied with current from public mains.

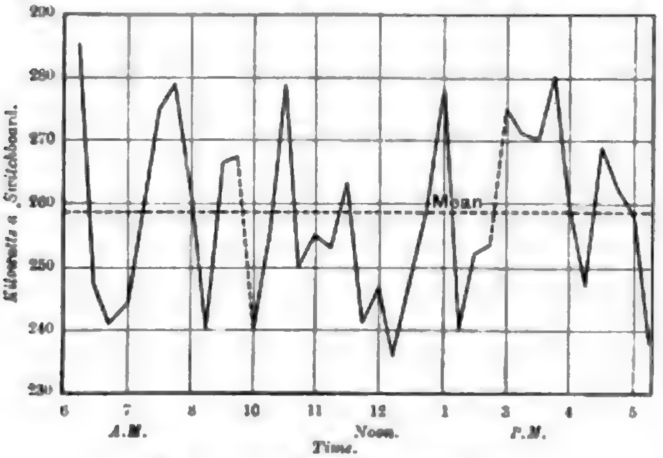

FIG. 1.—LOAD CURVE OF A FLAX MILL.

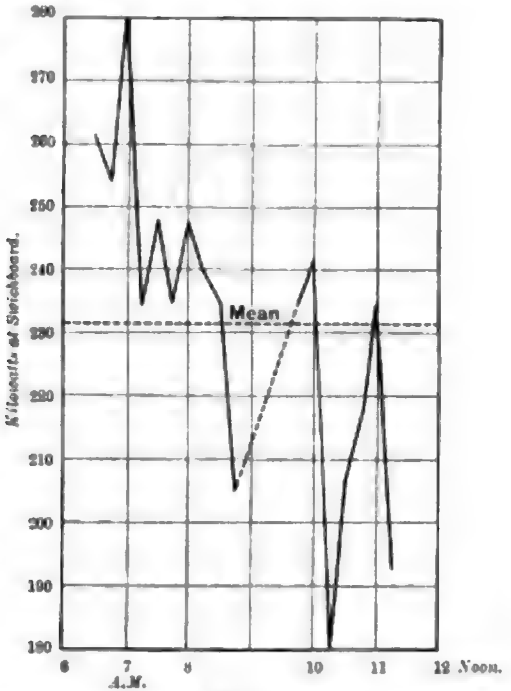

FIG. 2.—LOAD CURVE OF A FLAX MILL ON SATURDAY.

The preparation of animal or vegetable fibres involves a very large number of operations, and, owing to the delicate structure of the fibre, the amount of work done on it in each machine is small; it is therefore readily understood that the power required to drive the machines unloaded is a large percentage of the total required. Mechanical transmission of power from a main engine to the various machines by means of ropes, belts, gearing and shafting involves a steady loss of power which is very little reduced by the stoppage of individual machines. These facts have led many power users to believe that the load on the main engine is quite steady, and in comparing the cost of electrical with mechanical driving, on the basis of "horse-power-hours," they are apt to find an advantage in mechanical driving that does not exist. The efficiency of mechanical transmission in textile mills varies with each mill, depending as it does on the original design, the nature of any extensions which have been made, and the state in which the gearing is maintained. In a number of mills which the writer has tested, the average efficiency at full load is 50 per cent., the lowest 34 per cent., and the highest 70 per cent.; in all these cases the loss of power in the main engine being included; these losses, serious enough at full load, are practically constant, and so the efficiency rapidly decreases as the load becomes less. This steady loss in transmission has an important bearing on the variation of load on the main engine or source of power supply; in discussing this variation it will be convenient to speak of the ratio of the average power required to the maximum required during working hours, as the working load-factor—*i.e.*,

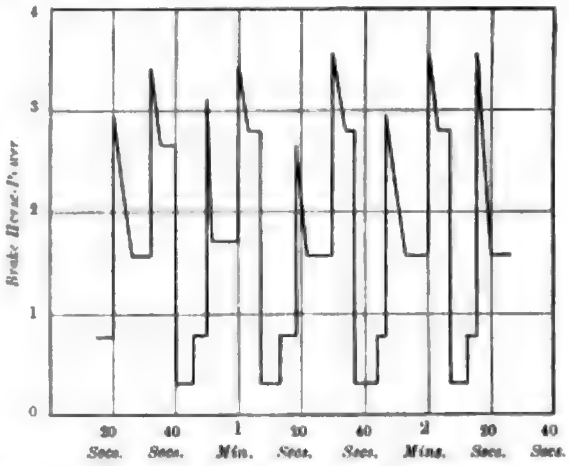

FIG. 3.—VARIATION OF LOAD. SELF-ACTING MULE. 120 SPINDLES.

$$\frac{\text{Average power}}{\text{Maximum power}} = \text{Working load-factor.}$$

When the source of supply is electrical, this is equal to

$$\frac{\text{Units consumed}}{(\text{Maximum demand in kw.} \times \text{working hours.})}$$

Fig. 1 is an actual record showing how the load varies through the day in a flax mill of the British Linen Thread Co. The mill is electrically driven and the transmission loss small. The maximum power demanded is 285kw. and the average 259kw., giving a working load-factor of 91 per cent. Had the various machines been driven by mechanical transmission from one main engine a steady extra loss would have been incurred, on account of the friction of extra shafting and gearing; assume this as only 20 per cent. of full load, then the maximum power would be raised to 342kw. and the load factor increased to 92·5 per cent. That is to say, the more inefficient the system of power transmission in a mill the steadier is the load on the main engine, and, though the useful power required varies in every mill, yet, with mechanical driving the variation is masked by the steady loss in transmission. Fig. 2 shows the variation of load, of the same mill, on Saturday morning; the load factor here is only 82 per cent. In a large cotton mill the following

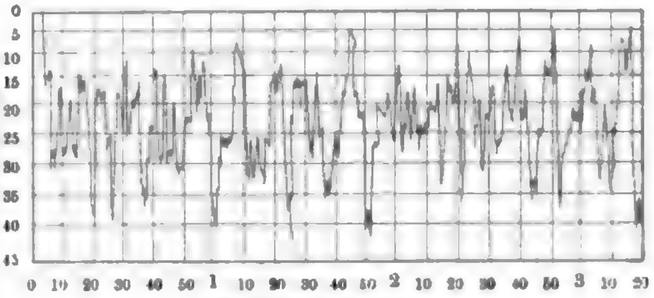

FIG. 4.—RECORD SHOWING THE POWER TAKEN BY FOUR SELF-ACTING COTTON MULES WORKING TOGETHER.

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* Paper read before the Leeds Local Section of the Institution of Electrical Engineers on December 15th.

variations of load were noted*:—Morning, maximum load 1,685 H.P., minimum load 1,640 H.P.; Afternoon, maximum load 1,635 H.P., minimum load 1,575 H.P. Mill owners usually reckon their costs in pounds per indicated horse-power per annum, and the figure is usually based on the maximum horse-power indicated; it is not possible to compare such a figure with the cost of electrically driving the sam emill without knowing the electrical or brake-horse-power taken to drive each machine, or group of machines, and the working load-factor of the machines.

In nearly every textile machine the starting effort is considerable —due to the inertia of the moving parts. In the "mechanical" mill starting a machine is usually accompanied by a slipping of several belts and a general loss of speed. For each particular class of machines there are peculiarities of working which determine the working load-factor; such as frequent stops of short duration, in the case of looms; a periodical stoppage of part of the machine, as in spinning; intermittent running, with long stops, as in milling or printing machines. A particularly irregular load is met with in the case of self-acting mules. Fig. 3 shows the power taken by a mule as it goes through the various operations of drawing, twisting, backing off and winding on. The working load-factor is 46 per cent. on one machine. When a group of mules are driven from one motor a heavy flywheel on the motor tends to steady the demand for current; despite this, however, the fluctuation of load on the motor is more extreme than on the main engine of a mechanical mill.

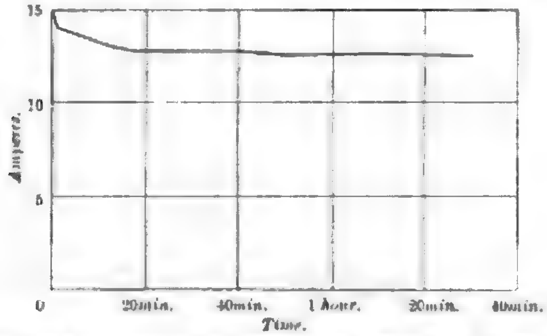

FIG. 5.—CAP SPINNING FRAME—NORMAL LOAD SPINDLES AT 7,000 R.P.M.

Fig. 4 is part of a record showing the power taken by a motor driving four self-acting cotton mules. The maximum horse-power required was 32 B.H.P., and the average 19 B.H.P., or a working load-factor of 59 per cent. The variation in the amount of power taken by machines having many bearings, with temperature, is brought out in Fig. 5, which shows the power required to drive a cap spinning frame. It will be seen that, as the bearings and the oil warm up, the power steadily decreases. This is, of course, true for all machines, and may be described as the "Monday morning effect."

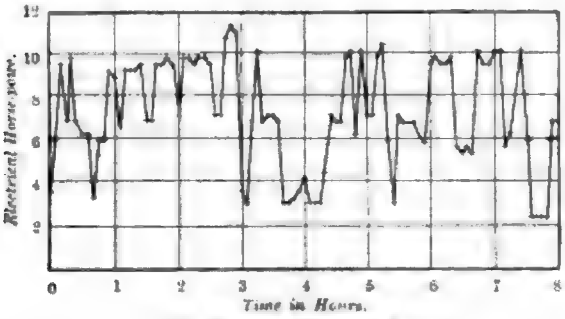

FIG. 6.—MILLING SHED LOAD.

The advantage of being able to see just what power a machine is taking under different conditions of working is a great point in favour of electrical driving. The following figures were obtained from a worsted spinning frame when two different qualities of spindle oil were used:—Oil A, 4·4 B.H.P. average. Oil B, 4·19 B.H.P. average, or a difference of nearly 5 per cent.

Where looms are driven in large groups the load is fairly constant, despite the frequent starting and stopping of individual looms, due to the large amount of shafting involved and the small power taken by each loom. In an "electrical" mill, however, a recording watt-meter will show the variations, and, more particularly, the tendency of the workers to start late and finish early.

The milling or fulling of woollen cloths is a process in which the power required varies from piece to piece, depending on the amount of milling required; the working load-factor is very low. Fig. 6 is an actual record of a day's work of milling and washing machines the working load-factor is only 63 per cent.

Tests made on carding machines show a fairly steady load during the time of running (Fig. 7). Rag-grinding machines often show a considerable variation, depending on the material they are being fed with. Fig. 8 is the load curve of two balling boxes, which are, normally, being repeatedly started and stopped.

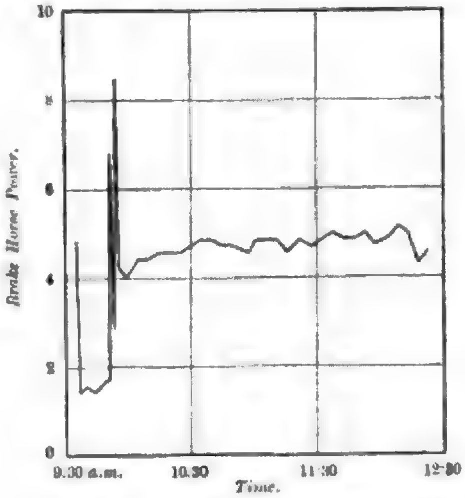

FIG. 7.—SCRIBBLER, INTERMEDIATE AND CARDER. NORMAL RUNNING, 65 R.P.M.

There is a lack of information as to the power taken by textile machines; the particulars of some tests are given below:—

Spinning.

* Test made of a motor driving 38 ring spinning frames of 10,032 spindles, running at 9,000 revs. per min., spinning No. 35 cotton yarn

Number of frames running......	38·0	28·0	18·0	8·0
Power in kilowatts	140·0	107·0	76·0	44·0
Spindles per kilowatt	81·2	83·8	82·5	78·2

Or an average of 62 spindles per electrical horse-power.

Tests made on worsted spinning frame of 200 spindles, running at 5,800 revs. per min.:—

1st test—average brake-horse-power	4·45
2nd „ „ „	4·19

The difference as explained above being due to the quality of oil used.

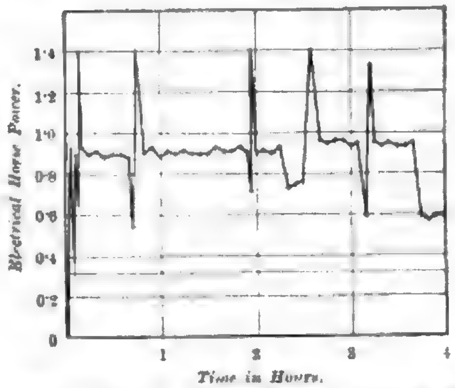

FIG. 8.—SINGLE AND DOUBLE HEAD BALLING BOXES.

Self-acting Mules—Cotton.

† Test made on motor driving line shaft and four mules:—

	Spindles.			
Mules running.	Number.	Revs. per min.	Max. H.P.	Average H.P.
All	2,712	—	32	19
No. 1 only....	672	7,600	20	13
No. 2 „	672	7,600	18	9
No. 3 „	684	7,900	15	9
No. 4 „	684	7,900	15	9

The result of tests made to determine the power taken by spindles at various speeds is shown in Fig. 9. It will be seen that the spindle friction and windage varies directly as the speed.

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* "Centralisation of Power," by S. B. Paine.—British Association of Textile Managers, 1904.

* "An Electrically-driven Cotton Mill," J. O' de Wolf.—New England Cotton Manufacturers' Association, 1902.

† "The Application of Three-phase Motor to Electrical Driving," A. C. Eborall.—Society of Arts, 1903.

Roving Boxes.—Worsted.

Dimensions of bobbins	6in. by 8in.
No. of spindles	12
Revolutions per minute	1,000
Brake-horse-power	0·4

Weaving.

The amount of power taken by looms varies with the class of work and dimensions of the looms.

	Power taken.	Authority.
Silk looms—Small loom	0·25 B.H.P.	A. C. Eborall.
„ Jacquard	0·5 „	..
Cotton looms—Draper loom, 160 picks per min.	0·25 „	De Wolf.
Woollen looms—Various	0·3 to 0·5 B.H.P.	..

Carding Machines.

Woollen, carding Botany..48in. wide swift.	Power at starting, 7 E.H.P.
	Running average, 3·2 „
„ „ ..60in. „	Running at 96 revs. per min.
	Average power, 5 E.H.P.

Scouring Machine, or Leviathan.

The dimensions of these machines vary considerably, and figures of horse power taken are not of much value. The following figures of relative power taken are from a test of one machine:—

Maximum running horse-power	100 per cent.
When changing liquor	38
Working load-factor	86

The changing and heating of liquor reduces this to about 70 per cent.

Milling Woollen Cloths.

Test on motor driving milling machine, washing machine and mangle:—

Maximum electrical horse-power	11
Working load-factor	63 per cent.

The amount of power taken in milling varies from day to day, depending on the nature and amount of milling required by the various cloths.

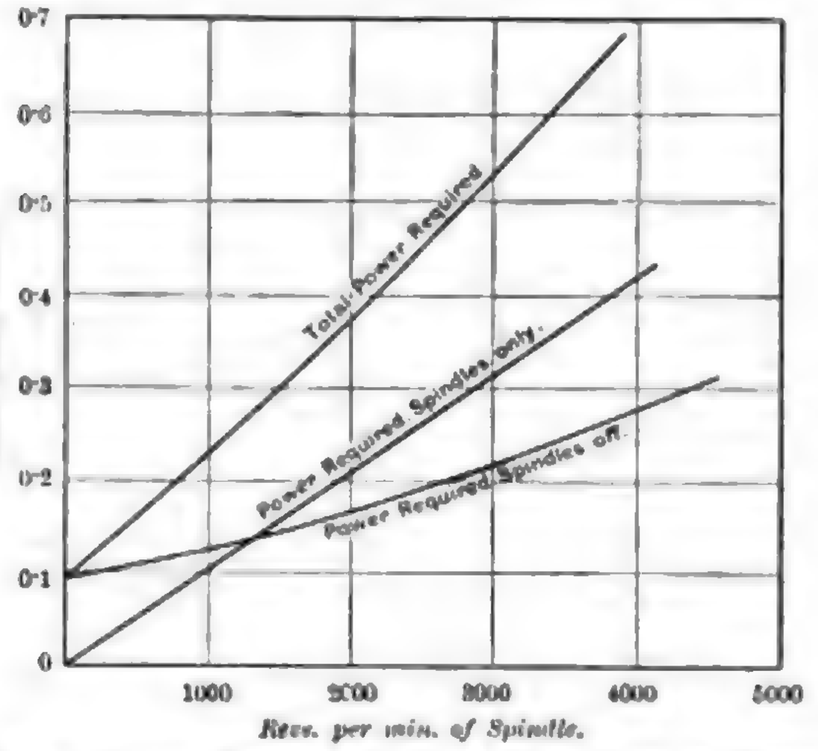

FIG. 9.—POWER REQUIRED TO DRIVE RING-TWISTING FRAME AT VARIOUS SPEEDS.

The advantages attendant on electrical driving are but partly gained if electrical transmission is adopted in the mill and the main engine or engines retained. The addition of a dynamo to the steam plant, and the replacement of mechanical transmission by electrical in no way lessens the responsibility attached to the use of steam plant, nor does it relieve the manufacturer from keeping his eye on the coal market as well as on the textile. Now that a public supply of electrical energy is available throughout the manufacturing districts of Yorkshire and Lancashire, at reasonable rates, manufacturers should not be slow to take advantage of it when once they realise the consequent benefits. Many of the advantages of a public supply are difficult to give an exact cash value to, but they are, nevertheless, very real. Briefly enumerated they are:—

1. A saving in space, buildings and capital expenditure. The manufacturer can employ his capital to greater advantage on productive machinery, and he is not compelled to decide beforehand what his requirements will be for 10 years ahead.

2. A reduction in fire risk, insurance, rent, rates and taxes, wages, repairs and maintenance.

3. An absolute freedom from worry as to spare plant in case of a breakdown, or as to extensions or alterations; if an extra 100 H.P. is required temporarily it can be drawn from the mains; if slack times come, the manufacturer can shut down any part of the mill without affecting the remainder; or overtime can be worked in any one section at, usually, a less cost than for ordinary working hours.

4. An accurate knowledge of the power taken in each department, and, by means of indicating or recording instruments, a check on the efficiency.

The effect of electrical driving on the general arrangement of a mill is to allow the various machines to be arranged in the natural order of the processes without reference to the position or direction of shafting. In a steam-driven mill the arrangement is decided by the main driving and, in a new mill, it is not difficult to lay out a good arrangement; extensions and alterations are, however, nearly always made at the expense of efficiency. The subdivision of the driving accompanying the use of motors may be carried to its full extent, and a motor provided for each machine, doing away thereby with all line shafting. It has found its most successful application in the driving of silk looms, the valuable material worked on making the risk of damage from oil or dirt thrown from a shaft or belt a serious one. The motors, rated at ½ H.P., either drive the looms by gearing or by a single belt, and to enable the tension of the belt to be adjusted the motor is swung on an arm and supported by springs; the weight of the motor tends to keep the belt tight, and the tension may be adjusted at will (Figs. 10 and 11). Such extreme subdivision is, however, rarely advisable, on account of first cost, and group driving must be nearly always adopted. In arranging such driving a considerable saving on the cost of equipment can be effected by increasing the speed of the line shafts, and thereby reducing the size of shafts, pulleys, and hangers—a standard diameter of shaft may often be adopted throughout.

Certain machines have their driving shafts running at a sufficiently high speed to be directly coupled to a motor, doubtless, as electrical driving spreads, textile machine makers will modify their designs so that this will be possible in a larger number of cases. Fig. 12 shows an excellent arrangement of a motor driving two spinning frames, through friction clutches. One belt between the motor and machine, more particularly a machine that is repeatedly started and stopped, saves undue stress on the motor. Group driving of from two to four machines without line shafting may be accomplished by fitting the motor with two pulleys. Fig. 13 shows this arrangement, four machine belts being driven from two pulleys, one at each end of the motor, the motor being fixed to the ceiling. Where a greater number of small machines makes a line shaft a necessity the motor may often be coupled direct to the shaft, being bolted to the wall or ceiling. A reduction of shafting may also be effected by driving the machines on two floors from the one shaft, holes being made in the intervening floor for the belts of the upper machines. Vertical shafts, when necessary, can also be driven by direct-coupled motors—the centrifugal hydro-extractor is an excellent example of the adaptability to this need. A word of warning may be given as to the installation of motors too large for their work, on account of the lessened efficiency and increased cost. Unless the variation of load is extreme the continuous rating of the motor should correspond with the average load, the small loom induction motors above referred to are designed with a considerable slip, and a consequent wide range of efficiency.

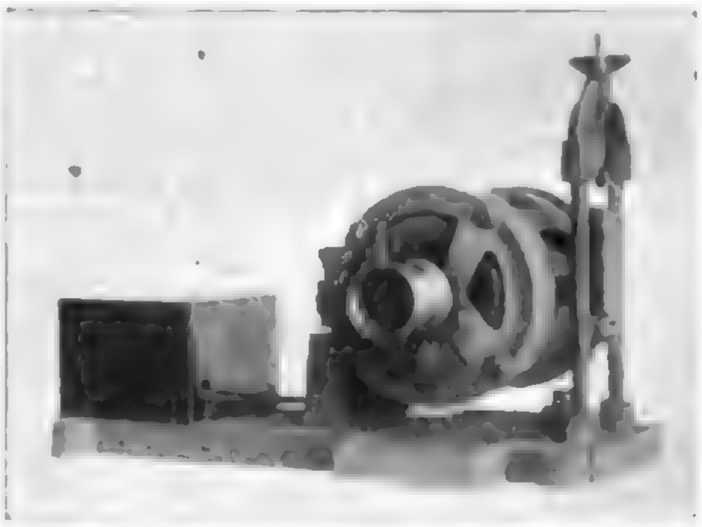

FIG. 10.—FLEXIBLY SUSPENDED MOTOR DRIVING BY BELT.

In the majority of textile operations constant speed is of vital importance; the output of a mill depends on the maximum speed at which the thread can be safely run, and any variation below this results in a decreased output. That regularity of speed at the machines in a "mechanical" mill is never obtained may be realised when one considers that there are often four or five belts between the engine and a machine, the bright surface of the pulleys indicating only too clearly that slipping is never absent. A quotation from a Paper by Mr. S. B. Paine, whose experience in electrical driving is unique, bears this out. Referring to a large cotton mill in South Carolina, where the motors were coupled direct to the spinning frames, he says: "The increase in quality and production has been very marked over mechanically-driven frames. I find that there is a very large loss in speed on the frames, due to the slipping of the various belts. In one case the speed on the front rolls in one room varied from 103 to 120 revs. per min. A direct connected motor showed a range in speed on the front rolls, during a week's run, of from 120 to 122." The provision of any speed regulation on motors driving the large majority of textile machines is unnecessary, for the reason that, although different qualities of fibre and different counts of thread require different speeds, yet the manufacturer finds it most economical to keep each machine on a particular class of work. This necessity of constant speed points clearly to the use of polyphase motors in preference to direct-current machines. The advantages of squirrel-cage motors are many; the constancy of speed, the simplicity due to the absence of commutators and sliding contacts, their low cost and the lessened fire risk due to the absence of exposed live metal, are all points in their favour. Their advantages have been recognised by the Fire Offices committee, and doubtless further concessions will be made as time goes on.

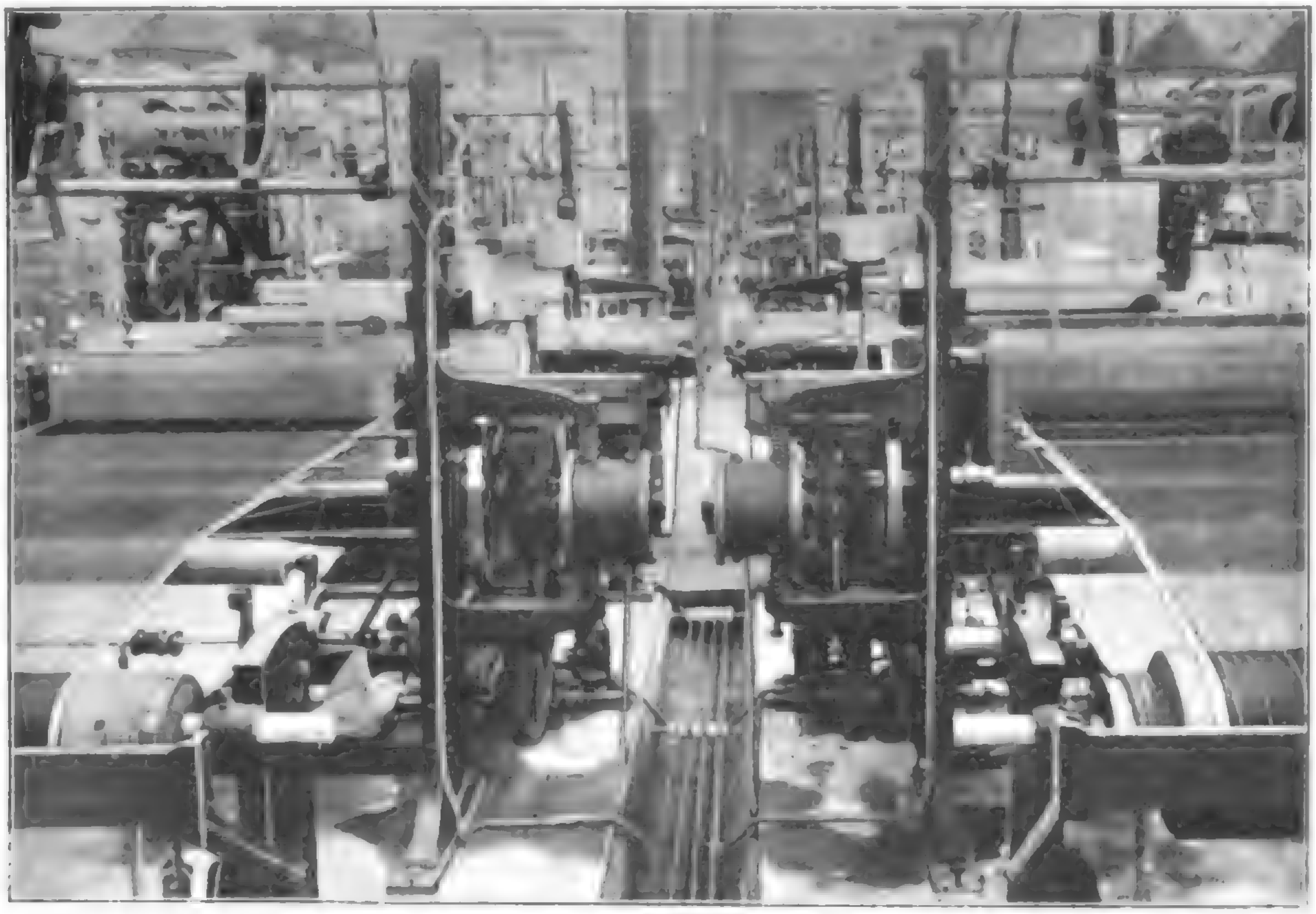

Fig. 11.—Flexibly Suspended Motors Driving by Gearing.

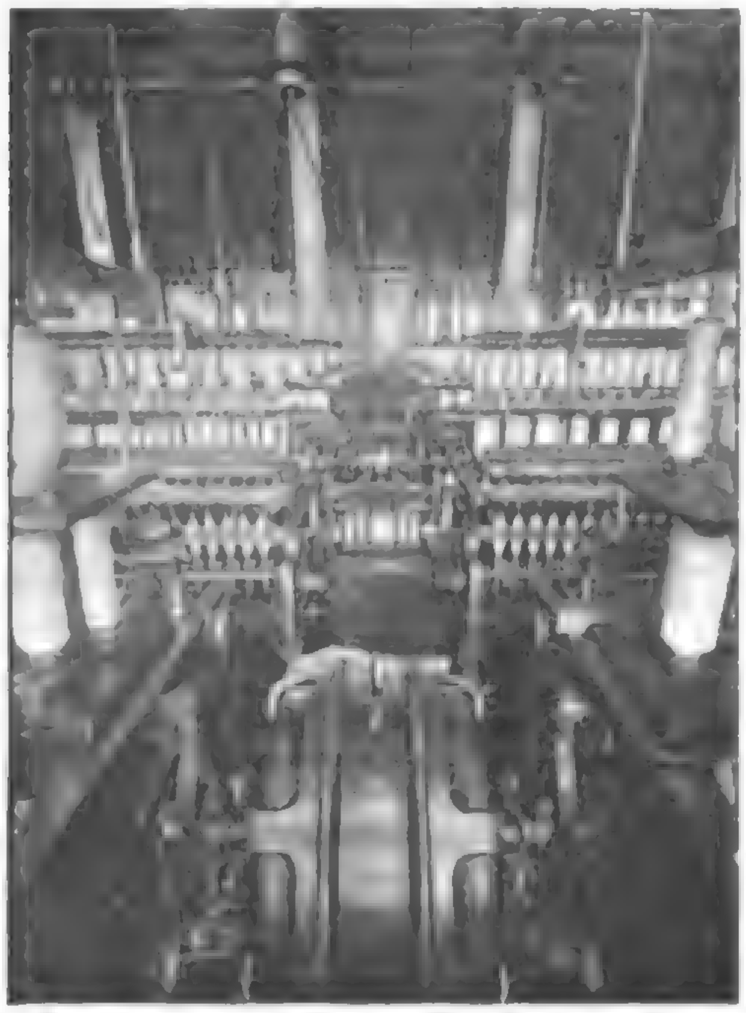

Fig. 12.—Motors, each Driving Two Spinning Frames, Through Friction Clutches.

With a continuous-current equipment more attention is required, and the motor must be completely enclosed. The great objection is, however, the variation of speed at different loads and temperatures. In a case brought before the writer's notice, where shunt motors were used, the complaint was made that on Monday mornings the machinery ran slow, with a consequent reduction of the output of the mill, and the same fault was noticed in a less degree on other mornings; this was, of course, due to the field windings being cold, and, to some extent, to the extra stiffness of the machinery. The polyphase induction motor under similar conditions would vary in speed by an inappreciable amount.

The only important class of variable-speed machines is found in textile printing. A detailed consideration of the various equipment which may be adopted are beyond the range of this Paper. Multi-voltage continuous-current systems, with shunt motors, have much to recommend them in the case of isolated plants, but excellent results have been obtained by the use of a single supply voltage,

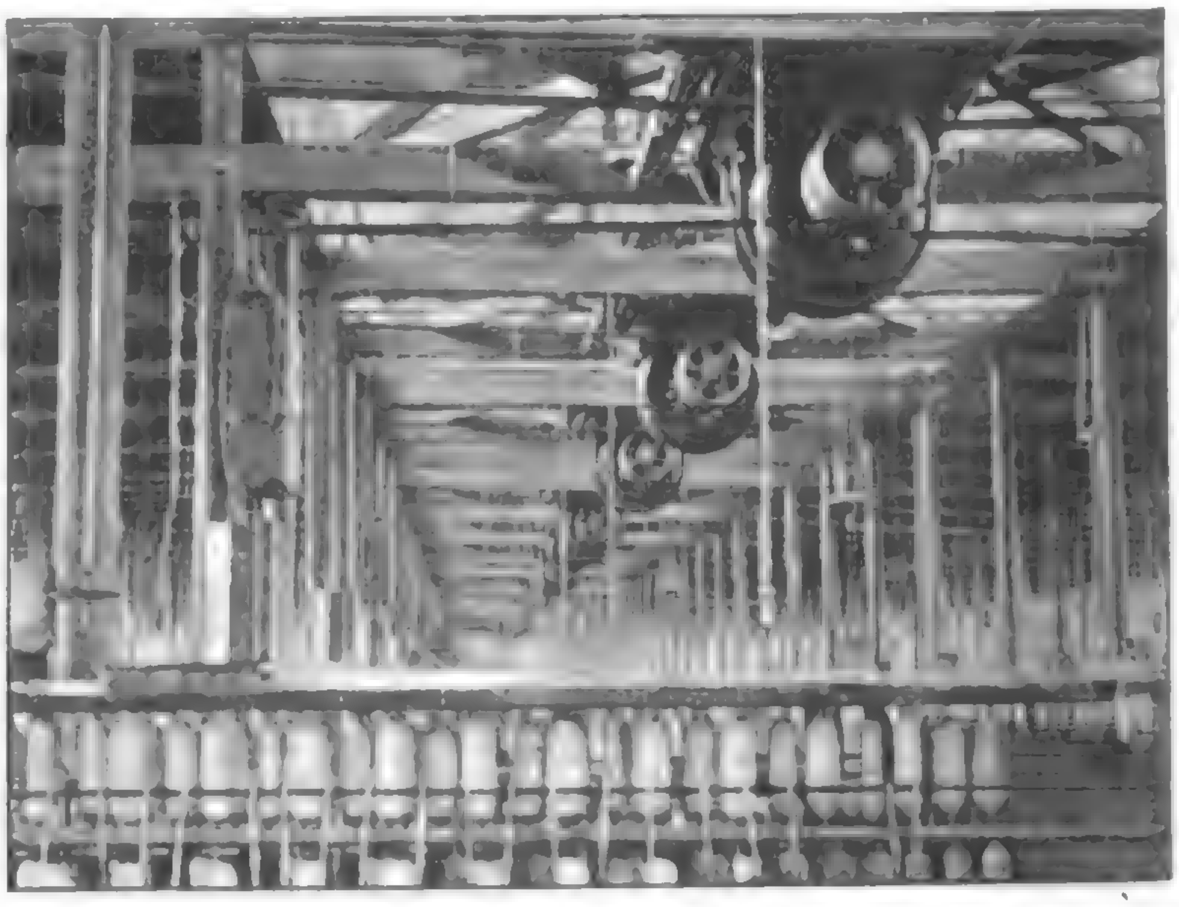

Fig. 13.—Arrangement of Motors each Fitted with Two Pulleys.

and motors with double-wound armatures and two commutators. In the latter case a high efficiency is obtained over a wide range of speed. Mention may be made of an equipment adopted in a large printing works in America, where each printing-machine motor was driven from a separate shunt generator, the generators being coupled together and driven at constant speed by a large induction motor. The printing-machine speed was altered by regulating the field of its generator. Such an equipment is, however, too costly for ordinary purposes. The writer's opinion is that almost any known system of speed regulation will meet the case, the determining factors being simplicity and first cost, and the wound rotor induction motor or the continuous-current series motor are from this point of view as good as any others.

The steam-driven centrifugal machine is exceedingly wasteful and messy, the belt or rope-driven machine involves a considerable amount of gear in the neighbourhood of the basket, and is very severe on the belts; the direct-coupled electrically-driven machine is compact, simple, and reliable, and can be placed anywhere. Either series continuous-current or induction motors may be used for this work; the induction motor has an important advantage in that it can never "run away." In practice the motor is completely enclosed, and flexibly supported beneath the basket. The time taken to accelerate depends on the maximum torque of the motor at various speeds. Hence, if a squirrel-cage motor is adopted, it should be built with a high resistance rotor, so that the current may be kept down during acceleration. The time taken to accelerate is then practically constant, and the machine needs no attention beyond switching on the motor, which runs up to speed and stays there until switched off. The following table gives the power required for two standard makes of machine:—

Power required to drive Centrifugals.

Pott, Cassel's & Williamson Type.						Broadbent & Sons' Type.			
Dia. of bask't	Units per hr.	Revs. per min.	Time to accelerate.	Starting watts.	Running watts.	Starting watts.	Running watts.	Time to accelerate.	Max. Speed.
24"	0·75	1,500	0·75'	2,530	690	..	..	..	..
30"	1·02	1,200	1·0'	3,100	1,260	5,400	2,700	1·5'	1,100
36"	1·28	1,000	1·5'	3,200	1,370	5,800	2,900	1·5'	1,000
42"	..	..	..	..	..	6,400	3,200	1·5'	950
48"	3·19	750	2·7'	5,950	2,070	7,200	3,600	1·5'	900
54"	..	..	..	..	..	8,400	4,200	1·5'	800
60"	..	..	..	..	..	10,000	5,000	1·5'	700
72"	..	..	..	..	..	17,600	8,800	1·5'	600

Brief reference may be made to the subject of electric lighting. The matching of colour can only be done satisfactorily by sun or arc light, and in some smoky Yorkshire valleys the sunlight cannot be depended on as a correct source of light. The use of enclosed arc lamps in mills gives excellent results for general illumination; for local lighting the incandescent lamp has the great merit of safety. The greater purity of the air, due to the absence of gas, has an important effect on the health of the workers.

Where steady temperatures are required, as in calenders, electrical heating has much to recommend it; steam joints have a way of giving trouble, and where higher temperatures are required gas is found somewhat unreliable. Where current is taken from the public mains the electrical heating of the mill is not out of the question; if the warming up be done at night time a moderate consumption only is necessary by day.

In addition to the use of electrically-driven fans for ventilating and removing dust, they are finding extended application as a means of transporting wool from the washing machines to the carders by way of an air-shute connecting the rooms.

THE COMBINATION OF DUST DESTRUCTORS AND ELECTRICITY WORKS ECONOMICALLY CONSIDERED.

BY W. P. ADAMS.

The following is an abstract of the first part of the discussion on the above Paper, which took place before the Institution of Electrical Engineers on Thursday, December 15th. The discussion is to be continued next Thursday. Our abstract of the Paper was published in *The Electrician* for December 16th, p. 348, December 23rd, p. 387, and December 30th, p. 423:—

Thursday, December 15th.

Mr. J. S. HIGHFIELD said that when he first began to work with the refuse destructor at St. Helens (Lancs.) he had great hopes that the value of refuse as a steam-producing agency would be considerable, and he had worked the plant with every idea of using it to the utmost. The net result, after five or six years' working (from figures supplied by the present engineer at St. Helens) was 86 units per ton of refuse. The electrical plant was direct current—combined lighting and traction load—and there was a great amount of motor driving, so that the load factor was exceptionally high. At St. Helens the refuse destructor was given the best opportunity for doing the utmost it could. It started up at midnight on Mondays, and was shut down over the week-end when the load began to get rather low. Therefore the value per unit generated to be allowed for the destructor plant, should be very much less than the value allowed for the units generated by coal during the peak part of the load during the week end. It was not fair, as was very often done, to credit the destructor with the same price per unit for those units generated during the day, when, perhaps, only 2lb. or 3lb. of coal per unit at the most would be used, as during the peak load, when as much as perhaps 10lb. of coal per unit might be used. It would be noticed in nearly all the diagrams in the Paper that the refuse started rather badly, and as the day went on the units per pound of refuse increased more and more. The reason was because of the varying quality of the refuse. In the morning great heaps of refuse of all sorts came in, and usually the last lot consisted of market refuse, such as cabbages and fish, which had a powerful odour. The first business of the men was to get rid of all this rather unsavoury material which had not a very great heat value. He did not think that one should agree altogether with the figures upon which the author based his conclusions that the whole electricity required in London could be made from the refuse. In Montreal 95 million units per annum were used, and there were 250,000 people. This was the sort of figure that had to be looked for, and he did not think it could ever be got from refuse. Another drawback to the combination of electricity works and dust destructor was that the amount of dust and smell from the destructor caused very great trouble in the engine room. A dust destructor was not a nice neighbour for any electricity works, and he had said a long time ago that the only way to make it at all tolerable was to build an enormous wall all round the destructor works so as to prevent dust and foul material of one sort and another leaking from the destructor into the electricity works. There was a little humour in the following sentence, but he did not know whether it was intentional or not. He was altogether in agreement with the author in this, however: "It is a convenience to the electricity works when the whole load of the station is being carried by the destructor to be able to rely upon the supply of steam.

Mr. C. NEWTON RUSSELL, referring to the author's remarks that dampers were provided at Shoreditch between the destructor and boiler furnaces to cut off the power when not in use, said that these dampers were certainly put in originally, but the heat proved so great that the cast-iron frames and the ⅜in. sheet-iron plates were burned out in a very few weeks. The construction of the cells was such that the dampers could not be renewed, and, consequently, they had been working at Shoreditch under very difficult and dangerous conditions ever since. In column 21 of Table B[*] the author gave the units per ton of refuse burnt, but in his (the speaker's) opinion this was the wrong basis for a comparison. In another column of the table a few figures were given showing how many pounds of steam were required to generate a unit of electricity. This was a better basis, because it had to be remembered that the value of refuse did not altogether depend upon its calorific value. Allowance had to be made for the deficiencies of the electrical plant. For instance, at Fulham it took 50lb. to 60lb. of steam to generate a unit of electricity, whereas at Hackney—one of the most modern stations—it only required 27lb. to 30lb. of steam per unit. Variations for the other stations also occurred, and he would suggest to Mr. Adams that he should add another column showing the value of the refuse in pounds of steam instead of units generated per ton. He did not think sufficient consideration had been given to the value of the land upon which the destructors were built. The revenue-earning capacity of land containing a destructor in London as compared to the revenue-earning capacity of the electric lighting plant was only about one-tenth. In other words, given two pieces of land of the same area, and erect a generating station on one and a combined destructor plant on another—roughly speaking, £50,000 per annum would be the gross revenue for the former and £6,000 for the latter. In Shoreditch and Stepney the interest and redemption of capital per ton of refuse worked out at about 1s., and therefore it seemed to him a mistake to put up destructors in the middle of large towns. They ought to be placed outside towns, where land was cheap. On the question of accounts they had been very unfortunate at Shoreditch owing to the complicated disposal of the steam. All the steam from the refuse boilers was mixed with the steam from the coal boilers, and there were four purposes for which the steam was used—viz., baths, pumping, boiling clothes and for heating the free library. In one case there was no possibility of finding out the exact amount of steam that was used, and a guess had to be made at it; but he did not know that much too small a sum was received to pay expenses. It might be of interest to the members to know that some time ago the Shoreditch Council gave him permission to try some experiments with a high degree of blast. These experiments proved without doubt that the point at which the refuse was turned out of the furnaces now was too early. There was still a large amount of carbon in the clinkers, and if only the air pressure was increased the residue could be reduced considerably. He had put up a smelting furnace, and with a small amount of coke had been able to smelt the residue down by its own calorific value and to run it out much the same as slag was run out of an iron furnace. It was possible to run it into moulds, but it was so brittle that it was very little good. Some experiments had been made by Carl Weber on the calorific value of refuse so smelted, but they had been discontinued. If, however, very large smelting furnaces were put up and the refuse smelted, it could be run down into vitrite, and the residue could be reduced to 15 or 17 per cent. It looked like black glass, and some of it had been made into glass paper. He regarded Hackney as a model destructor undertaking

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[*] Table IV. of the original Paper; Table B of *The Electrician* abstract (p. 387).

Mr. L. L. ROBINSON said that Mr. Adams had advocated a very large battery, and in this he agreed. For the benefit of the destructor the battery must be large, but as the electricity undertaking had to bear storage, maintenance and capital charges, complete usage of the destructor heat should be obtained by adopting low prices for day load electricity supply rather than by installing an enormous battery. With reference to the Hackney battery on December 19, 1902, as shown in one of the curves, he pointed out that they thought a great deal more of continuity of supply than of squeezing a few extra units per ton out of the refuse. He entirely concurred with Mr. Adams that the accounts of each undertaking should be dealt with as a separate department with its own capital, annual working costs and income carefully set out. As a matter of fact the tables prepared by Mr. Adams had little value as a comparison of the cost of working of the various destructors, because no uniform system had been adopted for keeping the accounts of combined stations. At Hackney a firm step had been taken towards a strict and uniform system of keeping accounts. One store was worked in connection with both undertakings, but most careful accounts were kept of all material issued to either department. Men's time was carefully analysed on time sheets, and every motor and lighting circuit in the destructor was supplied with electrical energy through an independent meter. The units generated at the terminals of each dynamo, and all the coal used, was very carefully weighed. As a check upon coal value the coal required per unit generated by the destructor was carefully measured every Sunday and records kept. These tests showed an average of 3·6lb. of coal per unit with Aitken navigation rough small at 13s. 8d. per ton, having calorific value of 13,300 B.Th.U. per lb.; 4·3lb. of coal per unit with Broomhill rough at 10s. per ton, calorific value 11,600 B.Th.U. per lb. Broomhill and Aitken Navigation coals mixed in equal proportions were used until a few months ago, but now Broomhill rough small alone was used. An arbitrary coal value of 5lb. of coal per unit generated had been adopted for the purpose of adjusting accounts, but undoubtedly this figure was too generous to the destructor. The quantity of coal per unit generated was lower in the case of Hackney than in the case of any other works dealt with in the Paper. This was due (1) to the use of triple expansion engines of 300kw. to 1,500kw. units, (2) condensing, (3) superheating, (4) good mechanical stoking, (5) all auxiliaries except three feed pumps being electrically driven. In connection with the accounts, the payment made by the sanitary authority was important. He failed to see how any other system could be more equitable than that which provided for the payment to the destructor department of the balance of expenditure after deducting the costs allowed by the electricity department for its steam and the sundry receipts. Any process of account keeping which could possibly reduce the apparent costs of refuse destruction at the expense of the electricity undertaking was to be deplored. The results would be an apparent increase of the electricity undertaking's costs and consequently a real increase in the price charged. This would tend to hinder the progress and prosperity of a really commercial undertaking. He felt sure that the Shoreditch undertaking must have suffered in this direction from its association with the destructor (he meant, of course, its accountancy association), but he knew that Mr. Newton Russell was doing his utmost to have his undertaking treated on the Hackney basis. With regard to the saving of labour, where mechanical stokers were employed the total number of men in the boiler house was so small that no labour was saved by combination with the destructor At Hackney two men were employed on the heavy shift and one on each of the light shifts. It was absolutely necessary to employ these men so that the coal-fired boilers might be ready to assist the destructor at any moment. The peak of the electricity supply load could easily be met by the same number of men whether the destructor was at work or not. The destructor foreman's services could not be utilised in the boiler house as it was found that his time was fully occupied supervising the work of the stokers in order to secure efficient working of the destructor cells. He thought that the author was too sanguine in regard to clinker disposal. As the output of clinker increased, and the destructors became further removed from building land owing to the extensions of the town's boundaries, the clinker would become even more a drug on the market than it was to-day. In his opinion no destructor was complete without a plant to work up the clinker into a saleable article, but here the municipality was at a great disadvantage owing to the legal difficulties which would be encountered in creating a wide market in which to sell. On the general question of credits to the destructor, he entirely dissented from the suggestion of the author that profit should be made by a local authority for permitting some of its ratepayers to pick over the refuse as it was turned out of the carts. The first essential in refuse destruction was that the refuse should be disposed of in a sanitary manner. At Hackney they went so far as to burn their tins and dispose of them at 5s. per ton with the full knowledge of the fact that they could dispose of unburnt tins at 16s. per ton, the reason being that they did not consider it right that any filthy articles which have once been in the ash bin should be allowed to be distributed broadcast throughout the borough. He agreed with Mr. Highfield that dust troubles were by no means a negligible quantity. No precautions seemed sufficient to keep the flue dust out of the hot wells and cooling towers. At Hackney endless trouble had been experienced with the feed pump valves and condenser tubes owing to this nuisance.

The discussion was adjourned until Thursday, January 12.

PATENTS EXPIRING IN 1905.

The following is a list of the patents of interest to electrical engineers which (unless specially extended by recommendation of the Judicial Committee of the Privy Council) will expire during the present year. The list includes only those patents of 1891 which have been kept in force up to date by payment of the renewal fees:—

Date (1891).	No.	Name of patentee.	Subject of patent.
Jan. 1	40	George Hookham	Electricity meters.
Jan. 12	564	M. Hutin & M. Leblanc	Alternating-current motors.
Jan. 13	647	Edward Weston	Electric measuring instruments.
Jan. 13	649	Rudolf Eickemeyer	Improvements in electric elevators and lifts.
Jan. 20	1,053	A. Noble & E. W. Lloyd	Method for testing the electrical firing gear of ordnance.
Feb. 2	1,904	Edward Tyer	Electric signalling on single lines of railway.
Feb. 10	2,443	G. Westinghouse and J. G. L. Schreuder	Electro-pneumatic and electro-hydraulic railway switch and signalling system.
Mar. 17	4,757	Thomas L. Willson	Electric reduction of aluminium, &c.
Mar. 18	4,860	Henry Howard	Electric heating and welding.
Mar. 21	5,074	C. A. Parsons	Improvements in steam turbines.
Mar. 23	5,167	F. E. Elmore & A. S. Elmore	Electrolytically-deposited tubes.
Mar. 25	5,342	Hugh L. Callendar	Electrical pyrometers.
Mar. 26	5,406	Howard C. Jobson	Brackets for telegraph poles.
Mar. 28	5,461	Alfred Dickinson	Swivelling trolley pole.
May [illegible]	7,827	Illius A. Timmis	Automatic railway signalling.
May 13	8,227	Henri O. Tudor	Accumulator electrodes.
May 23	8,784	S. Evershed & A. E. G. Richards	Electric transmission of signals on board ships, &c.
June 2	9,299	William R. Sykes	Electric controlling device for block systems of railways.
June 23	10,697	The Thomson-Houston International Electric Co.	Protection of electric machinery and apparatus from lightning effects.
June 27	10,940	C. A. Parsons	Improvements in steam turbines.
June 29	11,048	W. C. Johnson and S. E. Phillips	Improvements in the preparation and laying of mains on the Brooks' system.
July 16	12,117	E. Hartmann and W. Braun	Hot-wire measuring instruments
July 24	12,605	H. H. Lake	Accumulator terminals.
July 28	12,828	The Thomson-Houston International Electric Co.	Electric motors.
July 30	12,960	W. M. Mordey	Transformers.
Aug. 1	13,124	Henry Howard	Electric heating and welding.
Aug. 1	13,125	Henry Howard	Carbon holders and screens suitable for electric welding.
Aug. 27	14,509	H. Ward Leonard	Speed and torque regulation of electric motors.
Sept. 19	15,937	Edward Weston	Measuring instruments.
Sept. 29	16,572	W. B. Sayers	Arrangement for reducing the sparking of dynamos & motors
Oct. 6	16,958	H. A. Mavor, W. A. Coulson, S. Mavor and W. B. Sayers	Metallic junction boxes.
Oct. 6	16,991	F. H. W. Higgins	Type-printing telegraphic apparatus.
Oct. 13	17,426	Emilo Andreoli	Apparatus for generating ozone.
Oct. 21	18,280	W. Claude Johnson	Submarine cable grapnel.
Nov. 2	18,902	Sigmund Bergmann	Tubular conduits for electric conductors.
Nov. 14	19,775	August Breuer	Diaphragms for electrolytic decomposing apparatus.
Nov. 16	19,864	J. Dickson and R. G. Shapcott	Dynamo brushes.
Nov. 17	19,914	J. B. Barton	Electric arc lamps.
Nov. 20	20,203	Druitt Halpin	Improvements in working steam boilers.
Nov. 30	20,840	John Nebel	Armature windings.
Nov. 30	20,864	T. C. Hodgkinson and H. T. Tompsitt	Electro-medical apparatus.
Dec. 7	21,354	Hermann Aron	Apparatus for measuring electric currents.
Dec. 9	21,565	Wilhelm Deckert	Microphones.
Dec. 11	21,702	A. V. Kerckhove	Accumulators.
Dec. 21	22,304	S. P. Thompson	The introduction of inductances in telegraphic and telephonic lines of communication, &c.
Dec. 21	22,326	H. L. Callendar	Wheatstone bridge arrangement for pyrometers.
Dec. 23	22,482	Edward Weston	Improvements in voltaic cells.

"The Management of Electric Tramways."—Messrs. E. & F. N. Spon inform us that the book with this title, reviewed in our columns last week, has been withdrawn from sale.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

N-rays.—G. Weiss and L. Bull have endeavoured to obtain a photographic record of N-rays by a novel method, but without success. They produced an image of a piece of cardboard in an ordinary camera, but did not focus it sharply in order to avoid the grain of the card. They reversed the plate in the slide, so as to receive this image through the glass. They then substituted for the usual back of the slide a backing consisting of a few sheets of black paper and a plate of lead with two holes bored through it. N-rays from a Nernst lamp were passed through these holes, in the expectation that on impinging upon the gelatine film they would reinforce the image at the two holes, and that this reinforcement of the brightness would also result in a reinforcement of the photographic image. This, however, was not the case. Exposures were made varying from 20 seconds to five minutes, but the photographic image of the card was always uniform.

[Weiss and Bull, *Comptes Rendus*, December 12, 1904.]

Nickel-Steel Electric Pendulum.—Jean Mascart reports upon some pendulums made by Henri Lepaute for the Nice Observatory. They are of Guillaume's invar steel, and provided with Lippmann's electric driving gear. The extremely small coefficient of thermal expansion permits of a simple form of compensation, which in these pendulums takes the shape of a brass cylinder sliding on the steel rod. The magnets are so placed that the impulse is given at the centre of percussion. The suspension is of the flexible type. The pendulums have a rate of about two seconds per day. To construct such pendulums on a large scale for railway stations would require the analysis of the materials and the elaborate calculation of all their constants, but the main difficulty lies in the calculation of the influence of the flexible support. The author is, however, of opinion that it would be quite feasible to construct a less elaborate pattern keeping correct time to within one second per day, which may be easily corrected by moving the counter without stopping the pendulum.

[J. Mascart, *Comptes Rendus*, December 12, 1904.]

Radiation Pyrometry.—In a study of some special problems in the measurement of high temperatures, C. W. Waidner and G. K. Burgess have examined the methods of radiation pyrometry, which is the line along which the most marked advances in temperature measurement have been made in recent years, and they have made a study of the sources of error, the necessary precautions, and the limits of attainable accuracy in the use of some of the best types of exisiting radiation pyrometers. The advantages of this system of pyrometry are obvious in the measurement of temperatures of inaccessible or moving objects, the estimation of temperatures far beyond the range of any pyrometer requiring contact with the heated substance, and the rapid examination of surfaces for uniformity of heating, a problem of great importance in metallurgical processes. The discovery which made radiation pyrometry practicable was the electrically-heated "black body" devised by Lummer and Kurlbaum, whose radiation depends upon the temperature only, and not upon the material of the walls enclosing the hollow space. The authors describe the various instruments which may be used for radiation pyrometry, including the Le Chatelier pattern, in which a standard gasolene lamp is used for comparison, the Wanner pyrometer, in which a monochromatic red field is produced by a direct-vision prism, the Holborn-Kurlbaum pyrometer, in which the tip of the filament of a 4-volt incandescent lamp is set to the same brightness as the object whose temperature is sought, and the Féry thermo-electric telescope, in which radiation from the source whose temperature is sought is focussed by a fluorite lens on a minute iron-constantan couple in series with a potential galvanometer, whose deflections are proportional to the energy received by the couple, and hence to the fourth power of the absolute temperature, according to the Stefan-Boltzmann law, if the radiating source is a black body. An experimental study of the behaviour of the various radiation pyrometers shows that no one instrument can claim a decided superiority as to precision, certainty and ease of calibration, permanence of indications, and range. All of them are capable of an accuracy of 1 per cent., although this accuracy is not attained with the same ease in all cases. With the Wanner pyrometer, for instance, a rheostat and milliammeter have to be inserted in the lamp circuit, and with the Holborn-Kurlbaum and Morse pyrometers, although this accuracy is readily secured, the constancy of the lamp must be assured. Diffuse daylight, or light from other sources which is not reflected directly into an optical pyrometer, will not seriously affect its readings, a rise of only 5deg. being caused by changing from a dark room to bright daylight. The authors have reason to believe that the radiation laws which form the basis of optical pyrometry are still in agreement at the temperature of the arc. The black body temperature of the hottest part of the positive crater comes out as 3,690, 3,680 and 3,720 respectively when measured with the Holborn-Kurlbaum, Wanner and Le Chatelier pyrometers.

[Waidner and Burgess, *Physical Review*, December, 1904.]

French Academy Prizes.—Among this year's prizes awarded by the French Academy of Sciences, the award of greatest interest is undoubtedly that of the largest prize, the Prix Leconte of 50,000fr., to René Blondlot, the discoverer of the N-rays. In making the award, the adjudicators express themselves somewhat guardedly. After enumerating Blondlot's previous work concerning the instantaneous character of the Kerr effect, the construction of his electric resonator, and his determination of the speed of propagation of electric waves along wires immersed in various dielectrics—a determination which "furnished one of the most accurate verifications known of one of the most important consequences of Maxwell's theory"—they go on to say:—"Latterly, M. Blondlot has studied some curious actions which he attributes to a new radiation to which he has given the name of N-rays. All the properties of these new rays are not yet well known, and circumstances have not permitted all the members of the Commission to acquire on these questions the conviction which can only be produced by personal observation. Still, without prejudging the significance and bearing of these new discoveries, the Commission has thought it well not to defer any longer the reward which this savant has long merited. They wish at the same time to affirm their confidence in the experimenter, and to support him amongst difficulties which count among the greatest that physicists have ever encountered." Among other prizes awarded are the Prix Wilde of 4,000fr. to M. Paul Villard for his researches on cathode and Röntgen rays, the Prix Hébert of 1,000fr. to M. Georges Claude for his popular work on electricity and the Prix Kastner-Boursault of 2,000fr. to Capt. Ferrié for his work on wireless telegraphy. In 1905 the following prizes will be awarded to physicists of any nationality:—Prix Hébert for the popularisation of electricity, Prix Hughes of 2,500fr. and Prix la Caze of 10,000fr. for work contributing to the progress of physics. Claims must be sent in to the secretaries of the Academy by June 30th.

[*Comptes Rendus*, December 19, 1904.]

Evacuation of Vacuum Tubes by the Current.—In the course of a study of discharge phenomena in vacuum tubes, E. Riecke noticed that the pressure in the tubes seemed to fall of itself. This phenomenon is similar to the "hardening" of Röntgen tubes. In one case the pressure fell from 0·252mm. to 0·083mm. A further inquiry showed that the fall in the pressure was altogether due to the passage of the current. Careful measurements made with a charge of nitrogen showed that a current of one electromagnetic unit absorbs 0·97 milligrammes of nitrogen per second between the pressures of 0·1mm. and 0·075mm., and 0·398 milligrammes between the pressures of 0·044mm. and 0·030mm. If every atom of nitrogen were attached to an electron, only 11 per cent. of the current would be conveyed by the nitrogen ions in the first case, and 27·6 per cent. in the second case. The author also describes the formation of Newton's rings on the cathode and rings on the wall of the tube which accompanies this conduction by nitrogen.

[E. Riecke, *Annalen de Physik*, No. 15, 1904.]

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1904.

In our retrospect a year ago we referred to the effect which the agitation for tariff reform in 1903 had had in industrial circles. In the preparation of their case for or against tariff reform, statesmen, politicians, statisticians, and also prominent men in the industrial world, had been at pains to seek out the causes which were impeding our country's progress as a commercial nation. This critical examination, we predicted, could not but result in benefit to the various industries, whether as a final result the present system of Free Trade were left unaltered or a new method of preferential or protectional customs tariffs instituted. Our prediction has been falsified, however, owing to a phase in the controversy which it was impossible to foresee. A year and a half has passed since the suggestions for tariff reform were sprung upon the British public by their political leaders, but no action has been taken in Parliament and no definite announcement of policy has been made. Although, as we have said, the wide and exhaustive discussion as to the state of our industries has thrown into relief their weak points, and should have led to immediate improvement, alterations in existing conditions have been deferred until it has been seen what action on broad lines would be taken by the Ministers responsible for the government of the country. A feeling of unrest has been promoted in commercial circles and nothing has been done to allay it, with the result that our industries and commerce are suffering.

Trade has been bad during the year, and the reason is twofold: In the first place, capital has been "shy," capitalists refraining from investing their money in industrial undertakings on the eve of a possible general alteration of the existing commercial conditions. Secondly, insufficient advance has been made in cheapening the cost of production. The volume of trade is large but prices are "cut." In fact, while our own manufacturers have been waiting for the *elixir vitæ* promised by a beneficent Government, they have been neglecting the more homely remedies for local ailments which they are able to diagnose for themselves; foreign competitors have been maintaining their industries in full health and vigour, on the other hand, and can offer their manufactures at prices which show but a small margin of profit over our own costs of production.

Leaving this somewhat painful subject, we will turn to a more thankful one, and pass in review the progress that has been made in electrical engineering and science during the year that has gone by. The honours are divided between Electric Power Distribution and Electric Traction. The electric power companies which have started operations have met with an excellent reception. Works managers and colliery owners are being brought to realise the saving that can be effected by electric driving, and in addition to those works which take supply from the mains of the power companies, a large number have erected generating stations of their own, while the motor load on the electricity works in the provinces has increased enormously. The advantages of electricity supply "in bulk" are being more widely recognised, both by smaller local authorities themselves, and by the Local Government Board, which has in two cases refused sanction for a loan for building electricity works where the local authorities could obtain their electrical energy cheaper by buying it from a power company. In the equipment of generating stations steam turbines are largely displacing reciprocating engines in the case of large units, and with their introduction the great economies that are produced by the use of highly superheated steam are being more fully realised. Large gas engines, on the other hand, have not been adopted with the rapidity that was expected, and in addition to engineering reasons, the success, in January, of an action for injunction against a gas-driven works may be answerable for this to some extent. Another development in station design is the increasing use of "remote control" switch gear, and English engineers are seriously considering the employment of pressures of 30,000 to 40,000 volts for long-distance transmission as in America. In electric lighting, the carbon filament lamp still holds its own, although practically no improvements have been made in it for several years. The osmium lamp, in spite of its higher efficiency, has not yet become a serious competitor, but the Nernst lamp has acquired a greater popularity than last year, and this has been fairly earned, for the lamp is far more reliable than it was. Arc lamp design has not been at a standstill, although the lamps of the Bremer or "flame" type have not come as much into vogue as was expected by some engineers, owing, it is said, to a comparative want of steadiness in burning. Mr. STEINMETZ, in the United States, is busy perfecting an arc lamp in which magnetite is employed in place of carbon, and several workers are engaged on improvements in the ordinary types of both open and enclosed lamps. The mercury-vapour lamp has also been receiving its share of attention. Some valuable photometric tests of street lighting have been made by Mr. J. W. BRADLEY, of Westminster, and Mr. S. L. PEARCE, of Manchester.

Mention must be made of an important alteration drafted by the Board of Trade and Home Office in the regulations for electricity supply, which will authorise pressures between 250 and 650 volts on consumers' premises without the express consent of the Board of Trade if the consumer observes certain regulations for safety. High and "extra high" pressures will also be permitted in factories and collieries with the approval of the Board of Trade and subject to regulations made by the Home Office. A further improvement in the conditions of electricity supply in this country was contemplated in the Electricity Supply Bill which passed the House of Lords but did not reach the House of Commons in time to be dealt with last session.

The development in the applications of electricity in the colonies, and especially in South Africa, has been very marked. The number of electric lighting and traction undertakings either put into operation during the year, or in progress of construction, was large, and special mention may be made of Johannesburg, for which town a large gas-driven electricity works is being built, and Cape Town, a description of whose new works was published in our columns in the summer. In fact, all the more important South African towns have now embarked upon electrical undertakings. In Johannesburg also £10,000 has been voted for the construction of a new telephone exchange. In Australia a proposal is on foot to equip the South Australian railways and tramways electrically and large sums of money have been spent upon the extension of the Sydney and Melbourne electricity works, in addition to many smaller installations.

The chief events in regard to Electric Traction have been the opening of the electrically-equipped sections of the Lancashire and Yorkshire and North-Eastern Railways, and the completion of the Great Northern and City "tube" and the Harrow–Baker Street section of the Metropolitan Railway. The District Railway is also making progress with its enormous generating station at Lot's-road, Chelsea, and with the electrical equipment of its part of the Inner Circle and the various lines in connection with it. Considerable feeling antagonistic to the "third rail" has developed owing to fatal accidents to trespassers on the first two lines mentioned. Two new methods of protecting the third rail are being tried in the United States, and a more extensive use of guard planks is now being made in this country. Single-phase traction has been making such progress in the meantime, however, owing to improvements in the design of single-phase motors, that the solution of the problem is being sought in this direction; for the higher pressures at which alternating current may be led to the motor cars or locomotives admits the employment of an overhead system. Such a system is to be adopted on a short suburban section of the London, Brighton and South Coast Railway, and short lengths of single-phase railway are in operation on the Continent and in the United States.

Electric Tramways have extended considerably during the year, chiefly on the overhead system, which has become almost standardised. The chief tendencies to be noticed have been a reversion to the centre-running trolley and the abandonment of double-truck cars in many places, and the growing popularity of steel tyres, and of top covers on double-deck cars. Experiments with "regenerative" control, and "one-man" cars have been continued, and may lead to a considerable adoption of these methods. London has now a large system of electric tramways on the north as well as to the west and south, but the South London lines (the electrical equipment of which has been considerably extended during the year), and the short line at Bournemouth, still remain the only examples of the slotted conduit system in this country. Wolverhampton has retained its surface contact system, and is extending it, and surface contact systems have been selected for the tramways at Torquay and Lincoln, which are to be built this year. A Paper read by Mr. C. E. C. SHAWFIELD before the Incorporated Municipal Electrical Association last summer gave a useful account of the cost of equipping and working the Wolverhampton tramways, and the various difficulties that had to be overcome. Electrical automobiles have not made any marked progress during the year, and the Edison battery has not fulfilled popular expectations.

The same must be said of Wireless Telegraphy. Sufficient progress has been made to show that it is a valuable auxiliary to our present systems of transmitting intelligence, but it has accomplished nothing revolutionary. Transmission of messages to ships at sea is officially recognised by the Post Office from January 1, 1905, and this department now receives such messages at any post office for transmission to ships off the coast within range of six wireless telegraph stations. The utility of wireless telegraphy in naval warfare has been thoroughly demonstrated during the year, and the "wireless" news service instituted by *The Times* during the early stages of the Russo-Japanese War was a feat in journalism. The cross-Atlantic wireless telegraph service, so much advertised during the past two years, has got no further than the organisation of a system of weather reports from passenger steamers, and the publication of newspapers on board some of the Atlantic liners. A Wireless Telegraphy Act, passed at the end of the Parliamentary Session, gives the Government absolute control of wireless telegraphy in this country, but licences are issued to those desiring to employ this means of communication.

The older methods of Telegraphy have not been affected by the "wireless" methods. The Great Northern Telegraph Co. has built a new cable steamer, the "Pacific," and has also undertaken to lay a cable to Iceland. Considerable stir has been caused in cable circles by the issue of a return showing the results of 12 months' working of the All-British Pacific cable, for the loss on the undertaking was no less than £88,000, while the companies with which it competed have been severely affected by the competition. From a purely engineering point of view, however, the Pacific cable has been a great success, for it has worked without interruption since its completion. In connection with submarine telegraphy we may call attention to an article on duplex balancing, published by Mr. GAYE, and followed by an article by Mr. OLIVER HEAVISIDE. The British Post Office continues to add to its underground telegraph cables. It has also tested the Murray type-printing telegraph and the Pollak-Virag writing telegraph on its lines. Tests of the former system have been discontinued to enable certain improvements, suggested as a result of the tests, to be carried out in the instruments, and trials of the latter are still continuing.

In Telephony, the central battery system is being improved in small details and considerably extended; it has been adopted at the large new trunk exchange and at several other exchanges in London and the provinces during the year. One only has been added to the number of municipal telephone exchanges—namely, at Hull; but the municipal telephone systems at Glasgow, Portsmouth, Brighton and Swansea are still working, although it may be mentioned that Portsmouth had some difficulty in obtaining the sanction of the Local Government Board to a loan for extensions. The Bournemouth Corporation went so far as to approve a scheme submitted to it for a municipal telephone system in competition with the National Telephone Co., but eventually reconsidered its decision. In March it was announced that the Government had entered into "pourparlers" with the National Telephone Co. with a view to purchase of the company's system, but no further developments have been announced and the Government has missed its opportunity for compulsory purchase of the system on December 31, 1904. An automatic telephone exchange in Chicago aroused much interest during the American tour of the Institution of Electrical Engineers last summer, but the system has never found favour in this country; we believe there is some difficulty in obtaining precise figures as to the cost of building and maintaining exchanges on this system. Telephony between England and France has been extended to a number of provincial towns in both countries.

In Electro-chemistry attention has been devoted during the year to improvements in the electric furnace and in the electrical method of "fixing" the nitrogen of the air which is now employed on a practical scale. The event which is likely to have the greatest effect on the Electro metallurgical industry has been the issue of a report by a Commission appointed by the Canadian Government to inquire into electrical methods of manufacturing iron and steel. This report was in favour of the application of electricity where fuel is not cheap, and, in addition, the Commissioners expressed the opinion that the manufacture of high grade metal of the class of crucible steel can be economically conducted in the electric furnace.

No epoch-making discoveries have been made in "pure" Electrical Science. A long list has been added to the experiments with N-rays, but there are just as many sceptics as a year ago. Prof. J. J. THOMSON'S British Association contribution to the subject of radio-activity of ordinary matter was welcome. Prof. RUTHERFORD is continuing his researches in radioactivity, and has now discovered five products of the transformation of radium in addition to the emanation. Radioactivity has been put forward as a plausible explanation of the discrepancy between the physicist's and geologist's estimates of the age of the earth. The closing of the Ben Nevis observatory is to be regretted.

Among the legal decisions of interest to electrical engineers during the year were the two "noise and vibration" cases, in one of which gas engines and the other reciprocating steam engines were the offenders. In both cases an injunction was granted against the electricity supply undertakers. These decisions emphasised the necessity of enabling a supply undertaker to obtain power for compulsory purchase of land adjoining his works, a provision which was included in the abortive Supply of Electricity Bill already mentioned. Another important case was that of the Attorney-General *v.* the Metropolitan Electric Supply Co., in which it was held that a company must not supply a consumer outside the area defined in its Provisional Order; an appeal will be made against this judgment. A similar judgment was given in the case of the Urban Electric Supply Co., which proposed to supply electricity at Walton from their station at Weybridge. Mr. GEIPEL'S successful action against the Manchester Corporation for infringement of his steam trap patent has been upheld in the Appeal Court. If a general conclusion might be drawn from the award of the umpire in the Bournemouth and Poole tramway arbitration, it would appear that a light railway may be worth nearly double the value set on it by a Corporation wanting to buy it cheaply, and about one-fourth of the value estimated by the company which has it for sale. As the award was really on the construction of a specific agreement, however, no such general conclusion is admissible. A review of the result of the year's Parliamentary Session was published in our leading article of August 19, and a summary of the private bills deposited for consideration this year was given in our last two issues and commented on in our leading article last week.

The obituary list last year was not long. It included, however, one of the founders of the Institution of Electrical Engineers (Major-Gen. C. E. WEBBER), its energetic secretary, W. G. MCMILLAN, and among other names, R. C. QUIN, W. T. ANSELL, J. STAATS FORBES, ERNEST TALBOT, Prof. J. D. EVERETT, Dr. H. P. GURNEY, Prof. N. R. FINSEN, G. B. STACEY, DESMOND G. FITZGERALD, and Prof. C. S. LEMSTRÖM.

The Institution of Electrical Engineers has suffered severely by the loss of its secretary, but an able successor has been appointed in Mr. G. C. LLOYD. By the indefatigable energy of the President, Mr. R. KAYE GRAY, and of the secretarial staff, the business of the Institution was continued without a hitch, and the holiday visit to America passed off successfully. The visit included a short stay at St. Louis to view the Exhibition and to assist in the International Electrical Congress. Very few English electrical firms were represented in the Exhibition, but the firms that did send exhibits were successful in obtaining high awards. Some interesting Papers were read at the Congress, but on the whole the proceedings were more in the nature of a holiday gathering and no decisions of international importance were arrived at. With a few excellent exceptions, the Papers read at the home meetings of the Institution of Electrical Engineers were below the average, both in London and the Local Sections, and we trust that better work will be forthcoming from the membership this year. The reason for this falling off in the quality of the Papers may be due to the general industrial depression which we have referred to at the commencement of this article, and we wish all our readers better fortune in the New Year that is opening.

THE METROPOLITAN RAILWAY.

(Concluded from page 420.)

Having traced out the connections from the power house to the sub-stations and from the sub-stations to the track, it now remains to describe the track itself and the rolling stock. Although the running rails are not employed for the return, and have, therefore, not been bonded, yet it has been considered necessary to renew them almost entirely, and piece by piece, this by no means easy task, has been successfully accomplished. That portion of the line running from Harrow to Uxbridge is of new construction and standard Metropolitan Railway rails of bull head pattern have been employed for it. These rails weigh 86lb. to the yard and were supplied by the North-Eastern Steel Co. The conductor rails, of which there are two, the positive being 16in. outside the track and the negative exactly half-way between the running rails, were also supplied by the same firm. They weigh 100lb. to the yard and the resistance does not exceed six to seven times that of pure copper, while the analysis is as follows: Carbon, 0·03 to 0·05 per cent.; silicon, nil; phosphorus, 0·04 to 0·06 per cent.; sulphur, 0·04 to 0·065 per cent.; manganese 0·30 to 0·40 per cent. The steel is so tough that it is only drilled or sawn with great difficulty and it is practically unbreakable even after it has been nicked all round. Altogether, some 7,000 tons of conductor rails were used. Both positive and negative rails are supported on insulators supplied by Messrs. Bullers (Ltd.) and consisting of highly-vitrified porcelain. The crushing strain which these insulators will bear is very considerable, specimens having been tested with a ton weight on the top without any signs of failure. The fixing of the third rail is greatly facilitated by the adoption of this form of insulator, as only one clip is attached in the first place and the rail is then laid on the insulators, and when in position the other clip is attached and fixed. It is claimed by the makers that the insulator does not depend on glaze for its insulating properties but is thoroughly vitrified throughout.

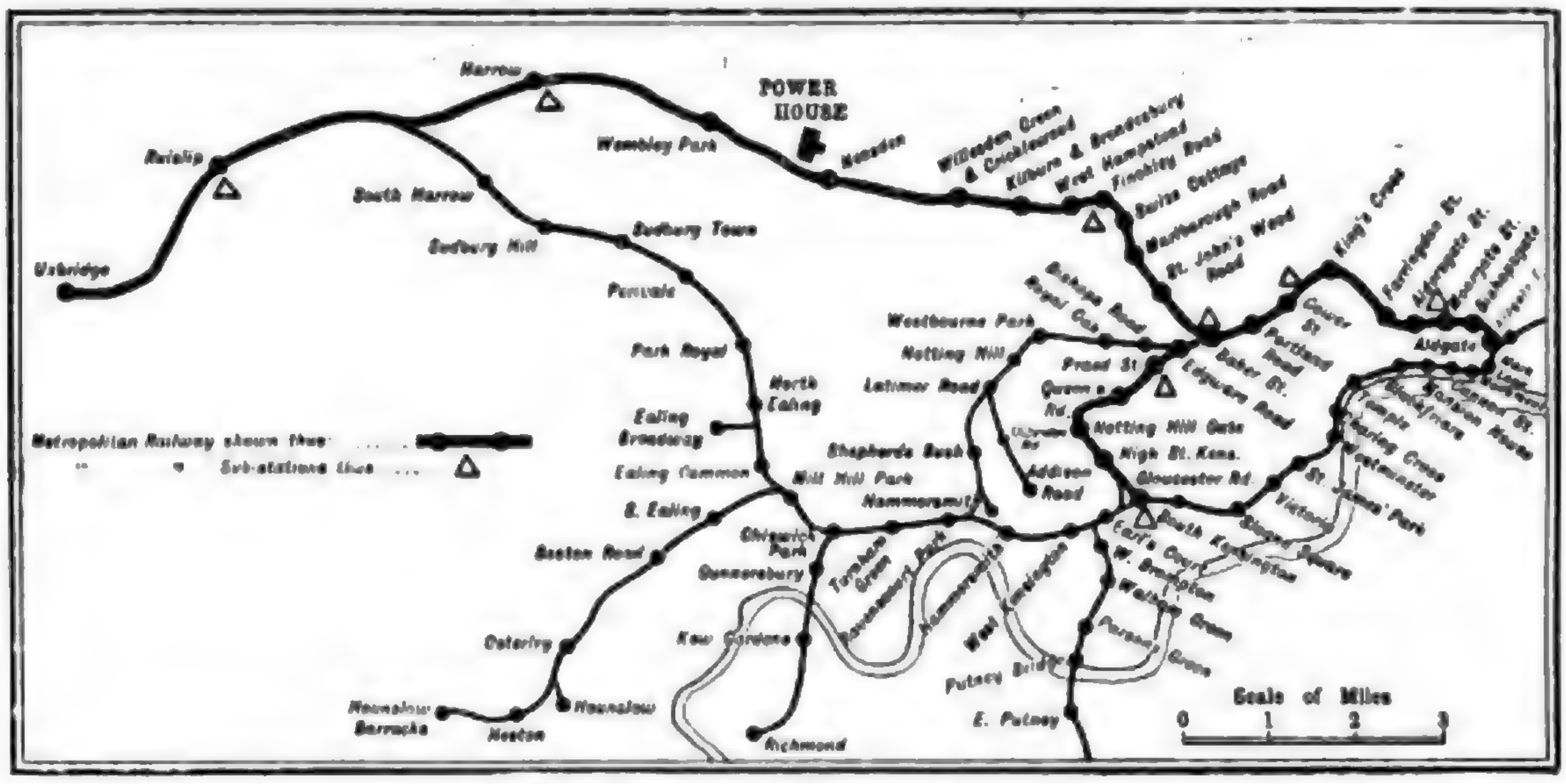
Harrow
POWER HOUSE
Ruislip
Wembley Park
Neasden
Willesden Green & Cricklewood
Kilburn & Brondesbury
West Hampstead
Finchley Road
Swiss Cottage
Marlborough Road
St. John's Wood Road
King's Cross
Farringdon St.
Aldersgate St.
Moorgate St.
Bishopsgate
Aldgate
South Harrow
Sudbury Town
Sudbury Hill
Uxbridge
Perivale
Park Royal
North Ealing
Ealing Broadway
Ealing Common
Mill Hill Park
S. Ealing
Boston Road
Chiswick Park
Gunnersbury
Kew Gardens
Osterley
Hounslow Barracks
Heston
Hounslow
Richmond
Metropolitan Railway shown thus
" " Sub-stations thus
Westbourne Park
Royal Oak
Bishops Road
Notting Hill
Latimer Road
Shepherds Bush
Hammersmith
Addison Road
Praed St
Queen's Rd.
Notting Hill Gate
High St. Kens.
Gloucester Rd.
Baker St.
Edgware Road
Portland Road
Gower St.
Temple
Charing Cross
Westminster
St. James' Park
Victoria
Sloane Square
South Kensington
Earl's Court
W. Brompton
Walham Green
Parsons Green
Putney Bridge
E. Putney
Turnham Green
Ravenscourt Park
Hammersmith
West Kensington
Mansion House
Blackfriars
Scale of Miles
0
1
2
3

FIG. 20.—MAP OF METROPOLITAN RAILWAY.

The copper bonds for the joints and hydraulic compressors for fitting the bonds were supplied by the Forest City Electric Co. Compared with that of the rail itself, the total cross-sectional area of copper at the joint is in the ratio of 1 to 6·5. The appearance of the bond is shown in Fig. 22. Copper ribbon or flat wire conductors are built up to form the bond and are fused on to the solid copper terminals, the whole constituting an almost solid mass of copper. It will be seen from the illustration that the conductors are sufficiently flexible to yield readily to vibration and are so shaped that they may be extended by the contraction of the rails without suffering any injury whatever. In order to obtain the requisite contact area between the copper of the bonds and the steel of the rail, it was necessary to divide the copper into four bonds. These are fixed in the flange of the rail, the longer bonds curving backwards and passing along under the centre of the rail, and behind the shorter bonds. In case of extension of the long bonds, through contraction of the rails, torsional strains would be produced in their terminals due to the fact of their being curved back to pass behind the shorter bonds. In order to avoid this objectionable feature the two longer bonds are merged into one along the centre of the rail, the two adjacent terminal heads at each end becoming one solid piece of copper, so that the only stresses to which the terminals can be subjected are those due to shearing, as in the case of the shorter bonds. The bond heads are bevelled to compensate to a certain extent for the angle of the flange. The terminals being 1in. in diameter and the average thickness of the flange at the bond hole ¾in., considerable pressure is required to expand the terminals and properly bring the steel and copper into intimate contact throughout the surface of the bond hole. For this purpose the portable hydraulic compressor shown in Fig. 23 was used; it was expressly designed for this class of work, and is capable of exerting a pressure of about 35 tons. Perhaps the most notable features of this compressor are the crank and side arms. By means of these the bonds are drawn home tightly against the base of the rail before pressure is exerted.

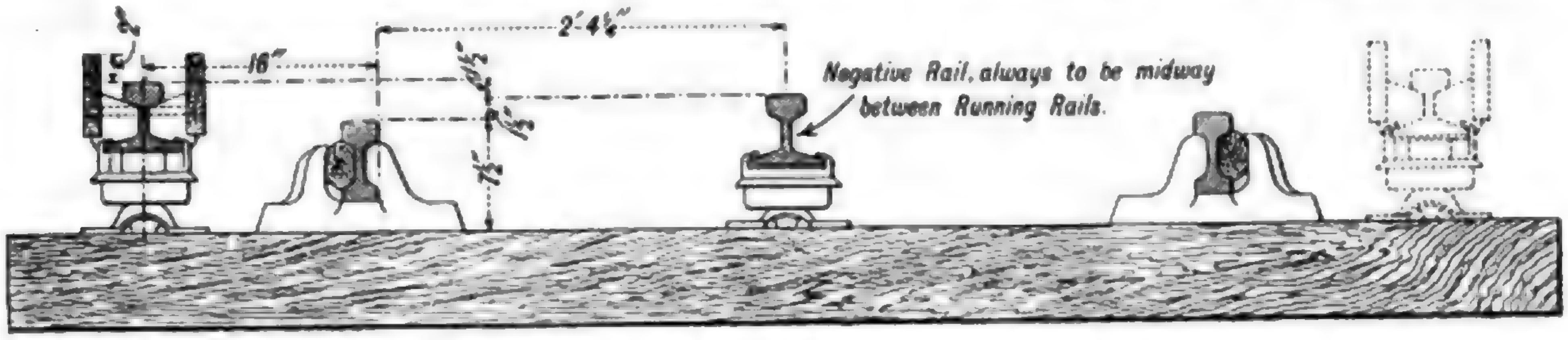

Fig. 21.—Cross Section of Track.

Every conceivable precaution has been taken to prevent accidental contact with the live rail, and at stations, crossings and yards, guard planks have been provided. At stations the positive rail is removed from the platform side of the track and fixed between the two tracks, thus entirely eliminating danger to persons falling from the platforms. In addition, however, it is provided with a guard plank which projects some distance above the top of the rail itself. At crossings and yards, where men frequently have to traverse the tracks two guard planks are bolted to the live rail in the ordinary way. It is worthy of note that the company is training its employés to avoid all rails, whether alive or dead, and has posted notices warning persons not to step on any rail whatever. This is undoubtedly an excellent plan, and might well be followed by other railway companies.

The rolling stock, although of standard design in many respects, differs considerably in certain details from the rolling stock in use on any other British railway. Its essential feature is fireproof construction, and the designers and contractors have certainly been eminently successful in their efforts to provide against outbreaks of fire. In an exceedingly close examination of the coaches it is difficult to discover any material of an inflammable nature, and although there is a certain amount it is so small as to be negligible. All coaches are of the corridor type with longitudinal and transverse seats. Each is 52½ft. long, and is mounted on two pressed steel four-wheel bogie trucks of English manufacture; the weight is approximately 39 tons. There are two motor cars to a train of six coaches, each of which is equipped with four 150 H.P. iron-clad British Westinghouse railway motors, one for each axle of the truck; there will therefore be the unusual amount of 1,200 H.P. available for propelling each train. The method of suspending the motors is an excellent one, the entire weight falling upon the driving axle so as to secure maximum tractive effort. One side of the motor casing is attached to the frame of the truck by means of a heavy spiral spring, which, owing to the tendency of the entire motor to turn in a given direction, is always in tension. Apart from this, however, the motor is carried by the driving axle. In the event of the spring breaking the entire motor system would be free to revolve if it were not for a pair of lugs cast on to the casing, which engage with a projection on the truck frame and prevent any tendency in this direction. The collecting shoes are carried by a stout wooden beam supported at the front or outer end of the truck. As the positive conductor rail is not always situated on the same side of the track, there is a positive collector shoe at each end of this beam, the return shoe being fixed in the middle. An auxiliary return shoe is also provided on a second beam carried at the other end of the truck. None of the cables carrying heavy currents enter the coaches themselves, but are laid under the floors in asbestos grooves, filled in with a fireproof composition and covered with sheet asbestos. In addition to this, the floors themselves are of sheet steel covered with non-inflammable asbestos composition. If a cable happened to fuse it would thus be quite impossible for any flame to reach the interior of the coach. Inspection of the motor commutators and of the cables themselves is rendered particularly easy by means of traps let into the floors.

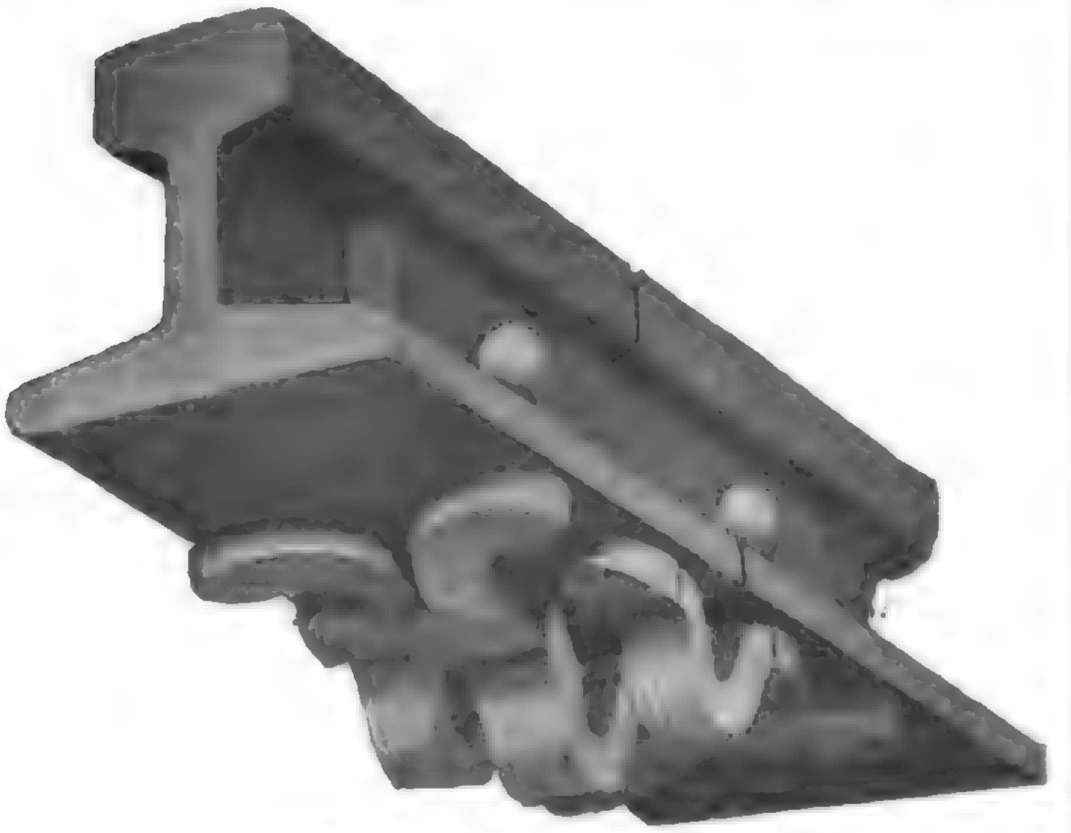

Fig. 22.—Method of Bonding Third Rail.

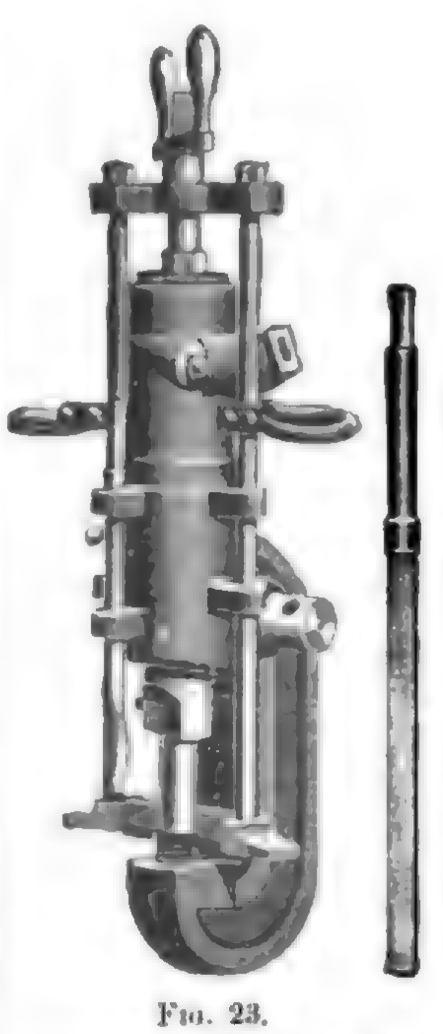

Fig. 23.
Compressor Employed in Fixing Bonds.

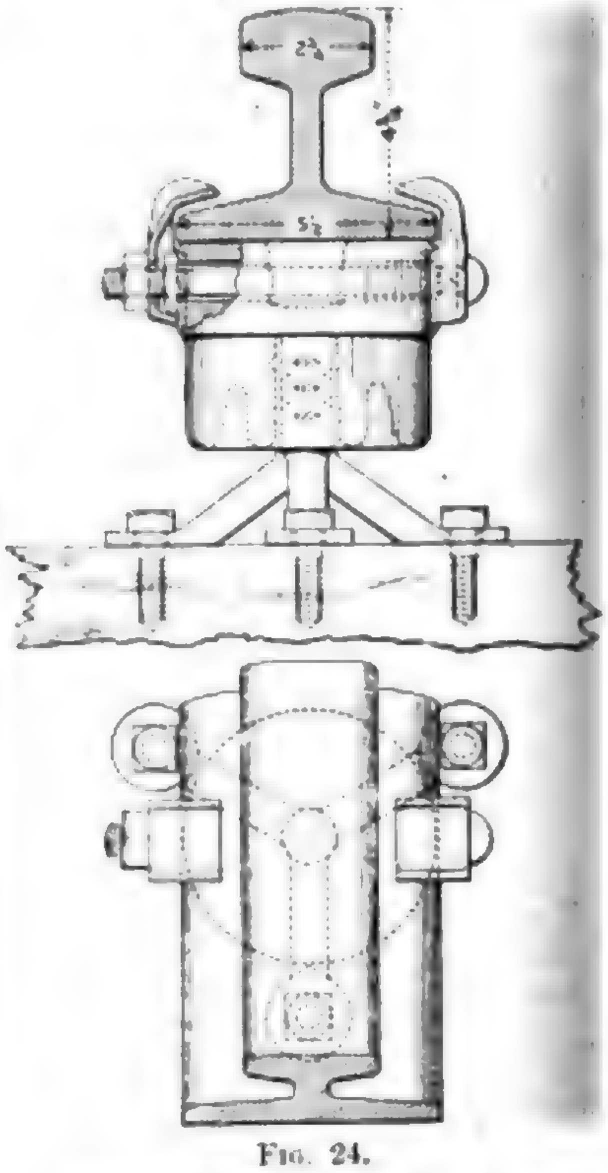

Fig. 24.
Elevation and Plan of Insulator.

... Manchester Corporation. See Table II., to be published with *The Electrician* of January 20, 1905.

nge South Metropolitan Electric Light and Power Co. See Table I. above.

... Huddersfield Corporation. See Table I. above.

ote. Midland Electric Corporation for Power Distribution. See Table III., to be published with *The Electrician* of January 27, 1905.

... Newcastle and District Electric Supply Co. See Table I. above.

St. Isle of Thanet Electric Lighting and Tramways Co. See **Margate** and **Broadstairs** in Table II., to be published with *The Electrician* of January 20, 1905.

... Midland Electric Corporation for Power Distribution. See Table III., to be published with *The Electrician* of January 27, 1905.

... Bournemouth and Poole Electricity Supply Co. See Table II., to be published with *The Electrician* of January 20, 1905.

ome Do. do. do.

... Salford Corporation. See Table II., to be published with *The Electrician* of January 20, 1905.

... Midland Electric Corporation for Power Distribution. See Table III., to be published with *The Electrician* of January 27, 1905.

... Do. do. do.

... Folkestone Electric Supply Co. See Table I. above.

... Midland Electric Corporation for Power Distribution. See Table III., to be published with *The Electrician* of January 27, 1905.

and Bray Maidenhead Corporation. See Table I. above.

... Twickenham and Teddington Electric Supply Co. See Table I. above.

... Midland Electric Corporation for Power Distribution. See Table III., to be published with *The Electrician* of January 27, 1905.

... Do. do. do.

... Newcastle-on-Tyne Electric Supply Co. See Table II., to be published with *The Electrician* of January 20, 1905.

... South Metropolitan Electric Lighting and Tramways Co. See **Sutton** in Table I. above.

... Midland Electric Corporation for Power Distribution. See Table III., to be published with *The Electrician* of January 27, 1905.

... British Insulated and Helsby Cable Co. See **Prescot** in Table II., to be published with *The Electrician* of January 20, 1905.

... Midland Electric Corporation for Power Distribution. See Table III., to be published with *The Electrician* for January 27, 1905.

... Windermere and District Electricity Supply Co. See **Keswick** in Table I. above.

... Manchester Corporation. See Table II., to be published with *The Electrician* of January 20, 1905.

IC S

I.

SECTIONS.

and Size of Lamps. Incandescent.	Motors. Total H.P.
...	...
62	189
None	None
36 16-c.p. 7 ½a. Nernst	25
None	76
...	20
...	30
None	8½
300 ½ amp. Nernst	220
120	20
64 c.p. 8 50 c.p. 3 ½ amp. Nernst	68
34 32 c.p.	16
614 16 to 200 c.p.	126¼
29 32 c.p.	2,015
84 25 c.p. 8½ amp. Nernst	70
253	64
None	285
None	...
...	601
215	None
16 c.p. 78 20 c.p. 174 10 c.p. 3 ½ c.p. Nernst	67½
...	6
...	20
5 16 c.p. 3 75 c.p.	2,306
None	100
30 25 c.p.	33
...	100
None	80

[illegible]	[illegible] [36,289]				
112	**Kingston on Thames** [37,000]	1891	Nov., 1893	Kingston Corporation	*a*J. E
113	**Leamington** [28,000]	1901	1887	Midland Electric Light and Power Co.	*a*F. W
114	**Leatherhead** [7,000]	1898 1902-3	Sept., 1902	Leatherhead and District Electric Supply Co.	H. V
115	**Leeds** [443,500]	1891	Co. May, '93 Corp. Dec, '98	Leeds Corporation	Har sq
116	**Leek** [16,484]	1900	June, 1904	Leek Urban District Council	R. M
117	**Leicester** [220,000]	1890	Dec, 1894	Leicester Corporation	Alfr
118	**Leigh (Lancs.)** [44,000]	1895	Jan., 1900	Leigh Corporation	A. T
119	**Leith** [78,880]	1897	Jan., 1899	Leith Corporation	*a*A. P R
120	**Lewes** [11,249]	1898	July, 1901	Lewes and District Electric Supply Co.	A. A
121	**Leyton** [110,000]	1894	Sept., 1896	Leyton Urban District Council	*a*F. H
122	**Limerick** [38,151]	1892	1903	Limerick Corporation	J. G
123	**Lincoln** [58,000]	1897	Dec., 1898	Lincoln Corporation	*a*Stan
124	**Liverpool District** [Great Crosby and Waterloo with Seaforth) (51,724)	1895-6	Sept., 1897	Liverpool District Lighting Co.	*a*W. M fal
125	**Llandilo** [5,878]	1900	Sept., 1902	Llandilo Council	W. J
126	**Llandudno** [9,307]	1895	Nov., 1898	Llandudno District Council	H. M
127	**Llangollen** [3,000]	1901	Nov., 1904	Llangollen Electric Supply Co.	
128		1896	Sept., 1901	**Battersea Borough Council** [180,000]	Vacan
129		1891	Jan., 1902	**Bermondsey Borough Council**	W. H

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ED KINGDOM.—1904–1905.

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RS & ERS. Location.	METERS.	PRICE PER UNIT. Small figs. (1) indicate first hour, (2) first two hours, &c. Lighting.	Power.	TARIFF SYSTEM. W. indicates the Wright system of charging. D. indicates Discounts.	Price of Gas in District.	Gasworks owned by. L.A. = Local Auth. Co. = Company.	—	REMARKS.
Houses	Hookham, Thomson and Bastian. Vulcan and Reason prepayment	6d.	...	...	4/3	Co.	1	Steam draught. Hand stoking. Worthington feed pump and injectors; town water. Alternators not paralleled. About to change over entirely to 3-wire 440 volt continuous current.
Station Station	Ferranti generally	4d. with discounts	3d.(1)–1d. with discounts	No demand indicator	2/6½ & 2/9	L.A.	2	Refuse destructor worked in conjunction with the boiler house plant. Motors, &c., on hire.
Station	Hookham; Watson and Reason prepayment	7d.(1)—4d.	...	W.	3/2	Co.	3	Berryman feed water heater. Worthington feed pumps. Hand stoking. 2s. per quarter charged for consumers' meters, &c. Free wiring by company. Motors on hire.
Engine room	Hookham; Reason prepayment	6d.(1)—4d.	3d.(1)–2d.	W.	2/8	Co.	4	144-tube Green economiser. Natural draught. Hand firing. Worthington feed pumps. No free wiring.
Station Station	Bastian, Hookham & Rochdale prepayment	5½d. & 4d.	2½d. & 1¼d.	D. 5% cash, 14 days	3/3	Co.	5	72-tube Green economiser. Natural draught. B. & W. chain grates. Electric and steam feed pumps.
Mostly in houses	Hookham, Shallenberger, Thomson and Westinghouse	6d.	3d.	...	2/10 to 3/4	Co.	6	488-tube economiser.
Station	Reason	7d.(1)—2½d.	4½d.(1)—1½d.	W. & D.	3/9 to 2/8	Co.	7	Two Empire Weir feed pumps.
Station	Bastian, Ferranti, Hookham; O.K. and Reason prepayment	5d.	2½d.	...	9/6	L.A.	8	Meldrum forced draught. Hand stoking. Duplicate Weir feed pumps working through Berryman exhaust steam heaters, and 96-tube Green economiser. Meldrum refuse destructor. Free wiring by company.
Station	Hookham ...	5d.	2d. with discount	D.	2/11	Co.	9	No economisers. Natural draught. Hand firing. Webster feed heater 13,000lb. per hour. Weir direct-acting feed pumps. River water. Batteries for day load. No free wiring, &c.
Station	Hookham, B.T.H., O.K. and Reason electrolytic; Reason prepayment	5d.	2d., 2½d. and 3d.	...	3/6	Co.	10	B. & W. superheaters. Green economiser. Hand stoking. Hall feed pumps. Holden & Brooks injectors.
...	Shallenberger, Vulcan, Hookham, Reason, Stanley & Eclipse	5d.	1¾d.	D.	2/1	Co.	11	Nat. draught. 1 Sturtevant ind. draught fan (mot. driven). Hand stoking. B. & W. superhtr. and econ. with marine boiler. Doulton water softener. 2 Blake, 1 Edwards 3-throw air, 1 Hayward-Tyler 3-throw feed pumps.
o Sub-stations	B.T.H. and Westinghouse	5d.	2d. to 1½d.	D.	2/5	2 Cos.	12	The station is in conjunction with a Horsfall 3-cell dust destructor. 96-tube Green economiser. Natural draught, but motor fan for destructor. Hand stoking. Weir & Worthington ram pumps. Town water and artesian well. Free wiring. Boby heater and detartarisers
Sub-stations	Aron, Hookham, Shallenberger, Westinghouse, Ferranti; B.T.H. prepayment	5½d. less ½d. dis.	2d. & 1½d.	D.	2/9 net	Co.	13	Green econs. Nat. and Davidson ind. draught. Vicars stokers. Worthington, Hall & Weir feed pumps. River water. Street inc. lamps from separate L.T. network fed from separate transformers & H.T. feeders.
erating station	Ferranti and Hookham	6d.(1)—1½d. or 4d., Churches 4d.	2½d.(1) – 1d. and 1d.	W.	2/8 less discounts to 1/9½	L.A.	14	384-tube Green econr. Steam blast, forced draught under bars. Proctor & Bennis stokers on Lancs. Chain grate and 3 units on B. & W. Duplex and compound steam feed-pumps and 3-throw electric. Free wiring. Motors on hire. Traction scheme in hand
Station	Hookham and Reason	7d.(1)—4d.	4d.(1)—1½d.	W.	3/9 less 15 p. c. large custmrs.	Co.	15	No econrs. Boby heater. Sugden's super-heaters. Meldrum forced draught and mech. stokers. Hall's compound feed pumps. Free wiring at 1½d. per lamp per quarter. 7d. per unit through prepayment meters. Motors hired out at 10 per cent. on cost
Station	Hookham & Reason electrolytic; Reason prepayment	7d.(1) & 2d. & 1½d.	3d. & 2½d.	W.	4/6	Co.	16	No economiser. Natural draught. Hand firing. Two Smith and Vaile pumps. Two feed mains. Town water. Superheaters. Exhaust steam feed water heater. Well sunk at station for feed and condensing purposes. Further extensions to plant and buildings in hand.
Sub-station	Ferranti and Hookham	6d.(1)- 3d.(2) - 1½d. 5d. flat rate.	1st 500—2½d. 500-1,200—2d. exceeding 1,200—1½d.	W.	2/6	L.A.	17	324-tube Green economiser. Natural draught. Vicars stokers. Worthington feed pumps and injector.
...	Hookham, Ferranti & Bastian	6d. to 4d.	3d. to 1½d.	...	2/6 to 1/10	L.A.	18	New station for traction and lighting in hand.
Station	Hookham, Bastian & Rochdale	5½d. to 4d.	2½d. to 1½d.	D. 5% cash 14 days	3/0	Co.	19	96-pipe Green economiser. Hand stoking and B. & W. chain grate stokers. Free wiring. Motors on hire. Rates with prepayment meters; 1d. each 8 c.p. lamp for 5½ hours.
Street [illegible]bers in footpaths	Hookham, Shallenberger and B.T.H.	6d.(1½)—3½d.	6d.(1½)–3½d.	W.	4/6	Co.	20	Alternators run on separate circuits. Hand stoking. Green economisers. Natural draught.
Station	Hookham & Reason. Vulcan, Reason Rochdale & Hookham prepayment	5½d., or 6d.(1)—4d.	4d.(1)—1½d. or 2½d.	W.	4/6	Co.	21	Berryman feed heater. No economisers. Natural draught. Hand firing. Duplicate Worthington feed pumps. Rented wiring at 1s. per lamp per year. Motors on hire.
Station	Bastian	7d.(1)—4d.(2)—2d.(3) Flat rate, 6d.	2d.	W.	2/10	Co.	22	Dowson gas plant.
...	Bastian, Ferranti, Hookham, and Reason	6d.	5d.	...	2/9	L.A.	23	......
[illegible] Station	Westinghouse, Shallenberger, Aron, Hummel, Ferranti and Thomson	5d. (3½d. day)	1½d.	D. up to 30%	2/3	Co.	24	Green econs. Meldrum and Vicars mech. stokers. Weir, Clarke, Chapman, J. P. Hall and Pearn feed and G.S. pumps. Natural, forced and induced draught. Superheaters. Two stations.
Station Bickley	Hookham & Reason	7d.(1)—4d. and 6d.	4d.(1)–1d.	W.	3/2	Co.	25	No economisers. Induced draught. Hand-stoking. Hall pumps. Motors on hire. Connections include about 120kw. supplied to Chislehurst Co. Sugden superheater.
...	Ferranti......	6d.	4d.	...	3/6	L.A.	26	......
Station	Thomson, Ferranti, Bastian, Hookham and Wright	6d.	3d., 2·75d., 2·5d., 2·25d.	D.	3/9	Co.	27	Hand firing. 96-tube Green economiser. Natural draught. Motor-driven 3-throw feed-pump. Gwynne pump. Max. load, 150kw.
Station	Hookham and	6d., 4d., 3d.	3d.(1)-1¾d.	7d. W., and 3d. [illegible]	2/6	L.A.	28	No economiser. Cold feed. Natural draught. Hand firing.

007.

Flexible knuckle joints are made in the cables so that in the event of it being necessary to lift a coach body from the trucks this operation is greatly facilitated. A special feature of the car body construction is the amount of steel which has been employed. No 16 B.W.G. sheet steel has been used for the bottom panels and No. 20 B.W.G. for the inside lining. Window frames and pillars are of Burmah teak, while the interior is finished in oak. The roof also is fireproof, and is built up of zinc and asbestos millboard. Each motor car accommodates 49 passengers, and compartments for a driver and luggage are provided at one end. There will be two different types of rolling stock in use on the railway shortly, the first equipped with ordinary swing gates and that of a later pattern with vestibules and sliding doors operated by levers from the platform. The seats are of an extremely comfortable design, consisting of convex sheet steel springs in angle iron frames. In the superior class non-smoking cars they are upholstered in art green moquette, and the smoking cars are similar in all respects except that the upholstery is in green leather. All the second-class cars have buffalo-hide covered seats, and only differ from the first-class in that the decorations are less elaborate. Bevel mirrors and panels containing photographs of country districts served by the Metropolitan Railway contribute greatly to the decorative scheme, and the comfort of the passengers in the winter is provided for by means of electrical heating. This is carried out with "Gold" patent electric heaters, supplied by Messrs. W. S. Laycock (Ltd.). These heaters are arranged to work in series on a 500 to 600-volt circuit, and to give three graduations of heat, the approximate consumption of current being 7 amperes on the first, 13 on the second and 20 on the third point. They are controlled from separate switches fitted on a small glass-covered panel at the end of the car, the lighting switches and fuses being also mounted on the same panel. The heaters themselves consist of suitably-arranged resistance coils, and are fixed under the seats.

All the rolling stock has been built at Birmingham and Manchester by the Metropolitan Amalgamated Railway Carriage & Wagon Co. under the immediate supervision of the railway company's carriage and waggon superintendent, and the entire electrical equipment has been designed and installed by the British Westinghouse Company. The trucks, which were designed and built by the Leeds Forge Co., are constructed on the Fox pressed-steel system, which permits of the use of a minimum number of parts, thus reducing liability to trouble from rivets working loose, &c. Each bogie truck equipped with two collector shoe beams weighs approximately 5 tons 8 cwt. Laminated side-bearing springs and elliptical bolster springs are provided, but in the new stock a slight departure has been made from this construction. Steel-tyred wheels, 36in. in diameter, of the open spoke type, have been employed throughout, and each is fitted with one brake block worked on the Westinghouse quick-acting system. The entire braking arrangements work automatically in conjunction with the unit switch system, and an emergency cock is fixed on every platform. In addition, however, it is possible to operate the brakes by means of a hand wheel in the driver's compartment. Every train is worked on the Westinghouse multiple unit turret control system, a full description of which appeared in *The Electrician*, Vol. LIII., p. 516. Each train consists of four trailer cars with a motor-car at each end, and arrangements are being made whereby each train may be divided into two portions and each portion driven from either end. The line from Baker Street to Uxbridge was opened to the public on Jan. 1.

In concluding this series of articles we have to express our indebtedness and thanks to Mr. A. C. Ellis, general manager of the Metropolitan Railway, for permission to inspect the work; to Mr. C. Jones, chief electrical engineer, for the facilities which he has given us and the information and drawings which he has placed at our disposal; to Messrs. J. F. Heath and S. Page, respectively chief electrical and mechanical assistants, for the time and trouble which they expended in conducting us over the works, explaining a large number of details; and to the various contractors who have supplied us with a large amount of information.

THE SOUTH AUSTRALIAN "TRAMWAYS ELECTRIC TRACTION ACT, 1904."

The Parliament of South Australia has just passed "The Tramways Electric Traction Act, 1904," and a serious effort will now be made, it is hoped, to bring about the conversion of the tramways with which Adelaide is so extensively equipped. The lines at present are worked entirely by horse traction, but though neither the present companies nor the Corporation of Adelaide are disposed to undertake the electrification of the lines, yet it is generally felt that the present system should be abolished at the earliest possible date. In our issue for December 9th we gave a summary of a report by Mr. F. E. Bradford upon the electrification of the South Australian railways.

Adelaide, with its suburbs, forms quite a garden city, there being a belt of "Park Lands," ½ mile in width, round the city proper, while in the suburbs, and, indeed, even in the less important streets of the town itself, the houses are largely single-storeyed, detached and standing in their own grounds. But while conducive to the health and cleanliness of the town, this has the disadvantage from a tramway point of view that the population served per mile of route is very small, so that, with about 165,000 inhabitants, Adelaide has over 70 miles of track —less than 24,000 persons per mile of track—and in this figure are included the residents of three important suburban districts which are served by railways and untouched by the trams. This will largely explain the fact that with its extensive system of tramways, mostly paying healthy dividends, Adelaide knows not the electric tram, save by hearsay.

The question of electrification of the tramways, has been prominent, however, since five years ago, when the first overtures were made by a company for the acquisition of the lines, and in 1901 a private Act was passed to enable an Adelaide gentleman, Mr. F. H. Snow, to carry out agreements with certain of the present tramway companies for the purchase of their lines, and to electrify the same, it being well known that he was acting for the British Westinghouse Company's Australian representatives. This Act required the completion of a large part of the conversion by the end of 1904, but owing to difficulties in obtaining the necessary capital—largely due, no doubt, to the onerous conditions of the Act—no active steps have been taken, and the present Government Bill was introduced on its being clearly seen that the "Snow" Act was to be allowed to lapse.

The main principle of the 1904 Act is that the electrification is to be carried out by private enterprise, the Government taking powers to purchase the present tramways, but exercisable only when a definite agreement has been entered into for the leasing of the lines to a company, who will be required to repay to the Government the cost of their acquisition. The electrification of the lines, as a national undertaking, is thus prohibited.

The provisions to govern the working of the above arrangement are as follows:—

At any time within the next two years the Government may give notice to the existing companies of their intention to purchase, and in default of agreement the price will be settled by arbitration. Thereupon the Government may not complete the purchase, but must first invite tenders for the leasing of the lines, upon such terms and conditions (subject to the Act) as they shall deem advisable, and if a satisfactory tender is received and accepted within 12 months, the Government may then complete the purchase, being given two months in which to do so. Failing a conclusion of the purchase agreement, a period of five years must elapse before the compulsory rights may again be enforced.

While allowing the Government a fairly free hand in drafting the specification upon which tenders are to be invited, a certain number of things are stipulated for, among which may be cited:—

Work is to be commenced within six months of the acceptance of the tender, 20 miles of certain specified lines shall be completed within a year and the remainder of these lines within a further 12 months. As to the rest of the lines, many of which serve sparsely populated neighbourhoods, these are to be converted gradually, not less than 9 miles in every three years, and the whole being completed within 12 years from the passing of the act. Whether electrified or not, the lines are to be kept in use, with a service of cars not less than is given at present.

After 14 years, the Government or a municipal trust (if such is formed) may purchase the tramways at a price fixed by arbitration upon a "going concern" basis. The Government need not purchase, however, if, after the settlement of the price, it prefers to withdraw, but thereupon it will lose all rights of purchase for a further five years.

The British Board of Trade regulations as to rail return will apply, but at the same time a protective clause has been given to the local gas and electric light companies, under which claims for electrolytic damages might be made. On the other hand, the powers given for the erection of posts and wires in the streets are sufficiently general to cover transmission of power by overhead mains, and in general the stipulations as to constructional work are considerably less onerous than those under which many an English company works.

Fares levied are not to exceed those at present in force, while the lines throughout are to be divided into penny sections not less than a mile in length, this being the exception rather than the rule at present. The lessee will be entitled to levy charges for the carriage of mails and parcels. No provision is made for workmen's fares, which is perhaps surprising in a land where the labour vote is so powerful, but a proviso is inserted that no employé may work more than 48 hours per week unless for unavoidable overtime.

The basis of tenders invited is to be the duration of the lease that the tenderer requires, and at the end of the lease, the lines are to be handed over in full working order free of charge. As royalty for use of the streets, a payment of 1 per cent. of the gross takings upon the electrified lines for the first seven years and of 1½ per cent. for the remainder of the term, is to be made to the Corporation of Adelaide, who will apportion this sum among the municipalities interested. In addition, rates are to be paid, and roads maintained, in accordance with the "General Tramways Act, 1884" which is incorporated.

The Government have a free hand (except where bound by the Act) in the imposition of terms and conditions to be included in their invitation for tenders, but these are hardly likely to be of moment, governing rather the details of the work and materials to be used, so that from the above one may obtain a fair idea of the nature of the obligations imposed upon the lessee; and in general they may be regarded as very reasonable, being much less severe than those included in the "Snow" Act of 1901. Indeed, the failure of the promoters of this Act to raise the necessary capital seems to have opened the eyes of both public and legislators to the fact that the electric conversion of a tramway is not invariably a gold mine, and to have conduced largely to the reasonable spirit in which the 1904 Act has been conceived.

It may be regarded as certain that unless the present South Australian Government should be overthrown at the next election, and the Labour Party—now in the Opposition—should rise to power, a speedy attempt will be made to give effect to the provisions of the act. The local Press states that the Government have the preliminary details of the matter already under consideration, and that copies of the Act are being sent to the local representatives of all large electrical firms to familiarise them with its details. And, seeing that it is fully admitted that no South Australian company is prepared to take over the trams and to finance their conversion, it is sincerely to be hoped that British firms will not be lacking in giving their attention to this matter. As stated at the outset, colonial conditions differ considerably from those prevalent in this country—an important point to which attention may be drawn being the wide straight streets lacking gradients of any severity and almost devoid of traffic, on which high speeds may well be allowed—and we fear that American and Continental firms often show much more enterprise in mastering the local aspects of a case such as this, to the serious detriment of Britain's chances when tenders come to be opened. It would be a thousand pities if a foreign firm obtained the rights over this extensive system of trams, thereby still further tightening the hold that our competitors have already taken upon the Australian electrical trade.

STANDARD FORM OF TENDER FOR CABLES.

The Cablemakers' Association has issued the following standard forms of tender for the supply and laying of cables:—

TENDER FOR THE SUPPLY OF CABLES.

Dear Sirs, ...190...

The accompanying tender is submitted in accordance with the general conditions and detailed specifications issued by you, subject to the following terms or reservations:—

1. *Conductors.*—The sizes, combinations and resistances of conductors shall be as specified in the British Engineering Standards Tables.

2. *Dielectrics, &c.*—The thicknesses of dielectric, lead, armouring or serving shall be as specified in the British Engineering Standards Tables unless otherwise provided.

3. *Maintenance.*—We are prepared to undertake that the goods tendered for are free from defects of material or workmanship, and we will supply free of charge, adequate material to replace any part removed and returned to us which within 12 months after delivery shows defective material or workmanship.

4. *Sureties.*—The sureties proposed by us shall be for the contract and for the maintenance during the 12 months referred to above.

5. *Arbitration.*—An arbitration clause, as provided in the Arbitration Act of 1889, shall be inserted to provide for the settlement of any disputes which may arise either in the carrying out of the work or as to the interpretation of the contract.

6. *Payment.*—Payment in full shall be made within one month from the end of the month in which delivery is made.

7. *Quantities.*—The approximate quantities required shall be stated in the contract, and we shall not be called upon to supply more than 10 per cent. in excess of these quantities, or less than 10 per cent. below them without special arrangement as to price being made.

8. *Drums.*—Drums shall be charged for, and we shall credit the amount in full if the drums are returned carriage paid and in good condition within three clear months after the month in which the goods are delivered. The amount credited as above for any drum received by us after the expiration of these three months shall be reduced at the rate of 1s. per week for each week in excess of such three calendar months.

Yours faithfully,

....

TENDER FOR THE SUPPLY AND LAYING OF CABLES.

Dear Sirs, ...190....

The accompanying tender is submitted in accordance with the general conditions and detailed specification issued by you, subject to the following terms or reservations:—

1. *Conductors.*—The sizes, combinations and resistances of conductors shall be as specified in the British Engineering Standards Tables.

2. *Dielectrics, &c.*—The thicknesses of dielectric, lead, armouring or serving, shall be as specified in the British Engineering Standards Tables, unless otherwise provided.

3. *Upkeep and Maintenance.*—We are prepared to maintain in good and efficient working order as hereunder set forth, the system of underground mains, boxes and accessories, which we now tender to lay so as to comply in all respects with the requirements of the Board of Trade, and no charge shall be made therefor for a period of 12 months next after such mains have been laid and tested. We are also prepared to continue to maintain as aforesaid all such mains, boxes and accessories, for such further period as may be arranged between us, in consideration of the payment to us of an annual sum calculated, as shown in our tender, by taking a percentage of the invoice value of the contract to be maintained, such sum to be paid to us at the expiration of each 12 months of the further period of maintenance. In the event of any fault occurring in the mains, boxes or accessories during the period of maintenance, we undertake to repair and make good the same immediately on being called upon by you to do so. If any such fault is shown to be due to the use by us of inferior or improper materials, or to our bad workmanship, in either the manufacture, handling, laying or jointing of the cables, the whole costs incurred, either in the actual repair or in opening and reinstating the ground, shall be borne by us, but where any such fault is due to damage from the outside, or to the working of the mains otherwise than as provided in the specification, or to any other cause over which we have no control, all reasonable expenses incurred by us in locating, repairing and making good any such fault, and in opening and reinstating the ground, shall be repaid to us by you.

4. *Sureties.*—The sureties proposed by us shall be for the execution of the work under the contract, and for the maintenance during the first 12 months referred to above.

5. *Arbitration.*—An arbitration clause as provided in the Arbitration Act of 1889 shall be inserted to provide for the settlement of any disputes which may arise either in the carrying out of the work or as to the interpretation of the contract.

6. *Suspension of Work.*—In the event of the works being suspended by the engineer the reasonable expenses incurred by us through this suspension and through the resumption of work shall be paid to us by you. This does not apply to any suspension due to a fault on our part, or to bad weather, or to accidents for which we, as contractors, may be fairly considered liable. In the event of the works being suspended from any cause beyond our reasonable control we shall be entitled to an adequate extension of the time within which the contract is to be completed.

7. *Engineer's Certificates.*—The engineer shall certify for payment as provided hereinafter within 14 days of presentation of each account, and payment shall be made to us, for the amount so certified, within one month from the date of such certificate. In the event of any dispute or claim arising as to any account, or otherwise in connection with the work, the issuing of the certificates shall not be delayed in consequence, but the engineer may withhold such reasonable sum as may be necessary to meet the claim or work in dispute.

8. *Payment.*—Payment for cables supplied and laid, or for other work done in connection therewith, shall be on the following terms:—

As the works progress, 80 per cent. upon the contract value of the work from time to time delivered or executed on the site to the satisfaction of the Engineer.

The remaining 20 per cent. (known as retention money), in respect of each distinct section or part of a section of the works, as follows:—

(*a*) 10 per cent. at the expiration of one month after the works shall have been taken over by the purchasers, or alternatively, at the option of the contractors, at the expiration of one month after the works shall have been put into beneficial use by the purchasers.

(*b*) 10 per cent. at the expiration of 12 months after the taking over or putting into use of the works as above.

In case of a lump sum contract not under schedule rates, the approximate value of each month's work shall be ascertained, and monthly payments shall be made on the above basis.

In the event of payments not being made by the dates specified herein, interest at the rate of 5 per cent. per annum shall be paid to the contractors on amounts overdue.

9. *Tests.*—Wherever cables have to be tested after being laid in the streets the current for tests on site shall be supplied free to the contractors at the pressure of the ordinary supply. As soon as the tests have proved that the plant has completely fulfilled the contract conditions the engineer shall forthwith so certify in writing to both the purchasers and the contractors, and thereupon it shall be deemed that the purchasers have taken over the plant.

10. *Extras.*—The contractors shall not be called upon to supply any materials or to carry out any work not detailed in the specification without being paid therefor.

11. *Schedule Rates.*—The schedule rates contained in the accompanying tender shall, unless otherwise therein expressly stated by us, be deemed to apply to work and materials done and supplied during the progress of the works, and shall not apply except so far only as they relate to the supply of materials, to alterations, additions, or extensions to be carried out after such time as we shall have withdrawn our men or plant in accordance with the contract.

Yours faithfully,

....

BOARD OF TRADE EXTRA-HIGH-PRESSURE REGULATIONS.

The following model description of, and regulations for, extra-high pressure, three-phase electricity supply systems, have been issued by the Board of Trade under the Electric Lighting Acts 1882 and 1888.

MODEL DESCRIPTION.

Description of the system to be adopted by the Undertakers for the supply of Energy under the .... Electric Lighting Order, ... and approved by the Board of Trade on the .... day of .... 190....

SUPPLY.

1. The supply will be given from the generating station to sub-stations at an extra high pressure of ...... volts.

2. The supply will be furnished from the sub-stations:—

(*a*) For ordinary lighting purposes to the consumers at low pressure between the adjacent conductors of a three-wire system, the intermediate conductor being, with the approval of the Board of Trade, connected with earth at one point only, namely, at the generating station, or at any sub-station supplying a distinct network;

(*b*) For special purposes where the approval of the Board of Trade is given under Regulation A. (1) of the Board of Trade Regulations, across the outer conductors of the three-wire system;

(*c*) For authorised tramways by continuous current at about 550 volts.

3. The extr-high-pressure supply will be given by [three]-phase alternating current, and the low-pressure supply will be given by continuous or by alternating current.

4. All alternating current will be at a frequency not differing from 25 or 50 complete periods per second by more than 2½ per cent.

5. Variations of the pressure will be allowed as provided in the case of the extra high pressure by the conditions of the consent of the Board of Trade to the supply, and in the case of the supply under 2 (*a*) and (*b*) as provided by the Board of Trade regulations.

6. Sub stations will be premises or parts of premises in the sole occupation of the undertakers.

MAINS.

7. Extra-high-pressure mains for three-phase supply will consist of insulated conductors laid together and enclosed in a lead sheath which must be permanently and efficiently connected with earth, and provision must be made either by copper strip under the lead sheath, or by steel wires outside it, or by bonding the lead sheaths of several cables together at joint boxes, or by other approved means, to ensure that the ground or any neighbouring electric line or conductor cannot become charged by leakage from the extra-high pressure main.

8. The extra-high-pressure mains will be laid in troughs filled in solid with composition and covered with hard burned tiles or other suitable protection.

9. The low-pressure mains will be insulated. They will be laid in troughing filled in solid with composition, or will be drawn into ducts or pipes, or will be armoured and laid in the ground.

CONDITIONS.

The Board of Trade approve the above system of supply only on the following conditions:—

(*a*) Sub-stations below ground must not be constructed except in accordance with plans approved by the Board of Trade.

(*b*) The power supplied to any sub-station below ground must not exceed 75kw. except with the consent of the Board of Trade.

(*c*) The power supplied to a transformer placed singly in a street box must not exceed 30kw. without the consent of the Board of Trade, and the vacant space in the street box must be so filled in as to prevent danger from explosion.

(*d*) Extra-high and high-pressure mains must not be brought into use for the supply of energy before they have been completely laid, properly jointed, examined and tested, or while they are still in charge of other parties than the undertakers.

(*e*) Where high and low-pressure mains pass through the same street box they must be readily distinguishable from each other.

(*f*) Extra high-pressure mains must not pass through the same street box with other mains.

And for the purposes of the .... Electric Lighting Order .... these conditions shall be treated as part of the approved system of supply.

Signed by order of the Board of Trade, the ...... day of ......, 190 .

REGULATIONS.

The   Order.

Consent of the Board of Trade to an extra-high-pressure supply being given by the   (hereinafter referred to as the "undertakers"), to sub-stations under the provisions of regulation 3 of the regulations made by the Board of Trade in pursuance of the above-named acts and order, and hereinafter called the "general regulations."

The Board of Trade hereby consent to an extra-high-pressure supply being given by the undertakers to sub-stations subject to the following regulations and conditions, that is to say:—

1. The extra high pressure shall not exceed a pressure of ...... volts by more than 10 per cent. under any conditions of working, without the consent of the Board of Trade.

2. At least two separate and distinct trunk mains shall be laid to each sub-station, and as far as possible by different routes.

3. The electrical power transmitted by any extra-high-pressure trunk main shall not at any time exceed 1,000kw. except with the consent of the Board of Trade.

4. The neutral point of the star winding of each distinct three-phase circuit may be connected with earth, or may be insulated. If connected with earth, the connection shall be made by means of a conductor possessing a mechanical strength and offering a passage to electrical discharges equal to that of a strand of 19 No. 12 copper wires.

If the neutral point is not connected with earth a separate electrostatic voltmeter placed in a conspicuous position in the generating station shall be connected between each distinct circuit and earth; and if the indications of the voltmeter show that the insulation of any of the circuits is faulty immediate steps shall be taken to restore the insulation.

5. The transforming apparatus at any sub-station supplied at extra high pressure shall be so arranged that there shall be no danger of any mains connected therewith being charged to any pressure beyond the limits of pressure prescribed for those mains.

6. The metallic portions (other than the conductors) of every transformer, and the casing thereof shall be efficiently connected with earth.

7. All boxes used in connection with the extra-high-pressure trunk mains shall be formed of strong metal, which shall be in good electrical connection with earth, and every such box shall be placed in such a position that there is no danger of persons coming into accidental contact with it.

8. A properly qualified electrician employed by the undertakers shall be in attendance at any sub-station supplied at extra high pressure while the machinery at the sub-station is in motion, and every such sub-station shall be in direct telegraphic or telephonic communication with the generating station from which it is supplied.

9. The officers of the Board of Trade shall at all times have the entry into any of the generating or sub-stations of the undertakers supplying or supplied at an extra high pressure, and they shall be permitted to make any examination and tests of the mains, dynamos, transformers, or other apparatus in use at such stations as may appear to them necessary, and the undertakers shall afford all due facilities for any such examination and tests.

10. The obligation to comply with these regulations is additional to the obligation to comply with the general regulations and to supply by means of a system approved by the Board of Trade.

The Board of Trade may at any time, if they think fit, revoke this consent.

Signed by order of the Board of Trade, the   day of   190

SPECIAL REGULATIONS FOR THE PROTECTION OF TELEGRAPHS.

The   Order.

In pursuance of the provisions of the   Order, 19 , the Board of Trade, with the concurrence of the Postmaster-General, hereby approve of the undertakers under the above-named order, connecting their circuits with earth, subject to the following conditions:—

(*a*) The connection with earth of any electrical circuit must be made at one point only—namely, at the generating station, sub-station or transformer and the insulation of the circuit must be efficiently maintained at all other points.

(*b*) The system of distributing mains must be separated into special sections corresponding approximately to the different feeders, and these sections must be inter-connected only through suitable fuses arranged so as to be easily inspected, and to be completely free from all risk of causing fire by defective action, arcing, &c.

(*c*) The current from the intermediate conductor of the three-wire system to earth will be continuously recorded, and if it at any time exceed one-thousandth part of the maximum supply current, steps will be immediately taken to improve the insulation of the system.

This approval is given subject to the observance by the undertakers of the regulations for securing the safety of the public made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, and of the above-named order, and of further regulations for extra-high-pressure supply made by the Board of Trade under regulation 3 of the above regulations, and may be revoked or varied at any time by the Board of Trade.

The concurrence of the Postmaster-General in this approval may be withdrawn at any time as to either the whole or any one or more of the earth connections to which this approval relates.

Signed by order of the Board of Trade, this .... day of . ... 190...

ELECTRIC LIGHTING PROVISIONAL ORDERS.

During October and November we gave brief particulars of the notices of intention to apply for Parliamentary powers for electric lighting, power and traction in the 1905 Session. In the last two issues of *The Electrician* further particulars of the electric lighting and traction bills were given, and we set out below a list of the applications for Electric Lighting Provisional Orders deposited with the Board of Trade by December 21st. Of the 62 applications for orders (compared with 74 in 1904), 33 are made by local authorities and 29 by companies or firms; 10 relate to Scotland and one to Ireland.

Title of Order and Area.	*Name of Promoters.*
Airdrie Burgh (Transfer of Powers and Amendment).	Scottish House to House Electricity Co.
Andover	Corporation.
Ballaghaderreen (Ballaghadarreen, and townlands of Lung, Friarshill, Knockanaconny and Kilcolman, in Rural District of Castlerea, Ireland).	Rural District Council.
Barnet	North Met. Elec. Power Dist. Co.
Barton-upon-Irwell	Lancashire Elec. Power Co.
Bishop's Stortford	Urban District Council.
Brentford	Brentford Elec. Supply Co.
Brentford	Metropolitan Elec. Supply Co.
Brockenhurst and Milton (in Lymington Rural District).	Messrs. Christy Bros. & Middleton.
Burslem (for Tunstall)	Corporation.
Bury	Rural District Council.
Clewer and Old Windsor (Parishes of Clewer Without and Old Windsor).	Windsor Electrical Installation Co.
Coatbridge (Transfer of Powers and Amendment).	Scottish House to House Electricity Co.
Conway	Corporation.
Croydon (Rural District)	County of London Elec. Supply Co.
Cults and District (Portion of Peterculter, Aberdeen).	Lowdon Bros. & Co.
Denny and Dunipace	Corporation.
Dorchester	Dorchester & Dist. Elec. Supply Co.
Dover (Extension to parishes of Hougham, Poulton, River, Alkham, &c.	Corporation.
Durham (Rural District of Durham, and portion of Rural District of Chester-le-Street)	County of Durham Electrical Power Distribution Co.
Eastbourne (Willingdon Extension)	Corporation.
Farnham	Farnham & Dist. Elec. Supply Co.
Golborne	Urban District Council.
Gosport (portion of Gosport and Alverstoke).	Gosport & Alverstoke Electric Lighting Co.
Grangemouth	Corporation.
Gravesend (Extension to Northfleet)	Corporation.
Haydock	Urban District Council.
Hemsworth (portion of Rural District).	Hemsworth Electricity Supply Co.
Hessle (Hessle and Anlaby.)	Urban District Council.
Hipperholme	Urban District Council.
Houghton-le-Spring & District (Transfer of Powers).	Mr. H. J. Almond and Sunderland District Elec. Tramways.
Inverness	North of Scotland Electric Light & Power Co.
Kingsbury	Urban District Council.
Lichfield	Foote & Milne.
Litherland	Urban District Council.
Little Hulton	Urban District Council.
Little Lever	Urban District Council.
Woolwich (London)	Borough Council.
Ludlow	Mr. William Norton.
Lytham	Foote & Milne.
Macclesfield	Foote & Milne.
Marlborough	Marlborough Electric Supply Co.
Penmaenmawr	Urban District Council.
Pollokshaws	Corporation.
Ravensthorpe	Urban District Council.
Renfrew (Burgh of Renfrew and portion of parishes of Renfrew and Govan).	Corporation.
Rushden, Higham Ferrers, Irthlingborough and Thrapston (Rural)	Mr. Edwin P. Harvey.
Rutherglen	Corporation.
St. Albans (Rural District)	St. Albans & Dis. Elec. Supply Co.
Southall-Norwood	Urban District Council.
Southall-Norwood	Metropolitan Elec. Supply Co.
Spalding	Urban District Council.
Stratford-upon-Avon (Amendment)	Corporation.
Surbiton (portions of Urban District)	Urban District Council.
Tewkesbury	Corporation.
Tottington	Lancashire Electric Power Co.
Uphall	Linlithgow County Council.
Ware	North Met. Elec. Power Dis. Co.
Whitwood	Urban District Council.
Whitworth	Urban District Council.
Wimborne and District	Bournemouth & Poole Electricity Supply Co.
Woking (Chertsey Extension)	Woking Electric Supply Co.

TRAMWAY PROVISIONAL ORDERS.

Following is a list of the applications deposited with the Board of Trade under the provisions of the Tramways Act, 1870, for tramway orders. There are only 12 applications, compared with 15 in 1904 and 14 in 1902:—

Aberavon District.
Bradford Corporation.
Colchester Corporation.
Gorton Urban District.
Keighley Corporation.
King's Norton and Northfield Urban District.
Leeds Corporation.
Liverpool Corporation (Extensions).
Luton Corporation.
Portobello and Musselburgh (Amendment).
Pudsey Corporation.
Southampton Corpn.

ELECTRICAL JOINT STOCK COMPANIES OF 1904.

The following are the more important limited liability companies connected with the electrical and allied industries registered during the past year, with their capital:—

Aberavon District Tramways Syndicate	£2,000
A.E.G. Electrical Co. of South Africa	50,000
A.E.G. English Mfg. Co.	150,000
Amalgmtd. Dry Batteries	20,000
Anderson, Boyes & Co.	10,000
Applegarth & Ostlere	4,000
Armorduct Mfg. Co.	10,000
Arnold Goodwin & Son	10,000
Automatic Electric Co.	1,000
Barber & Colman	10,000
Bastian Mercury Vapour Lamp	20,000
Thomas Beeley & Son	75,000
Birmingham and Midland Motor Omnibus Co.	60,000
Bishop's Stortford & Stanstead Elec. Lighting Co.	1,000
Bowen's Electric & Motor Boats	20,000
Brecknell, Munro & Rogers	30,000
Brentford Elec. Supply Co.	1,000
Britannia Electric Carriage Syndicate	12,000
British Contracting Synd.	5,000
British Electric Equip. Co.	40,000
British Elec. Separating Co	20,000
British Textile Design and Elec. Card-Cutting Co.	10,000
Brynamman & District Electric Supply Co.	2,000
Camberley Elec. Supply Co.	1,000
Cambridge Electric Tramways Syndicate	5,000
Canadian Elec. Trac. Co.	120,000
Carbone Arc Lamp Synd.	9,880
H. J. Cash & Co.	10,000
Casualty Insurance Co.	60,000
Chameleon Signs (Ltd.)	2,700
Chaston Synd.	5,000
Checkogram (Ltd.)	42,500
Cheshire Light Rys. (Ltd.)	1,500
Church Stretton Electric Supply Co.	10,000
City of Buenos Ayres Tramways Co.	1,240,000
Clarkson Bros.	10,000
Cleminson Electric Lamp Attachment	2,500
A. Cunnell & Co.	2,000
Cutting Bros.	£6,000
Daimler Motor Co.	200,000
Davies, Kent & Stewart	3,500
Delafon Batteries Synd.	1,000
T. H. P. Dennis & Son	30,000
Dorchester & District Electric Supply Co.	1,000
Dulverton Elec. Light. Co.	3,000
East Cheshire Light Railway Syndicate	3,000
Easton Lift Co.	25,000
Edmundson's Furnishing & Engineering Co.	18,500
Electrical Bleaching Co.	75,000
Electric Circuit-Breaker	12,000
Electrical Fittings Co.	15,000
Electric Fog Signal Co.	10,000
Electric Heating Corp.	25,000
Electric Light Insurance & Maintenance Co. (1904)	5,000
Electric Power Develop. Co.	250,00
Electrograph (Ltd.)	10,000
Electroid (Ltd.)	60,000
Electro Peat-Coal Co.	130,000
Evans Bros.	30,000
Falkirk Electric Construction Synd.	100,000
Farnham & District Electric Supply Co.	1,000
Fireproof Celluloid Synd.	15,000
Garcin Renault Electric Cars and Accumulators	20,000
E. P. Gascoigne & Co.	3,000
Generators (Ltd.)	5,000
Gosport & Alverstoke Electric Lighting Co.	5,000
Gratze Patents and Engineering Synd.	5,000
Harvey & Co.	240,000
Hastings & District Elec. Tramways Co.	500,000
Hayward's Heath Electric Supply Co.	1,000
Heberlein Co.	10,000
Henry Wallwork & Co.	100,000
Hove and Worthing Electric Tramways	100,000
Hunter Electric Candle Lamp Co.	800
Hyderabad Electric Light & Traction Co.	10,000

Hope-Smith Electrical Co.	£3,000
Immiech Launch & Boat Co.	10,000
Imperial Engineering Supplies Co.	1,500
Kendal and Gent	100,000
Kingsbridge & S. Devon Elec. Ltg. & Traction Co.	2,000
Kramos Limited	4,000
Lemmon & Co.	2,100
Lewis Motor Co.	2,000
Lodge Electric Light & Power Co.	3,000
London Electrical Synd.	10,000
London Electron Works Co.	26,000
R. H. Longbotham & Co.	10,000
Lowne Electric Clock & Appliances Co.	8,000
J. C. Lyell & Co.	2,000
Madras Electric Tramways	100,000
Magnetic Separator (Ltd.)	1,250
Marks & Hodgkinson	5,000
Marlboro' Elec. Supply Co.	1,000
Mechan & Co.	200,000
Mill, English & Co.	30,000
Miniature Arc Lamps	2,000
Morris-Hawkins Elec. Co.	11,000
Mors Limited	15,000
Muirhead & Co.	60,000
Musselburgh Constrn. Synd.	76,000
Nealeron (Ltd.)	3,005
Nicholson & Robinson	2,000
Otto Electrical Mfg. Co.	10,000
Oulton Broad Elec. Co.	5,000
Penmachno, Corsen and Bettws-y-Coed Light Railway Co.	3,000
Paddington Elec. Supply Co.	£1,000
Peto & Radford	40,000
Pneumatophone (Ltd.)	3,000
Pollak-Virag Telegraph Synd.	2,500
Raworth's Tractn. Patents	30,000
Rhodes Electrical Mfg. Co.	60,000
Rhodes Electrical (Parent) Syndicate	5,000
Rubber Reclamation Co.	10,000
Saxonia Electrical Wire Co.	10,000
Scotch Water Power Synd.	5,000
Scottish Elec. Traction Co.	500
Shropshire, Worcestershire & Staffordshire Synd.	10,000
Simplex Arc Lamp Synd.	16,000
Simpson Automatics	2,000
W. Sisson & Co.	25,000
Sprague Elevator Co.	5,000
J. Stone & Co.	700,200
Supplies Limited	5,000
Sykes & Sugden	6,000
Telephos (Ltd.)	10,000
Thermit (Ltd.)	50,000
Topsham Electricity Supply Co.	3,000
Tramways Exten. Synd.	5,000
United Electric Tramways (Monte Video)	500,000
Vaughan, Brown & Co.	15,000
Veroon Mechanical and Electrical Registers	25,000
Wallace Lamp Synd.	35,000
Thos. W. Ward (Ltd.)	350,000
Weston, Clevedon & Portishead Docks Ry. Co.	120,000

PUBLIC COMPANIES WOUND UP, DISSOLVED, &c. IN 1904.

The following are the principal electrical and engineering limited liability companies which have been wound up (either voluntarily or compulsorily) during the past year. An asterisk (*) denotes that the company was wound up by order or under the supervision of the court, and (†) that the company has been struck off the register of joint-stock companies :—

Argentina Electric Traction Co.
*Automatic Telephone Co. (1903).
Auxiliary & Light Railways & Tramways Co. [struction).
Bath Electric Mfg. Co. (for recon-
†Berrenberg Electric Lamp Synd.
Blake-Morscher Elec. Ore Separator Synd.
†British & Foreign Tramways Co.
British Electric Separating Co.
Bury, Rochdale & Oldham Tram-
†Carbon Co. [way Co.
City of Buenos Ayres Tramways Co.
†City of Mexico Electric Power Synd.
Cleveland & Durham County Electrical Power Co. (Ltd.).
†Colwyn Bay Elec. Light & Power Co.
Cross Elec. Engineering & Mfg. Co.
†Crystal Palace Light Railways & Tramways Co.
Derbys. & Notts. Elec. Power Synd.
Dover Electricity Supply Co.
†East Suffolk Tramways Co.
Edison Gower-Bell Telephone Co. of Europe.
†Elec. Maintenance & Access. Synd.
Elec. Supplies, Rubber & Ebonite Co.
Electrical Wool Pulling Synd.
Electric & General Contract Corpn.
Electric Extension Co.
Electric Generating Stations.
Electric Light, Insurance & Maintenance Co.
†Electric Tested Lamp Co.
*Electric Timber Seasoning & Preservation Co.
Electric Traction Co.
Electro Institute.
Electrical Bleaching Co.
Electrical Fittings Co.
Electrical Indicator Synd.
Electrical Inkless Printing Synd.
Elect. Machinery Developments Co.
†Electrical Navigation Protection Co.
†Electro Stannus Co.
*Electro-Voelker Synd.
†Fleet & District Electricity Co.
†Fermoy & District Electricity Co.
Ferranti Limited (to be reconstructed). [(Mauritius).
†Gas & Electric Lighting Corpn.
†Gramme's Magneto-Electric Co.
Hawaiian Tramways Co.
†Hedges, McKrell & Taylor.
Industrial Storage Battery Synd.
†Italian Elec. Light & Power Co.
†Joel Electric Carriage Motor Battery Synd.
Johnson Electro-Germicide Synd.
†Kew, Richmond & Kingston Tramways Co.
†Leeds, Wakefield, Dewsbury & District Elec. Tramways.
Lincoln Tramways Co.
London Electrical Synd.
London Telegraph & Steam Gauge Electric Co.
†Love's Electric Traction Co.
*Sir Hiram Maxim Elect. & Engi-
*McGuire Mfg. Co. [neering Co.
*Motor Mfg. Co.
*National Electric Traction Co.
P. & R. Storage Battery Co.
Peto & Radford.
Pioneer Electric Co.
†Pollard Elec. Engineering Co.
†Railways Electric Supply Synd.
Rangoon Elec. Construction Synd.
Reliance Electric Co.
Rhyl & Prestatyn Light Railway
†Round's Accumulator Co. [Co.
Sheffield Electric Advertisements.
*Shippey Bros.
South Lancashire Electric Traction & Power Co.
South Western Electrical Co.
H. Sutton & Co.
Thames Valley Launch Co.
Traction Development Co.
Tramway & General Appliances Co.
†Tramway Trolley Co.
Walker & Hodgetts.

RECENT DEVELOPMENTS IN SELF-EXCITED COMPOUNDED ALTERNATORS.*

BY ALEXANDER HEYLAND.

As is known, the main point of the system is that single-phase or polyphase alternating current generated by the machine is directly led to the field windings for excitation and for compounding by means of a commutator. By the interposition and suitable interconnection of transformers, or by certain circuit arrangements in a single transformer, the exciting current of the machine is taken off in shunt to the main winding, and the compounding current in series, and so conducted to the commutator that the exciting current entering the field winding remains approximately constant for all loads, while the compounding current increases and decreases with the wattless component of the main current. By proper regulation we then obtain the condition that for any load the armature reaction is annulled and the drop in voltage of the machine is compensated for, or, if desired, an over-compounding of the machine with increasing load is obtained. The main feature of the machine is the commutator and the connection of the field windings to the same. This arrangement has for an object, first, to divide the main current before it enters the main winding, into two components, the watted and the wattless components; and to conduct only the wattless component to the field winding, so that the exciting current in this winding increases and decreases proportionately with the armature reaction of the machine. The second object is to prevent sparking at the commutator. For this purpose, the field winding and the commutator are so subdivided, and the field winding connected to the latter in such a manner, that two groups of circuits are obtained. Of these, the one is the field winding and receives the exciting current, as well as the wattless component of the main current; the other consists of cross-connections between the separate parts of the field winding, forming thus a circuit which is connected to the commutator, displaced by one-quarter of a period relative to the pole winding, and serves to receive the remaining energy component of the main current. In consequence of a peculiar connection of the transformers, these cross-connections need not be dimensioned for the entire energy component of the main current, but only for a comparatively small part of the same.

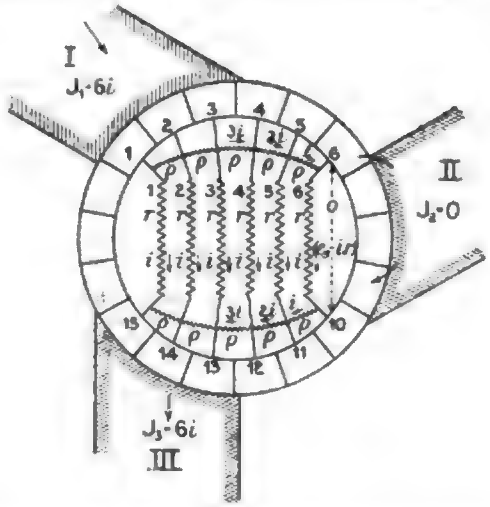

FIG. 1.

In an earlier type of machine† the field winding consisted of parallel-wound wires (generally four) but as this design had some drawbacks of both a mechanical and electrical nature, another field winding was devised, which is just as simple as that of ordinary machines, and allows furthermore of an exceedingly simple mathematical calculation of the commutation, so that in no case do difficulties due to the formation of sparks occur.

By this new construction the separate parts of the field winding do not consist of parallel-wound wires, but each part consists of a group of field windings which are connected to the commutator in parallel to one another. The separate groups are constructed exactly as in the case of the field winding of ordinary machines, and consists of field coils of a single conductor. As the separate parts consist of separate coils of a single conductor, the current is not interrupted, as was the case in the earlier arrangement, and this is avoided in the most simple way by placing the cross-connections at the ends of the conductors. But in this case the cross-connections, in order to prevent a short-circuit between neighbouring brushes in every brush position, must have a certain resistance which, as will

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* Abstract of a Paper read before Section B of the International Electrical Congress of St. Louis.

† *The Electrician*, Vol. LI., p. 969.

by Google

be shown, must bear a very definite relation to the resistance of the field winding itself.

The arrangement is reduced in Fig. 1 to a bipolar diagram, and shown in Fig. 2 for a 12 pole machine. The field winding is here subdivided into six parts. We accordingly get in the 12-pole machine (Fig. 2), six-pole groups with two poles each, which are separately connected to the commutator. The commutator has nine segments per pole, six active and three blind segments. The segments per pair of poles are accordingly designated by the numerals 1 to 18, and the like segments of all poles are connected with one another. The cross-connections between the wire ends which are designated by ρ, ρ, ρ, are joined to the commutator segments. I., II., III. are the brushes, to which the three-phase exciting and compounding current is directly supplied.

Of special interest is the theoretical process of commutation and the preliminary calculations of the resistance of the cross-connections. These latter can be calculated in a very complete and exact manner, and it may be shown that, with a certain resistance of the cross-connections, the commutation voltage and the short-circuit currents of commutation become nil. If then the resistance is chosen too large, a short-circuit current is produced in the one direction: if it is chosen too small, in the other direction. That is to say, with a certain resistance of these cross-connections the commutation voltage becomes equal to zero. On the other hand, we should emphasise the fact that this ideal commutation is not practically obtained here, for the field pulsations and other conditions have as effect a certain commutation voltage. However, the result is theoretically very interesting in so far as it shows that there is for the cross-connections a certain most favourable resistance, with which the commutation becomes a theoretically complete one.

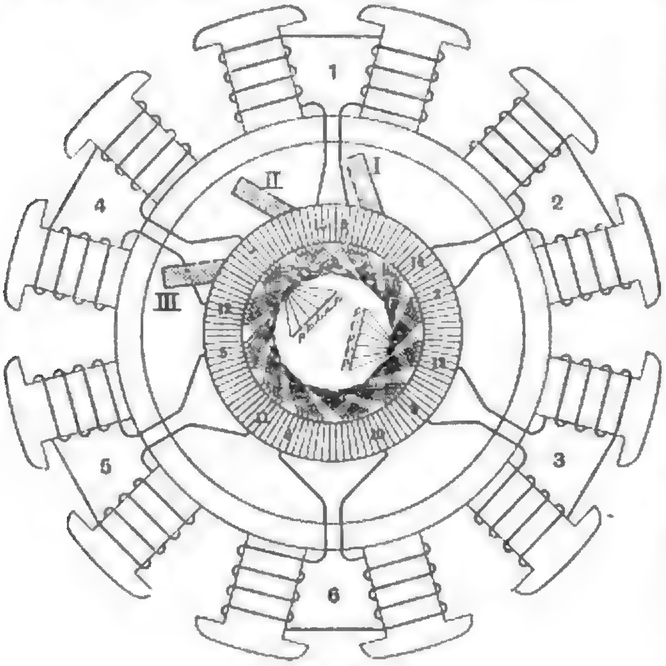


Fig. 2.

The calculation is made in the following manner :—

Let us consider (Fig. 1.) Brush II. to be in the commutation position, that is, the position in which the brush bridges the blind segments, and thus connects the beginning and the end of the field winding at points 6 and 10. As above mentioned, the current of Brush II. should, with an exact compounding, be in this position $I_2=0$. We disregard inaccuracies and any remaining part of the energy component of the main current in this brush. A short-circuit current would take, in general, the course of the arrows shown in dotted lines at Brush II. The current in the separate parallel-connected parts of the winding is assumed to be $=i$, the resistance of the separate parts of the winding $=r$, the P.D. between the beginning and the end of the parts of the winding, lying at the time beneath the brushes—for example, 1 to 15—is then $ir=E$, the same as the voltage between Brushes I. and III. As the self-induction in the separate parts of the winding (pole groups) is very high, the separate current strengths i, i, i, can be taken as constant. As a matter of fact, these currents are not exactly constant but slightly pulsating. Thus, for example, the current in the position shown will be a minimum in the parts of the winding 6 to 10, and a maximum in 1 to 15. Let us call the difference di. This is so much the smaller, relative to i, as the self-induction is greater, and we can, therefore, in order to dimension the cross-connections ρ, consider the separate current strengths as constant. It is assumed that the brushes should have the width of about three segments; the currents led to the three parts of the winding shown to the right in Fig. 1 must, therefore, flow over the cross-connections, and we obtain in the cross-connections the designated current divisions—that is, in the connections 5 to 6 and 10 to $11=i$, 4 to 5 and 11 to $12=2i$, 3 to 4 and 12 to $13=3i$.

That no short-circuit current may occur in the positions shown for Brush II., the voltage between the segments 6 and 10, that is between the ends of the part of the winding 6—10, must evidently be equal to zero. In this portion of the winding there appear two E.M.F.s which have opposite directions; first, the ohmic drop in pressure ir, and second, an E.M.F. of self-induction, e_s, which is produced by taking off the current di in the part of the winding, 6 – 10. The commutation voltage then becomes zero when e_s becomes $=ir$. It is clear that for this purpose the current di needs to be only very slight, so that we may assume, without making any practical error, that the current i is constant. In order that these conditions exist, that is $e_s=ir$, and that the voltage between the segments 6 and 10 becomes equal to zero, the drop in voltage in the shunt connections 3 to 6 and 10 to 13 must evidently be equal to the brush voltage. If ρ is the resistance of the separate cross connections, this drop in voltage becomes

$$2(3i\rho+2i\rho+i\rho)=12i\rho.$$

The brush voltage was $E=ir$. We thus have $12i\rho=ir$ or $\rho=r/12$.

For this value the commutation voltage would be theoretically exactly equal to zero. If we make ρ smaller, a short-circuit current will appear at Brush II. in the direction of the dotted arrows; or if we make ρ larger, in the opposite direction. Let us call the resistance of the entire field winding, that is of the six parts in parallel, $R=r/6$; the resistance of the cross-connections, that is, of the 2 by 5 cross-connections in two groups in parallel is $P=5\rho/2$. We then have $P=5\rho/2=5r/24=5R/4$. That is, the resistance of the cross-connections will be about the same as the resistance of the winding itself. While the current in the field winding is $I=6i$, the mean current of the cross-connection would be about $2i$, that is, only about one-third of the entire current of the field winding. The additional losses in the cross connections are, therefore, not more than 10 to 15 per cent. of the losses in the field winding.

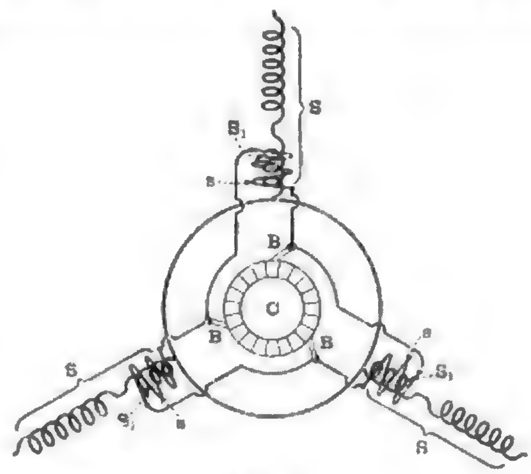


Fig. 3.

The resistance of the connections ρ depends upon the number of parallel groups and on the breadth of the brushes. In practice the brushes are made four to five segments wide; so that they shall bridge across the blind segments which are not connected to the winding. In the case for the position of the commutator shown in the illustration, the connections between 3 to 4 and 12 to 13 are without current, and the resistance of the shunt connections must be approximately $\rho=r/6$. The shunt connections are, therefore, greater, but the losses smaller, since the mean current decreases; so that in general the losses in these shunt connections amount to less than 10 per cent. of the losses in the field winding.

The transformer connections for compounding by means of two or a single transformer remain the same as before, and have been described in former publications.

In parallel connection the compound machines work excellently, and if they are compared with ordinary machines of small armature reaction they will be found even better than the latter. For parallel connection the series windings of the tranformers are connected together through three-compensating conductors, either at the terminals or at selected points of the winding. Consequently, the machines work directly upon and through one another as though the compounding was altogether removed; and since, in general, compounding machines are built with larger armature reaction than ordinary machines, they work well together in parallel connection, The compounding works only outwardly, and, on account of the compensating conductors for all parallel machines, together. The machines combine the advantages of machines of large armature reaction (as to operation in parallel) with those of machines of smaller armature reaction (as to constant-potential relation).

Similarly, these machines work very well if connected in parallel with ordinary machines and in existing stations. In this case one must naturally take care that the machine is at least sufficiently large that its load corresponds to the wattless currents of the plant, since otherwise it could be overloaded. When one connects a compounded machine in parallel with an existing plant it corrects entirely automatically all pressure variations. If, for example, it is desired to keep automatically the voltage constant at certain points in a network, this can be accomplished in the simplest maner by connecting at these points the compounded machines in parallel as no-load motors.

Finally, I will mention a more recent compounding connection which is of interest in so far as the connection can be applied directly to the machine without the interposition of transformers. In this arrangement the polyphase exciting current is generated in three auxiliary coils which are located on the stator. In order that such a machine may be at the same time compounded, a most simple arrangement has been devised whereby, in the same slots in which the auxiliary winding lies, there is placed also a part of the main winding, the respective coils being, however, connected in opposite directions to the remaining part of the main winding. The arrangement is diagramatically shown in Fig. 3. C is the commutator, BBB are the brushes, and *sss* the three auxiliary coils wound on the stator and supplying the exciting current. SSS is the main winding of the stator and $S_1S_1S_1$ the part of the main winding which lies with the auxiliary winding in the same slots. These coils are connected in opposite directions to those of the remaining part of the main winding. We can then consider the auxiliary winding together with the coils of the main winding lying in the same slots as a compounding transformer. The compounding is effected under the influence of the stray field of the machine, which is perfectly sufficient for the purpose. If the machine is loaded with a more or less inductive current, which has a tendency to produce a decrease of the field in the main winding, the same current will cause in part S_1 of the main winding, which is wound in opposite direction to the remaining part, a corresponding increase of the field, and thus correspondingly increase the exciting voltage of the exciting current in the auxiliary winding *s*. With a suitable choice of the number of turns of the compounding coils of the main winding we can in this manner obtain a complete compounding, without employing a compounding transformer.

This mode of connecting is mainly advisable for smaller machines, in which it is of importance to reduce the cost of the machines to the extent of the cost of a transformer. It, moreover, has the advantage that it is very simple, consisting mainly in reversing the direction of connection of the coils of the main winding (which lies in the same slots with the auxiliary winding) with regard to the remaining main winding. At present there is exhibited at the St. Louis World's Fair such a machine of 60kw., by the "Société Alsacienne de Constructions Mécaniques," Belfort.

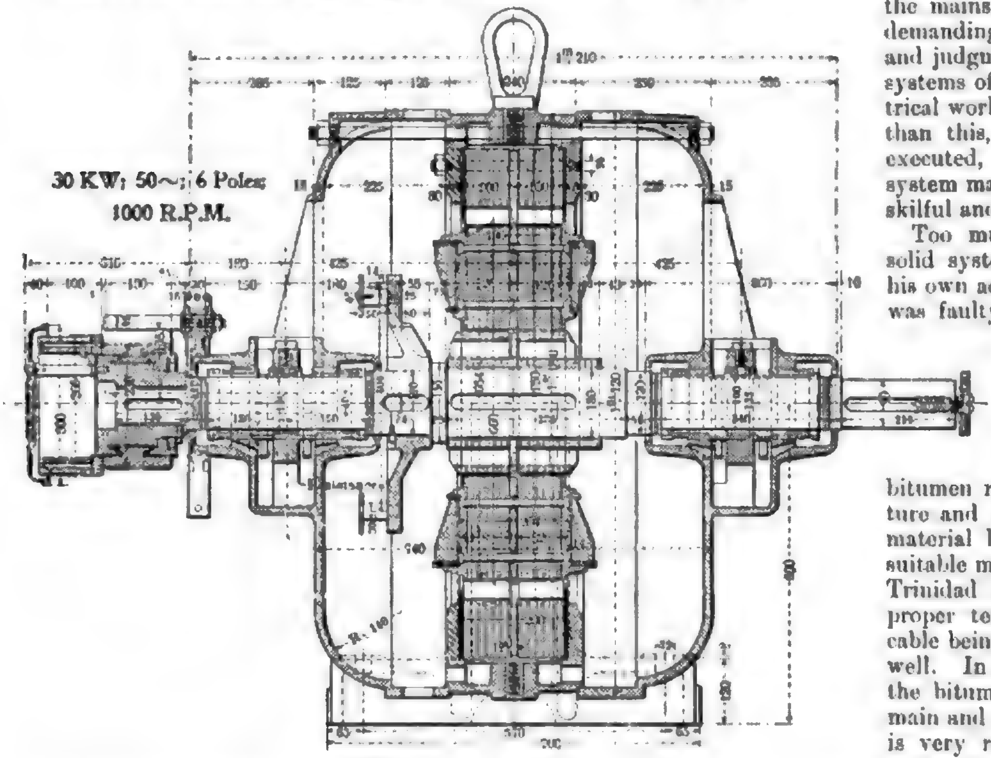


FIG. 4.

Fig. 4 shows a view of a standard machine, from which all relations can be clearly seen. As shown, the commutator is of very moderate dimensions in comparison with the total size of the machine and can be easily placed where otherwise the slip rings or the exciting machine would be located. The machine represents one of the first constructions, in which the field winding consists of parallel-wound wires, and has been, up to the present, in operation for about 10 months. The field winding can be clearly seen at the lower part of the field frame. All machines at present in course of construction are being built according to the diagram of Fig. 2, otherwise nothing has been changed in the exterior appearance of these machines.

CORRESPONDENCE.

CABLE LAYING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Few of those who have had any experience of mains will agree with Mr. James Perry that they constitute an apparently simple question. On the contrary, the greater the length of their experience the more convinced will they be that the mains are the vital portion of their work demanding the greatest care, skill, attention and judgment. Mr. Perry appears to confound systems of mains with laying mains. No electrical work is more apt to be carried out badly than this, and the best of systems, if badly executed, will fail, while even an indifferent system may give good results in the hands of a skilful and conscientious foreman.

Too much appears to be expected of the solid system by the writer of the letter. By his own account, the lead covering of his cable was faulty, but he blames the bitumen. It is to be feared that his coal tar will not give him any better results; if it does, he should take out a patent for eliminating the lead covering of a cable and substituting a coating of tar and sand. The function of the bitumen round the cable is to exclude moisture and chemical reagents, and, if the proper material be employed, and it be applied in a suitable manner, this result is attained. Refined Trinidad bitumen poured round the cable at a proper temperature, the lead covering of the cable being dry at the time, will adhere perfectly well. In the event of subsidence of the ground the bitumen has sufficient fluidity to follow the main and maintain the impervious covering. It is very rare indeed, in districts not subject to earthquake, that mains are subjected to sufficient vibration to cause cracks.

Tar is objectionable in many ways. It contains impurities which attack certain classes of dielectric, and by itself is useless as an envelope on account of its fluidity. If mixed with pitch, the resulting compound is either too fluid or too brittle and liable to crack. If mixed with sand, there is danger of mechanical damage to the cable, and interstices are unavoidable, rendering it impossible to obtain a thoroughly waterproof envelope. Mixtures of tar and sand date from the earliest days of main laying, and have been abandoned long ago.

Since Mr. Perry asks in a despairing manner whether there is one right way of laying mains, perhaps I may be permitted to say that I believe there is for low-pressure work. If he will employ stiff bare copper strip, strained between porcelain insulators, carried, through the intervention of vulcanised rubber buffers, by enamelled cast-iron supports, in a well-drained five to one concrete culvert, covered by York flags, well cemented with Portland cement, he will have a main that will not have deteriorated when his great-grandchildren are white-haired. He may, however, have to rebuild his town round the main in order to find sufficient space for it. The next best thing is a continuously-insulated cable properly laid in Trinidad bitumen such as Mr. Perry condemns.—Yours, &c.,

London, Jan. 3. C. H. WORDINGHAM.

ELECTRICAL EXTRACTION OF NITROGEN FROM THE AIR.

[Translation.]

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In an article on "Electrical Extraction of Nitrogen from the Air" by Edstrom, in No. 1,380, p. 54, of your journal, our name is mentioned in connection with a process for obtaining calcium cyanamide from the nitrogen of the air. That the process has a greater significance than might be supposed from the article cited above may be gathered from the following facts:—

1. The process is no longer merely a laboratory method, but is already at work in Berlin on a fairly large scale. In addition, the Società Italiana per la Fabbricatione di Prodotti Azotati is building a works at Piano d'Orta, in Italy, having an output of 4,000 tons a year.

2. The calcium cyanamide can be used as a fertiliser instead of nitrate or ammonium sulphate, this fact having been established by experiments extending over three years conducted by Geheimrat Prof. Dr. Wagner and Prof. Dr. Gerlach, of the Royal Agricultural testing station in Darmstadt and Posen; also by Prof. Wright, Glasgow; Prof. Hall, Rothamstead; Prof. Meyer, Wageningen; and Agronom Carvallo, Tortosa-Valencia, engineer, who are well known experts.

3. There is a process devised by our firm for preparing calcium cyanamide which differs from that associated with the name of Dr. Frank and his colleagues, Dr. Caro, Dr. Rothe, and Dr. Pfleger. By this method the nitrogen is fixed by heating lime and carbon in a stream of air in a resistance furnace, under determined conditions, this direct process of fixation dispensing with the previous formation of calcium carbide.

4. Both processes for the preparation of calcium cyanamide (commercially known in Germany as Kalkstickstoff) are being developed by the Cyanidgesellschaft in Berlin, which is one of the offshoots of Siemens and Halske, and has been making and supplying the material for a year past.—Yours, &c.,

SIEMENS AND HALSKE A.G.,

Berlin, Dec. 19. Rap. Erlwein.

A NEW RESISTANCE FOR ARTIFICIAL LOADS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following may be of interest to your readers, if it has not already been noticed in your columns:—

A few weeks ago a short paragraph appeared in the *Engineer* describing a water-cooled iron wire rheostat used by M. Weber, of Nancy, for dissipating electric energy during a dynamo test. It consisted of six lengths of iron wire, each 0·128in. diameter and 65yds. long, wound into coils and placed side by side in a wooden box with terminals at the end of the coils connected up in parallel. This arrangement dealt with a current of 1,660 amperes at 500 volts. About 27 gallons of cold water per minute were passed through the box. The test lasted five hours, and the wires showed no sign of deterioration. Each coil carried 1,660÷6=276·17 amperes. The current density was 25,300 amperes per square inch. The theoretical drop in each coil is only about 247 volts, or, say, 50 per cent. of the actual drop. Admiring the compactness and cleanliness of such an arrangement, but doubting the recorded drop, we had a small coil fitted into a box about 30in. long. The wire was of steel, 0·0085 in. diameter and 25ft. long, wound into a coil $\frac{3}{8}$in. diameter and $\frac{1}{16}$in. pitch. It was connected to the 220 volt service in this city, and theoretically should have passed 10 amperes, but only 5 amperes would pass, and about half the length of wire had to be removed before 10 amperes would flow, confirming M. Weber's record. We are not able at present to explain how this result comes about, but it seems to us to be interesting and worth investigation. The current density was 175,000 amperes per square inch, an amazing amount, but the wire carried it perfectly well. Clean tap water was used in the box to keep the wire cool. As the water is not intended to act as a conductor no acid or salt is necessary. Any addition of that kind would no doubt lead to rapid corrosion of the wire. Subsequently we used two coils of this kind in parallel for testing a 75kw. plant at 220 volts. The wire was of iron 0·0625in. diameter. The box was 7ft. long and 12in. by 6in. inside. There were four coils in the box, intended for testing two 75kw. sets in parallel, but only one set was then tested and only two coils were used. A small stream of tap water was passed through the box, but on this occasion its volume was not measured. The temperature of the water rose only a very few degrees. The apparatus answered perfectly and gave no trouble whatever. The current density was 56,000 amperes per square inch.

A very convenient arrangement is to put four coils in a box side by side with the terminals at one end provided with holes through which a horizontal copper bar can be passed and clamped. When the bar connects all four terminals in parallel the coils carry full load. When withdrawn from one terminal three coils carry three-quarter-load, two coils carry half-load and one coil carries quarter-load. If switches be added the load can be varied very quickly. A final adjustment of load within small limits can be made by varying the quantity of water passing through the box, for the resistance of the wire rises and falls as the temperature rises and falls, and the temperature depends upon the quantity of water passing through. The chief value of the device is in testing generating plants after they have been erected at the purchaser's works. Compared with a set of tubs, such as we have seen used, containing lead plates and salt water, replenished, when the tubs boil over, by a jet of water from a hose pipe, directed by a man standing on an insulated platform, the Weber contrivance is elegance itself, and would, we are sure, be greatly appreciated by any of your readers who might give it a trial.—Yours, &c.,

Birmingham, Dec. 21. HENRY LEA & SON.

MOVING-IRON INSTRUMENTS AND THEIR "MAGNETIC HISTORY."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In view of the interesting figures given by Mr. G. F. C. Searle in his recent Paper before the Institution of Electrical Engineers, it occurred to us to investigate the possible error introduced into the readings of moving-iron ammeters and voltmeters working at low magnetic inductions.

It is well known that, for many reasons, it is of great importance to keep down the induction in instruments of this description when used for alternating currents, but it appeared possible that, in the case of direct-current instruments, the low inductions employed might introduce errors due to varying "Magnetic Histories." To determine this point, a low reading "Universal" moving-iron ammeter was tested and calibration curves taken under various conditions. It may be noted that the induction in the moving-iron in these instruments is kept exceptionally low so as to avoid frequency errors when used with alternating current; hence it was thought possible that the readings might be affected by a direct-current overload.

In the first place, the instrument was thoroughly demagnetised and a set of up readings taken. It was then again demagnetised and a downward curve obtained. After this the instrument was overloaded to the extent of some 700 per cent, and another upward and downward curve obtained. It was found that the mean difference in the reading, brought about by this exceptionally drastic treatment, was as follows:—At full load 0·5 per cent., at two-thirds full load 0·1 per cent., at one third full load 0·6 per cent. It will thus be seen that the influence of the previous "Magnetic History" can, for all practical purposes, be entirely neglected in this type of instrument as manufactured by us.—Yours, &c.,

London, Jan. 2. EVERETT, EDGCUMBE & Co.

Trade Marks in China.—It is officially stated that in consequence of representations made by H.M. Minister at Peking and other foreign representatives, the Chinese Government have undertaken that no trade marks shall be registered until an agreement has been arrived at with regard to the amendments which it is desired to introduce. In the meantime offices at Shanghai and Tien-tsin remain open to applicants.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Applications are invited for the position of second assistant electrical engineer upon the central office staff of the Bradford city electrical engineer and manager. Salary £250 per annum. Applications by first post Jan. 19. See also advertisement.

Hammersmith Electricity and Lighting committee require a technical assistant for the meter department. Application forms from chief engineer (Mr. G. Gilbert Bell), 57, Fulham Palace-road, London, W., to whom applications by Jan. 18. See advertisement.

The Alliance Electrical Co. (Ltd.), 137, Regent-street, London, W., require at once several electrical engineers capable of estimating for electrical power work, especially for colliery plants. Applications to Mr. A. J. Bloemendal, manager. See advertisement.

Three additional assistants are wanted in the department of electrical engineering of the City and Guilds Central Technical College. Commencing salaries £200. £150 and £150 per annum respectively. Applications to Prof. Ayrton, Exhibition road, London, S.W. See also advertisement.

Two improvers are wanted to act as switchboard attendants in a combined lighting and traction power station in the Midlands. See advertisement.

An experienced canvasser is required for an electric power and light company. Wages 25s. per week and commission. See advertisement.

A lecturer in mechanical engineering is required at the South-Western Polytechnic, Chelsea, London, salary £150. Applications by Jan. 12.

Hanley Corporation require an electrical engineer to take entire charge and management of their electricity undertaking. Salary £300, rising, by annual increments of £10, to £350 per annum. Applications to the town clerk (Mr. Arthur Challinor) by Jan. 10.

The Council of Victoria University, Manchester, propose to appoint a professor of engineering. Total income not less than £1,000 per annum during the first three years. Applications by Feb. 15.

On Tuesday Worcester Council had before them the short list of three selected candidates (Messrs. C. M. Shaw, E. E. Hoadley and W. J. Bache) for the position of city electrical engineer in succession to Mr. C. J. Sutherland, who is retiring through ill-health, and ultimately the choice of the Council fell upon Mr. Shaw.

Mr. Shaw, who was born in 1875, was educated at Victoria University, Leeds. After serving an apprenticeship with Messrs. Blakey, Emmott & Co., he went through the engineering shops of Fairbairns, Naylor & Co., Leeds. He was shift engineer at Dewsbury from 1894 to 1897. In 1897 he joined the staff of the Yorkshire House to House Electricity Co. as mains engineer, and remained with the company for 4½ years. In April, 1902, he was unanimously elected to the position of city electrical engineer at Wakefield. The undertaking has since made great progress. In addition Mr. Shaw has acted as adviser to Wakefield Corporation in connection with the system of tramways recently opened in that town.

Mr. Edward Rayner was recently appointed canvassing engineer and general commercial agent to Wolverhampton Corporation electrical department. Mr. Rayner has been for six years chief electrical engineer to Messrs. W. A. Baker & Co., Newport (Mon.), and was formerly engineer-in-charge for nearly five years at Southport.

In our issue of Dec. 16 we announced that Mr. J. H. Fooks Bale had been appointed borough electrical engineer at Battersea, but Mr. Bale was in the meantime offered a similar position at Walthamstow, which he decided to accept.

Mr. A. V. Wardrop, of York, has been appointed chief electrical engineer to Elland District Council.

Mr. Harold W. Seymour has been appointed car-shed superintendent by Blackburn Corporation Tramways committee.

Personal.—We understand that Mr. F. R. Davenport has accepted a position with the firm of Peter Brotherhood, engineers, Westminster, and has left the service of the British Thomson-Houston Co. with whom he has been for many years, latterly as manager of the London office.

EDUCATIONAL.

Technical Education.—In order to encourage technical education in motor engineering, the Society of Motor Manufacturers and Traders, whose third international motor exhibition will be held at Olympia from Feb. 10 to 18, have determined to grant free admission to all engineering students attached to any recognised school or polytechnic classes. Principals of engineering schools and polytechnics are invited to apply for these free admission tickets to the secretary, Clun House, Surrey-street, London, W.C.

Portsmouth Technical Institute.—The students in electric wiring have become so numerous that the class has been divided into two sections.

Aberdare.—A meeting of the electors, at which it is stated over 6,000 persons were present, on Wednesday considered the Council's bill seeking power to construct electric tramways and a refuse destructor.

The Chairman of the Parliamentary committee (Mr. E. M. Hann) presided and explained the scheme, for which it is proposed to borrow £93,000. Mr. Stephen Sellon had assured them the scheme would not cost more than £82,000.

Mr. C. B. Stanton moved the approval of the Council's proposals, and said the British Electric Traction Co. were prepared to pay £1,000 a year to the Council for the right to construct a tramway in the town, and he argued that if the company could earn a dividend and pay £1,000 besides the Council should themselves be able to make such a scheme pay.

Opinion seemed to be about equally divided and the voting close, but the resolution was declared carried. It is said that a poll will probably be taken.

Arbroath.—The arrangements for the transfer of the Arbroath electric lighting order to the Empire Electric Light & Power Co. have been completed, and consent of the Board of Trade to the transfer has been applied for.

Argentina.—The "Review of the River Plate" says:—

The Buenos Ayres Director of Public Lighting has reported that the City Council pay $23.26 per lamp per month for their 760 arc lamps, and he advises the acceptance of the offer of the Compañia Alemana to supply current in bulk at $0·035 gold per kilowatt-hour. The cost of maintenance is $6.90 per lamp per month, and the total cost per lamp would be $20.64 against $23.26 now paid, which would represent an economy of $24,020 per annum, and allow of the purchase of all the lamps, fittings, &c., in a year.

The commissioners appointed by the La Plata Government and the River Plate Electricity Co. to assess the property of the company with a view of liquidating the share held by the Government, have decided that the company are to pay for machinery, &c., $47,763, and for land and buildings $179,847. The Government are to pay for lighting accounts $158,236, leaving $89,575 in favour of the Government.

The section of the Buenos Ayres Metropolitan Tramway Co. from Las Heras to Plaza Constitucion has been converted to electric traction and opened for traffic.

Mr. Eduardo Jones, who has had to go through six years' litigation to prove his right to possession of the Oriental & Platense Telegraph Co.'s undertaking, has at last been victorious.

Beckenham (Kent).—The electricity works are leased to the British Insulated & Helsby Cables (Ltd.), and at the last meeting of the Council a proposal was submitted to extend the company's period of lease, which expires in November next. Pending the financial report to be presented in March the proposal was not adopted.

Belfast.—The undertaking of the Belfast Street Tramways Co. passed into the hands of the Corporation on Saturday. A contract for the conversion of the whole system to electric traction has already been let to Messrs. J. G. White & Co.

Bradford.—In consequence of the recent failure of electricity supply one of the officials (the outside superintendent) has, it is stated, been requested to tender his resignation.

The city electrical engineer (Mr. Blackman) has reported to the Electricity committee that the maps which should locate the exact situation of the cables were found to be incorrect. In some cases cables shown on the plans to be on one side of the street were found on the opposite side, and in other instances they were found in the roadway when marked under the pavement. In sinking a trial hole in Kirkgate two cables were found in a stoneware drain-pipe The committee held that the outside superintendent is responsible for the absence of working plans.

At the meeting of the Electricity committee last week the city electrical engineer (Mr. Alfred S. Blackman) presented a report advising the adoption of the three-phase system for extensions for both tramway and general supply in outlying districts. The report was adopted.

The city tramways department inaugurated its parcel delivery system on Monday.

Bridlington.—The borough electrical engineer (Mr. Beckett) has prepared a report on public lighting setting out the average charge in 36 towns for arc lighting and that proposed to be made in Bridlington.

The average cost per lamp per annum was found to be £20. 19s. 6d., the proposed charge at Bridlington would be £15; average cost of Nernst lamp £5. 5s., proposed charge £5; average cost of 120-watt incandescent £7, proposed charge £5; average cost of 90-watt incandescent £4. 15s., proposed charge £4; average charge 60-watt incandescent £3 10s., proposed charge £3. Mr Beckett proposed to introduce 32 660-watt arcs, 15 120-watt Nernsts, 85 120-watt incandescents, 197 90-watt incandescents and 113 60-watt incandescents, the total cost being estimated at £2,107, and the total c.p. 43,703. The Corporation are paying £1,349 for gas lamps giving only 8,384 c.p.

Councillor Mainprize said that the town could not possibly tolerate the present quality of lighting much longer, for it was perhaps the worst lighted town in England.

Mr. Beckett's report was adopted.

Chefoo (China).—The Imperial German Post Office are the owners of the telephone service in the foreign settlement in Chefoo. The head office is at Shanghai. There are three exchanges (Chefoo, Hankow and (Tsingtao). There are 43 subscribers and the subscription is 60 Mexican dollars per annum. The service was established in 1901.

Chester-le-Street.—The Council have rescinded their resolution to oppose the Durham Electric Power Distribution Co.'s application for a provisional order, which will now be unopposed.

Cuba.—In a report on the trade of Cuba for the year 1903, Mr. Lionel Carden, H.M. Minister at Havana, states that the imports of British machinery into Cuba are now nearly double what they were in 1902, but still only represent 14 per cent. of the total, 75 per cent. being supplied by the United States. In electrical machinery British manufacturers are scarcely represented at all.

Darlington.—The Corporation claim £14,000 from Durham County Council for the paving of main roads in the borough in which tramways have been laid. The County Council dispute their liability, and contend that macadam paving would have been sufficient for the roads in question if the tramways had not been laid, and that the undertakers should bear the extra cost of paving necessitated by the tramways. The Local Government Board will shortly hold an inquiry to settle the point.

Dartford.—The Council have applied for sanction to a loan of £300 for "free" wiring. The Board of Trade have been asked to extend the period of the Council's tramway order.

Dock Lighting.—The Mersey Docks and Harbour Board have approved the scheme of the Works committee to adopt electric lighting at the Brocklebank Graving Dock and Herculaneum Graving Dock No. 4 at a total estimated cost of about £3,000.

Dover.—All the municipal buildings are to be lighted electrically at a capital cost of £178. 10s.

Dublin.—The report of the Council in committee on electric lighting matters, which was presented at the Corporation meeting on Monday, stated

> That the committee unanimously recommended the Council to retain in its own control the electric lighting undertaking and the working thereof. The committee also recommended that the committee undertake no further or additional constructional work until the consulting engineer has reported that the works covered by his agreement with the Corporation of Sept. 22, 1899, had been finally completed. The lighting committee are to be at liberty to carry out service work for new consumers and extend the existing distributing mains where necessary within the present area of supply, and where there may be a statutory obligation to give supply. The question of the condition of the machinery to stand over.

The report was adopted.

Durban.—The accounts of the municipal electricity department for the year ended July last show total capital expenditure £254,000, or with tramway power plant £294,000.

£36,550 has been placed to depreciation. The year's revenue (including £1,028 for outstanding accounts) was £69,052, and included £9,375 for current supplied to tramways, £18,004 for private lighting, £2,561 for lighting public buildings, £6,100 for street lighting and £6,984 for power. The total working expenses were £38,264, gross profit £30,788. Interest required £7,725, £6,400 was placed to depreciation, besides special allowances of £5,000 on account of abandonment of works and £750 for temporary buildings demolished. 4,612,146 units were generated, 1,343,385 used by the tramways, 1,361,754 sold to private consumers for lighting and 680,301 for power and 401,635 for public lighting. There are 2,141 private lighting and 140 power consumers. The capacity of the plant is 5,000 H.P.

Eccles.—The Council has decided to apply for sanction to a loan of £5,000 for purchase of electric motors to be let on hire.

Egypt.—A contract has been entered into between the municipality of Mansourah and the Mansourah Electric Supply Co. (Ltd.) (a British company) for the establishment of electricity supply in the town.

An agreement has been arrived at between the municipality of Helouan and the Metropolitan & Cairo-Helouan Railway Co. for the electric lighting of the town.

Electric Power in India.—It is announced that Sir Thomas Higham, who represents the Punjaub Power Association, has arrived in Lahore for the purpose of acquiring from the Punjaub Government concessions for the utilisation of the water power, and especially the irrigation canals of the Punjaub for the generation of electrical energy.

Electrical Engineering in the North.—In the Shipbuilding and Engineering Annual to the "Glasgow Herald," published on Dec. 31, considerable space is devoted to a review of electrical engineering progress in Scotland.

Fire and Waterproof Dynamos.—A fire recently occurred at the New England Building, Cleveland, Ohio, which is electrically lighted throughout by a plant consisting of three Westinghouse 62·5kw. engine type generators, installed in the basement. The heat to which the machines were subjected was sufficient to completely burn away the insulation on the outside of the field coils, and for an hour they were played upon by six hose pipes. We are, however, informed that within an hour of the extinction of the fire the first of these machines was carrying its full load, and another followed in a short time, the two machines dealing with the entire lighting of the building that under normal conditions utilised three machines. With the exception of the outer layer on the field coils, which was burnt away, the insulation was fireproof, and easily withstood a heat that was sufficient to burn and blister the paint on the frames.

Forthcoming Book.—Messrs. Longmans & Co. will shortly publish "N" Rays, a collection of Papers by M. R. Blondlot, with additions, translated by M. J. Garcin, and revised by Prof. A. W. Reinold.

German Exports.—The total exports of machinery from Germany in 1903 were far in excess of the imports, and nearly all descriptions of machinery participated in this increase. Electrical machinery exported to the United Kingdom stands for £289,550, to Russia £98,700, Belgium £98,500, Italy £87,100, Spain £73,300, the Netherlands £62,450, Austria-Hungary £45,700, Sweden £39,800, Argentina £38,400, Switzerland £29,100, France £25,100. Steam engines were exported to the United Kingdom to the value of £276,000, a sum comparatively similar to that of electrical machinery, being about three times larger than the exports of similar machines to any other country.

Germiston (Transvaal).—The township of Germiston as well as the group of mines controlled by the Consolidated Goldfields of South Africa are supplied with current by the General Electric Power Co., whose service commenced in 1898. For the township there is on the lighting load the equivalent of 13,600 8 c.p. lamps connected, 432 consumers being on the company's books for this service. The charge for lighting is 9d. and for power within the township 4d. per unit. The supply for lighting is from the company's station, which is primarily equipped for supplying power to the mines above mentioned. Of these there are nine in number, and the equivalent of 75,000 8 c.p. lamps is connected up, the transformer sub-stations being owned by the Consolidated Goldfields Co.

Plans are now being prepared for three-phase plant of an aggregate of 4,000kw. to be added to the 2,000kw. plant now operating. The supply to the mines is charged at 1·75d. per unit, a reduction from the charge of 2d. per unit having recently been made.

Gloucester.—The electrical engineer (Mr. W. J. Bache) last week submitted to the Electricity Supply committee proposals and plans for additional boilers and generating plant. Consideration of the matter was adjourned.

Gravesend.—King-street schools are to be wired for electric lighting at a cost of £48.

Haslingden.—The revocation of the electric lighting order has been deferred for six months.

Islington (London).—On Wednesday the Lighting committee reported that an agreement had been entered into with the County of London Electric Supply Co., under the provisions of the London Electric Lighting Areas Act, 1904, for the re-arrangement and transfer of parts of Finsbury and Islington electricity supply areas, and in which mains had been laid.

Islington (London) Finance committee have passed the following estimates:—£1,745 for arc lighting and conduits, £500 for an electrical exhibition to be held at Hornsey-road baths, £385 for proposed purchase of seven transformers, maximum indicating devices, &c., £320 for painting and cleaning generating station.

Kirkcaldy.—The scheme for the construction of the Kirkcaldy to Leven tramway has been approved. Only about 2 miles of the line will be on the public roads, the remaining 6 miles being run on the estate of Mr. Wemyss.

Littleborough.—Sanction has been received by the Council to a loan of £34,854 for the purchase and reconstruction of the tramways.

Liverpool.—The Corporation confirmed the promotion of the Liverpool Omnibus Bill and Tramway provisional order on Wednesday.

London Electric Power Schemes.—Shoreditch Council have called a conference of London local authorities to consider the steps to be taken to oppose the various bills which have been lodged for acquiring powers to supply electricity in bulk in the metropolitan area. The conference will also be asked to consider what action should be taken in regard to the Supply of Electricity Bill if it should be introduced next session.

London County Council Tramways.—The experiment referred to in our last issue (p. 443) on the Tooting route with a top-deck car travelling from London to Tooting (passing under the two bridges at Clapham-road and Balham) took place last Thursday without mishap, but on the return journey, owing to the peculiar gradient of the road, the car would not pass under the Clapham-road bridge, and the Council have now to decide whether the road gradient is to be altered or a modified pattern of top-deck car adopted.

Manchester.—The chairman of the Electricity committee (Mr. Howarth) announced at the Corporation meeting on Wednesday, that terms had been arranged in the matter of the action of Harters v. Manchester Corporation.

This action was brought to recover compensation for vibration caused in working the machinery at the Bloom-street station. It was thought the committee might have been able to avoid having to purchase any property, and an eminent authority on vibration was consulted. He proposed a scheme, which was tried, at a cost of several thousands of pounds, but it proved a failure. A proposal was now made, which the Council were asked to sanction, that the committee should agree to purchase two warehouses adjoining the station.

The agreement was approved.

Mr. Bowie moved a resolution in favour of allowing the present fire insurance policies of the Corporation to lapse and the establishment of a Corporation fund with the amount of the premiums,and reference to a committee for report. The Corporation (he said) insured boilers, ships, against street accidents, tramways and buildings, schools and other matters If a system of municipal insurance were adopted no extra staff would be required. One clerk could deal with the whole of the business. He had investigated the figures as to the profits of insurance companies, and he found that for every sovereign paid into the coffers of the great insurance companies, the public got back 5s. 9d. As to the tramways, the present responsibilities of the city in payments for compensation were increasing. In 1902 the amount paid was £941, in 1903 £5,093 and in 1904 £9,130. In Glasgow a system of municipal insurance for the electric tram service had resulted in a considerable saving. During 20 years Manchester Corporation had paid in insurance premiums nearly £30,000, and had only received back a little over £8,000.

Mr. Elverston moved an amendment that a special committee be appointed to inquire whether insurances should be dispensed with or could be placed on a better basis. He thought that if the Council adopted the suggestion of Mr. Bowie it would be guilty of false economy.

The amendment was accepted.

The Radcliffe Whitefield tramway route has been opened for traffic.

Mansfield Woodhouse.—The District Council have appointed a deputation to negotiate with Mansfield Corporation for a supply of electric current.

Municipal and County Club.—Sir William J. Collins, M.D., D.L., J.P., chairman of the Education committee of London County Council, will be the guest of the Municipal and County Club, Whitehall Court, at their next house dinner on 27th inst.

Municipal Telephony.—It is announced that Dewsbury Corporation are to be approached on the subject of the establishment of a municipal telephone system.

Newcastle-on-Tyne.—At the City Council meeting on Wednesday the mayor said that when the Revision committee took over the tramway system at the end of the financial half-year, there was a deficit of £5,000. 13 weeks later that had been wiped out, and there was a balance of £3,500, not due to increased profit, but to a reduction in expenditure of more than £300 per week.

Obituary.—We have to record the death of Mr. Wallis Rivers Goulty, M.I.M.E., which took place suddenly on the 31st ult. at Walberswick, Suffolk. Mr. Goulty was 70 years of age.

Penge.—The South Metropolitan Electric Light Co. have notified the Council that they will shortly proceed with the laying of further cables. Cables have already been laid in a portion of the district, but supply has not yet been commenced.

Power Transmission in Russia.—St. Petersburg Municipal Council have appointed a commission to inquire into various schemes for the utilisation of the waterfalls of the Wuoxen river in Finland. It is proposed to transmit electric energy to the city for both lighting and power.

Proposed Electrical Exhibition.—As announced on page 484, the Lighting committee of Islington (London) Council propose holding an electrical exhibition in the Hornsey-road Baths from Feb. 27 to March 11 inclusive, provided the Council at its meeting to-day (Friday) approves the proposal. The three largest baths will be utilised for the exhibition, which will include not only machinery in motion and all kinds of electric lighting, heating, cooking and power appliances, but also electrical novelties of all kinds, electric fountains, illuminations, &c. The men's large first class bath will be used for swimming and diving entertainments, model yacht races, trips on electric boats, musical entertainments, &c., the intention being not only to attract intending consumers but also the general public, and thereby greatly increasing the value of the exhibition to the exhibitors as a medium for advertisement

Provisional Order Revocation.—The Board of Trade have revoked the Lyndhurst Electric Lighting Order, 1903.

Radcliffe.—The New-road section of the tramways was opened for traffic on Wednesday. The line is worked by Bury Corporation, electric current being supplied from the Radcliffe Council station.

Rotherham.—The Borough Council have granted increases of salary to Messrs. J. Williams and J. R. Lillekor, assistant engineers in the electricity department.

Royal Warrants.—The "London Gazette" announces that the following hold warrants of appointment:—

Electrical Power Storage Co., secondary cells; Edison & Swan United Electric Light Co., electric lamps; Tasker, Sons & Co., Sheffield, telephone and electric light engineers; City & Suburban Electric Carriage Co., London, electric carriages.

St. Lucia.—The length of telephone line open in this island is 127 miles, and there are 108 telephone subscribers. The receipts for 1903 amounted to £553 and the expenditure to £575, which includes a charge of £225 for interest on construction loans. There was a slight improvement in the working during the year, but the lines erected some 10 years ago are now in need of almost entire reconstruction. One of the many difficulties which has to be overcome is the loss by theft of considerable lengths of wire.

Seoul (Corea).—A complete system of electric lighting and an independent telephone service is established in the Palace at Seoul, entirely separate from the supply of the American Corean Electric Co. and from the telephone service which supplies the city. Current is generated within the palace area and both services are in charge of Mr. Thos. Koen, the palace engineer.

The telephone service in Corea serves a radius of about 150 miles of the capital. It has been in operation since 1902. The subscription is $100 per annum, payable six months in advance.

The Seoul Electric Co. has been reorganised, and has become the American Korean Electric Co. with a fully paid-up capital of $1,000,000 (U.S. gold). The capital stock of this company is held one-half by the Emperor of Corea and one-half by the American firm of Collbran & Bostwick. The company has been organised under the laws of the City of Connecticut, U.S.A., with head offices and principal place of business at Seoul, Corea. The company controls and operates the street railway, electric lighting and electric telephones of Seoul, the capital of Corea. The new company has in preparation plans for installing two additional generating units at the supply station, each of 250kw., and an extension of the railway of about 7 miles single track. There is to be added to the rolling stock 15 28ft. passenger cars and five freight cars. The tramway plant is also to be provided with an up-to-date fully-equipped machine shop. Seoul has a population of 350,000.

South Africa.—On the 9th ult. Ladysmith (Natal) Town Council decided to wire and fit premises for the electric light on the hire-purchase system, taking a guarantee from the landlord to repay the cost at the rate of 10 per cent. per annum.

South Shields.—It has been decided to obtain tenders for the construction of the projected tramways.

Sunderland.—The Electricity and Lighting committee have offered to supply electric current to and maintain four arc lamps in the Lower Promenade, Roker, at £14 each lamp per annum, or if the Lighting committee have to provide the capital, £20.

Switzerland.—A concession for a narrow-gauge electric railway has been granted to M. R. Vontobel, of Winterthur, and M. C. Probst, of Lucerne, the railway running from Meiringen to Gletch. The estimated cost of the railway is over 6,000,000fr.

Sydney (N.S.W.)—The City Council's supply of electric current was commenced on July 8 last, and there was at Oct. 31 an equivalent of 27,500 8 c.p. lamps connected, including 278 H.P. for motors. 56 consumers are taking supply. The district served by the works has a population of about 500,000.

Torquay.—On Wednesday an inquiry was held into the application of the Council for permission to borrow £12,000 for the erection and equipment of new electricity works.

The town clerk (Mr. F. S. Hex) gave particulars of debt, assessable value, &c. Having regard to the largeness of the amount, and the permanency of the work, he desired that the period should go beyond the usual 25 years for electric lighting. He gave a brief history of the progress of the electric lighting undertaking. The number of consumers had increased from 55 in 1893 to over 400, and the revenue had risen from £1,800 to £6,700 a year. It was not possible to meet the increased demand for current at the present station, and a site for the new station had been found on municipal land. The Corporation had entered into an agreement to supply the Dolter Electric Traction Co. with current for the new tramways. A tender for the erection of the chimney at £3,719 had been provisionally accepted from the Alphons Custodis Chimney Construction Co.

Mr. Easterbrook (for the Torquay Gas Co.) asked the inspector (Mr. H. R. Hooper), in view of the finances of the Corporation, that, in the event of sanction being given, it should be made conditional on the Corporation giving an undertaking that they would carry on the works under what was known as the Northumberland clause. The effect of this clause was that the rates for electric lighting should be revised every three years, so that no loss should be incurred by the general ratepayers in respect of the undertaking.

The Inspector remarked that he was inquiring into the scheme upon its merits, and not in regard to any conditions.

The Town Clerk objected to this application as unprecedented in such a case, and said that since the working of the electricity undertaking the Corporation had been able to meet their liabilities, had put £300 to reserve, and would take care to so watch the progress of the undertaking as to endeavour to prevent any deficit occurring.

The borough surveyor (Mr. H. A. Garrett) explained the plans in detail, and the borough electrical engineer (Mr. F. Storey) gave evidence as to the plant in the existing electric light station on Beacon Quay, and its transfer to the new station.

The inquiry was adjourned until Thursday next week to enable Mr. Hex to prepare financial details.

Turbine Record.—Following the close of the St. Louis Exposition was the formal shut-down and inspection of the 600 H.P. Westinghouse steam turbine generating unit in the machinery hall after a continuous run of 3,962 hours. The machine was started at 9.20 a.m. on June 20 and was stopped at 11.32 a.m Dec. 2. When stopped it was, we are informed, found to be in perfect condition. The machine was run at a speed of 3,000 revs. per min. for the whole period. From 8.30 a.m. to 10.30 p.m. each day, the load carried varied from 25 per cent. underload to 25 per cent. overload.

Twickenham and Teddington.—The price of current has been reduced from 6d. to 5½d. per unit, with free renewal of lamps.

West Hartlepool.—The Corporation have declined an offer of the tramway company to reduce the period of the company's lease over the Seaton Carew line and to reconstruct the permanent way and overhead equipment where required, if the Corporation would extend the lease of the borough lines to 1919.

Wilmslow.—The Council have resolved to adopt public electric lighting.

Wimbledon.—The Electric Lighting committee have reported that the sub-committee appointed to consider the question of providing additional plant at the electricity works had expressed the opinion that it was necessary that further extensions of the present plant should be made forthwith, and they recommended that the plant be extended by the erection of three 1,000kw. turbo-alternators with condensers and that one 1,000kw. turbo-alternator with condenser be obtained and erected forthwith. The matter led to discussion, and some of the members advised delay. Eventually it was decided that the matter be referred to the General Purposes committee.

Wireless Telegraph Notes.—We stated in our issue for April 15 last (p. 1,012) that a wireless telegraph service had been inaugurated between Bocas del Toro (Panama) and Port Limon (Costa Rica). It is now stated that a contract has been signed with an American company at Bocas del Toro for the establishment of a wireless service between Bocas del Toro and Colon, similar to that now existing between Bocas del Toro and Port Limon, and for a similar service connecting Colon with Panama. The contract stipulates that the service between Colon and Borcas del Toro is to be ready for working within 12 months, and that between Colon and Panama within 18 months.

Worthing.—The Council have decided to allow discounts on the charges made for electricity supplied to the theatre. 7½ per cent. will be allowed for a demand between 1,000 and 5,000 units, and 15 per cent. between 5,000 and 10,000 units, or a flat rate of 4½d. per unit, if the annual consumption exceeds 10,000 units.

York.—The Electricity committee are considering a report of the city electrical engineer (Mr. C. A. Midgley) on the proposal to adopt public arc lighting in the Heworth district. It is also proposed to erect additional lamps in the centre of the city, and to light three or four thoroughfares with enclosed arcs.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Grimsby Corporation invite tenders for motors (from ½ H.P. to 10 H.P.) with starters (two years' contract); water-purifying plant for separating oil from condensed water; and 12 months' supply of oil, stores, arc lamp carbons and globes, incandescent and Nernst lamps, tools, rubber goods and cables, &c. Specifications from the borough electrical engineer (Mr. W. A. Vignoles), Electricity Works, Grimsby, to whom tenders for motors and purifier by Jan. 23, and for stores by Feb. 1. See also an advertisement.

The Municipal Council of *Johannesburg* is prepared to receive tenders for 100 electric tramcars, two electric water cars, one 5-ton travelling crane, one electric car traverser and various workshop tools, including erection at Johannesburg, to specification No. 10 of the consulting engineers (Messrs. Mordey & Dawbarn, 82, Victoria-street, London, S.W.). Specification may be seen at the Council's offices, Johannesburg, and at Messrs. Mordey & Dawbarn's offices, where tenders are to be sent by March 6. See also advertisement.

Johannesburg Municipal Council invite tenders for Vignoles rails, fishplates, angle steel guard-rails, bolts, nuts, coach-screws, and dog-spikes. Tenders to the consulting engineers (Messrs. Mordey & Dawbarn), 82, Victoria-st., Westminster, S.W., by noon Jan. 26.

The Directors of the *South London Electric Supply Corpn. (Ltd.)* invite tenders for supply and erection at their works, Bengeworth-road, Loughborough Junction, London, S.E., of one 750kw. steam alternator and pipe connections and sundry iron work. Tenders to the secretary (Mr. H. H. Boyer), by noon Jan. 16.

The Public Health committee of *Belfast* Corporation invite tenders for supply and erection at the new infectious diseases hospital, Purdysburn, of steam boilers, &c.; heating of pavilions and administrative block: electric light installation, including engine, dynamos, &c. Tenders to Sir Samuel Black by 11 a.m. Jan. 12.

London County Council require tenders by 24th inst. for road-work and plate-laying for their conduit system of Northern tramways in Rosebery-avenue, and a portion of the authorised tramway in St. John Street-road.

The Guardians of *Whitechapel* (London) Union invite tenders for the electric lighting of section 2 of the infirmary. Tenders to the Guardians' Offices, 74, Vallance-road, N.E., by noon Jan. 16.

Ormskirk Guardians invite tenders for steam and other piping and erection of plant, and for booster, battery, wiring, &c. Tenders by 12th inst.

Bradford Guardians require tenders by Jan. 16 for electrical engineers' work in two new hospitals.

Ashton-under-Lyne Corporation invite tenders until noon of Jan. 17 for overhead equipment of about 682yds. of electric tramway.

Blackpool Electricity and Tramways committee require tenders by 14th inst. for supply of 10,000 tons of steam coal.

Rochdale Corporation want tenders by 16th inst. for supply of tramway points and crossings, &c.

Tenders are required by noon 28th inst. for electric light installation and electric pump for Read's Grammar School, *Drax*, near Selby.

Halifax Tramway and Electricity committee require tenders by 31st inst. for coal conveyor, shutes, &c.

Ghent Municipal authorities invite tenders until Feb. 13 for 15 electric cranes for the docks. Particulars from and tenders to l'Hotel de Ville, Ghent.

Tenders are invited by Jan. 31 for the supply of 33 brass gas-electroliers for use in the leading theatre of Saragossa. Tenders are to be sent to the Secretary of the Ayuntamiento, Saragossa, through a local representative.

TENDERS RECEIVED AND ACCEPTED.

Aberdeen Gas and Electric committee have accepted the following tenders:—

Glegg & Thomson and Shirras, Laing & Co., malleable iron; Farquhar & Gill, paint; B. Millar & Sons, timber; James Jamieson, tallows; Gourock Rope Co., ropes; A. & C. M'Arthur, brass, lead, &c.; James Abernethy & Co., cast-iron work; John Fyfe & Sons, brushes.

The Admiralty have placed an order with Meldrum Bros. for refuse destructor plant for Chatham Dockyard. The same firm also recently shipped similar plant for Kalk Bay and Muizenberg, Cape Colony. In both cases the plant will be worked in conjunction with electricity generating plant.

Dartford Council have accepted the tender of S. W. Gibson & Co. for wiring premises on the pre-payment system, and that of the Western Electric Co. for the maintenance for three years of the feeder cable and mains recently laid at £28. 8s. 1d.

Eight tenders for a new cooling tower at the Hylton-road (Sunderland) Electricity Works were received, figures ranging from £485 to £850, and these were referred to the borough electrical engineer (Mr. J. F. C. Snell) for consideration.

Aberdeen Council have accepted the tender of Babcock & Wilcox for removing the remaining boilers at Cotton-street, and fitting them with chain grate stokers, &c., at £870.

Graham, Morton & Co. have obtained the contract for the supply to the electrical generating station at H.M. Dockyard, Devonport, of a complete coal-handling plant.

Gloucester Council have accepted the tender of Dick, Kerr & Co. for an electric water sprinkler at £550. The B.T.-H. Co tendered at £557 and the Brush Co. at £565.

Cardiff Electric Lighting committee have accepted the tender of the General Electric Co. for two 1,100kw. generators at £3,114, and that of J. Musgrave & Sons for two 1,600 I.H.P. engines at £14,304.

Brighton Lighting committee now recommend the acceptance of Messrs. W. Cory & Son's tender for 5,000 to 7,000 tons of Nixon steam navigation coal at 21s. 6d. per ton seaborne.

Stockport Guardians have accepted the tender of Stroud & Co. for wiring and installing telephones at the new hospital at £773.

W. G. Armstrong, Whitworth & Co. have a contract for the supply of electrical plant for the East Indian Railway Co.'s offices, Calcutta.

BUSINESS NOTICES.

Messrs. Bergtheil & Young, 12, Camomile-street, E.C., notify that for the more convenient working of their business the undertaking has been converted into a limited liability company under the style of Bergtheil & Young (Ltd.), which will take over the business as from 1st inst. Messrs. Arthur Bergtheil, H. W. Young and E. Bergtheil are directors of the company and the management will be the same as heretofore. Some further particulars are given on p. 488.

Messrs. Chas. F. Quicke & Co., electrical, mechanical and consulting engineers and agents for Messrs. Connolly Bros. have removed their offices and stores to 315, Euston-road, London, N.W.

Messrs. C. S. Rolls & Co. announce that their motor works have been reorganised, and are now under the management of Mr. B. M. Campbell, M.I.M.E., A.M.I.E.E., &c., who has had great experience in motor car construction work.

Messrs. J. E. Mellor & N. Wilkinson, electrical engineers, 48, Mincing-lane, London, E.C., have dissolved partnership. Debts by Mr. Wilkinson.

Owing to the growth of the National Telephone Co.'s metropolitan business, it has been found necessary to reorganise the office arrangements in London, and from Jan. 1 all business hitherto conducted locally by the six district offices will be concentrated at the new metropolitan offices, Salisbury House, London-wall, E.C., where all written communications should be sent and payments of cash, &c., made.

Kramos Limited, Bath, advertise for agents for sale of portable electric drills.

Messrs. Balcke & Co., condenser specialists, have opened a new branch office at Imperial-chambers, Albert-street, Derby, for the Midland and South Yorkshire district.

LIQUIDATIONS, &c.

W. & E. Sumner, electrical and mechanical engineers, Victoria-street, and St. Mary's-road, Garston, and Grange-road, West Kirby, have been adjudicated bankrupt. First meeting of creditors Jan. 13, and public examination on Jan. 19, at the Court House, Victoria-street, Liverpool.

Claims against Thos. Williams, electrical engineer, Bridge-street, Llandaff, by Jan. 18 to Mr. G. David, 117, St. Mary-street, Cardiff.

The trustee in the bankruptcy of G. Jackson and David Smith, electrical engineers, 6, Annetwell-street, Carlisle, has been released.

The Electrical Fittings Co. (Ltd.) is being wound up voluntarily. Mr J. D. Pattulls, 65, London Wall, London, E.C., is liquidator.

The Industrial Storage Battery Synd. (Ltd.) is to be wound up voluntarily. Claims by Feb. 8 to Mr. W. W. Futcher, 103, Gresham House, Old Broad-street, London, E.C.

The Derbyshire & Nottinghamshire Electric Power Synd. (Ltd.), is being wound up, and its assets and business transferred to the Derbyshire & Nottinghamshire Electric Power Co. Mr. G. D. Prince, 5, Great George-street, S.W., is liquidator.

Partnership.—A partnership is offered (see an advertisement elsewhere) in a manufacturing electrical instrument business.

. **Plant for Sale.**—Electric lighting plant (a gas engine, dynamo, &c.), is for sale. Applications to Manager, New Cross Empire, New Cross-road, S.E., or Mr. E. Wingfield-Bowles, 28, Victoria street, S.W., London.

A 200-light plant (dynamo, batteries, &c.), is advertised for sale. On view at 18, Rupert-street, Leman-street, London, E.

Two 14 H.P. Stockport gas engines and two Castle dynamos, with belting, pulleys, &c., are for sale. The plant can be seen running after 7 p.m., or by appointment with the manager, Paragon Theatre, Mile End-road, London, E. See also advertisement.

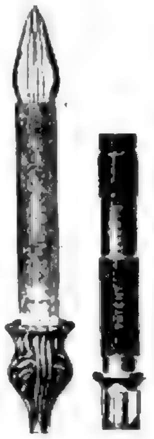
Old P.O. Stores Sale.—Tenders are invited for the purchase of about 450 tons of gutta-percha, 75 tons of copper, a quantity of other metals, gutta-percha-covered copper wire, tools, lamp tops, &c. Forms of tender from Controller of Stores department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders by 10 a.m. Jan. 18.

Premises to Let.—A factory in Pentonville (8,000 super. ft.) is to be let. Applications to Mr. H. Holme, 472-4, Caledonian-road, London, N. See advertisement.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Dec. 24 to Jan. 3, with the ports of destination:—

Aden, £10. ***Africa***—Alexandria, £178; Cape Town, £1,415 (including £641 telegraph material); Delagoa Bay, £28; Durban, £2,084 (including £176 telegraph material); East London, £76; Sekondi, £24; Tangier, £13. *Argentina*—Buenos Ayres, £2,113 (including £606 telegraph apparatus); Rosario, £145. ***Australasia***—Adelaide, £40; Auckland, £104; Fremantle, £29; Geraldton, £9; Hobart, £510; Melbourne, £83, and 60 cwt. telegraph wire; Otago, £202; Perth, £47; Sydney, £872; Wellington, £1,360 (including £992 telegraph material). *Belgium*—Antwerp, £245; Brussels, £30; Ostend, £120. *Brazil*—Pernambuco, £42; Rio Janeiro, £184. *Canada*—Toronto, £40. *Ceylon*—Colombo, £15 (telegraph material). *Chili*—Valparaiso, £272. *China*—Shanghai, £142 (including £77 telegraph material). *Germany*—Bremen, £1,974; Hamburg, £42. *Gibraltar*, £101. *Holland*—Amsterdam, £831; Rotterdam, £78. *Hong Kong*, £15. *India*—Bombay, £1,201 (including £16 telegraph material); Calcutta, £1,256 (including £270 telegraph material); Karachi, £15. *Japan*—Yokohama, £1,784. *Malta*, £80 (telegraph material). *Norway*—Christiania, £20. *Russia*—St. Petersburg, £1,169. *Siam*—Bangkok £1,979. *Spain*—Bilbao, £12; Grenada, £52. *Straits Settlements*—Singapore, £458. *Sweden*, Stockholm, £192 (including £23 telegraph material). *U.S.A.* New York, £158. *Zanzibar*, £24 (telegraph material). Total £21,873, (for 11 days), against £13,087 for six days last year (Dec. 31 to Jan. 5).

Candle Lamps.—The accompanying illustration shows an example of the "Ideal" candle fitting, complete with candle tube and candle lamp, the smaller figure showing the adjustable fitting. The "Ideal" fitting is supplied by the Electrical Co., 162, Shaftesbury-avenue, London, W.C., and the lamps are stocked by the company in voltages from 100 to 250 and for 5 c.p. and 8 c.p. They can also be obtained for series running in voltages from 83⅓ to 115. Each fitting can be adjusted from [illegible] in. to 1¼in. The tubes are the natural size of a wax candle, and the complete fitting can be supplied to measure either 4in. or 6in. in height.



THE "IDEAL" ELECTRIC CANDLE-FITTING.

Ball Bearings for Motors.—In our issue for December 9 we gave a brief description and illustration of an improved ball bearing which the Lahmeyer Electrical Co. are fitting to their motors. We are asked to state that these bearings are manufactured by the Deutschen Waffen und Munitionsfabriken, Berlin, whose agents in this country are L. Loewe & Co.

Calendars, Diaries, &c.—A very useful diary and calendar is that issued by the Simplex Steel Conduit Co., and among its useful features may be mentioned the serviceable foredge index, strong binding, and, not least, an accident insurance coupon for £1,000. Neatly packed into the preliminary pages are particulars of "Simplex" conduits, fittings and accessories.

A bold set of date sheets are affixed to a hanging card which is sent out by Messrs. Mavor & Coulson, 47, Broad-street, Mile End, Glasgow, and which serves the additional purpose of illustrating several examples of Mavor & Coulson plant.

The Armorduct Mfg. Co., Farringdon avenue, London, E.C., forward a strong and useful combined desk-pad calendar and pen rest, the pad being constructed on the pilot file principle, enabling memoranda to be made and kept on the separate date sheets.

From Messrs. Nalder Bros. & Thompson, of 34, Queen-street, London, E.C., we have to acknowledge receipt of the familiar set of date sheets serving as an effective advertisement for some of the company's manufactures.

The useful date remembrancer for 1905 sent out by Messrs. W. H. Willcox & Co., of 23, Southwark-street, London, S.E., is a set of illustrated sheets which serve as an index to a selection from the numerous articles in the class of engineers' stores, lubricating oils, beltings, boiler packings, hose, tools, pumps, &c.

A useful hanging calendar is issued by the Willesden Paper & Canvas Works, Willesden Junction, London, N.W. The company has received no less than 18 gold medals for their special class of manufactures.

Catalogues.—Kramos Limited, Bath, have ready a new price list of electrical drills. The same firm have a showcard ready, of which copies can be obtained by the trade.

The Underfeed Stoker Co., South place, London, E.C., have ready a well-illustrated pamphlet describing their apparatus for the smokeless and economical combustion of all classes of coal. The principle of this stoker is fully described.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Life as an Engineer: Its Lights, Shades, and Prospects." By J. W. C. Haldane. (London: E. & F. N. Spon.) 5s.

"Science Abstracts." Dec., 1904. Section A: Physics. Section B: Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

"The Beginner's Guide to the Lathe." By Percival Marshall. Nov. 25. Model Engineer Series. (London: Marshall & Co.) 6d.

"The Letter of Petrus Peregrinus on the Magnet, A.D. 1269." Translated by Brother Arnold, with Introductory Notice by Brother Potamian. (New York: McGraw Publishing Co.).

"Annuaire pour l'an 1905." Edited by Le Bureau des Longitudes. (Paris: Gauthier-Villars.) 1fr. 50c.

"The Fan: Including the Theory and Practice of Centrifugal and Axial Fans." By C. H. Innes. (Manchester: Technical Publishing Co.).

"The Construction of Cranes and other Lifting Machinery." By E. C. R. Marks. Third edition. (Manchester: Technical Publishing Co.) 3s. 6d.

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

November 28, 1904.

25,801 Electric & Ordnance Accessories Co., R. F. Hall and J. R. Garner. Birmingham. Reversing controllers for use with electro motors.
25,811 A. C. Keeping. Hampshire. Adjusting height of pendent electric lamps.
25,829 S. Wohle and A. M. Hart. Composite material for insulation purposes.
25,833 M. Walker. Manchester. Regulating voltage of alternate-current generators.
25,839 E. L. Thorp. Electrolysing apparatus.
25,898 R. J. B. Mills. (W. P. Hammond, U.S.) Switchboards.*
25,902 Ekstromer Accumulator Co. and E. L. Oppermann. Secondary batteries.
25,903 C. W. Atkinson. Distribution of electric current.
25,905 P. W. Smith. Electromagnetic change speed gear.

November 29, 1904.

25,933 R. H. Clarke. Bradford. Junction and disconnecting boxes.
25,937 T. M. Hickman. Wolverhampton. Composition for prevention of corrosion of metallic surfaces and insulating same.
25,950 H. D. Stroud. Coin collecting device and system for telephone exchanges.*
25,972 S. S. Galsworthy. Protection of conductors and insulation.*
25,979 P. Wenigmann. Electromedical appliances.*
25,985 G. Hartmann. Automatically winding clocks by electricity.

November 30, 1904.

26,034 J. Young. Telephonic intercommunication.
26,043 I. Kitsee. Submarine telegraphy.
26,063 W. S. Frost. Electric current generating and motive power machine.
26,082 H. Leitner and R. N. Lucas. Dynamo construction.
26,092 I. B. Birnbaum and F. G. Bell. Receiver switches for telephones.
26,094 W. P. Burke. Device for testing electric ignition arrangements of internal combustion engines.
26,096 A. C. Eastwood. Controlling systems for electric motors. (Date applied for, March 21, 1904, date of application in U.S.)*
26,097 A. C. Eastwood. Magnetic clutches. (Date applied for, April 1, 1904, date of application in U.S.)*
26,098 and 26,099 A. C. Eastwood. Motor-controlling systems. (Date applied for, June 10, 1904, date of application in U.S.)*

December, 1, 1904.

26,124 C. Vincent. Electric release movement.
26,157 F. Nusch (A. Cotis, France). Arc lamps.
26,161 W. S. Toplis. Circuit-breakers.
26,169 B.T.-H. Co. (G.E. Co., U.S.). Thermal cutouts.
26,170 B.T.-H. Co. (G.E. Co., U.S.). Switches.
26,171 B.T.-H. Co. (G.E. Co., U.S.) Armature windings.
26,172 B.T.-H. Co. (G.E. Co., U.S.). Switches.
26,174, 26,175 and 26,176 B.T.-H. Co. (G.E. Co., U.S.). Transformers.
26,179 P. J. Ogle. Percussive tools for electrically-operated percussive drills.
26,194 L. Torda. Dynamo electric generators and motors.

December 2, 1904.

26,220 J. Wilkinson. Conduits for underground mains or cables.
26,260 J. B. Sipe. Arc lamps.*
26,262 C. Schott. Liverpool. Magnetic separating apparatus.*
26,264 R. H. Gaynor, jun. Liverpool. Rosettes, bell pushes, &c.
26,269 J. B. Sipe. Coils for electro magnets, solenoids and the like.*
26,282 Siemens Bros & Co. (Siemens & Halske Akt. Ges., Germany). Switch installations for telephone exchanges and switches therefor.*
26,283 O. Imray. Société pour l'Exploitation de Compteurs Electriques Rittener & Co., Switzerland). Electricity meters.
26,285 C. D. Abel (Siemens & Halske Akt. Ges., Germany). Rotary field electricity meters.*
26,288 Vickers Sons & Maxim (A. D. Williamson and C. L. Sumpter). Electrical apparatus for training and elevating heavy guns.*
26,290 B. T. H. Co. (G.E. Co., U.S.). Control of alternating-current motors and apparatus therefor.
26,291 B.T.-H. Co. (G.E. Co., U.S.). Vapour electric apparatus.
26,292 B.T.-H. Co. (G.E. Co., U.S.). Joints between metals and vitreous materials and method of forming same.
26,293 A.E.G. Dynamo-electric generators. (Date applied for, Dec 3, 1903, date of application in Germany.)*
26,294 B.T.-H. Co. (G.E. Co., U.S.). Electric brakes.*
26,295 B.T.-H. Co. (G.E. Co., U.S.). Electric control systems.

December 3, 1904.

26,327 T. H. Large. Glasgow. Switches.
26,331 F. Darnton. Sunderland. Lifeguard for electric cars.
26,365 L. Huttenbach. Hygienic pad for mouth or ear-pieces of telephones, &c.
26,367 W. P. Thompson (Gesellschaft für Drahtlose Telegraphie, Germany). Liverpool. Wireless telegraphy.*

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

BERGTHEIL & YOUNG (LTD.) (83,061.)—Reg. Dec. 30, capital £40,000 in £1 shares, to acquire business of electrical engineers and contractors carried on as Bergtheil & Young, and to carry on the business of manufacturers of and dealers in all kinds of electric, magnetic, galvanic, chemical and other machinery apparatus and appliances, &c. The subscribers are A. Bergtheil, engineer, H. W. Young, engineer, E. Bergtheil, contractor, C. E. W. Ogilvie, S. G. Leach, engineer, J. W. Stourbridge, engineer, and A. G. Elliott, engineer. First directors, A. Bergtheil, H. W Young, E. Bergtheil and one other to be appointed by them.

E P. GASCOIGNE & CO. (LTD.) (83,020.)—Reg. Dec. 24, capital £3,000 in £1 shares, to adopt an agreement with E. P. Gasgoine and E. B. Wade to construct, lay down, establish, fix and maintain cables, wires, lines, accumulators, lamps and works for generation, accumulation, distribution and supply of electricity, and to carry on the business of electric lighting contractors, electrical engineers, &c. First directors are E. P. Gascoigne (man.) and E. B. Wade (sec.).

MEADOWS, TEETON & MINSHALL (LTD.) (83,006.)—Reg. Dec. 2, capital £1,000 in £1 shares, to acquire business of Meadows & Teeton, and to carry on business of electrical and mechanical engineers, manufacturers of and dealers in telephonic and other appliances, makers of steam and other engines, generators and suppliers of electricity, manufacturers of electric lamps and fittings, &c. Reg. office, 7, Albion-street, Hanley.

STATUTORY RETURNS.

BULLERS LIMITED.—In return to Dec. 15 capital is £400,000 in 20,000 ordinary and 20,000 preference shares of £10 each, of which 15,000 ordinary and 15,000 preference have been taken up. £10 per share has been called up on seven ordinary and 15,000 preference and £150,070 has been received. 14,993 ordinary shares are considered as fully paid. No mortgages or charges.

PACIFIC & EUROPEAN TELEGRAPH CO. (LTD.)—The return to Dec. 13 gives capital as £100,000 in 10,000 shares of £10 each, all of which have been taken up. £4 per share has been called up and £40,000 has been received. Mortgages and charges, £100,000.

THOMPSON, RITCHIE & CO.—The capital in return to Dec. 20 is £5,000 in 200 preference and 300 ordinary shares of £10 each, of which 200 preference and 140 ordinary shares have been taken up. £10 per share has been called up on 170 and £1,700 has been received. 170 shares are considered as fully paid. Mortgages and charges, £1,900.

TOTNES ELECTRICITY SUPPLY CO. (LTD.)—Return to Nov. 28 gives capital as £10,000 in 10,000 shares of £1 each, of which 1,207 have been taken up. £1 per share has been called up and £1,200 has been received, leaving £7 in arrears. No mortgages or charges.

WALSALL ELECTRICAL CO. (LTD.)—According to return to Dec 1 capital is £25,000 in 25,000 shares of £1 each, of which 12,000 ordinary and 4,380 preference shares have been taken up. £1 per share has been called up on 10,000 ordinary and 4,380 preference and £14,380 has been received. 2,000 shares are considered as fully paid. Mortgages and charges, £4,000.

MORTGAGES AND CHARGES.

ELECTRIC LAMP RENOVATING CO. (LTD.)—A debenture, dated Dec. 15, 1904, to secure £1,000, charged on company's undertaking and property, present and future, including uncalled capital, has been registered. Holder, R. C. Bell.

NORTH-WEST LONDON ELECTRIC SUPPLY CO. (LTD.)—Issue on Dec. 7 of 5 per cent. prior lien debentures for £10,000, part of series created Aug. 4, 1904, to secure £20,000. Property charged: Company's undertaking and property, present and future, including uncalled capital. No previous issue of same series.

A trust deed dated Dec. 7, 1904, securing the above-mentioned series of £20,000 prior lien debentures, has also been registered. Property charged: Leasehold hereditaments and premises, with fixed plant and machinery and fixtures thereon, the benefit of an agreement dated Jan. 31, 1896, and company's goodwill, rights and general assets, present and future, including uncalled capital. Trustees, A. H. P. Strickland and P. A. M. Hoare.

CITY NOTES.

MEMORANDA (Jan. 5).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 27⅝d. per oz. Consols 88⅝—88¾ for money, 88¾—88⅞ for account; 2½ per cent. annuities 87¼—87¾. Consols Pay Day, Feb. 1. Stocks and Shares Continuation Days, Jan. 11 and 25; Ticket Days, Jan. 12 and 27; Pay Days, Jan. 13 and 28; Mining Share Carry-over Days, Jan. 10 and 24.

BATH ELECTRIC TRAMWAYS (LTD.)—The total receipts for the first year's working, which ended on Saturday, were £53,000.

CAPE ELECTRIC TRAMWAYS (LTD.)—An interim dividend of 2½ per cent., tax free, has been declared payable Jan. 9.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Dec. 31	1,232	– 179	51	44,126	+ 5,508
Airdrie	,, 23	189	...	46	9,201	...
Ayr Corporation	,, 31	160	– 26	53	10,818	+ 464
Barnsley	,, 23	151	– 63	51	9,565	– 604
Barrow	,, 23	195	...	46	9,163	...
Bath Electric Trams, Ltd.	,, 28	737	...	12	32,966	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	Jan. 1	993	+ 87	...	...	...
Birmingham Corporation	Dec. 31	379	...	52	15,869	...
Birmingham Tramways Co.	,, 31	5,602	+ 198	26	140,985	...
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 29	337	+ 1	40	43,512	+ 5,987
Blackpool and Fleetwood	,, 31	224	...	56	21,322	+ 406
Blackp'l, St. Anne's & Lytham	,, 29	137	– 33	¶19	1,109	– 228
Bolton Corporation	...	...	...	...	...	...
Bournemouth Corporation	,, 28	1,031	+ 56	39	43,210	+ 2,042
Bradford Corporation	,, 31	4,237	+ 593	37	177,164	+ 17,106
Brighton Corporation	Jan. 1	1,104	+ 175	39	40,433	+ 3,441
Brisbane Tramways	Nov. 9	2,151	+ 47	40	47,674	+ 650
	,, 16	2,365	+ 141			
Bristol Trams & Carriage	Dec. 30	5,546	+ 709	21	164,317	+ 2,170
Buenos Ayres & Belgrano	,, 4	2,545	– 610	7	21,071	– 590
Burnley Corporation	,, 31	1,029	+ 261	13	18,158	+ 2,576
Burton Corporation	...	...	...	...	...	...
Calcutta Tramways Co.	,, 31	R44,463	+ R4,183	27	R996,957	+ R107,767
Camborne-Redruth	Jan. 2	112	+ 7	9	1,008	– 207
Cardiff Corporation	Dec. 24	2,013	– 120	39	80,093	+ 1,978
	,, 31	2,113	+ 130			
Carlisle Tramways Co.	,, 31	184	– 15	52	10,199	+ 170
Central London Railway	,, 31	6,296	– 239	26	169,546	+ 719
Chatham & Dist. Lt. Rys.	,, 29	701	+ 175	52	30,478	+ 2,340
City & South London Rly.	Jan. 1	8,221	– 51	1	8,221	– 51
Colchester Corporation	Dec. 22	168	...	28	5,612	...
	,, 29	269	...			
Cork Electric Trams Co.	...	...	...	...	...	...
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 28	502	– 56	51	25,003	+ 3,168
Dover Corporation	,, 31	214	+ 56	46	9,018	– 129
Dublin & Lucan Railway	,, 31	158	– 19	26	5,378	– 17
Dublin Southern Districts	,, 30	639	+ 189	26	132,849	– 1,709
Dublin United	,, 30	4,050	+ 475			
Dudley—Stourbridge	,, 23	475	– 181	51	43,827	+ 1,935
Dundee Corporation	,, 23	855	+ 45	¶51	16,969	+ 99
East Ham Council	,, 31	621	+ 92	30	26,301	+ 1,521
Gateshead & Dist. Trams	,, 28	897	– 163	51	45,332	+ 1,926
Glasgow Corporation	,, 31	14,119	– 557	†31	440,097	+ 20,105
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 23	176	– 118	51	12,006	+ 247
Gt. Northern & City Rly.	,, 31	1,467	...	46	49,045	...
Greenock & Port Glasgow	,, 23	514	+ 17	51	29,232	+ 1,465
**Halifax Corporation	,, 18	2,498	+ 121	50	57,544	+ 4,192
Hartlepool Tramways	,, 23	242	– 59	51	14,991	+ 920
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 31	2,302	+ 169	39	86,316	+ 10,619
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	,, 28	120	– 18	13	1,470	– 232
Ipswich Corporation	,, 31	444	+ 64	39	19,122	...
Isle of Thanet Co.	,, 31	311	+ 82	13	9,091	+ 217
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	,, 23	102	– 13	51	6,463	– 11
Kirkcaldy Corporation	,, 18	201	– 6	52	11,085	...
Lanarkshire Trams Co.	,, 31	836	+ 266	52	33,925	+ 19,581
Leeds Corporation	,, 31	5,747	+ 477	40	231,541	+ 12,832
Leicester Corporation	,, 31	2,162	...	38	49,851	...
Liverpool Corporation	,, 31	10,478	– 362	52	537,171	+ 14,290
Liverpool Overhead Rly.	Jan. 1	1,488	– 150	1	1,433	– 150
London County Council	Dec. 17	12,485	+ 3,113	†39	488,717	+ 105,187
	,, 24	11,643	+ 1,999			
Lowestoft	,, 31	167	+ 13	...	...	...
Maidstone Corporation	,, 29	145	...	34	3,201	...
Manchester Corporation	,, 30	11,972	+ 836	30	479,137	+ 19,517
Mersey Railway	,, 31	1,731	+ 266	26	89,603	+ 4,100
Merthyr	,, 23	178	– 74	51	10,174	67
Metropolitan Elec. Trams	,, 30	2,534	+ 1,290	26	48,929	+ 14,946
Middleton	,, 23	234	– 62	51	16,334	+ 513
Nelson Corporation	,, 31	117	+ 26	40	4,780	+ 1,501
Newcastle-on-Tyne Corp.	,, 31	3,153	– 94	26	95,498	+ 3,166
Newport (Mon.)	...	...	...	...	...	...
Oldham, Ashton & Hyde	,, 23	413	– 151	51	27,685	– 1,207
Oldham Corporation	Jan. 1	1,459	+ 467	40	49,473	+ 2,333
Perth (W. A.) Elec. Trams	Dec. 30	1,840	+ 183	54	65,792	+ 6,574
Peterborough	,, 23	103	– 6	51	7,159	– 315
Poole and District	,, 23	224	– 40	51	15,251	– 24
Portsmouth Corporation	,, 24	1,389	+ 129	§38	74,442	+ 6,111
Potteries	,, 23	1,621	– 206	51	87,017	+ 5,047
Reading Corporation	,, 29	740	+ 106	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 13	30	– 11	[illegible]	6,245	– 18
Salford Corporation	Jan. 2	4,055	+ 104	29	161,274	+ 7,708
Sheerness	Dec. 21	58	+ 4	51	3,252	– 459
Sheffield Corporation	Jan. 1	5,191	+ 67	§40	187,606	+ 4,161
Southampton Corp'ation	Dec. 29	915	+ 107	39	39,657	– 2,810
Southend Corporation	,, 28	233	+ 26	30	14,416	+ 1,433
Southport Tramways	,, 23	507	– 45	51	16,316	+ 291
S. Staffordshire Trams.	,, 23	621	– 425	51	35,642	– 6,717
Stockport Corporation	,, 30	454	+ 40	30	22,119	+ 7,056
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	,, 23	451	– 148	51	27,339	+ 702
Taunton Trams	,, 23	43	– 17	51	2,736	– 351
Tynemouth and District	,, 23	169	– 61	51	14,570	– 1,025
Tyneside Trams Co.	,, 28	367	+ 40	52	20,016	+ 3,340
Wallasey District Council	,, 31	681	+ 93	§39	19,757	+ 1,912
Walsall	,, 31	560	...	51	15,028	...
Warrington Corporation	,, 29	354	+ 39	39	14,[illegible]	+ 411
West Ham Corporation	,, 29	1,561	...	14	42,139	...
Weston-super-Mare	,, 21	25	+ 6	51	6,209	+ 513
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 28	311	– 86	51	10,729	– 93
Worcester	,, 23	262	– 135	46	14,357	+ 7,914
Wrexham	,, 23	92	– 64	51	5,100	– 1,059
Yorkshire Woollen District	,, 23	460	– 168	51	19,495	+ 6,770

(a) These comparisons are with the corresponding period last year.
† Minus 5 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. ** Fortnight.

CITY OF BUENOS AYRES TRAMWAYS CO. (LTD.)—The transfer of the undertaking of this company having now been completed in Buenos Ayres, the liquidators have decided to make the cash distribution of 30s. per share under the scheme, and also to convert the share capital and debenture stock of the City of Buenos Co. into share capital and debenture stock of the City of Buenos Ayres Tramways Co. (1904) (Ltd.)

COMMERCIAL CABLE CO.—The regular quarterly dividend of 1 per cent. on the preferred shares and a dividend of 1 per cent. on the common shares in the Mackay companies will be paid on Jan. 10 to shareholders of record on 31st ult. The transfer books will be closed from Jan. 1 to 9 inclusive.

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS (LTD.)—The report for the past year presented at the meeting last week stated that the total receipts were £4,785, against £4,961 in 1903, net profit £1,681, against £1,965. There was a slight increase in working expenses.

EDMUNDSONS ELECTRICITY CORPS. (LTD.)—An interim dividend for the half-year ended Sept. 30 of 5 per cent. per annum on the ordinary shares has been declared, payable 14th inst.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.).—Warrants for the interim dividends on the 6 per cent. cumulative preference and of 10 per cent. per annum on the ordinary shares have been posted.

LONDON ROAD CAR CO. (LTD.)—Applications were invited this week for the balance of the unissued share capital in order to provide funds for substituting motor for horse traction on the company's vehicles.

MANX ELECTRIC RAILWAY CO. (LTD.)—At the meeting on Tuesday the chairman (Mr. E. Schenk) said that the directors had thought it wise to begin a renewal fund, to which they had placed £1,000. It was not necessary to charge depreciation, as in the case of a tramway company having a term of years only, inasmuch as the company had the freehold of the property with perpetual rights. The number of passengers carried last year had been less than the previous year by 85,000.

METROPOLITAN DISTRICT RAILWAY CO.—The secretary (Mr. Wm. Jones) retired from active service on Monday, and Mr. Joseph Carter succeeds him.

RAND CENTRAL ELECTRIC WORKS (LTD.) For December 798,000 units were generated, yielding gross revenue of £7,400, against 693,185 units and £6,344 for the corresponding period of last year.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee have been asked to grant a quotation to a further issue of 10,000 £5 fully paid 6 per cent. cumulative preference shares of *Edmundson's Electricity Corpn. (Ltd.)*.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., Jan. 4.	Rate per cent. yielded.	Dividend Due.	Business, Week to Jan. 4.	
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.		Highest.	Lowest.
1	3/0	Anglo-Argentine Ord. Shares	7¾–8	4 15 0	Ap, Oc	8	7½
1	2/6	† Do. 6% Cum. Pref.	5 1/16–5 3/16	4 12 8	..	5⅛	5 1/16
St.	6%	† Do. Permanent 6% Deb. Stock	140–142	4 3 11	..	[illegible]	[illegible]
St.	5%	† Auckland Elec. Trams 5% Deb. (red.)	104–106	4 15 3	..	..	..
1	5%	Barcelona Tramways Ord.	11⅜–11⅝	2 13 5	..	11⅝	11½
10	5/0	† Do. 6% Cum. Pref.	9¾–10	6 0 0	..	9⅞	..
St	4½%	Do. 4½% Deb. Stock (red.)	[illegible]	4 10 0	..	..	..
100	5%	Do. 5 per Cent. Debs.	99–101	4 19 8	..	..	..
1	..	Brisbane Electric Trams. Invest. Ord.	1¾–2	..	..	..	..
	3/6	Do. 5 per Cent. Cum. Pref.	3½–4½	5 17 6	..	..	..
St	4½%	† Do. 4½ per Cent. Db. Prov. Cts	94–98	4 11 10	..	..	..
St	6%	British Columbia Elec. Rlwy Def. Ord.	100–103	5 16 6	..	..	..
St.	5%	Do. Pref. Ord. Stock	100–103	4 17 2	..	..	..
1	5/0	Do. 5% Cum. Perp. Pref.	10½–10¾	4 13 0	..	..	..
	4½%	Do. 4½ per Cent. 1st Mort. Dbs	102½–104½	4 6 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	98–101	4 11 0	..	..	..
1	1/6	Buenos Ayres and Belgrano Ord.	3¼–3½	5 16 8	..	3⅜	3¼
1	3/0	Do. 6 per Cent. "A" Cm. Pref	5¼–5¾	5 3 6	..	..	..
1	3/0	Do. "B"	5¼–5½	5 11 6	..	..	..
St	5%	† Do. 5 per Cent. Debs.	104–106	4 14 4	..	..	..
St.	5%	† Do. 5% 2nd Deb. Stock Prov Certs.	101–104	4 16 2	..	..	..
St.	5%	† Buenos Ayres Elec. Trams (1901) Ltd.	94–97	5 3 1	..	..	..
1	3/0	Calcutta Tramways	5½–5¾	5 13 2	..	5 11/16	5 9/16
100	4½%	† Do. 4½% 1st Deb. Stock (red.).	106–108	4 3 4	..	107	..
1	1/0	Cape Electric Tram Shares	1¾–1⅞	5 9 1	..	1 13/16	1¾
St.	5%	Colombo Trams & Ltg. 5% 1st Mt Deb. (red)	101–104	4 16 3	..	..	..
St	5%	† Madras Elec. Trams 5% Deb. Stk.	101–103	4 17 3	Ja, Jul	..	..
100	5%	Montreal St. Ry. St'g 5% Mort Debs. (1908)	100–103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103–105	4 5 9	..	..	..
St.	5%	† Perth (W.A.) Elec. Trams 1st Mt. Deb. Stk.	101–104	4 16 2	..	..	..
		ELECTRICITY SUPPLY.					
5	3/0	Calcutta Electric Supply Ord.	5½–5¾	4 2 4	..	[illegible]	[illegible]
St.	5%	† Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	86–91	5 9 11	..	..	..
10	..	Havana Electricity Co. Shares	9½–10½	..	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	¾–1¼	..	..	..	..
1	..	Rand Electric	1 3/16–1 5/16	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	100–102	4 8 0	Ap, Oc	..	..

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* In calculating the yield, allowance has been made for accrued interest but not for redemption.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., Jan. 4.	Rate per Cent. Yield.	Dividend Due.	Business Week to Jan. 4. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
1	6%	Bath Elec. Trams Pref. Ord.	½—¾	..	..	..	..
1	1½d.	† Do. 5% Cum. Pref.	¾—1	5 0 0	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19—20	4 0 0	Feb, Aug	..	..
10	6%	† Do. Cum. Pref. (fully paid)	10—10½	5 16 2	..	..	..
St.	4%	† Do. 4 per Cent. Debs.	106—108	3 14 0	Feb, Aug	..	..
10	8/0	†British Electric Traction Ord.	9½—10	8 0 0	..	10	9½
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—11½	5 7 10	Feb, Aug	10¾	..
St.	5/0	Do. 5 per Cent. Perpetual Debs	118—120	4 3 4	—	119½	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	96—98	4 11 10	..	96½	..
St.	4%	Central London Ordinary Stock	91—93	4 6 0	June, Dec	92½	91
St.	4%	Do. 4 per Cent. Pref. Stock	101—103	3 17 9	..	101½	..
St.	4%	Do. Deferred Stock	84—86	4 13 6	—	..	..
100	4%	Do. 4 per Cent. Debs.	108—110	3 12 4	..	109½	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—4¾	4 17 6	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99—102	3 19 0	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	46½—47½	4 15 5	Feb, Aug	47	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122—125	4 0 3	Feb, Aug	..	..
St.	5%	Do. (1896)	117—120	4 3 6	..	..	..
St.	5%	Do. (1901)	116—119	4 4 10	..	116½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104—107	3 14 9	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13—14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15—16	3 15 0	—	..	..
10	3 0½	Gt. Northern & City Rly. Prf. Ord. (4%)	6½—6¾	4 8 10	—	..	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8½—9½	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19—20	4 0 0	Mar, Sept	..	..
10	6%	‡†Do. 6 per Cent. Pref.	15—15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡†Do. 4½ per Cent. Debs.	110—112	4 0 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	89—91	4 7 11	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3¾—4¼	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10—10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—101	3 19 3	Jan, July	..	..
10	5/0	†London United Trams. 5% Cum. Pref.	10½—10¾	4 14 1	..	10½	..
St.	4%	† Do. 4% 1st Mort. Deb. Stock	102—104	3 17 3	..	102½	..
St.	..	Mersey Con. Ord. Stock	6—9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10—13	..	—	..	..
1	..	Metropolitan Electric Trams Def	⅛—¼	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	—	..	..
St.	4½%	† Do. 4½% Deb. Stock	102—104	4 6 7	..	103½	102½
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—1½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	8—9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99—102	4 8 3	—	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	—
..	[illegible]	Underground Elec. Rys. Co. of London	97—98	5 2 0	..	97½	..
St.	3%	Waterloo and City Ord.	90—92	3 5 3	June, Dec	90	..
		TELEGRAPHS.					
100	4%	*†African Direct Tel. 4% Mrt. Deb. (red.)	99—102	4 0 0	Jan, July	..	..
20	..	Amazon Telegraph	½—1	..	Jn, Dec ..	..	..
St.	12/6	Anglo-American	57—59	4 10 3	F,My,Ag,N	..	..
St.	25/0	Do. Preferred	104—106	5 0 0	F,My,Ag,N	104½	104
St.	2/0	Do. Deferred	13½—14½	0 14 11	F,My,Ag,N	13½	13¼
100	8%	Commercial Cable Capital Stock	170—180	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	92—94	4 5 1	Jn,Ap,Jy,O	..	..
10	5/0	Cuba Submarine Ord.	8¾—9¼	5 8 7	Feb, Aug	9¼	9
10	10/0	Do. Preference 10 per Cent.	16¾—17¼	5 14 3	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3½—3¾	5 11 9	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7½—8½	6 1 3	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	100%—102%	4 10 0	Jan, July	..	..
20	3/0	Direct United States Cable	10½—11	5 9 1	Ja,Ap,Jy,O	..	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99—101	4 9 1	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	135—138	5 3 8	Ja,Ap,Jy,O	137½	136
St.	17/6	Do. 3½ per Cent. Pref. Stock	88—90	3 18 8	Ja,Ap,Jy,O	89½	88½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106—107	3 14 9	May, Nov	106½	106½
10	2/6	Eastern Extension	15½—16	5 0 0	Ja,Ap,Jy,O	15¾	15½
St.	4%	Do. 4 per Cent. Deb. Stock	106—108	3 14 3	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	101—103	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 5	May, Nov	..	..
10	5/0	Great Northern (of Copenhagen)	28½—29	5 3 8	Jan, July	..	..
100	4½%	†Halifax & Bermudas 4½% 1st Mt. Db. (red.)	99—101	4 9 1	June, Dec	..	..
25	12/6	Indo-European	44½—45½	5 7 6	May, Nov	..	..
100	4%	†Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	98—100	4 10 11	June, Dec	..	—
10	4/0	West African Telegraph Shares	7½—7¾	5 3 2	—	..	..
2½	..	West Coast of America	⅜—⅝	..	..	..	..
100	4%	† Do. 4 per Cent. Debs.	97—99	4 10 11	Jan, July	..	..
10	..	West India and Panama	½—1	..	May, Nov	..	..
10	7/0	Do. 6 1st Pref. ex 7 on act. of arrears	7½—7¾	7 17 6	May, Nov	7⅝	7½
10	..	Do. 6 per Cent. 2nd Pref.	6½—7½	..	May, Nov	..	..
100	5%	*†Do. 5 per Cent. Debs.	101—103	4 17 1	Jan, July	..	..
10	3/0	Western Telegraph	13½—14	5 0 0	Mr,Jn,O,D	13½	..
100	5%	*†Do. 5% Debs. (2nd Series, 1900)	101—103	4 17 1	June, Dec	..	—
St.	4%	† Do. 4% Deb. Stock (red.)	100—102	3 18 5	—	..	..
		TELEPHONES.					
5	4/0	Chili Telephone (fully paid,	6½—6¾	5 15 6	August ..	6⅝	..
1	0/7½	Monte Video Telephone Ord.	1¾—2	..	..	..	..
St.	6%	National Co. Pref. Stock	108½—109½	5 9 7	—	109½	108½
St.	5%	Do. Def. Stock	102—104	4 15 2	..	103	103½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	15—15½	4 0 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12—13	4 12 4	Feb, Aug	12⅝	..
5	2/6	Do. 6 per Cent. Non-Cum. 3rd Pref.	5⅛—5⅜	4 11 9	Feb, Aug	..	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	96—98	3 11 5	June, Dec	97	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101½—103½	3 17 5	..	102½	101½
..	4%	† Do. Do. Prov. Certs, all paid	101½—103½	3 17 5	..	..	..
1	0/7½	Oriental	1—1¼	5 18 6	April, Oct	1⅛	—
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼—1½	4 16 0	..	..	..
St.	20/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	99—102	..	..	..	..
5	5/0	†United River Plate	6½—6¾	5 18 6	July......	..	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	5—5½	4 17 9	June, Dec	5⅞	5½
St.	5%	*†Do. 5 per Cent. Deb. Stock (red.)	104—106	4 14 4	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	†Elec. & Gen. Investment 6% Cum. Pref.	4¾—5½	5 17 1	—	..	..
10	2/0	Globe Telegraph and Trust	10½—10¾	5 4 9	Ja,Ap,Jy,O	10½	10⅜
10	3/0	Do. 6 per Cent. Pref.	14—14½	4 3 9	Ja,Ap,Jy,O	14½	..
100	6%	Submarine Cables Trust (Cert.)	120—123	4 18 4	April, Oct	120½	..

Share.	Last Dividend.	Name.	Price Wed., Jan. 4.	Rate per Cent. Yield.	Dividend Due.	Business Week to Jan. 4. Highest.	Lowest.
		ELECTRICITY SUPPLY.		£ s. d.			
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12—13	6 5 1	..	12½	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10	4 10 0	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11—12	5 0 0	—	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock (red.)	102—104	4 6 6	—	103½	
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5½—5¾	3 9 7	—		
St.	4½%	Do. Do. 1st Debs	101—104	4 7 0	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 5 1	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	104—107	3 14 9	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8½—8¾	4 11 6	Feb, Aug	8¾	
5	2/3	Do. 4½ per Cent. Pref.	5⅛—5⅜	3 17 5	Feb, Aug	5¼	5¼
St.	4%	Do. 4% Deb. Stock (red.)	103—105	3 17 8	..	..	..
5	1/3	† Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	—	..	..
5	2/3	† Do. Do. (1903)	4¾—5	4 10 0	..	5	4¾
5	2/3	Chelsea Electric Supply Ord.	6½—7	4 2 2	March ..	..	..
St.	4½%	*†Do. 4½ per Cent. Deb. Stock (red.)	107—109	4 2 6	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10¾—11¼	4 9 0	Feb, Aug	11⅛	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13½—14	4 5 9	Jan, July	13¾	..
St.	5%	*†Do. 5 per Cent. Deb. Stock (red.)	121—123	4 1 2	Jn, Dec ..	124	—
St.	4½%	† Do. 4½% 2nd Deb. Stock (red.)	101—103	4 7 3	..	..	..
10	4/0	County of London Elec. Supply Ord.	9—9½	4 4 2	..	9½	
10	6/0	Do. 6 per Cent. Cum. Pref.	13—13½	4 16 0	Mar, Sept	13⅛	13
St.	4½%	† Do. 4½% Deb. Stock (all paid) (red.)	106—108	4 4 0	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101—103	4 7 5	..	..	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	102—106	4 7 0	—	..	—
5	3/6	Hove Electric Lighting Ord.	7½—8	5 6 3	..	..	..
St.	4½%	I. of W. Elec Lt. & Power 4½% Db. St (red.)	100—102	4 8 9	..	101½	..
5	5/0	Kensington & Knightsbridge Ord	12½—13	4 13 4	..	12¾	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102—104	3 17 3	—	..	..
5	..	London Electric Supply Ord.	2½—2¾	..	..	2⅝	..
5	3/0	Do. 6 per Cent. Pref.	6⅛—6⅜	4 3 3	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95—97	4 2 5	Mr,Jn,S,D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	18—18½	5 0 0	April, Oct	18½	18¼
5	2/3	† Do. 4½ per Cent. Cum. Pref.	5⅛—5⅜	4 1 0	Jan. July	5⅛	
St.	4½%	† Do. 4½ per Cent. Deb. Stock 1st Mort.	110—115	3 18 3	Jn, Dec ..	..	..
St.	3½%	† Do. 3½ per Cent. Mrt. Db. Stock (red.)	96—98	3 11 5	..	..	—
100	4½%	†Midland Elec. Corp. for P.D. 1st Mort. Db.	92—95	4 15 0	..	..	—
10	8/0	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	16½—17½	5 7 1	Feb, Aug	..	—
5	8%	Newcastle Elec. Supply Ord.	8⅛—8⅜	4 17 6	Feb, Aug	..	..
5	5%	Do. 5 per Cent. Non-Cum. Pref.	6¼—6½	4 0 0	Feb, Aug	..	..
1	2%	Northern Counties Elec. Sup. 17/- pd.	15/6—16/9	3 6 8	Mar. Sep		
10	6/0	Notting Hill Electric Ord.	14½—15	4 0 0	March....	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	102—104	3 17 0	..	..	..
5	2/6	Oxford Electric Ord.	6½—6¾	5 2 2	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99—101	4 0 0	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	13½—14	5 3 7	Feb, Aug	14	..
5	3/6	Do. 7 per Cent. Pref.	8½—9	3 17 9	Feb, Aug	..	..
St.	3½%	† Do. 3½ per Cent. Deb. Stock (red.)	98—100	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3½—3¾	6 2 1	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85—87	4 12 6	..	..	..
5	3/0	South London Electric Supply Ord.	4½—4¾	3 3 8	—	..	..
1	..	South Metrop'n Elec. Lt. & Power Ord.	⅛—⅜	..	—	..	..
1	0/8½	Do. 7% Cum. Pref.	1⅛—1⅜	4 16 9	—	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	107—110	4 2 3	—	108½	
5	2/6	Urban Electric Supply Ord.	5—5½	4 17 6	..	5⅛	5
5	2/6	Do. 6% Cum. Pref.	5⅛—5⅜	4 15 6	..	5¼	—
St.	..	Do. 4½% 1st Mort. Deb.	104—106	..	..	105½	
5	6/6	Westminster Electric Supply Ord.	12½—12¾	5 1 11	Mar, Sept	13	
5	2/6	† Do. 5 per Cent. Cum. Pref.	6—6¼	3 17 0	—	6⅛	
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	⅛—⅜	5 14 2	..	..	
1	..	Aron Elec. Meter 6% Cum. Pref.	⅜—⅝	..	..	..	
5	4/0	British Insulated & Helsby Cables Ord.	5½—5¾	6 19 2	July, Feb	..	
5	3/0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..	
St.	4½%	† Do. 4½% 1st Mort. Deb. (red.)	101—104	4 6 6	—	..	
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101½—103	4 5 9	—	..	
5	3/0	British Westinghouse 6% Pref.	2½—2¾	..	—	..	
St.	4%	† Do. 4 per Cent. Mort. Deb. Stock	86—88	4 11 0	..	..	
2	..	Brush Electrical Engineering	½—¾	..	March ..		
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½—1¾	8 0 0	Mar, Sept	..	
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	93—96	4 14 0	Mar, Sept	..	
St.	4½%	† Do. Perpetual 2nd Deb. Stock	72—75	6 0 0	Jan, July	..	
5	5/0	Callender's Cable Con. Ord.	9½—10	5 5 0	Jan, July	9¾	
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4 15 3	Jan, July	5⅛	
St.	4½%	† Do. 4½ per Cent. 1st Mort. Debs. (rd.)	103—105	4 5 9	Nov, May	..	
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	[illegible]	4 18 9	—		
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	96—98	4 18 4	..	..	
1	0/6½	Chadburn's (Ship) Telegraph Ord.	¾—1⅛	3 17 6	..	..	
5	1/6	Crompton and Co. (Nos. 1 to 54,000)	1¼—1½	5 10 3	Jan, July	..	
100	5%	*†Do. 5 per Cent. 1st Mort. Debs. (red.)	93—95	5 2 0	Jan, July	93½	
5	10/0	Dick, Kerr & Co. Ord.	8—8½	5 17 8	Sept	8¼	
5	3/0	Do. 6% Cum. Pref.	5½—5¾	5 2 0	Sept	..	
St.	4½%	Do. 4½% Deb. Stock	105—107	4 4 0	..	..	
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	..	
5	..	Do. (£5 paid)	1—1½	..	Feb, Aug	..	
St.	4%	† Do. 4 per Cent. Mort. Deb. Stock (rd.)	77—82	4 17 8	June, Dec	..	
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79—84	6 0 6	..	..	
5	4/0	Edmundson's Elec. Corp. Ord.	6½—6¾	5 7 8	H'lf-yearly	6½	
5	3/0	Do. 6 per Cent. Cum. Pref.	6—6½	4 16 0	—	6⅛	
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	108—110	4 2 3	..	109	
2	1/7½	Electric Construction Co.	1¼—1½	6 3 0	July	..	
2	2/9½	Do. 7 per Cent. Cum. Pref.	2½—2⅝	5 12 0	July	..	
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98—100	4 0 0	Jan, July	99½	
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90—96	5 5 3	—	..	
10	5/0	†General Electric (1900) 5% Cum. Pref.	9½—10	5 0 0	—	..	
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91—96	4 3 4	..		
5	6/0	Henley's Telegraph Works Ord.	10½—10¾	6 10 3	Feb, Aug		
5	2/3	Do. 4½ per Cent. Pref.	4½—4¾	4 5 9	Feb, Aug	..	
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	110—112	4 0 10	Feb, Aug		
10	6/0	†India Rubber, Gutta Percha, &c., Wrks.	15—16	6 5 0	Feb, Aug		
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99—102	3 18 5	Mar, Sept		
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11—11½	4 7 0	Mar, Sept		
12	12/0	Telegraph Construction & Mainten'ce.	38—40	5 18 6	Mar, July		
100	4%	† Do. 4 per Cent. Deb. Bonds, 1909	101½—103½	3 17 3	Jan, July		
5	—	Willans and Robinson Ord.	1—2	..	Apr, Oct		
5	—	Do. 6 per Cent. Cum. Pref.	2—3	—	Apr, Oct	2½	
	4%	Do. 4 per Cent. 1st Mort. Debs	74—79	5 1 3	May Nov		

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote the

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NOTES.

THE report made by the electrical advisor to the Board of Trade with regard to the recent breakdown at Bradford fully confirms what we have said on the subject in previous issues. Not only was the mains network arranged in a way contrary to the best practice that has prevailed for many years, but the various Board of Trade Regulations had apparently been deliberately ignored by those who were responsible for the laying of the mains. An official has been forced to resign his position on the staff of the Electricity Department, but whether he was responsible for the prolonged and systematic neglect of proper precautions, or has been made the scapegoat for the sins of an official or former official of higher standing, it is impossible to say. In reply to Mr. TROTTER's report, the Committee have made the Board of Trade acquainted with the steps that are being taken to put the system into proper condition, and we trust that the cure will be effectual.

AS we had anticipated, the Bills which have been deposited in Parliament for the next session by companies seeking extended powers to supply electricity in the Metropolitan area have caused some stir in municipal circles, and joint opposition on the part of a large number of the Borough Councils has been decided upon. A well-attended Conference was held on Wednesday at the Shoreditch Town Hall at the instigation of the Shoreditch Borough Council, and resolutions to consolidate the opposition to these Bills were passed. Although the resolutions to oppose jointly go down on record as "passed unanimously," strictly speaking this was not so, a very evident undercurrent of somewhat long-standing animosity between certain Councils having forced itself into the proceedings. Further, the Finsbury Borough Council, whose district is supplied by the County of London Electric Supply Co., has pledged itself not to oppose this company's measure, while opposing other bills affecting its area. Consequently the interests of all the Councils are not identical, and hence the careful wording of the resolution set forth in our report on another page of this issue. No doubt the object of the Conference—viz., to secure combined opposition to the schemes in question at the lowest possible expenditure—can be attained by the executive committee which is to be appointed, but it may be hoped that the authorities taking part will not shirk their liabilities when the financial question comes to be considered. It was averred at Wednesday's meeting, that some Councils were guilty of this last year in connection with the conferences called by the St. Pancras Borough Council regarding the vibration question and the Electricity Supply Bill. The proposal of the Town Clerk of Shoreditch with regard to a joint municipal bulk supply scheme met with very curt treatment at the hands of the delegates, and the heated discussion even degenerated into an exchange of personalities. It certainly does appear that the passing of such a resolution would have weakened the case to be presented to Parliament in connection with the previous resolutions; and the quarrelsomeness which characterised the proceedings is sufficient warning of the difficulties that would arise in connection with a joint board of management. An executive committee has not yet been appointed, and, as an example of the want of unanimity, it may be pointed out that the Hackney delegates, in view of the tone of the proceedings, indicated their intention of advising their Council to withdraw from the Conference.

We are in a position to contradict the report which has been circulated in some of the daily papers to the effect that the conduit system of traction is to be adopted on the London County Council tramways in the North of London. The County Council decided over a year ago to adopt the conduit system on about half of the North London lines and to equip the remainder on the overhead system, provided the consent of the Borough Councils could be obtained for the overhead equipment, this consent being necessary under the terms of the Act of Parliament authorising the electrical equipment of these tramways. The Borough Councils, however, refused to consent to anything but the conduit system, and no understanding has yet been arrived at between the two parties. The County Council, we believe, is doing its utmost to bring about a friendly settlement of the dispute, as it has withdrawn the clause in its Tramway Bill in the next session of Parliament which would have had the effect of waiving the necessity for the consent of the Borough Councils to the overhead system of traction. The Council, however, still maintains its original position to the effect that the conduit system is not necessary for a large number of the tramway lines in the North of London. Probably this mistake has arisen owing to the fact that the Board of Trade has officially "approved" the use of "a slot not exceeding one inch in width" on some of the North London lines which are to have the conduit system.

The discussion which followed Mr. W. B. Woodhouse's Paper on "Electric Driving of Textile Mills" revealed very little fresh information of any value, although some of the experiences undergone by certain of the speakers are interesting and instructive. Everybody asked for figures, and although the author had given some, he had to admit that there was a great lack of authentic data. Mr. S. D. Schofield quite missed the point of the argument in comparing engines, running condensing and using high-pressure superheated steam, with electric motors. The coal and wages cost per brake horse power may, as he points out, compare very well with similar costs obtained in a central station, but unfortunately there are also such items as capital cost and depreciation to be considered. Besides, there are other issues, such as greater convenience and cleanliness, which come into the question. An important point was raised by Mr. J. W. Dawson, who complained that even the makers themselves did not know what power was required by their machines. This is certainly a matter that should receive immediate attention, for the mill-owner should acquaint himself with the power required by his various machines and in the different departments of his mill, in order to be able to bring about the greatest economy when the time for extensions comes round. This difficulty of obtaining data as to power required when introducing electric driving has been one of the greatest that the electrical engineer has been confronted with in non-textile as well as in textile factories. Mr. H. Dickinson obviously viewed the whole matter from the point of view of the engineer to a municipal electric lighting station, and apparently did not appreciate the author's aspect. As a matter of fact, a power company has practically no lighting peak at all, simply because the lighting load is insignificant compared with the power load, and therefore it will not be necessary to come to any arrangement with the manufacturer whereby he does not use his machines between certain hours. Mr. Woodhouse is to be congratulated in bringing forward a subject pregnant with such great possibilities, and it is to be hoped that other engineers will be equally energetic in endeavouring to obtain information which will tend to throw more light on the matter.

The problem of compensating the voltage drop in alternators on load has grown to be associated with the employment of commutators or other more or less complicated devices to such an extent that it is perfectly refreshing to be reminded by Mr. Miles Walker, who recently read a Paper on "Compensated Alternate-current Generators" before the Manchester Local Section, that there exist also quite simple solutions. Such an elementary solution is given by the author. Let us say at once that the method proposed, a description of which will be found on p. 506 of this issue, has certain limitations, and that the more complicated alternatives still have a field of application all their own, notably in plants where the power-factor is low or where the alternator is required to be highly compounded at full load. The new method is quite direct, and is based on the influence which the armature ampere-turns exert on the field ampere-turns. Every pole of the rotating field is to consist of two parts. The main part is provided with a magnetising coil, which sends a large flux through this pole, keeping it well saturated. A small auxiliary pole branches off from the base of the main pole and extends radially to the outside diameter of the rotating magnet. This small auxiliary pole lies outside the field coil alluded to. Mr. Walker remarks that the small pole remains unmagnetised at no load, but an inspection of the various magnetic circuits involved would seem to indicate that at no load it has a polarity which is opposite to that of the main pole and partially counteracts its effect. When load is put on the alternator and the current is approximately in phase with the E.M.F., the armature current above the field poles acts as a cross-magnetising current, weakening that part of the field coil which passes between the main and the auxiliary pole, but strengthening the opposite part of the field coil. The magnetomotive force which causes the auxiliary pole to be opposite in polarity to the main pole diminishes as the armature current increases, and after the armature current has reached a certain value both poles act in the same direction. All the while the E.M.F. of the alternator has increased, and machines of 150kw. capacity have, it appears, already been built on this principle, which possess the property of over-compounding to a considerable degree. It is at once clear that, with increasing phase differences between current and electromotive force, the action of the armature current on the field flux will diminish. This, of course, is a disadvantage of the method, but Mr. Walker justly points out that in most practical cases the power-factor is at its maximum at full load—*i.e.*, precisely when the maximum degree of compounding is required.

Under the heading "An Audacious Promotion," six years ago, we criticised with little mercy an attempt made to float a company to take over a 320kw. generating station and an overhead distribution network in Hampstead for the sum of £165,000. Those who remember the circumstances of the case will be amused to learn that this same miniature electricity undertaking has now been transferred to the Metropolitan Borough of Hampstead for less than one-tenth of the above sum—viz., £12,000.

◆

SINCE the first electric tramway was constructed, few have presented more difficult problems than that connecting Amsterdam, Haarlem and Zandvoort, a description of which we conclude this week. Apart from the large amounts of money which had to be spent in obtaining concessions, the engineering difficulties were sufficient to damp the ardour of the most enthusiastic tramway engineer. For ten miles, sheet piling had to be put down on both sides of the road, and all calculations as to the amount of sand required for filling were upset again and again. Tons upon tons were brought to the road and poured into the aperture only to disappear from view immediately. It is not surprising to learn, therefore, that the permanent way will require several months to settle down before anything like high speeds can be attempted upon it. As a matter of fact, the cars are built for speeds up to 40 miles per hour, or even more, but the maximum attained now does not reach this figure. A certain amount of trouble has been experienced, too, with the bow collector, chiefly owing to the three different heights of trolley wire which are encountered. The wear on the contact bar is very great, especially in frosty weather, when the trolley wire becomes coated with ice. However, a spring has now been fixed to the bow, which equalises the tension for all three heights, and this mitigates the evil to a certain extent.

◆

Wireless Telegraphy Agreement.—*The Times* on Tuesday published a Reuter telegram to the effect that an agreement has been signed between the Italian Government and the Marconi Company for the construction of a powerful station at Coltano, intended to communicate with stations in Great Britain, Erythrea, the Netherlands and other countries.

Cable Interruptions.	**Date of Interruption**
Cayenne—Pinheiros	**Aug. 18, 1902**
Beissi-Issa (Yemen)—Camaran	**Oct. 22, 1902**
Tarifa—Tangier	**Jan. 18, 1904**
Cayenne--Paramaribo	**July 13, 1904**
Sitka—Valdez (Alaska)	Nov. 11, 1904
Trinidad—Demerara	Dec. 20, 1904
Assab—Perim	Dec. 26, 1904
Cap Haytien—Puerto Plata	Dec. 27, 1904

The Royal College of Science and School of Mines.—It is announced that the President of the Board of Education has appointed the Right Hon. R. B. Haldane, K.C., M.P., as Chairman of the Departmental Committee inquiring into the present working of the Royal College of Science and School of Mines, in succession to Sir Francis Mowatt, G.C.B. Sir Francis Mowatt is retiring from the Chairmanship owing to ill health, but continues as a member of the Committee.

Treasury Grants to University Colleges.—Considerable additions have been made to the annual Treasury grants to University Colleges. Appended are the names of the various colleges participating and the amounts which they received last year and will receive this year:—

	1903-4.	1904-5.		1903-4.	1904-5.
Manchester	£3,500	£6,000	**Nottingham**	£1,700	£2,900
Univ. College, Lond.	3,000	5,000	**Sheffield**	1,300	2,300
Liverpool	3,000	5,000	Bedford Coll., Lond.	1,200	2,000
Birmingham	2,700	4,500	Bristol	1,200	2,000
Leeds	2,300	4,000	Reading	1,000	1,700
King's College, Lond.	2,300	3,900	Southampton	1,000	1,700
Newcastle-on-Tyne	1,800	3,000	Dundee	1,000	1,000

Attendance at St. Louis Exhibition.—The final official statement shows that the total admissions to the St. Louis Worlds's Fair were 19,694,855, of which 12,804,616 were paid. The large number of free admissions, 6,890,239, was partly due to the army of workmen required for completing things during the first two or three months of the exhibition, and partly to the number of days on which children were admitted free. An official statement of the passenger business handled at the St. Louis Union Terminal station during the exhibition period gives the following figures: Total number of trains, 91,560; cars, 457,688; daily average, 436 passenger trains—2,180 cars. During September and October the daily average was 520 trains and 2,600 cars.

The American Visit of the Institution of Civil Engineers.—In the course of an Address on "The Visit to the United States and Canada," delivered by Sir W. H. White before the Institution of Civil Engineers on Tuesday, the speaker referred to recent developments of some electrical undertakings in America. Most of the electric installations alluded to have been fully described in our columns from time to time, and were also referred to quite recently in our description of the American visit of the Institution of Electrical Engineers. Some new figures and facts, were, however, announced by Sir W. White. In speaking of the Shawinigan Falls power station, which supplies electric energy to Montreal, the author mentioned that the falls were about 150ft. high, and the water-power is estimated to be sufficient to produce upwards of 100,000 H.P. Here water was taken out of the river by a canal 1,100ft. long, 100ft. wide, and 20ft. deep. In the power house there are installed three pairs of inward-discharge turbines, each pair (at 180 revs. per min.) being capable of delivering 6,000 H.P. A fourth unit is being installed, and will be capable of delivering 10,500 H.P. The electric energy was utilised in factories from 2 to 20 miles distant, and in Montreal, 85 miles away. Amongst the industries obtaining power from these falls were electric lighting and traction, the manufacture of calcium carbide and ferro-manganese, and pulp mills; linen mills are to follow. Within four years of the time when the Shawinigan Falls were accessible only by canoe, they have been thus utilised and made readily accessible, with a population in the district of 3,000 people. It is pleasant to add that those concerned have endeavoured to preserve the beauty of the falls while making them serviceable to mankind. In connection with the utilisation of the Niagara Falls on the Canadian side it was stated that the power house of the Ontario Power Co. is placed in the Gorge below the Falls, with an effective head of 175ft.; the controlling and distributing station is placed at an elevation of 250ft. above the power house, 550ft. back from the Gorge. About 180,000 H.P. are to be developed eventually; but at present only one of three conduits is being laid underground from the head-works near Dufferin Islands to the power house. The conduit is nearly 6,200ft. in length and 18ft. in internal diameter: built of ½in. steel plates and stiffened on the upper half of its circumference by 7in. T-bulbs spaced 4ft. apart. An open relief and spill-way are provided at the lower end to reduce fluctuations of head and pressure which might result from alterations of load. The aggregate development of the three largest Canadian works when complete amounts to more than 400,000 H.P., and a fourth establishment on the Canadian side will develop 40,000 H.P., which will be utilised chiefly in the City of Hamilton. The grand total of power derived from the Niagara River will then be about 700,000 H.P., two-thirds being on the Canadian side. Two of the three great undertakings are practically due to American capital and enterprise—a fact which does not redound to our credit, having regard to the enormous amount of British capital available for investment. The third company is distinctively Canadian, and is closely associated with Toronto. At the generating station the current will be at a pressure of about 12,000 volts, but it is contemplated to transform it to 40,000 to 60,000 volts for transmission through overhead lines carried by two lines of steel towers 46ft. high placed at intervals of 400ft. The capital of this company is 1½ million sterling, and its total development of power will be 125,000 H.P.

The Paris Telephone Service.—In May of this year the dissatisfaction of the Paris public with regard to the inefficient telephone service furnished by the French Administration of Posts and Telegraphs took definite form in the organisation of an Association of Telephone Subscribers, constituted for the purpose of bringing sufficient pressure to bear on the Administration to improve the service. The French Telegraph Administration acquired the telephone system of Paris in 1889, and complaint is made that not only is the service very bad, but that the general practice of the Administration with regard to rules and regulations, rates and other matters of business relations with the public, is most arbitrary. The President of the Association of Telephone Subscribers is the Marquis de Montebello, and on the council are prominent members of the legal and business world of Paris, including Mr. Max Vincent, President of the Touring Club de France, and Mr. Archdeacon, member of the Chamber of Deputies. The association has a steadily growing membership, which already numbers between 4,000 and 5,000 of the Paris telephone subscribers. Since July a monthly bulletin has been published by the association, containing articles and reports on the various aspects of the telephone question in France. With a view to acquiring thorough information on the technical side of the telephone service, the Council of the Association recently retained Mr. Herbert L. Webb, of London, as consulting engineer. Mr. Webb has furnished the association with a report on the general conditions of a modern telephone system and with a further report on the principal causes of the defective service in Paris. Mr. Webb's first report contains a well-written popular description of the central battery system, as at present employed in the most modern exchanges in Great Britain. The report even includes a description of the methods for junction working, the French expression "auxiliary" line being used instead of what is called "junction" line in England and "trunk" line in America, in order to facilitate the work of the translator. As Mr. Webb has not been allowed to visit the exchanges, his second report is based on general knowledge of the Paris telephone service acquired from public descriptions and from observations made on visits to Paris during the past few years. He divides telephone exchange working into three periods. During the first period, from 1880 to 1890 or 1892, the methods in use were largely experimental. During the second period of another five or six years, the development of telephonic apparatus was, he says, more scientific, while during the last period effective methods and apparatus have been perfected and standardised. The Paris system, in Mr. Webb's opinion, has largely remained in the first period, having only adopted some improvements belonging to the second period mentioned, and being "entirely innocent" of the apparatus and methods of the third period dating from 1897. While these older methods may still be suitable for small exchanges, they should not be applied to larger systems, and, moreover, owing to the defective working of antiquated apparatus, Mr. Webb continues, the nerves of the operators are so taxed that it is unreasonable to expect a high standard of efficiency and discipline from these ladies. Mr. Webb next criticises the peculiar practice of the French Telephone Department in compelling each subscriber to supply his own telephone set, with the result that there are various types in existence, some having radical technical defects when considered in relation to other apparatus in the system. The variety of instruments also makes it impossible to train a force of inspectors to familiarity with the peculiarities of all the numerous types. A further evil is the extensive use of primary batteries instead of magnetos or a central battery for signalling, a method which, Mr. Webb says, belongs to the first period of telephony already mentioned. The necessity of keeping these cells in order must constitute a serious cause of defective service and also be a source of great expense. The cure suggested is the reconstruction of the whole system on modern lines, which would occupy two or three years according to Mr. Webb's computation, during which period a gradual improvement would occur. Mr. Webb does not give an actual estimate of the cost of this conversion, but is of opinion that it would be "far less than the cost of a single battleship, and even less than the cost of an armoured cruiser, and well worth the price." In Paris the total number of telephones is about 45,000, and there is a yearly increase of about 3,600 subscribers. In New York, which has a somewhat smaller population than Paris, there is a telephone service serving over 150,000 telephones and increasing at the rate of 30,000 per year. The flat rate of charging in Paris should be abolished, says Mr. Webb, and with a scientifically arranged message-rate tariff he thinks it would be possible to reduce the minimum charge to £6 or even £5 per annum. If this were done, he concludes, and an active business policy were adopted, Paris would have in five years 150,000 telephones, and in 10 years 250,000 or 300,000 telephones. The Association and the Telephone Administration are still in correspondence with regard to the proposed inspection of the Paris exchanges by Mr. Webb, but we understand, that up to the present, permission to view the exchanges has been withheld, although the President of the Association has made a formal application to the Administration that Mr. Webb should be allowed to make an official inspection with a view to reporting on their condition and on the apparatus and methods employed.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, January 13th.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER STUDENT'S SECTION.

7.30 p.m. Meeting in the Municipal School of Technology. Paper to be read: "Electric Heating," by A. E. Jephson.

GLASGOW UNIVERSITY ENGINEERING SOCIETY

7.30 p.m. Meeting in the Engineering Department of Glasgow University. Paper to be read: "Gas Producers," by Prof T. Gray.

TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

8 p.m. Meeting at the Society of Arts. Paper to be read: "Overhead Equipment," by H. M. Sayers.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel, when Prof. Vivian B Lewes will deliver a lecture, illustrated by lantern slides, and experiments on: "The Theory of the Incandescent Mantle"

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

8 p.m Meeting at 25, Great George-street, Westminster. Mr. James Swinburne will deliver a lecture on: "Theory of Electricity and Magnetism." Sir Guilford L. Molesworth, the President, will occupy the Chair, and members of all classes are invited to attend.

MONDAY, January 16th.

INSTITUTION OF ELECTRICAL ENGINEERS: NEWCASTLE LOCAL SECTION

7.30 p.m. Meeting at the Durham College of Science. Paper to be read: "Description of Some Plants Inspected during a Recent Visit to the States," by H. L. Riseley.

TUESDAY, January 17th.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER LOCAL SECTION.

7.30 p.m. Meeting in the Physical Laboratory of the University. Paper to be read: "Electric Driving in Textile Factories," by H. W. Wilson.

WEDNESDAY, January 18th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7.30 p.m. Meeting in the Library, 92, Victoria-street, Westminster. Paper to be read: "Notes on the Construction and Maintenance of Large Telephone Exchanges," by A. L. Stanton.

ROYAL METEOROLOGICAL SOCIETY.

7.30 p.m. Annual General Meeting at the Institution of Civil Engineers, 25, Great George-street, Westminster. The President, Capt. D Wilson-Barker, will deliver an Address on "The Connection of Meteorology with Other Sciences."

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Wireless Telegraphy and War Correspondence," by Capt. Lionel James.

THURSDAY, January 19th.

RUGBY ENGINEERING SOCIETY

8 p.m. Meeting in the Benn Building, High-street. Lecture by H. S. Meyer on "A Novel System of Electric Traction," illustrated by lantern slides.

FRIDAY, January 20th.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when the following Papers will be read: (1) "Some Impressions of American Workshops," by A. J. Gimson. (2) "Waterworks Pumping Engines in the United States and Canada," by John Barr. (3) "Some Features in the Design and Construction of American Planing Machines," by Archibald Kenrick, jun. (4) "Engines at the Power Stations and at the St. Louis Exhibition," by Alfred Saxon.

ROYAL INSTITUTION.

9 p.m. Evening Discourse by Prof. Sir James Dewar, F.R.S., on "New Low-Temperature Phenomena."

DIRECT WHEATSTONE WORKING BETWEEN ENGLAND & TEHERAN.

BY T. W. STRATFORD-ANDREWS.

Direct Wheatstone working over the line of the Indo-European Telegraph Co. has been in operation since the beginning of 1903. Previously there were two re-transmissions between London and Teheran—viz., at Emden in Germany and Odessa in South Russia, with an additional re-transmission in London for Liverpool and Manchester messages.

Morse working, which had been employed throughout the company's system, became inadequate to cope with the increase in traffic, and Wheatstone was experimentally introduced on the section Odessa-Teheran in the summer of 1897. The experiments showed that signals could be transmitted satisfactorily in both directions on this section, and as soon as the clerks became efficient in punching the slip, and technical alterations were introduced at the relay stations, Teheran could block Odessa with homeward messages. Attention was then called to the section Odessa-Emden, and the Wheatstone system, with its improvements, was introduced upon this section. So soon as the working over this section was satisfactorily established the two sections were amalgamated by working direct Teheran-Emden. This, however, was at once found to block the Emden-London section, and it became obvious that the Wheatstone working must be still further extended.

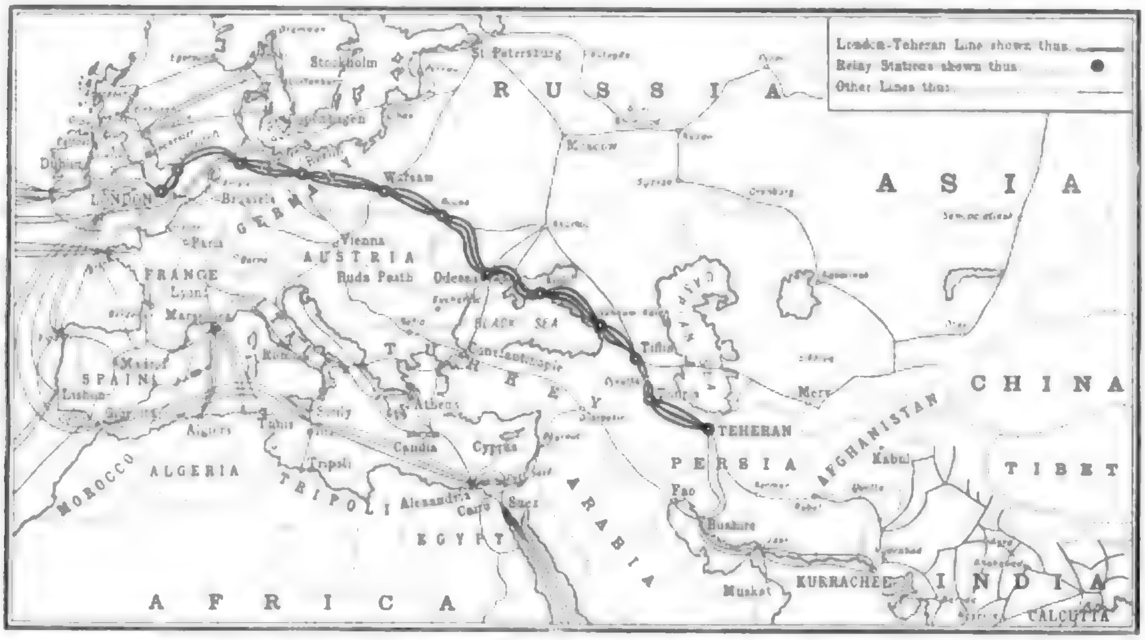

FIG. 1.—MAP SHOWING INDO-EUROPEAN TELEGRAPH CO.'S LINE.

Although Morse duplex was worked through the cable between Emden and London, full advantage could not be taken of it, because, owing to the difference of time, the bulk of the homeward traffic comes through during the daytime and the outward traffic during the evening. It was, however, necessary before Wheatstone could be introduced on the section Emden-London to convince the English and German postal authorities that no disturbance would be caused by induction to the other wires in the Norderney and Borkum cables (the company only using one of the conductors in each of these cables). Experiments were made and witnessed by Government officials at both ends, in order to satisfy them upon this point. Having demonstrated that the Wheatstone transmission would not in any way interfere with the work of the other conductors, permission was given to the company to introduce the Wheatstone automatic transmission between Emden and London. Experiments were thereupon made for direct working between London and Teheran, a distance of, approximately, 3,800 miles. These experiments having conclusively proved that direct Wheatstone working could be thoroughly relied upon, the system was finally introduced on January 1, 1903, and has since been used exclusively between London and Teheran.

During the last few weeks, the messages arriving in London from Teheran have been relayed in London direct to Liverpool and Manchester respectively, instead of the slip being gummed up in London and re-transmitted by Morse, and it was found that the signals arrived in those places as clear as they were formerly registered on the slip in London. Wheatstone transmission from these stations to Teheran having proved so successful, the Manchester and Liverpool stations now exchange their messages direct with Teheran (about 4,000 miles). Through Wheatstone working has also been extended to all the company's through circuits thus:—London (Manchester and Liverpool) and Odessa in both directions for South Russian traffic; Berlin and Teheran in both directions for Continental messages for the Far East.

Key work on the company's system is thus practically superseded, except for the purpose of repetition, checking the number of messages sent, and making any corrections.

The relays used by the company are the Post Office standard "B" relay, manufactured by Messrs. Siemens Brothers, and the Siemens relay, with improvements added by the Indo Company. In order to assist the clerks in the relay stations along the line, a Wheatstone receiving instrument is placed in "shunt," and by putting this instrument in circuit the clerks are able to see how the signals are leaving their station. In this way there is a perfect system of control. If the marks are leaving one station perfect, and the clerk at the next station finds the marks faulty, the latter knows, provided the line is in good electrical condition, that his regulation is at fault, and is able to adjust his relay until the marks on his slip are perfect.

In estimating the value of this achievement, the composite nature of the line and the character of the ground traversed must be taken into account. The company's line, which includes 200 miles of cable across the North Sea, runs through Germany to Russia, where it passes over desert, forest, mountain and river, into Persia, again crossing a range of mountains and more desert to Teheran. From this it will be seen that the line is exposed to the many perils of storm, flood, hoar frost (a very serious cause of faults owing to the accumulated weight of ice breaking the wires), damage from passing traffic and deliberate damage. The electrical condition of the line is also seriously affected by lightning during the summer months, and sea fogs, which are very prevalent in certain seasons along the Black Sea coast. The maintenance has therefore to be watched with the greatest care by the company's staff distributed along the line in Russia and Persia for that purpose.

The number of relays in operation on this long line is a

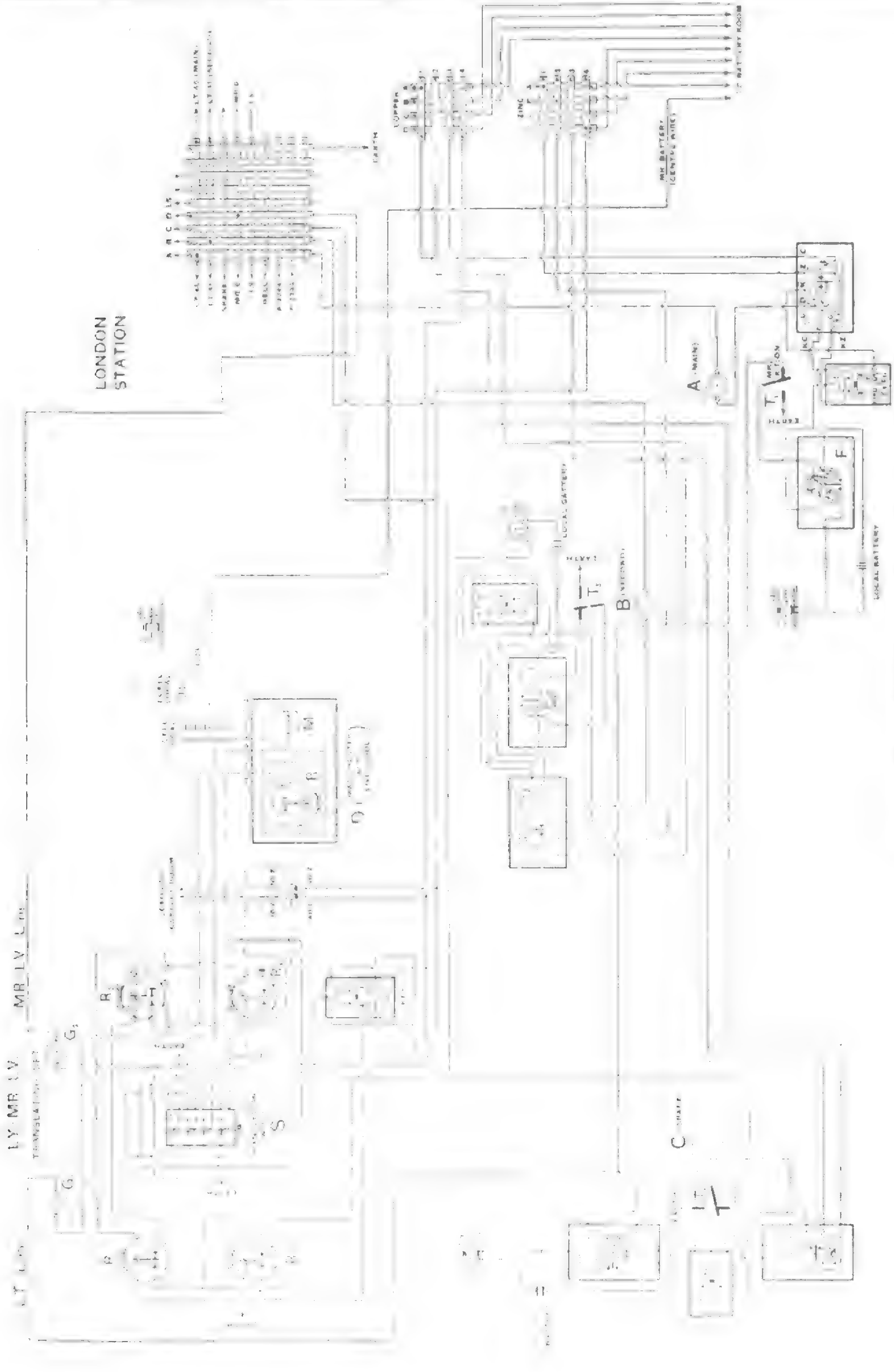
LONDON STATION
LY MR LV
MR LV Lon
TRANSLATOR
G
G1
R
S
D
A (MAINS)
B
C
F
T1
T2
EARTH
COPPER
ZINC
MH BATTERY (CENTRE WIRE)
LOCAL BATTERY
LOCAL BATTERY

FIG. 2.—DIAGRAM OF CONNECTIONS AT LONDON STATION.

feature as striking as the length and composite nature of the line itself. Between London and Teheran there are 10 automatic relay stations with systems of translation which differ necessarily according to the date of introduction, and the varying requirements and conditions of the different sections of the line.

TECHNICAL DESCRIPTION.

London Station.—The London station (Fig. 2) has three principal circuits, A (main), B (second) and D (Liverpool and Manchester), and a spare set C, on to which any of the others can be switched at will. The Liverpool-Manchester line is worked as a through circuit, Manchester being the intermediate station. London's current is received at both stations. In setting up translation for that portion of the traffic destined for, or coming from, Liverpool and Manchester, several novel conditions presented themselves. The homeward traffic comes through from Teheran in practically a continuous stream, telegrams for Manchester, Liverpool and London being in one and the same batch. Traffic from and to other parts is dealt with on the second line and some of this has to be transmitted by London for Liverpool or Manchester. It therefore became necessary to be able to switch Teheran through to Liverpool or Manchester and to return to normal working on both sides at any moment, and at once, and to make the arrangement available for whichever of the three sets A, B or D might require it. Further, it became necessary to be able to stop Manchester or Liverpool in the event of either of those stations being in the act of sending to London when translation was signalled for. This is accomplished by a device at Manchester and Liverpool by which, on the momentary turning of the key switch in London, a bell is rung at the sending station. Switches T_1, T_2 and T_3 are provided, one at each of the three sets A, B, and C, and their function is to divert the line current after it has passed through the receiver coils F* and transfer it to the translation set. This switch carries two additional terminals for the ends of a local circuit in which is included a small gong placed close to the translation set. The act of turning the switch handle from left to right, in addition to transferring the line current to the translation set, momentarily closes the local gong circuit and signals the switching to the clerk at D.

"Evans" Translation London-Manchester-Liverpool (D).—Considerations of space and staff made it imperative that the translation and ordinary working should be carried on in one and the same place by one and the same clerk. The system of translation in use, which was devised by one of the company's staff, is marked by great simplicity. The whole operation, in both directions, is effected by four relays, and the essential parts of the system could be fixed on a board 18in. square.

The Relays.—R_1 and R_2 are non-polarised relays. Soft iron pieces are fixed on both sides of the axle in such a position that the front piece is close to the core of one coil, and the back piece close to the core of the other. The pull of the electric magnet is exerted on both pieces to turn the axle in the same direction. When these coils are traversed by either positive or negative line currents the tongue is carried over to the left-hand stop. The self-inducing effect of the coils, if any, is beneficial, serving to keep the tongue firmly held between the reversals. A fine spiral spring suffices to bring axle and tongue back to the normal position. R_3 and R_4 are two ordinary standard polarised relays, the stops of which are connected with the C and Z poles of the line battery.

The Recording Instrument.—One battery is used for both lines, and is a "divided" or "double" one. With normal working London-Manchester-Liverpool the centre of the battery is put direct to earth through the barrel-switch S. When translating the centre of the battery is put to earth through the coils of R_5, with the result that whenever a current traverses either line, whether incoming or outgoing, R_5 is worked, and by means of a local Morse circuit signals are recorded. Everything that passes is recorded, and the record is that of the actual line current and not a "derived" or "leak" circuit. The barrel switch S, besides effecting the above-mentioned change in the battery connections, changes the connections on the Manchester side from "normal" to "translation" and also reverses the direction of the current through the coils of R_5.

Let us suppose Teheran is sending a batch to London on the main (A) set. Suddenly the sounder raps out "M.R., M.R." (Manchester). The key clerk turns switch T_1, the gong at the translation set sounds, the clerk there turns the switch S, and Teheran's signals pass across and through galvanometer G_1 over the tongue and right hand stop of R_3 into and through the coils of R_1 and R_5 to earth. The tongue of R_3 playing between its two stops, to which the poles of the line battery are brought, sends out the fresh current by way of the left-hand stop and tongue of R_1, through the barrel switch, the key and the galvanometer G_3 into the Manchester line. When Teheran has finished with Manchester he may have something for Liverpool and proceed with it, both these stations being in the one circuit. When he is finished with both, he signals LY (London) and the switches are turned back. Teheran continues sending to London, and at the other table London resumes working with Manchester or Liverpool. The process of translation is the same when Manchester or Liverpool is sending to Teheran save that the incoming current, after passing G_3, goes through key and barrel switch before reaching the tongue of R_1. No key is needed on the other side, as that on the main set is always in circuit.

The "Pump" Translation.—M_1 and M_2 (Fig. 3) are the "pump" switches. The coil S_1 is traversed by current in a local circuit closed by the contact of the tongue of R_3 with the right-hand stop. As this contact only occurs during the passage of line currents in one direction, the currents in the local circuit are intermittent. At the entry of the initial local current the armature of the right-hand lever V_1 is attracted, the upper arm falls, carrying the left-hand lever N_1 into the horizontal position, where it makes contact with the lower stop and with the spring contact Y_2, and at the same time forces a vertical rod or plunger carrying a disc at its lower extremity into a cylinder, H_2, partly filled with oil. This disc has a valve, and the oil displaced by the downward pressure of the disc rises through the valve to the upper surface. The upper extremity of the vertical rod is attached to the body of the instrument by an adjustable spiral spring. When the local current is shut off the armature of V_1 is released and the two levers, together with the plunger, would, by the tension of the spiral spring, regain the normal position at once were it not that the presence of the oil on the upper suface of the disc only allows the latter to rise slowly. Before this rise is sufficient to break the contacts of the left-hand lever N_2 the local circuit is again closed. The position is established in the first place by the presence of a current in the local circuit, and maintained for a short time after the disappearance of the current by the action of the oil pump. With the fairly regular alternation of line currents, as in the "Morse" system, the local currents are frequent enough to keep the pump in the position for translation.

E is a condenser, or rather two condensers, each of 1 mfd. capacity. The inside plate of each condenser is joined through a telephone, T, to earth. They are charged, one by incoming, one by the outgoing current. When these two currents coincide in character and duration the results are harmonious and rhythmical vibrations of the telephone disc. This gives an audible and reliable indication of the working. Slow sending can be read by ear and a sounder dispensed with.

K_1 and K_2 are double current keys of the nutcracker type. The lever is compound, the upper and lower portions are hinged together at one end and held against the back or relay stop by a spiral spring. On the underneath surface of the upper portion is a long flat spring. The lower portion of the lever is insulated in the middle and pivoted near the end on an axle to which the terminal carrying the line wire is joined. The Z pole of the battery is connected with bar (Z) and a metallic projecting piece which makes contact with the lower portion of the lever from above.

The C pole of the battery is brought to the front bar (C). When the upper portion of the lever is pressed against the lower, contact is broken between line and relay and made between line and Z. When the lever as a whole is further depressed the zinc contact is broken, and the front stud of the lever resting on the front bar, copper and line are joined. With the two parts of the lever held together and worked up and down, copper and zinc currents are alternately sent out.

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* It was found advisable for writing up purposes to have Teheran's signals recorded on the Wheatstone receiver even when in translation.

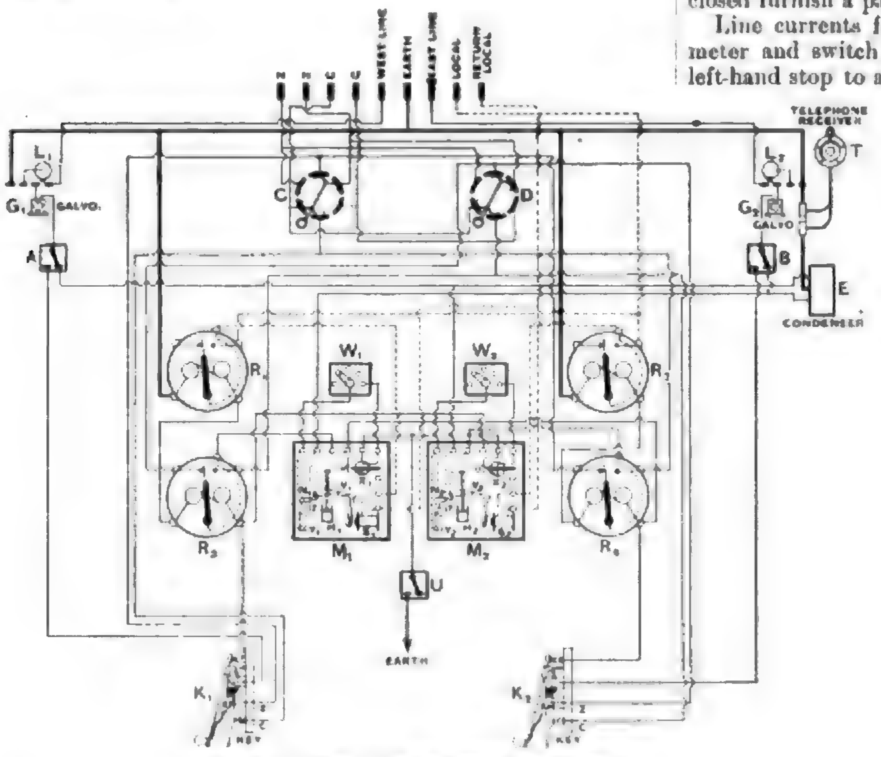

Fig. 3. "Pump" Translation Connections.

The keys are only used occasionally for purposes of control, and are brought into circuit by turning the switch A or B.

The "Pump" Translation in Action.—Line currents from the east pass through the lightning guard L_2 and galvanometer G_2, over switch B by the right-hand terminal, and there diverge to charge the condenser E and flow by way of the left-hand lever N_1 (of the pump M_1) through the top stop into and through the coils of R_4 and R_2 to earth. Being moved by positive currents to the right-hand stop, the tongue of R_2 closes a local circuit in which the coils S_2 (of M_1) are included. Until the eastern station stops sending the levers of this pump M_2 are brought to and kept in the translation position as already explained. The stops of R_1 are connected respectively with the Z and C poles of the line battery. Working under the influence of the incoming current the tongue sends on the fresh current to the lower stop at the left-hand lever N_2 (of M_2). At this point the current has two paths open, one by way of the spring contact Y_2 through a high resistance W_2 into the coils of the registering Morse X_2 and to earth, and by the other path through the lever N_2 itself, into the west line by A, G_1 and L_1 having charged the second condenser. The signals from west to east are, of course, translated in the same manner by the similar apparatus on the other side.

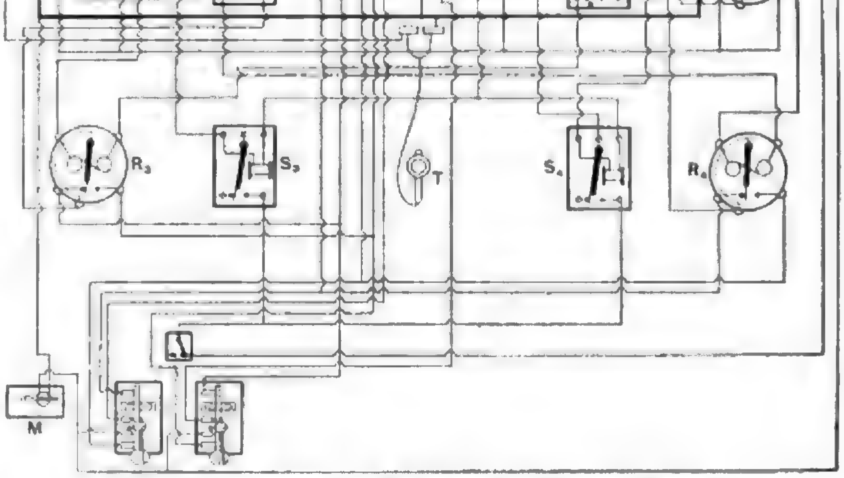

Fig. 4.—Connections for Translation with Neutral Relays.

Translation with Neutral Relays.—This system of translation is well known. The relays R_1, R_2, R_3 and R_4 (Fig. 4) are all of the "Standard" type. R_1 and R_2 differ from the others only in that the tongues are held midway between the stops by the tension of springs acting from each side. S_1, S_2, S_3 and S_4 are electromagnets provided with shunts of a resistance equal to that of the coils with the object of increasing the effects of self-induction. The coils in a local circuit are closed by the movement of the tongues of the neutral relays in either direction. S_1 and S_2 furnish in one position a path for the incoming, in the other position a path for the outgoing current; S_3 and S_4 when closed furnish a path for a leak current.

Line currents from east after passing through the galvanometer and switch B pass to the armature of S_1 and by the left-hand stop to and through the coils of R_4 and R_2 to earth.

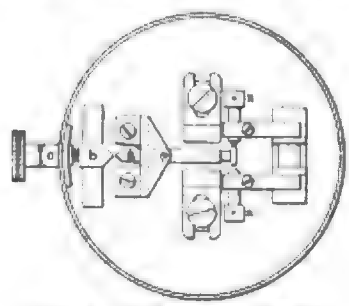

Fig. 5.—New Neutral Relay.

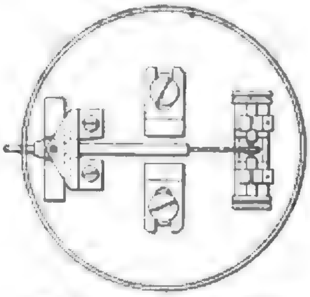

Fig. 6.—Old Neutral Relay.

The tongue of R_2 playing between its stops keeps the armatures of S_2 and S_1 depressed (to the right). The battery current from the stops of R_1 passes over the right-hand stop of S_2 to the armature, after which it divides, one portion passing along the armature of S_1 and out by the right-hand stop, through a high resistance W into the registering Morse M and to earth, while the other portion passes by switch A and the galvanometer out into the west line. Translation from west to east is similarly effected. The condenser and telephone circuit is arranged as in the "pump" translation already described.

A New Neutral Relay.—This is a Siemens relay modified to act as a neutral. The attached diagram shows the new (Fig. 5) and the old (Fig. 6) styles one above the other. In the new relay the tongue has been considerably shortened and the contact stops brought close to the centre of the instrument. The tongue is pivoted near its centre, and presents a wedge-shaped end (a) to the similarly shaped end of the permanent magnet (b). The latter is a movable piece adjustable by means of the screw (c). By this means the tongue is brought into, and maintained in, a neutral position between the poles of the electromagnet without touching either of the contact stops. The nearer "b" is brought to "a" the greater this effect. It is claimed that by this arrangement the tongue is less liable to respond to induction and stray currents whilst no less sensitive to working currents.

THE AMSTERDAM-HAARLEM TRAMWAYS SYSTEM.

(Concluded from page 462.)

The power house is situated in a central position at a village called Halfweg, midway between Amsterdam and Haarlem, practically in the best position for distributing power to the line, being located on the banks of the Ringvaart Canal, which affords cheap carriage for coal and other supplies, and also abundance of water for feed to boilers and jet condensers. Owing to the nature of the country and the poor condition of the ground at the site of the power station, an elaborate arrangement of piling was necessary, the entire site being piled with 46ft. long by 9¾in. diameter piles, placed 4ft. 1in. apart, each pile being estimated to carry 4 tons. On the top of the piles runners 7⅝in. by 9¾in. are carried for the entire length of the building, and support a floor 3in. thick over the space occupied by the building. The piling is carried below the water level to a distance of 3ft. 7⅜in., and from this point the foundations rise to the floor level—a height of 7ft. 2⅜in.

The buildings are of brick, substantially and neatly finished with stone trimmings, and the total ground area occupied by the power station site is about 9,150 sq. ft., with sufficient ground for future extensions. A wharf is erected 26ft. 3in. wide, and immediately adjoining is the boiler house, which is 88ft. 7in. by 52ft. 6in. A division wall separates the boiler and engine rooms. The latter is 59ft. by 34ft. 7½in. by 21ft. 4in. high from engine-room floor to top of wall. Situated at one end of the boiler room is a coal storage room 50ft. 8in. by 35ft. 4in., with storage capacity for 400 tons. An outhouse for offices communicates with the engine room, and is 12ft. 9in. by 12ft. 9½in. The walls of the buildings are 14in. thick above and 20in. below the ground line; they are supported by pilasters 14ft. 9in. apart and 21in. thick, which are carried to the top of walls for supporting the roof principals. The latter are rafters of tee section, with angle iron struts and flat bar ties securely riveted to suitable plates, and the purlins are of channel iron with wooden runners, and are supported by angle iron brackets fastened to the principals. Red tiles, secured to a wood lining which is fastened to the purlins, cover the slopes. A monitor is formed along the full length of the boiler room, 9ft. 10in. in width, and each side is filled in with nine rows of louvre boards, supported at intervals by intermediate fittings. Good light is obtained throughout the entire building by large glass windows with iron frames, and ample door space is provided for bringing the machinery into the building. A 10-ton overhead hand travelling crane works over the engine room at a height of 15ft. and a span of 32in. 4in., the gantry construction being of tee rail resting on wooden beams and supported on brick arches.

In the boiler house are six hand-fired Lancashire steel boilers, by Stork, of Hengelo, Holland, the heating surface of each boiler being 926 sq. ft., the grate area 35 sq. ft., and the steam pressure 160lb. per square inch. The boiler shell is 7ft. 6in. diameter by 27ft. 10in. long, and contains two furnaces, each 2ft. diameter; each flue has five Galloway tubes. There is 11ft. 4in. between centres, and the foundations, which are of brickwork, rise from the wooden floor and are composed of brick arches filled in with sand. The boilers are encased in heavy brickwork walls, 1ft. 9¾in. thick, and supported on cast-iron stools. Directly behind them are the Stork superheaters, which have two chambers and an arrangement of dampers, so that the gases can pass either through the superheater after passing through the internal flues of the boiler, or the superheater can be cut out and the gases then

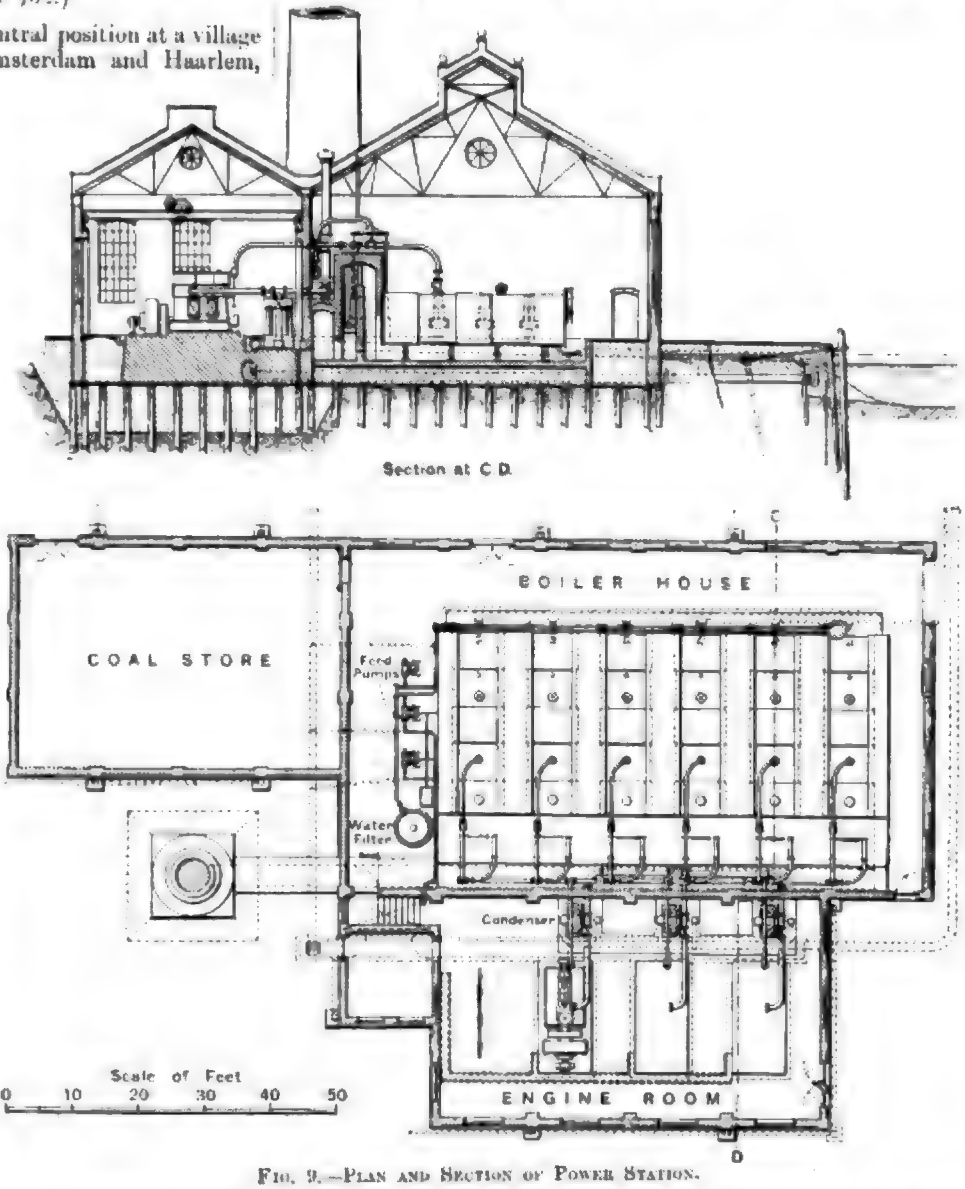

Fig. 9.—Plan and Section of Power Station.

pass along the sides of the boiler to an underneath flue, which adjoins the main flue. A round brick chimney is situated free from the building at the end of boiler house, being 131ft. high by 5ft. 5in. diameter (internal). It is lined with firebrick set in fireclay, extending from the bottom to a height of 65ft., the foundations consisting of a large bed of concrete, 23ft. square by 6ft. deep, and supported by wooden piles, 9¾in. diameter by 46ft. long, placed 2ft. 2in. apart.

There is one superheater to each boiler, and all are arranged to work at a temperature of 500°F. Each has a heating surface of 330 sq. ft., and consists of 10 rows of coils, the ends of which terminate in two cast-steel headers 8ft. 11⅝in. apart, the coils being bound by steel straps bolted together. Steam enters the one header, passes through the tubes, and discharges at the other. Fixed to the discharge steel header is a 1¼in. safety valve, a 1in. blow-off cock, and two small holes for testing purposes.

All feed water to the boilers is taken from the adjoining canal, which contains an average amount of suspended matter, necessitating the filtering of the water. Under the boiler-room floor, in front of the boilers, a duplicate arrangement of tanks is situated, built of brick. Each arrangement consists of a filter tank with reservoir, the filtering medium consisting of sand and clinkers, and is supported on a wooden floor perforated with holes, thus allowing the water to percolate through the medium to the reservoir. A branch pipe connecting both reservoirs leads to a hot well. Inside of the hot well and fixed to the side of the tank is a ball float valve, with connecting pipe to the water inlet supply to the condensers, the latter being used as an automatic emergency water supply in the event of the filtering tanks failing to supply the hot well. The area occupied by the filter tanks is about 710 sq. ft.

A vertical exhaust feed water tube heater, 9ft. 7in. high by 24⅝in. diameter, made by the Wheeler Condenser & Engineering Co., is placed directly behind the feed pumps, the feed water entering at the bottom and leaving at the top, and the exhaust steam vice versa. The shell is made of cast iron, while the tubes are of the best quality seamless drawn brass, fastened to the tube plates at the top end by ferrules and asbestos packing, and at the bottom end by screwed joints. By removing the upper cover of the heater and the bottom hand hole plates, the tubes can be readily cleaned.

There are two sets of directly driven horizontal duplex end packed feed pumps, 6in. by 3½in. by 6in., made by the Buffalo Pump Co., N.Y., each capable of delivering 2,400 gallons per hour against a pressure of 300lb. per square inch, the working steam pressure being 160lb. per square inch. Each unit is capable of supplying the total amount of feed water to the boilers.

The feed-water piping to the boilers is arranged in duplicate, the discharge from the pipes passing through the heater into one of two mains, which runs along the side on to the top of the boilers and branches off to a Y-piece into the feed check valve in front of the boilers. By an arrangement of valves, the heater can be cut out and water pumped direct to the boilers.

All the steam piping was made by Messrs. Seiffert & Co., of Berlin. From the angle stop valves on the boilers 6in. pipes join the cast-steel header of the superheater, and then branch into the main header, from which the engines take their supply of steam. The piping, which is extra heavy throughout, is arranged, by means of valves in the main header, to permit the operation of the plant as three independent units. Owing to the high temperature of the steam, ample allowance has been made for expansion and contraction, and the piping is designed in such a way that any steam condensing in pipes connected to the main header, collects in the latter, and is drawn off by three drains of large size, one in each section, so as not to permit of any accumulation of water in the pipe. The three drains, being coupled to two steam traps which can be worked independently, discharge into a drip main, which runs along the division wall to the hot well. A stand-pipe from the drip main is placed in a prominent position in the boiler house, with its end open, so that any excessive discharge of steam will show a defective trap at once. From the superheater to the main header the diameter of the steam pipe is 4½in., while that from the main header to the engine is of the same diameter, and the main header itself is 8in. in diameter.

From each of the angle stop valves on the boilers, a drain is connected to a drip main which discharges into the hot well. This drain will only be used in the case of any of the boilers being shut down, so as to prevent any water from accumulating in the valve. From each of the stop valves on the engines are drains leading to traps, which are connected with the common

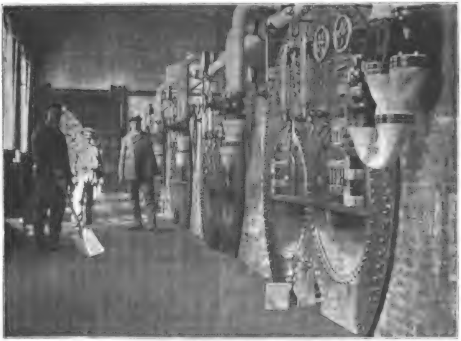

Fig. 10.—View of Boiler Room.

drip main and run off to waste. The piping is arranged so that one or more boilers can supply any one engine independently of the others, and allow the consumption of steam in the engine to be determined at any time.

Concrete foundations have been put down for the main engines and condensers, the engine centres being 14ft. 9in. apart. Surrounding the engine and condenser foundations are arches of concrete, which support the engine-room floor. The flooring consists of tiles bedded in concrete and supported on two layers of brick, the tiles and brickwork being laid in a bed of sand. The main engine plant consists of three Belliss, three-crank, triple-expansion engines, each of 430 B.H.P., and having a steam consumption of 13¾lb. at 26in. vacuum with superheated, and 17lb. with saturated, steam. The speed is 375 revs. per min., and its regulation is within 3 per cent. even with sudden variations from full to no load. The engines are of the enclosed type, supported on heavy cast-iron frames, and each is secured by nine foundation bolts. The generators, made by the Société Anonyme Westinghouse, Le Havre, are three in number, and are coupled directly to the engine shafts. Each machine is capable of developing 300kw. at 525 to 575 volts, when running at a speed of 375 revs. per min., and is supported on a cast-iron frame, which also supports the outward bearing, the whole being secured by four foundation bolts. They are six-pole machines.

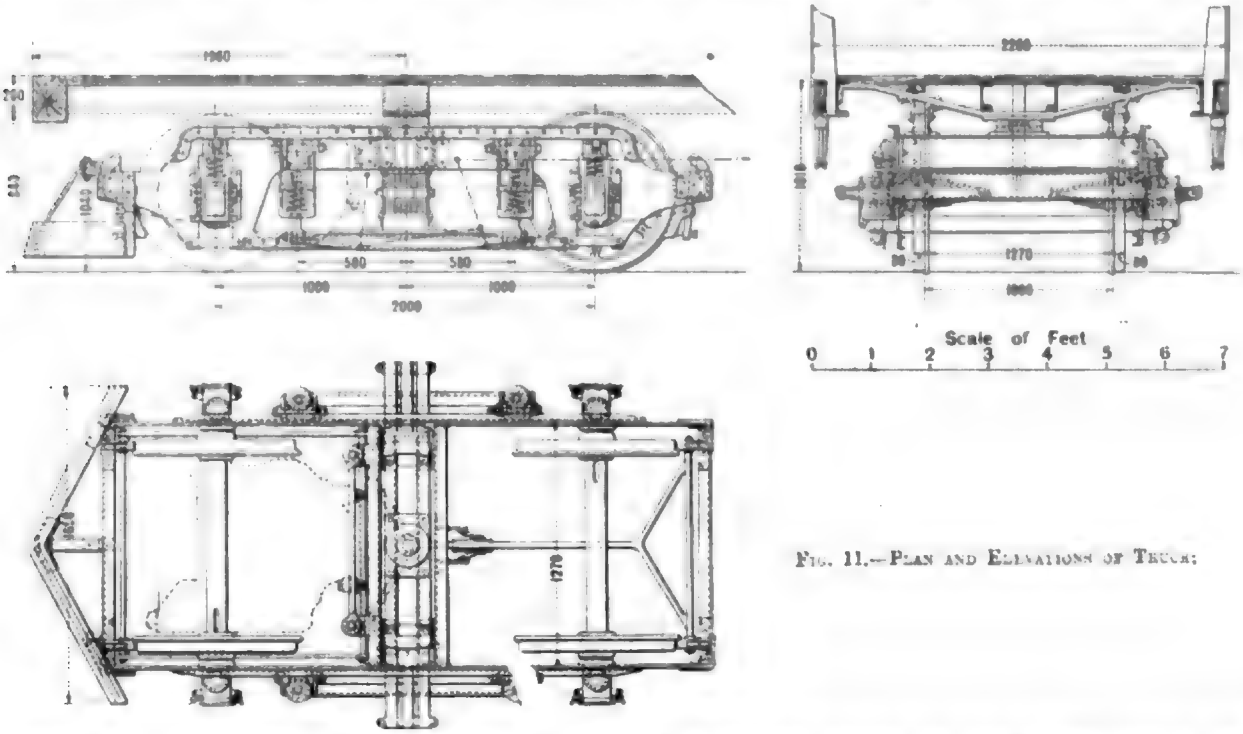

FIG. 11.—PLAN AND ELEVATIONS OF TRUCK.

The switchboard, also by the Société Anonyme Westinghouse, consists of five panels (three generator and two feeder), and is situated on the ground floor at one end of the engine room. The panels are of marble fitted to a steel frame, and having the usual standard forms of instruments, switches, &c. Cables from each of the generators are led into a trench which runs along the engine-room floor in a direction at right angles to the shafts of the generating sets and terminates behind the switchboard. This trench is 15¾in. wide, and is covered by chequer plates.

The condensing plant for the main engine, made by the Nederlandsche Fabrick, Amsterdam, consists of three jet condensers, each capable of condensing 9,000lb. of steam per hour. The pumps are of the vertical type, the cylinders being placed side by side, supported by a cast-iron frame. Directly below are the Edwards pumps, each set being secured by six foundation bolts. The condenser and injector water inlet are situated behind the pumps, the pumps discharging into a large air vessel placed in front of them.

From each of the three engines, an 11in. exhaust pipe is carried across the engine room at a height of 2 metres (6ft. 6¾in.), and through the division wall into the boiler room, where it is supported on the main flue, the three pipes connecting up at a central position, when the pipe is enlarged to 16in., and an automatic relief valve is situated in the vertical pipe leading to the atmosphere, on which there is an exhaust header. A branch pipe is taken from each exhaust pipe into an independent jet condenser, by valves situated conveniently in the piping. This arrangement permits of the operation of any engine in conjunction with any condenser. All condensation in the pipes drains back into the condensers.

Auxiliary units (feed pumps and jet condensers) are worked with saturated steam taken from branches off the main steam pipe, between the stop valves and superheaters. This system of piping is designed on the loop system, alternate boilers being connected to one side of loop. From the loop a main is taken, in which a separator is fixed before entering the engine room, where it branches off to the three condensers. Other branches are taken to supply the three feed pumps.

The exhaust from each of the three condensers joins into a main pipe, which passes through the division wall into the boiler house and runs along the division wall, where it meets a main exhaust pipe from the three feed pumps to the heater, the heater being bye-passed by butterfly valves, which can be operated to divert the steam either through the heater into the atmosphere or into the atmosphere direct. Valves are placed in the piping, so that any unit can be isolated when required.

The inlet water to the jet condensers is taken from the canal through a pipe into a channel reservoir built into the foundations in the engine room, from whence the suction pipes of the condensers take their supply of water. A valve is placed at the pipe entrance to cut off the water supply, if necessary: there is also a manhole at the entrance to the reservoir, for cleaning out purposes.

The 34 cars were made by La Metallurgique at Nivelles, Belgium. They are divided into two compartments, the larger for seating 22 passengers and the other 12, the smaller compartment being for smoking. The cars are vestibuled, and besides being fitted with hand brakes, they are also equipped with the Christensen air brake, supplied by Messrs. R. W. Blackwell & Co. An automatic electric motor works the air pumps. The trucks were also furnished by La Metallurgique, and their special feature is that the swing hangers are pivoted on the outside of the truck frame. This permits of a maximum distance between the supports of the spring plank and a maximum distance from centre to centre of the swing hangers. The result of this construction has been most satisfactory, the trucks being very easing riding, even at the higher speeds of 35 to 40 miles per hour. Union Elektricitäts Gesellschaft motors of 50 H.P. each are fitted to the trucks.

The overhead equipment is on the bow system, with a pressure of 500 to 575 volts. Lattice girder type poles of three different weights—viz., "A," 250 kilos; "B," 317 kilos, and "C," 590 kilos—have been employed. Types "A" and "B" are constructed of two channel sections, bolted together, and "C" is built up of angles. All poles are provided with heel plates and are set two metres in concrete. Bracket arm construction is used throughout, except in Haarlem, and the poles carry both the feeder cables and telephone wires. Bracket arms consist of two channel sections bolted together. Two bare copper conductors, each 194 sq. mm. section, are used as feeder cables, and the trolley wire is 68 sq. mm. in section. On that part of the route from Haarlem to Zandvoort, bow contact is made with two wires simultaneously and in order to equalise the wear on the bow the trolley wire is zig-zagged throughout. The height of the wire from the ground varies in Amsterdam, on the Government Road, and on the E.N.E.T. section; this variation in height at first caused considerable trouble with the bows, but the bow base is now so arranged as to maintain equal tension on the bow at the various heights. The wire is screwed and held up by mechanical clips, which, with the bow, give noiseless running, and the whole overhead construction impresses one with a sense of lightness without loss of strength.

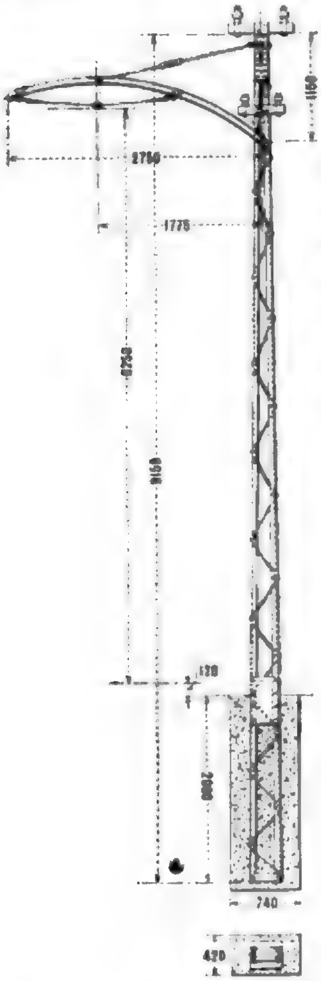

FIG. 12.—TYPE "B" POLE.

Any description of the Amsterdam-Haarlem tramway would be incomplete without some information regarding the safety signalling apparatus on the single-track section. This apparatus operates in such a manner as to prevent two cars entering upon a section at the same time on which traffic passes in both directions, and the end points of which cannot be seen at one time. Fig. 14 shows the wiring diagram of the apparatus and the connections of the same with the contact pieces *a*, *b*, *c*, *d*, and the lamp signals, overhead wiring, and connections to earth. At each switch point, where trains enter and leave, the same contact pieces, *a*, *b*, *c*, *d*, are installed, and by the passing of a car are connected by means of a stirrup with the trolley wire, in consequence of which the current flows for a brief period. This current flows through the windings of an electromagnet *e*, whereby the armature of the magnet is drawn up, and a ratchet *f* is engaged with a toothed wheel *g*, and at the same time this toothed wheel turns through one section of its circumference. Firmly connected to this toothed wheel is a contact wheel *h*, one segment of which, *i*, forms, with the spring *k*, an arrangement for breaking contact in the circuit of the light signals is such a manner that the contact is normally broken; therefore, no light burns when the section is free—that is to say, when no car is passing between A and B. As soon, however, as a car enters the section in the one or other direction, a turning moment acts on the toothed wheel, as above described, the lamps are lit, and when the green lamp is alight the signal is free, and when the red lamp burns the signal is at danger. When, now, the car leaves the single-track section and touches the contact apparatus in connection with the trolley wire, the toothed wheel is turned in the opposite direction, by means of which the spring *k* slips off from the segment and the lamps are extinguished.

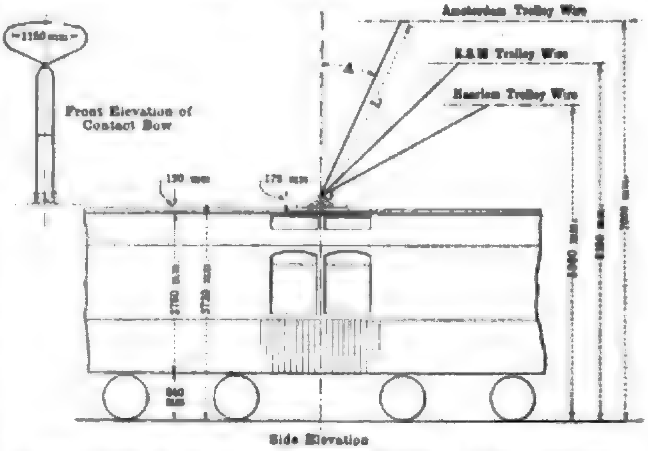

FIG. 13.—DIAGRAM SHOWING VARIATION IN HEIGHT OF TROLLEY WIRES.

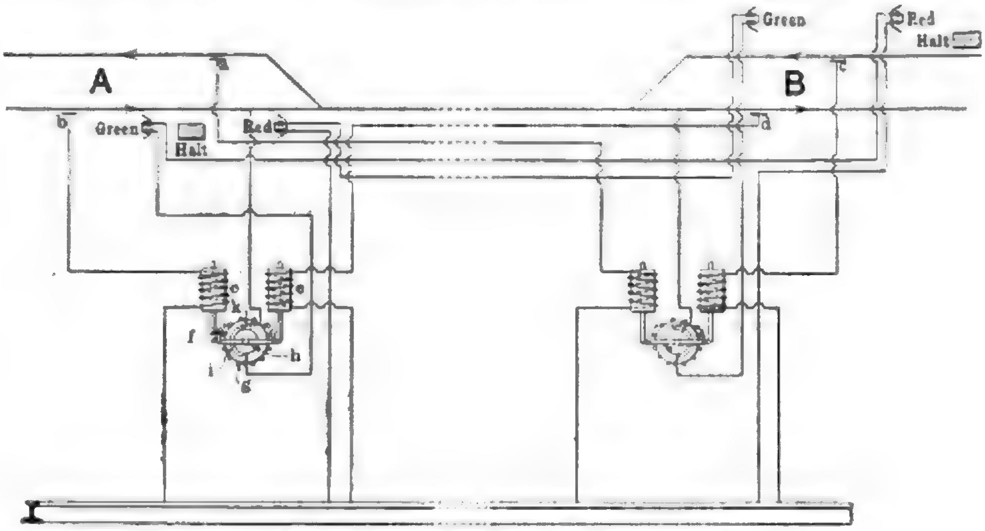

FIG. 14.—DIAGRAM OF SIGNALLING CONNECTIONS.

It is easy to see that the apparatus works in exactly the same manner for several cars following one after the other, and that the number of cars is only limited by the number of teeth on the toothed wheel. By the entrance of each car into the section, the wheel is turned forward one tooth, and by the same car leaving the section it is turned back by one tooth, so that the lamps are extinguished only after all the cars have passed out of the section.

If we now follow the course of a car from A to B, Fig. 14, we shall notice that the car on nearing the point A touches the contact piece *b* and through a stirrup operates the relay as above described. The spring *k* touches the segment, the green lamp lights up and is seen from the car, showing that the track is open. At the point B the red danger signal appears. The section, therefore, is closed for cars coming in the direction of B. After the car has passed the stopping place, it passes through the single-track section and making contact with *d* works the relay in the opposite direction, and the lamps are extinguished. The same process is gone through when cars pass from B to A with this difference, that the relay at B lights or extinguishes the lamps.

For the case when two cars make contact at *b* and *c* simultaneously, red and green lights appear on both sides. In order to prevent any confusion in the mind of the motorman, and in order to give one car the right of way, the signals are spaced as is marked on the wiring diagram, and the stopping place at the point A is located between the signals, and the stopping place before the signals is located at the point B. By this means, when there is accidental simultaneous contact at *b* and *c*, the car coming from B will see only the green light, which means "free track." The car coming from A, however, will see from its stopping place only the red light danger signal, and will, therefore, be obliged to wait until the first car has passed the section. As can be seen from the plan, the apparatus and signal lights are attached to poles near the switch points. The contact pieces through which the relays are operated are spaced a short distance from the signal lights on the span wire. The signal wires, which are made of silicon bronze of 2mm. diameter, are fixed to the poles by means of cross-pieces of angle iron. These cross-arms are placed between the cross-arms carrying the feeder cables and telephone wires. Hard porcelain insulators are used, and the connecting leads to the apparatus, signal lights, contacts, &c., are insulated in the very best possible manner.

In bringing this article to a close we have to express our thanks to Messrs. J. G. White & Co. for their kindness in giving us an opportunity to inspect the work, and for their courtesy in furnishing us with particulars of it. A most enjoyable week-end was spent in Amsterdam at the invitation of Messrs. J. G. White, and the party was entertained with great hospitality by their chief engineer, Mr. A. N. Connett, who has been responsible for the designs of the tramway described above. Mr. Connett's assistant, Mr. **Murphy**, accompanied the party on the outward and return journeys, and was untiring in his efforts to secure the comfort and well-being of all in his charge. Messrs. J. G. White's resident engineer-in-charge was Mr. C. E. Wood, who has had considerable experience in tramway construction both in America and in England, and the engineer and manager of the E.N.E.T. and the E.S.M. is Mr. C. H. Julius.

STAND-BY CHARGES AND MOTOR LOAD DEVELOPMENT.*

BY A. M. TAYLOR.

Gas, Oil and Electric Motors.—As regards the gas engine working with lighting gas, it is fairly safe to say that a gas engine of about 5 B.H.P. (rated) will take at least 25 (to 30) cubic ft. of gas per hour per brake-horse-power when working steadily with about half its rated load; and 25 cubic ft. of gas, at 2s. 1d. per 1,000, costs five-eighths of a penny per brake-horse-power per hour. Unfortunately, however—both for gas, oil and electricity—it is very rarely that an average load can be found corresponding to anything like one-half the full load of the engine, and one-fourth the rated power is a much more frequent proportion. At this output the gas consumption will be of the order of 35 (to 40) cubic ft. per brake-horse-power per hour, costing, at 2s. 1d. per 1,000 cubic ft., 0·875d. per brake-horse-power per hour. To this sum add 0·61d. per hour to cover interest, &c., charges (see Mr. Ade Clark's Paper, read before the Institution of Mechanical Engineers, reprinted in *The Electrician* of August 7, 1903), plus 0·051d. for lubricant, and we have a total of 1·53d. per brake-horse-power per hour. As regards oil motors, taking data from the same source, it would seem that with a 5 H.P. oil motor working at one-fourth the rated load, a sum of 0·3d. per brake-horse-power-hour will cover the cost of crude petroleum and lubricant, and to this add interest, &c., charges, amounting (with a 35 H.P. motor) to 0·92d. per brake horse-power-hour, giving a total of 1·22d. per brake-horse-power per hour. Taking an electric motor on the same basis, and taking the cost of current at 1d. per unit—it will be shown later that 0·70d., and even less, can be offered under certain circumstances—and adding 0·31d. per brake-horse-power-hour for interest, &c., on cost of motor, and 0·051d. for lubricant, we have a total cost of 1·36d. per brake-horse-power per hour, exclusive of wages. The item for wages has been omitted in all the three cases, but it is needless to say that, of the three motors, the electric is that which suffers most from such a method of treatment. It should also be mentioned that the capital charges in all three cases are based on a 35 H.P. motor (see Mr. Ade Clark's Paper), which, again, unduly handicaps the electric motor. For instance, if we add 50 per cent. to the capital charge in each case (to express it in terms of a 5 H.P. motor), the respective costs per brake-horse-power per hour would be: Gas = 1·845d.; oil = 1·68d.; and electric = 1·51d. It is not sufficient for electrical engineers to be content to obtain intermittently-loaded motors; can they not make a bid for continuously-loaded motors also?

"*Continuous*" versus "*Intermittent*" *Motor Loads.*—Let us consider for a moment whether it is possible to tempt consumers having the continuous class of load to come on to the mains by offering an attractive rate—say 1d. per unit—and making up for a possible deficiency of profit by taxing the intermittent class of motors with a higher rate—say 2d. per unit. Such a method of charging has the valuable property that it emphasises the difference between the two classes of load, and attracts consumers by the low rate for the more favoured class. On the other hand, unless the lower rate offered is such as to show economy over gas or oil, few consumers will be added of the class most sought for, while some of the intermittent class of consumers will probably be lost who might otherwise have been gained. The author is also very doubtful whether such a low rate as 1d. unaccompanied by restrictions will pay in the majority of stations which are purely lighting stations, even when coupled, as it should be, with the condition of a high load factor. Take, for instance, the case of a lighting station of the ordinary type in any moderate-sized town, and let it be granted that the overlapping of the motor and lighting loads necessitates extra plant and mains being put down in proportion to that overlapping, or nearly so. Assume, further, that *all* the motor load consists of the class of motor under consideration at the time. Then:

CLASS 1.—MOTOR CONTINUOUSLY LOADED TO ITS FULL OUTPUT.

For nine hours per day (say 50 hours per week).

Maximum load of motor = 1 H.P. = 0·90kw. at consumer's terminals.

Average load of motor = 1 H.P. = 0·90kw. at consumer's terminals.

Hours of running per annum = nine hours per day × 5½ days × 52 weeks = 2,600 (approx.).

Hours of running per quarter = 650.

Diversity factor = 1.

Units sold per annum = 0·90kw. × 2,600 hours = 2,340 units.

Units per horse-power installed per quarter = 585.

1kw. at motor = £70 additional capital outlay at general station.

Interest and sinking fund (at 7 per cent.) = 1,175d. per annum = 1,175/2,600 = 0·45d. per unit.

To this add a proportion of office expenses, say 0·05d. per unit; also of rates, rent and taxes, say 0·03d.; also a proportion of net profit, say 0·10d. per unit, and we get a total, exclusive of depreciation or of works costs, of 0·63d. per unit. About depreciation the author forbears to say anything, as it is rather a vexed question; but as to works cost, let us assume the excellent figure of 0·70d. per unit (= 0·63d. per horse-power), which is surpassed by comparatively few stations in this country which have not got a traction load, and we get a total cost to the consumer of 0·63d. + 0·70d. = 1·33d. per unit. It will be noted that even this does not reach a "bed rock" price of 1d. per unit, which would only be warranted where the "works cost" was as low as 0·4d. per unit, and then only in the case of motors consuming at least 585 units per horse-power installed for quarter.

We now come to—

CLASS 2.—MOTOR INTERMITTENTLY LOADED WITH VARYING LOADS.

Max. load = 1 H.P. = 0·90kw. at consumer's terminals.

Average load = ½ H.P. during hours of running = say ½kw.

Hours of running per annum = 4½ hours per day × 5½ days × 52 weeks = 1,300.

Hours of running per quarter = 325.

Units sold per annum = ½kw. × 1,300 hours = 650 units.

Units per horse-power installed per quarter = 162.

1kw. at motor = £70 additional capital outlay at general station.

Interest and sinking fund (at 7 per cent.) = 1,175d. per annum on £70 = 1,175/650 = 1·81d. per unit.

Now, diversity factor = anything between 1 and 4, = say, 1·5 as a safe figure.

Hence, revised interest, &c., charge = 1·81d./1·5 = 1·21d. per unit.

Add to this:—Office expenses = say, 0·10d.; rates, rent, and taxes = say, 0·05d.; profit = say, 0·15d.; total, exclusive of "works cost" = 1·51 per unit. Add "works cost" = 0·70d. × 1¼ (on account of diversity factor) = say, 0·90d. per unit. Total cost, exclusive of depreciation = 2·41 per unit.

The above is for the case of a consumption of 162 units per horse-power installed per quarter, corresponding to an average of one-being very easing riding, even at the higher speeds of 35 to 40 miles per hour. Union Elektricitäts Gesellschaft motors of 50 H.P. each are fitted to the trucks.

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* Abstract of a Paper read before the Birmingham Local Section of the Institution of Electrical Engineers on Dec. 14th.

The overhead equipment is on the bow system, with a pressure of 500 to 575 volts. Lattice girder type poles of three different weights—viz., "A," 250 kilos; "B," 317 kilos, and "C," 590 kilos—have been employed. Types "A" and "B" are constructed of two channel sections, bolted together, and "C" is built up of angles. All poles are provided with heel plates and are set two metres in concrete. Bracket arm construction is used throughout, except in Haarlem, and the poles carry both the feeder cables and telephone wires. Bracket arms consist of two channel sections bolted together. Two bare copper conductors, each 194 sq. mm. section, are used as feeder cables, and the trolley wire is 68 sq. mm. in section. On that part of the route from Haarlem to Zandvoort, bow contact is made with two wires simultaneously and in order to equalise the wear on the bow the trolley wire is zig-zagged throughout. The height of the wire from the ground varies in Amsterdam, on the Government Road, and on the E.N.E.T. section; this variation in height at first caused considerable trouble with the bows, but the bow base is now so arranged as to maintain equal tension on the bow at the various heights. The wire is screwed and held up by mechanical clips, which, with the bow, give noiseless running, and the whole overhead construction impresses one with a sense of lightness without loss of strength.

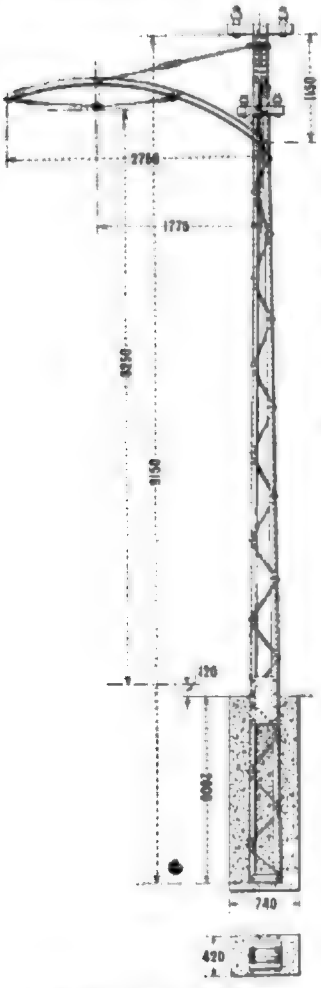

Fig. 12.—Type "B" Pole.

Any description of the Amsterdam-Haarlem tramway would be incomplete without some information regarding the safety signalling apparatus on the single-track section. This apparatus operates in such a manner as to prevent two cars entering upon a section at the same time on which traffic passes in both directions, and the end points of which cannot be seen at one time. Fig. 14 shows the wiring diagram of the apparatus and the connections of the same with the contact pieces *a*, *b*, *c*, *d*, and the lamp signals, overhead wiring, and connections to earth. At each switch point, where trains enter and leave, the same contact pieces, *a*, *b*, *c*, *d*, are installed, and by the passing of a car are connected by means of a stirrup with the trolley wire, in consequence of which the current flows for a brief period. This current flows through the windings of an electromagnet *e*, whereby the armature of the magnet is drawn up, and a ratchet *f* is engaged with a toothed wheel *g*, and at the same time this toothed wheel turns through one section of its circumference. Firmly connected to this toothed wheel is a contact wheel *h*, one segment of which, *i*, forms, with the spring *k*, an arrangement for breaking contact in the circuit of the light signals in such a manner that the contact is normally broken; therefore, no light burns when the section is free—that is to say, when no car is passing between A and B. As soon, however, as a car enters the section in the one or other direction, a turning moment acts on the toothed wheel, as above described, the lamps are lit, and when the green lamp is alight the signal is free, and when the red lamp burns the signal is at danger. When, now, the car leaves the single-track section and touches the contact apparatus in connection with the trolley wire, the toothed wheel is turned in the opposite direction, by means of which the spring *k* slips off from the segment and the lamps are extinguished.

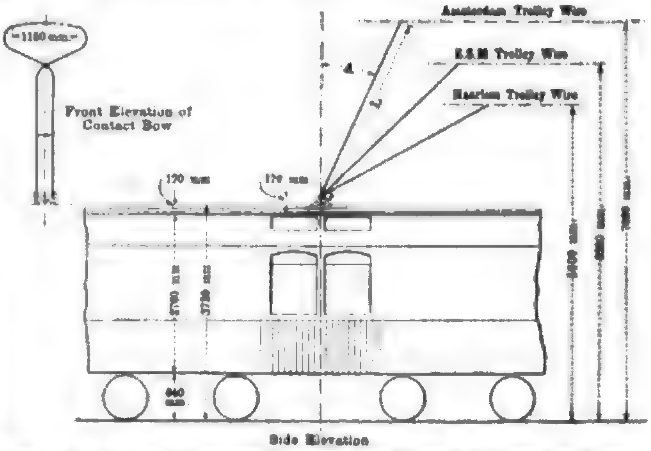

Fig. 13.—Diagram showing Variation in Height of Trolley Wires.

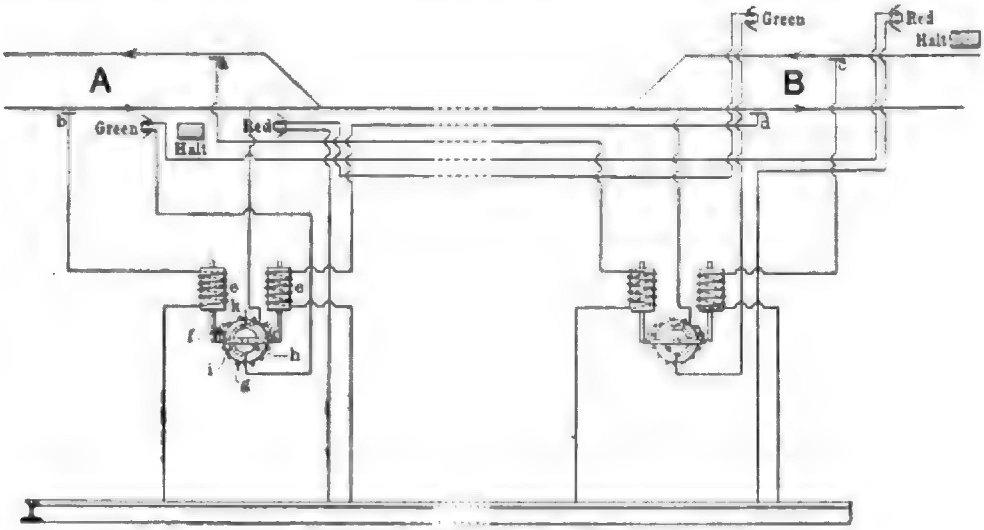

Fig. 14.—Diagram of Signalling Connections.

It is easy to see that the apparatus works in exactly the same manner for several cars following one after the other, and that the number of cars is only limited by the number of teeth on the toothed wheel. By the entrance of each car into the section, the wheel is turned forward one tooth, and by the same car leaving the section it is turned back by one tooth, so that the lamps are extinguished only after all the cars have passed out of the section.

If we now follow the course of a car from A to B, Fig. 14, we shall notice that the car on nearing the point A touches the contact piece *b* and through a stirrup operates the relay as above described. The spring *k* touches the segment, the green lamp lights up and is seen from the car, showing that the track is open. At the point B the red danger signal appears. The section, therefore, is closed for cars coming in the direction of B. After the car has passed the stopping place, it passes through the single-track section and making contact with *d* works the relay in the opposite direction, and the lamps are extinguished. The same process is gone through when cars pass from B to A with this difference, that the relay at B lights or extinguishes the lamps.

For the case when two cars make contact at *b* and *c* simultaneously, red and green lights appear on both sides. In order to prevent any confusion in the mind of the motorman, and in order to give one car the right of way, the signals are spaced as is marked on the wiring diagram, and the stopping place at the point A is located between the signals, and the stopping place before the signals is located at the point B. By this means, when there is accidental simultaneous contact at *b* and *c*, the car coming from B will see only the green light, which means "free track." The car coming from A, however, will see from its stopping place only the red light danger signal, and will, therefore, be obliged to wait until the first car has passed the section. As can be seen from the plan, the apparatus and signal lights are attached to poles near the switch points. The contact pieces through which the relays are operated are spaced a short distance from the signal lights on the span wire. The signal wires, which are made of silicon bronze of 2mm. diameter, are fixed to the poles by means of cross-pieces of angle iron. These cross-arms are placed between the cross-arms carrying the feeder cables and telephone wires. Hard porcelain insulators are used, and the connecting leads to the apparatus, signal lights, contacts, &c., are insulated in the very best possible manner.

In bringing this article to a close we have to express our thanks to Messrs. J. G. White & Co. for their kindness in giving us an opportunity to inspect the work, and for their courtesy in furnishing us with particulars of it. A most enjoyable week-end was spent in Amsterdam at the invitation of Messrs. J. G. White, and the party was entertained with great hospitality by their chief engineer, Mr. A. N. Connett, who has been responsible for the designs of the tramway described above. Mr. Connett's assistant, Mr. Murphy, accompanied the party on the outward and return journeys, and was untiring in his efforts to secure the comfort and well-being of all in his charge. Messrs. J. G. White's resident engineer-in-charge was Mr. C. E. Wood, who has had considerable experience in tramway construction both in America and in England, and the engineer and manager of the E.N.E.T. and the E.S.M. is Mr. C. H. Julius.

STAND-BY CHARGES AND MOTOR LOAD DEVELOPMENT.*

BY A. M. TAYLOR.

Gas, Oil and Electric Motors.—As regards the gas engine working with lighting gas, it is fairly safe to say that a gas engine of about 5 B.H.P. (rated) will take at least 25 (to 30) cubic ft. of gas per hour per brake-horse-power when working steadily with about half its rated load; and 25 cubic ft. of gas, at 2s. 1d. per 1,000, costs five-eighths of a penny per brake-horse-power per hour. Unfortunately, however—both for gas, oil and electricity—it is very rarely that an average load can be found corresponding to anything like one-half the full load of the engine, and one-fourth the rated power is a much more frequent proportion. At this output the gas consumption will be of the order of 35 (to 40) cubic ft. per brake-horse-power per hour, costing, at 2s. 1d. per 1,000 cubic ft., 0·875d. per brake-horse-power per hour. To this sum add 0·61d. per hour to cover interest, &c., charges (see Mr. Ade Clark's Paper, read before the Institution of Mechanical Engineers, reprinted in *The Electrician* of August 7, 1903), plus 0·051d. for lubricant, and we have a total of 1·53d. per brake-horse-power per hour. As regards oil motors, taking data from the same source, it would seem that with a 5 H.P. oil motor working at one-fourth the rated load, a sum of 0·3d. per brake-horse-power-hour will cover the cost of crude petroleum and lubricant, and to this add interest, &c., charges, amounting (with a 35 H.P. motor) to 0·92d. per brake horse-power-hour, giving a total of 1·22d. per brake-horse-power per hour. Taking an electric motor on the same basis, and taking the cost of current at 1d. per unit—it will be shown later that 0·70d., and even less, can be offered under certain circumstances—and adding 0·31d. per brake-horse-power-hour for interest, &c., on cost of motor, and 0·051d. for lubricant, we have a total cost of 1·36d. per brake-horse-power per hour, exclusive of wages. The item for wages has been omitted in all the three cases, but it is needless to say that, of the three motors, the electric is that which suffers most from such a method of treatment. It should also be mentioned that the capital charges in all three cases are based on a 35 H.P. motor (see Mr. Ade Clark's Paper), which, again, unduly handicaps the electric motor. For instance, if we add 50 per cent. to the capital charge in each case (to express it in terms of a 5 H.P. motor), the respective costs per brake-horse-power per hour would be: Gas = 1·845d.; oil = 1·68d.; and electric = 1·51d. It is not sufficient for electrical engineers to be content to obtain intermittently-loaded motors; can they not make a bid for continuously-loaded motors also?

"Continuous" versus "Intermittent" Motor Loads.—Let us consider for a moment whether it is possible to tempt consumers having the continuous class of load to come on to the mains by offering an attractive rate—say 1d. per unit—and making up for a possible deficiency of profit by taxing the intermittent class of motors with a higher rate—say 2d. per unit. Such a method of charging has the valuable property that it emphasises the difference between the two classes of load, and attracts consumers by the low rate for the more favoured class. On the other hand, unless the lower rate offered is such as to show economy over gas or oil, few consumers will be added of the class most sought for, while some of the intermittent class of consumers will probably be lost who might otherwise have been gained. The author is also very doubtful whether such a low rate as 1d. unaccompanied by restrictions will pay in the majority of stations which are purely lighting stations, even when coupled, as it should be, with the condition of a high load factor. Take, for instance, the case of a lighting station of the ordinary type in any moderate-sized town, and let it be granted that the overlapping of the motor and lighting loads necessitates extra plant and mains being put down in proportion to that overlapping, or nearly so. Assume, further, that *all* the motor load consists of the class of motor under consideration at the time. Then:

CLASS 1.—MOTOR CONTINUOUSLY LOADED TO ITS FULL OUTPUT.

For nine hours per day (say 50 hours per week).

Maximum load of motor = 1 H.P. = 0·90kw. at consumer's terminals.

Average load of motor = 1 H.P. = 0·90kw. at consumer's terminals.

Hours of running per annum = nine hours per day × 5½ days × 52 weeks = 2,600 (approx.).

Hours of running per quarter = 650.

Diversity factor = 1.

Units sold per annum = 0·90kw. × 2,600 hours = 2,340 units.

Units per horse-power installed per quarter = 585.

1kw. at motor = £70 additional capital outlay at general station.

Interest and sinking fund (at 7 per cent.) = 1,175d. per annum = 1,175/2,600 = 0·45d. per unit.

To this add a proportion of office expenses, say 0·05d. per unit; also of rates, rent and taxes, say 0·03d.; also a proportion of net profit, say 0·10d. per unit, and we get a total, exclusive of depreciation or of works costs, of 0·63d. per unit. About depreciation the author forbears to say anything, as it is rather a vexed question; but as to works cost, let us assume the excellent figure of 0·70d. per unit (= 0·63d. per horse-power), which is surpassed by comparatively few stations in this country which have not got a traction load, and we get a total cost to the consumer of 0·63d. + 0·70d. = 1·33d. per unit. It will be noted that even this does not reach a "bed rock" price of 1d. per unit, which would only be warranted where the "works cost" was as low as 0·4d. per unit, and then only in the case of motors consuming at least 585 units per horse-power installed for quarter.

We now come to—

CLASS 2.—MOTOR INTERMITTENTLY LOADED WITH VARYING LOADS.

Max. load = 1 H.P. = 0·90kw. at consumer's terminals.

Average load = ½ H.P. during hours of running = say ½kw.

Hours of running per annum = 4½ hours per day × 5½ days × 52 weeks = 1,300.

Hours of running per quarter = 325.

Units sold per annum = ½kw. × 1,300 hours = 650 units.

Units per horse-power installed per quarter = 162.

1kw. at motor = £70 additional capital outlay at general station.

Interest and sinking fund (at 7 per cent.) = 1,175d. per annum on £70 = 1,175/650 = 1·81d. per unit.

Now, diversity factor = anything between 1 and 4, = say, 1·5 as a safe figure.

Hence, revised interest, &c., charge = 1·81d./1·5 = 1·21d. per unit.

Add to this:—Office expenses = say, 0·10d.; rates, rent, and taxes = say, 0·05d.; profit = say, 0·15d.; total, exclusive of "works cost" = 1·51 per unit. Add "works cost" = 0·70d. × 1¼ (on account of diversity factor) = say, 0·90d. per unit. Total cost, exclusive of depreciation = 2·41 per unit.

The above is for the case of a consumption of 162 units per horse-power installed per quarter, corresponding to an average of one-fourth of the horse-power installed during the nine working hours of the day; a figure not greatly above the average in manufacturing towns—in some cases even below it. The author would suggest for intermittent users a charge based on one-fourth of the horse-power during the hours of running, with substantial discounts according to the number of units consumed per quarter per horse-power installed. It must be borne in mind that where power is supplied through sub-stations it cannot be done at the above figures.

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* Abstract of a Paper read before the Birmingham Local Section of the Institution of Electrical Engineers on Dec. 14th.

"*Non-interest-paying*" *Motor Load.*—It would seem to be impossible in ordinary electric lighting stations worked under municipal conditions (*i.e.*, limited in size by the size of the town whose needs they supply) to offer the supply of power during the day time at rates below 1d. per unit on a sound financial basis, except subject to certain restrictions. Referring to the motors typified under classes 1 and 2, it will be seen that, apart from interest charges, the respective costs would be only 0·88d. and 1·2d. per unit. If an electric light station were to start charging rates as low as these, the regulation amounts for interest and sinking fund and the usual "net profits" would still be maintained for the first four or five or more years, and a fine motor business would be built up. After the fourth or fifth year, however—the actual time depending on the normal rate of growth of the lighting business—it would be found that "extensions" in plant and mains begin to be required very rapidly, and the price for motive power would then have to be raised. The safer course is to be found, it seems to the author, in offering these rates subject to such stipulations as shall protect the scheme from financial unsoundness. Briefly the stipulation to be made is that the consumer shall enter into an agreement with the supply company, or the corporation, to take no current for motive power purposes between certain hours during the winter months, in return for these extremely low rates, subject to the penalty of being put on a two-rate meter combined with a time-switch in the event of the offence being persisted in. The company's or corporation's inspector to have the right to enter premises without notice (as he has now) for purposes of ascertaining compliance with conditions. The hours at which current would be cut off would be as follows:—September, 5:30 p.m.; October, 4:30 p.m.; November, 3·30 p.m.; December, 3 p.m.; January, 3:30 p.m.; February, 4:30 p.m.; March, 5:30 p.m. It may be said that such conditions will deter anyone from taking current for motors. There are two obvious answers to this—viz., (1) that if this is so, there can at least be no risk, in offering these conditions, of the station being swamped with a motor load which might exceed even its "midday" capacity; (2) the station must, at least, better its present motor load, for it is inconceivable that, in any industrial town of moderate size, there shall not be some consumers who could afford to have their power cut off at certain hours in the winter. Further, if the rumour as to the success of the Montreal Supply business (as given in *The Electrician* for September 30, 1904), is to be trusted—and the author knows no reason why it should not—a sale of 85,000,000 units annually, mostly for motive power, in a town whose population is only some 250,000 to 300,000, has been built up during the last few years, in great part, on these very lines. By the side of this the 2,000,000 units sold at Bradford in 1902—a town of equal population—shrinks into insignificance.

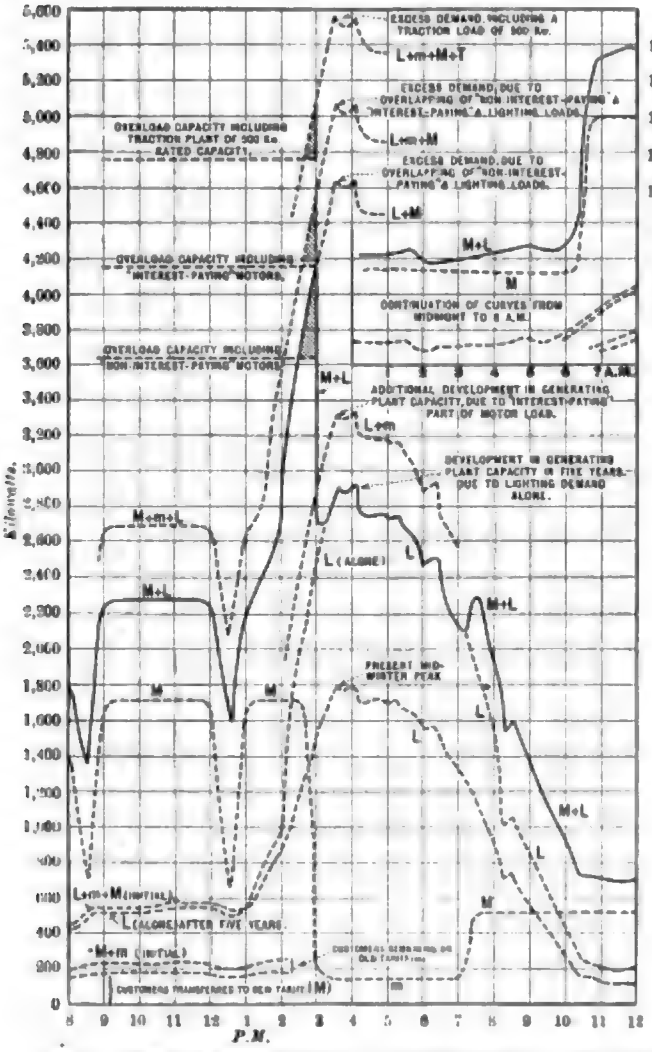


Fig. 1.—Diagram showing Motor Load Limit imposed by Day Fogs on a steadily-growing Lighting Load combined with a rapidly-growing Motor Load, after 5 years.

Limit of Station Plant Dependent on Day Fogs.—This raises a question on the other side: "If the development is likely to be so rapid, what is to protect the lighting load from extinction in the event of a day fog?" This difficulty is not so easily met, but a reference to Fig. 1 shows that, where the lighting load undergoes steady development year by year—10 per cent. is here assumed—and the motor load starts from small beginnings, as in the vast majority of lighting stations at the present time, it takes several years for the motor load to overtake the lighting load to such an extent as to imperil the lighting in the event of a day fog. The author does not speak at random when he states that in most large towns, except perhaps London and one or two others, it will be found that the worst day fog never gives a demand, for lighting alone, greater than 60 per cent. of the worst "peak" of the following December. In Fig. 1 this is taken as a basis, and it is found that 1,700kw. of motor load, representing about 5,500,000 units per annum, can be added to the output of a station whose initial "peak" is only 1,800kw., before the limit of the capacity of the plant to deal with a day fog is reached. This assumes a 60 per cent. motor load development annually for five years—very nearly equal to the magnificent results obtained at Bradford between 1896 and 1901. If such an extremely rapid motor load should not be realised, owing to the restrictive conditions, the period of development will be longer before the limit is reached, and the limit itself will also be raised in consequence. Fig. 2 shows the same principle applied to a lighting load which refuses to be developed. Here the limit is reached in four years, for the same rate of motor load development as before. The annual motor units thus added are in this case only 3,360,000, and the kilowatts are 1,060. But most engineers will concede that a 10 per cent. annual growth in the lighting demand alone is not at all an exaggerated estimate of probabilities. Hence we may reckon upon the 5½ million units of Fig. 1; for the rate of growth of the motor load is certainly not under-estimated, but probably the reverse.

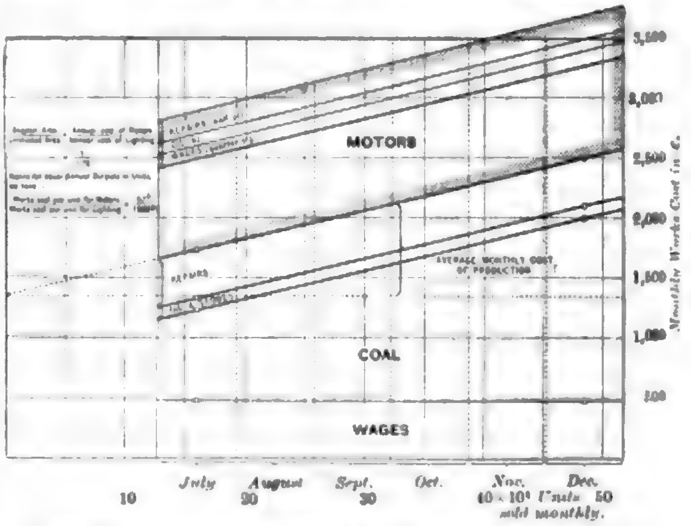


Fig. 5.—Diagram showing relative Works Costs per Unit for (Day) Motor Load and for Lighting Load.

Taking all things into consideration, the author feels safe in suggesting that the risk in offering to consumers their power free of interest charges, but subject to the "excepted hours" condition is a very slight one, even where there is no traction load, and it is still less where there is.

Suggestion for meeting Consumers who object to the "Excepted-Hour" Conditions.—In those cases in which it is imperative to consumers to have the supply at all hours, it would seem practicable to offer some such arrangement as the following:—Coupled to the consumer's motor would be a small dynamo of very low voltage, shunt-wound and connected up with, say, half-a-dozen or a dozen cells of moderate size. During the day the motor, which would normally be working at, say, one-half to one-fourth of its full power, could spare power to drive the dynamo to charge the cells at a low rate. As the time of evening peak load drew near, a time switch in the 500-volt motor circuit would first insert resistance into the field of the dynamo; then, as the latter began to act as motor, driven from the cells, the switch would open the circuit of the 500-volt motor and not close again till, say, 5 p.m. It would also be practicable to arrange the time switch to be controlled by current traversing lamps which were certain to be lighted during a fog peak: so that the 500-volt motor was disconnected from the mains while the fog was on. This would relieve the generating station of any demand on account of fog peaks for those consumers who had the arrangement installed; and would, to that extent, extend the motor load development limit of the station indefinitely. The special dynamo, the battery, and accessories, could be easily installed and maintained free of charge by the company or the corporation. The author estimates that only some 0·25d. to 0·8d. would be necessary to be charged additional on each unit sold, to pay for and maintain the dynamo and battery, in the case of a 5 H.P. motor working on the average at half its rated load. If the consumer bought his own battery and dynamo, the maintenance of the battery would only cost him about 0·06d. per unit. The battery for a 5 H.P. motor would occupy a floor space no greater than is usually occupied by a bicycle, and should be easily accommodated in the basement of a building. This suggestion has the advantage over what would, at first sight, appear to be the most obvious course (viz., to put the battery at the central station), in that any battery put down at the station would not save the mains from having to be extended.

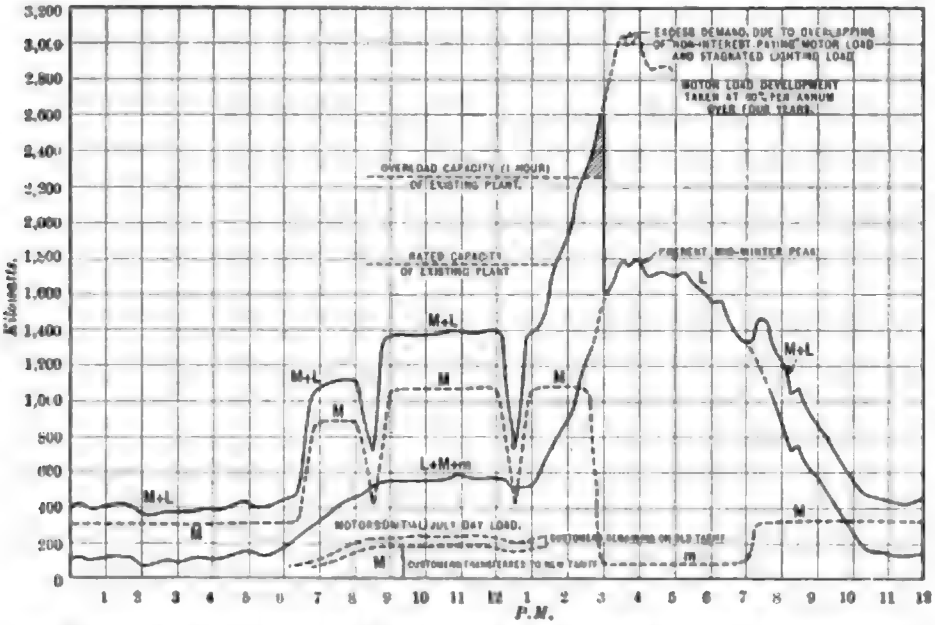


FIG. 2.—Diagram showing Motor Load Limit imposed by Day Fogs on a stagnated Lighting Load, combined with a rapidly-growing Motor Load, after 4 years.

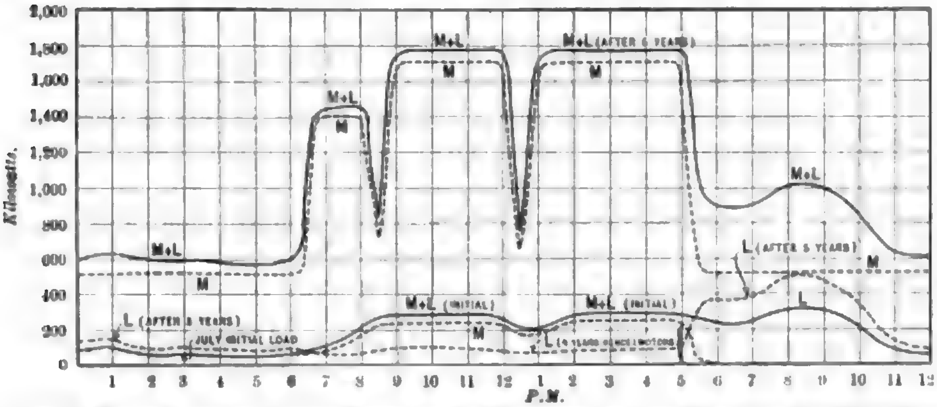


FIG. 3.—Diagram showing Relative Proportions (in Midsummer) of a rapidly-growing Motor Load and a steadily-growing Lighting Load, after 5 years.

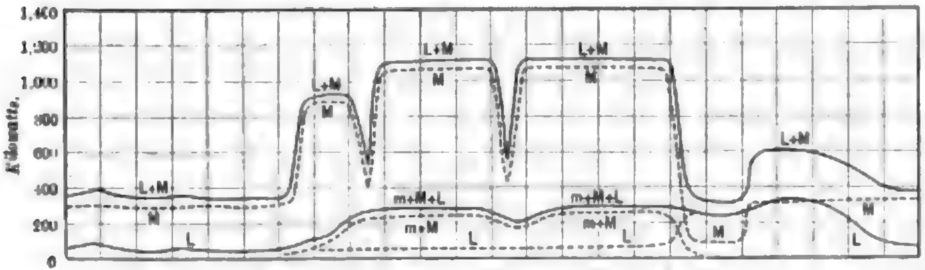


FIG. 4.—Diagram showing Relative Proportions (in Midsummer) of a rapidly-growing Motor Load and a stagnated Lighting Load, after 4 years.

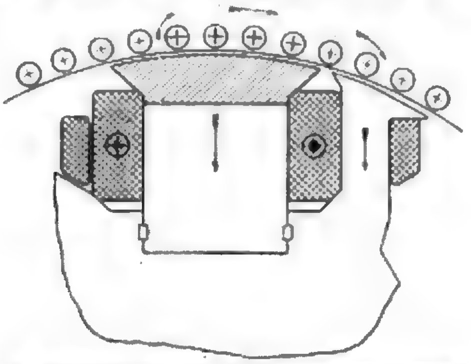
Reduction in Works Cost to secure "Non-interest-paying" Motor Load.—Hitherto in this Paper it has been assumed that it was correct to charge the motor load with the full present value of the "Works Cost." Such a course, however, the author believes to be quite unnecessary. The charge on account of wages may be almost entirely dropped—may, at any rate, be safely reduced to, say, quite 25 per cent. of its present cost in any station about to make the change in its policy. This item, in stations of about 2,000kw. capacity, is frequently of the order of 0·2d. per unit, especially where there is no traction load. This might be reduced to 0·05d. per unit. The item of repairs Mr. Arthur Wright (see *The Electrician*, December 27, 1901) considers is capable of division into "production" and "preparation" charges in the ratio of 1 to 3 in the case of Brighton. Let us be content to take a ratio of 1 to 2 as being safer. A figure frequently obtained for this item is 0·2d. per unit; let us then take 0·10d. per unit. Oil and stores we may put at 0·05d. per unit. We now come to the coal bill. Mr. Arthur Wright, in his very interesting and valuable Paper read before this Institution in 1901, represents the monthly costs plotted against sales by a diagram (Fig. 5), which I have modified to suit another station, and in which you will find bracketed a monthly sum representing the average "production cost" for coal alone obtained on Mr. Wright's system, for an average month's output.

Suppose now that the station were to take up a motor load of an average number of units monthly equal to an average month's lighting output; we can then draw a line parallel to the upper boundary of the diagram and at a height above it equivalent to the average monthly cost of "production," and the area thus added (shaded and marked "Motors" in Fig. 5) will represent the additional total cost for six months. Now the relative areas of these figures are as 1 to 1·75, and each corresponds with an equal number of units generated; hence the costs per unit are in the same ratio, and if the lighting cost had averaged 1d. per unit we should be justified in charging only 0·57d. per unit for the complete "works cost" of the motor load. It is, of course, plain that the relative areas of the two figures depend very greatly—in fact, if we take repairs, wages, and oil as constant values, as has been done in this diagram, they will depend *entirely* —on the "stand-by" losses of the station; and in a station, for example, that has a traction load the "motor" cost would bear a larger proportion to the existing works cost. The diagram is, however, given to illustrate the principle, and must not be taken as representative unless for a station that has nothing but a lighting load. As indicated above, it will be seen that if the items for wages, repairs and oil be omitted from the above diagram, the actual sum bracketed remains true for the coal alone for the motor load, and the ratio between this and the average total cost for coal would, in the case taken, be as 1·1·5. Hence, if the station has been costing 0·45d. per unit for coal with the lighting load alone, we could assess the coal item at 0·3d. for the motor load. This the author considers the better way of estimating this item. Summing up the items for the works cost we thus have: Wages = 0·05d., repairs = 0·10d., oil and stores = 0·05d., coal = 0·3d.; total works cost = 0·5d. Add to this, for the less favourable class of consumer, as follows:—Office expenses = 0·10d., rates, rent, takes = 0·05d., net profit 0·15d.; and we have: Total charge to (non-interest-paying) consumer = 0·5d. + 0·30d. = 0·80d. per unit.

(*To be continued.*)

A NEW METHOD OF COMPENSATING AND COMPOUNDING ALTERNATORS.*

The following is a description of the author's compensating method, in which the field excitation is maintained constant and in which use is made of the armature reaction to strengthen the field on load. The illustration shows the arrangement of the generator field circuit. Each pole consists of at least two parts, a saturated part and an unsaturated part. The first is wound with a magnetising coil, and there may or may not be another magnetising coil placed around the whole pole. This second winding may be necessary for varying the normal voltage of the machine. The broad pole is very highly saturated in the region marked with shaded lines, while the narrow pole on the right is unsaturated, and at no load is unmagnetised. The field rotates counter-clockwise, and as the pole depicted in the figure is a south pole, it gives rise to an E.M.F. in the conductors above it, which is in the sense indicated by the crosses, that is to say, away from the observer. Any current in the armature which is in phase or nearly in phase with this E.M.F. will tend to demagnetise the saturated part of the pole and magnetise the unsaturated part. The flux from the saturated part cannot be changed to any great extent, while the unsaturated part becomes highly magnetised by armature reaction and increases the E.M.F. of the armature. The British Westinghouse Company have thoroughly tested this type of machine, and in all cases where the power-factor is not lower than 0·85 they find it possible to make a machine hold its voltage from no load to full load. In the great majority of cases in which alternate-current generators are used, the power-factor is higher than 0·85, so that a compound alternator without commutator or any complications can be supplied. The armature, in increasing the E.M.F., is instantaneous in its action. In cases where the power-factor ranges between 0·9 and 0·95, as in a great number of lighting stations, considerable over-compounding can be guaranteed. The following are the results of a test made on a 150kw. three-phase generator, 415 to 440 volts, 25 periods, 500 revs. per min. The generator was belted to a shunt-wound direct-current motor, and loaded on a rack of iron wire (power factor 0·97). With 28 amperes in the main field coils, and no current in the auxiliary field, the voltage was 416 at no load. On throwing on a load of 150kw., and correcting the speed, the voltage rose to 445 volts, showing a compounding of 6 per cent. between no load and full load. On another test the main field current was diminished and the voltage brought up on the auxiliary field winding. The rise in voltage on load was not so great as before. By fixing the current in the two windings at a suitable figure, it was found possible to make the machine hold its voltage exactly between no load and full load. The generator was then loaded on 100kw. rotary converter through transformers. The rotary ran well in parallel, loaded and unloaded, at power-factors varying between unity and 0·7. The synchronising current could be reduced to a value too small to read upon the instruments by adjusting the field of the rotary. When the rotary was loaded so as to produce full load in the generator with unity power-factor, a rise in voltage of 10 per cent. was obtained between no load and full load. At a power-factor of 0·87 the voltage was maintained constant at all loads. The drawback to this method of compounding is that as the power-factor decreases the magnetising effect of the armature also decreases, but this objection is not so serious as might at first be supposed, for in the majority of cases the generator is carrying all day the greater part of its non-inductive load. Take the case, for instance, of a station supplying principally incandescent lamps. All day the generator has to supply the magnetising current to transformers, and when the load comes on suddenly in the evening the power-factor increases, so that a generator of the type described would have exactly the right kind of regulation. Similarly, where a generator is loaded with induction motors running light, a load on the motor increases the power-factor, and again the generator behaves well. In cases where sudden and large draughts of power at low power-factor are required, this type of generater would not be suitable.



Mr. M. Walker's Method of Compounding Alternators.

It may appear at first sight that a generator with a field magnet shaped as shown in the illustration would not have a good E.M.F. wave form. It has been found that by proper design the wave form at full load can be made to approximate very closely a sine wave; in fact, more closely than the wave form of the old simple type generator. At no load the wave form will not depart much from the true sine wave, but will have a slightly peaked form—the form, in fact, which has been found to be most economical with transformers working on light loads.

The gentlemen who took part in the discussion which followed the Paper were Messrs. Taite (chairman), Andrews, Cowbrough, Firth, Dr. Rhodes and Dr. Bowman. On the whole, the author's views and conclusions were agreed to, although the mathematical part of the Paper had apparently been digested by a few only. Mr. Cowbrough thought that the simple form of alternator, with hand regulation, would be found more satisfactory than any of the automatic devices described. Both Dr. Rhodes and Dr. Bowman were of the opinion that all methods of regulation which made use of unidirectional currents were wrong and that better results would be obtained if the magnetic flux of the fields were directly influenced by the alternating currents.

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* From a Paper on "Compensated Alternate-current Generators," by Mr. Miles Walker, recently read before the Manchester Local Section of the Institution of Electrical Engineers.

THE BRADFORD BREAKDOWN.

The electrical advisor to the Board of Trade has reported as follows with regard to the recent breakdown at Bradford:—

The breakdown of electric cables at Bradford on the 8th ult has been so fully described by the report of the engineer that no further inquiry appears to be necessary. The breakdown was not accompanied by any injury to the public, though two employés of the electrical department were slightly hurt; but risk of serious injury was involved.

The chief causes appear to have been:—

1. The lead sheaths of the cables are not electrically continuous across the joint boxes.

2. Leakage currents have been allowed to pass and appear to have been undetected, or, if detected, they had not been localised or removed.

3. No fuses had been provided.

4. No arrangement had been made for preventing an extensive stoppage of supply

Regulation 8 of the general regulations provides that "the leakage current shall not under any conditions exceed one-thousandth part of the maximum supply current; and suitable means shall be provided for the immediate indication and localisation of leakage. Every leakage shall be remedied without delay.

"Every such circuit shall be tested for insulation at least once in every week and the undertakers shall duly record the results of the testings."

It appears that this has been neglected.

Regulation 28 provides that "Where any electric line crosses, or is in proximity to, any metallic substance, special precautions shall be taken by the undertakers against the possibility of any electrical discharge to the metallic substance from the line or from any metal conduit, pipe or casing enclosing the line."

It appears that damage was done to iron plates forming the bottom of a bridge, and to a gas main, owing to failure to comply with this regulation.

Regulation 29 provides that "All metal conduits, pipes or casings containing any electric line shall be efficiently connected with earth; and shall be so jointed and connected across all street boxes and other openings as to make good electrical connection throughout their whole length."

The lead sheaths of the cables should have been so jointed and connected.

I recommend that the system of distributing mains in Bradford should be separated into sections corresponding approximately to different feeders, and that these sections should be inter-connected only through suitable circuit breakers or fuses arranged so as to be easily inspected.

It is desirable that the switchboard at the works should be arranged so that the current returning from any "middle-wire" feeder may be measured and so that, if necessary, in case of leakage, the feeders to any section or district of the city may be disconnected from the main "'bus bars," and may be supplied by a separate generating set, in order that the leakage may be removed from the main "'bus bars."

(Signed) A. P. Trotter.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Conductivity of Very Dilute Acids.—The great difficulty in obtaining an exact value for the equivalent conductivity of completely dissociated acids lies in the large effect of impurities of the water on the conductivity of even strong acids in very dilute solutions. H. M. Goodwin and R. Haskell have, therefore, tested the equivalent conductivity of the hydrogen ion, as determined by Kohlrausch and by Noyes and Sammet with a view to clearing up the discrepancy between them. They measured the electrical conductivity at 18deg. of very dilute (0·0001 to 0·02 normal) hydrochloric and nitric acid solutions, made by adding to a known weight of water successive portions of 0·01 normal acid. To eliminate the effect of the impurities of the water, two methods of computation of the equivalent conductivity were used. In both of these the assumption is involved that the total effect of the acid and impurities on the conductance of each other is produced when a relatively small quantity of acid has been added to the water. The experiments themselves furnish evidence of the correctness of this assumption. In the first method the increase of the specific conductance over this initial value divided by increase of concentration is regarded as the equivalent conductivity at the higher concentration. In the second method, such a quantity, constant at every concentration, is added to the observed values of the specific conductance as will cause the maximum in the equivalent conductivity values calculated therefrom to occur at the lowest concentration at which the total influence of the acid and impurities on each other has been produced. The results are a brilliant confirmation of Kohlrausch's values, being less than 1 per cent. lower than his.

[Goodwin and Haskell, *Physical Review*, December, 1904.]

Theory of Magnetism.—P. Langevin makes another attempt to formulate an electron theory of magnetism, and claims that it is possible with the aid of the conception of the electron to obtain the necessary distinction between paramagnetic and diamagnetic bodies. He thus accounts for the two laws found by P. Curie, which imply that feeble ferromagnetism varies inversely as the absolute temperature, whereas diamagnetism, except in the case of solid bismuth, is rigidly independent of the temperature. The author starts from the notion of the molecular Amperian current represented by the electron revolving about the molecule in a circular orbit. The magnetic moment resulting from the various electrons revolving round the molecule may be zero, and that is the normal condition of so-called diamagnetic bodies. But strictly speaking, all bodies, even iron, are diamagnetic, if the effect of a magnetic field upon the speed of revolution of individual electrons is considered. For the increase of magnetic moment on the establishment of such a field is negative for each elementary current. If the molecule is supposed to be immovable, the work necessary for the change of magnetic moment is furnished by the electric field created during the establishment of the magnetic field. This electric field, the author maintains, has hitherto been neglected in magnetic theory. In cases where the change of magnetic moment is due to the displacement of the molecules themselves, the work is furnished to the elementary currents by the kinetic energy of the molecule or by the surrounding molecules. The important point is that the diamagnetic property acquired at the moment of establishing the field is independent of the molecular agitation, and hence also of the temperature. If the resultant moment is not zero, the substance possesses a paramagnetism which masks the underlying diamagnetism. The exchanges of energy between the molecular magnets and the external magnetic field are made through the intermediary of this diamagnetism. This fact leads the author to an explanation of the law of the variation of feeble paramagnetism in a manner inversely as the temperature. The change in the period of revolution of the electrons is what is known as the Zeeman phenomenon, and the generality of this phenomenon proves the fundamental diamagnetism of all bodies. The orbits which represent the Amperian currents are also Weber's diamagnetic circuits of zero resistance, with this difference, that the flux across these circuits does not remain constant, as Weber supposed, unless the inertia of the electrons is altogether of electromagnetic origin. The orbits remain always the same, the only change being in the period of revolution. If the inertia of the electrons is entirely electromagnetic, all the facts of magnetism and diamagnetism may be accounted for by considering the elementary currents as ordinary currents existing in rigid but mobile circuits of zero resistance but of enormous inductance, to which all the ordinary laws of induction apply.

[P. Langevin, *Comptes Rendus*, December 26, 1904.]

Molecular Weight of Radium Emanation.—Rutherford and Brooks determined the rate of diffusion of the emanation of radium into air by a method similar to that employed by Loschmidt in his investigations on the coefficient of interdiffusion of gases, and deduced that the molecular weight lies between 40 and 100. It is important to know the molecular weight with greater accuracy, and Walter Makower has, therefore, just completed a series of diffusion experiments which place the molecular weight near the maximum value. During the course of his work Curie and Danne published some observations upon the rate of diffusion of the emanation from radium through capillary tubes of different lengths and diameters, and found for the coefficient of interdiffusion between the emanation and air the value 0·1, which gives a molecular weight corresponding with the lower limit given by Rutherford and Brooks. The author, however, thinks that the value 0·1 is probably somewhat too high, since no precautions seem to have been taken to ensure that temperature conditions were steady. In his own experiments, the emanation was made to diffuse through porous plugs, and its rate of diffusion compared with that of other gases of known molecular weight. Assuming Graham's law, that the rate of diffusion of a gas is inversely proportional to the square root of its density, it is possible from such a comparison to calculate the molecular weight of the emanation. Three different plugs were used, and the values arrived at for the molecular weight of radium emanation were 85·5, 97, and 99 respectively. On the assumption that the emanation is a monatomic gas, it probably occupies the vacancy in the periodic table in the fluorine group between Mo (96) and Ru (102). As this is the first vacancy in the periodic table, it is impossible to assign a place to the emanation on the assumption that it is polyatomic. The author's experiments, therefore, confirm the view that the emanation is a monatomic gas. He also determined the molecular weight of thorium emanation, and found it to be, if anything, slightly smaller than that of radium emanation.

[W. Makower, *Philosophical Magazine*, January, 1905.]

Thermal Conductivity of Copper.—G. F. C. Searle describes a simple apparatus for the determination of thermal conductivities which is suitable for an elementary course. He employs the principle of continuous-flow calorimetry. One end of a stout copper bar is heated by steam, while the other is kept cool by a stream of water flowing through a narrow copper tube soldered to that end of the bar, and means are provided for determining the temperatures of two intermediate points on the bar. When in addition to these temperatures the difference of temperature between the inflowing and the outflowing water and also the mass of the water flowing through per second are known, the conductivity of the copper is easily calculated. The limit of error attainable is about 3 per cent., and the sources of error are small enough to be neglected.

[G. F. C. Searle, *Philosophical Magazine*, January 1, 1905.]

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ELECTRICITY SUPPLY IN THE UNITED KINGDOM.

Once more it is our privilege to present to readers of *The Electrician* the first of our annual supplements relating to electric supply and traction undertakings. The labour involved in the compilation of these statistics and data is obviously very great, for it is an essential that no pains should be spared to ensure the accuracy of the Tables, but no amount of work on our part would enable us to produce this result if it were not for the courtesy of the engineers in charge of the various undertakings, who so kindly lend us their aid and to whom we tender most hearty thanks. Previous to last year it had been our custom to include stations supplying tramways as well as lighting in our first Table, but the number of entries became so enormous that the Table had to be divided into two, one for lighting only and the other for lighting and tramways. This year the same plan has been followed, but another innovation has been made, namely, the introduction of a separate Table, included in the present supplement, giving particulars of undertakings which purchase their energy "in bulk" from others. The number of such "bulk" stations is rapidly increasing, and in view of the recent action of the Local Government Board in the case of Stourbridge and Wood Green there is every probability that this new Table will be much larger next year. Another point worthy of note is that the number of generating stations "in progress" is less that of last year, although this will be more than compensated before the end of the year by the number of undertakings in which the supply is to be bought "in bulk" and then retailed. It is evident that, with but few exceptions, none but the very smallest towns will be without electric light in the near future, and consulting engineers who have specialised in the work of designing electricity works have now to be seeking fresh fields for their talents. It does not necessarily follow, however, that the electric light and power industry is declining; quite the reverse is really the case. The actual connections to mains at the end of 1904 are very far in advance of those at the end of 1903, and there is every indication that this growth is likely to continue for very many years. Existing stations are adding to their generating plant in order to cope with the demand, and instead of two or three small new stations being built it is now recognised that great economies are effected by supplying from one very large station. Thus there is not the least cause for lamentation, but ample reason for rejoicing. In this connection we may also call attention to the small Table on the supplement sheet under the heading, "Transferred Provisional Orders," giving a list of Provisional Orders for the supply of electricity to many smaller places, which have been acquired by Companies or Local Authorities already possessing larger works. It may also be mentioned that the Board of Trade is now far more active than formerly in calling to order those Local Authorities who have merely acquired Provisional Orders in order to sit on them until such a time as they are in the humour to build electricity works themselves. Formerly these cases were dealt with by the Board only, as a rule, if a Company had been trying without avail to obtain powers to supply in one of these districts; but now the fact that a Local Authority has been holding an undeveloped Provisional Order for many years is sufficient reason for the Board to threaten the rescission of the Order. Moreover, in recent Provisional Orders a clause has been inserted making it incumbent to start supply in the "compulsory area" within a specified time. This is a wise precaution; one of our enquiry forms returned by a small Local Authority has been filled in: "Nothing done towards getting supply, and no intention of doing so," and is signed by the Town Clerk.

The enormous increase in the number of connections to the electricity works has been largely due to the increased popularity of the electric motor and the low price at which it has been possible to sell energy to consumers with a high load-factor. The adoption of a "time switch" tariff, in which an especially low tariff is offered to power consumers who are willing to be switched off during peak-time, has largely contributed to this. The additions of motors to single-phase mains, on the other hand, has been disappointing in view of the advance that has been made in the design of single-phase motors during the past two years. It is evident that, taken as a whole, thousands of horse-power in motors have been connected to mains during the 12 months just elapsed, and we hope that no efforts will be spared to cheapen the generation and distribution of electricity both for lighting and power, and to bring forward devices which will appeal to consumers as capable of effecting economy. The Nernst lamp is an excellent example of the latter, and a glance through our Table I. will show what tremendous headway it has made in the last year for street lighting alone. In actual practice, the introduction of a more economical consuming device does not diminish the total amount of energy sold, but invariably results in an increase, for the numbers of new consumers attracted by the prospect of greater economy by far counterbalances a slight loss in revenue that may be incurred on each individual. Before the introduction of the Nernst lamp those interested in the gas industry used very great efforts to discount the advantages of electricity for lighting and power, and now their efforts are redoubled since the Nernst lamp is providing a formidable and successful rival of the much vaunted incandescent gas mantle both for private and public lighting. There were those that predicted the supersession of the arc by the Nernst lamps, but these prophecies are unfulfilled; the arc lamp still holds its ground, while the Nernst is gaining new territory. As an indication of the continued popularity of the arc lamp, it is only necessary to call attention to developments which are taking place in large cities such as Manchester and Leeds. In the latter place it has been decided to adopt arc lighting in all the principal tramway routes for a radius of one mile from the centre of the city.

REVIEWS.

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Bau der Dampfturbinen. By ALFRED MUSIL. (Leipzig: B. G. Teubner.) 1904. 8m.

The object of the author is to give an account of the theory, and some information concerning the construction of steam turbines, in a way to meet both the requirements of students of technical high schools and of those who have steam turbines in their charge. The object of the author is most admirably carried out. He has produced a book full of interest and full of information, which is arranged in a manner very convenient for reference. After a general reference to the history of steam turbines and a passing glance at the effect of the developments of the electrical industries in creating a demand for a rotatory prime mover, he closes with a problem and develops it clearly, the problem being to construct a steam turbine which shall be an efficient heat engine and which shall run at a reasonably low speed so that it can be coupled directly to an electric generator. There are several relatively low-speed turbines in the market at the present time, but they are all developments of two fundamental forms, either the Laval or the Parsons turbine.

If steam issues from a boiler under a pressure of 10 atmospheres through a properly formed nozzle the speed of the jet is about 1,200 metres per second. If this jet is allowed to strike vanes set round the periphery of a wheel it is known from the theory of turbines that the peripheral velocity must be at least one-third of the speed of the jet or better one-half the speed of the jet, if the turbine is to work efficiently. Supposing, therefore, that the turbine is arranged to work with a peripheral speed of from 400 to 500 metres per second, and it is desired to couple it directly to a dynamo making 1,500 turns per minute, the diameter of the turbine wheel would have to be from 5 to 6 metres. The making of such a wheel is not practically possible at the present time. De Laval evades the difficulty by introducing gearing between a small turbine wheel, making in some cases 30,000 revs. per min., and the dynamo shaft, but the system has not yet been developed beyond units of 300 H.P. This method of converting all the energy of the steam into the kinetic energy of the jet and then reconverting as much as possible of the energy of the jet into mechanical energy by allowing it to impinge on buckets set round a single wheel may be called "simple working."

Mr. Parsons uses a method, well known to readers of this journal, where the energy of the steam is never allowed to be converted into kinetic energy. The casing of the turbine may be looked upon roughly as a nozzle into which is inserted a series of guide blades and vanes, so that each pair of rings carrying guide blades and vanes forms a single turbine, and a definite quantity of the energy is taken from the steam by each turbine. This may in general be called compound working. The pressure of the steam gradually falls from the boiler pressure to the atmosphere or the condenser pressure, but when it issues from the casing into the condenser its velocity is reduced to an insignificant amount. In this way the revolutions of the turbine shaft have been reduced to from 5,000 to 3,500 for the smaller powers and as low as from 1,000 to 750 revs. per min. for the 5,000 H.P. size.

A development of the De Laval turbine may be made in the direction of compound working with graduated velocity steps. In this case the energy is given to the jet as in the Laval turbine, but no endeavour is made to turn all this into mechanical work at the periphery of one wheel. After striking the vanes set round the periphery of one wheel, the steam leaves the vanes with considerable velocity, and the jet is led through guides to strike a second wheel, and so on. Illustrations of this method of working are given in connection with the Curtis turbine and the Reidler-Stumpf turbine. Explanations are also given of the way this method may be combined with a two or three-step compound working with regard to the pressure.

After generally explaining these things in the first chapter, the author goes on to consider the proper form to be given to the nozzle in the second chapter. The peculiarities of the adiabatic flow of steam are investigated and the mathematical method is based on the assumption that the dryness of the steam remains constant, the particular value of the index in the equation, pv^n = constant, being found from Zeuner's well-known equation for n with given initial dryness. The results of the theory are compared with the results of experiments and recent researches of Stodola of Zurich, Guterman, Zeuner, Fliegner and others are mentioned and discussed. Then follow five chapters devoted respectively to the De Laval, the Parsons, the Zoelly, the Riedler-Stumpf, the Curtis, and the Rateau turbines. Each of these chapters follows the same general plan. After a general description of the turbine particulars of the constructive details are given, followed by a discussion of the way the speed is regulated. Then figures collected from published experiments with respect to the steam consumption at different loads are introduced and discussed. Altogether the author has produced a book which is a notable addition to the literature of steam turbines. It is in every respect a book for practical engineers and students.

W. E. Dalby.

Dampfturbinen. Entwickelung, Systeme, Bau, und Verwendung. By Wilhelm Gentsch. (Hanover: Helwing.) 1905 16s.

In the development of the subject of the theory, construction and peculiarities of machines or engines which are all variants of a common type, either of two methods may be employed. In the one method each machine may be taken alone and fully described and illustrated. In the second method a property common to all the machines may be chosen and described by itself. The first method has the advantage that greater prominence can be given to the more successful of the many variants from the common type; in the second case a particular machine has to be traced all through the book in order to get an idea of it as a whole. It is on the latter plan, however, that the author has arranged his treatise, being driven to it probably because of the large number of types noticed. The relative importance of each type can be gathered from the number of references indicated in the index, a glance through enabling one at once to pick out the names of Curtis, Rateau, De Laval, Riedler-Stumpf and, above all, Parsons as the chief workers in the subject. The book begins with the usual historical sketch. The second and third chapters are respectively devoted to the subjects of "Pressure" and "Velocity" turbines. The relation between pressure and velocity is considered in the third chapter. Then follow 21 more chapters, each devoted to some particular property of the turbine. Chapter viii. deals entirely with condensation, chapter xii. with regulation, chapter xx. with stuffing boxes. Some idea will be formed of the magnitude of the work and the devotion of the author to the subject from the fact that in the 389 pages there are 637 illustrations. At the end there is an exhaustive list of German, Swiss, French, English and United States patents relating to steam turbines, the number of each patent having placed opposite to it the number of the page in the treatise on which it is referred to. Undoubtedly, this is the most exhaustive and most important treatise on steam turbines which has yet appeared, though it must be confessed that it is not a book for students who are approaching the subject for the first time. It will be, however, invaluable to inventors, patent agents, and engineers who devote themselves specially to the subject of steam turbines. W. E. Dalby.

Entwurf und Konstruktion: Moderner Electrischer Maschinen fur Massenfabrication. By Ernst Schulz. (Hanover: Gebruder Janecke.) 7.50m.

This book deals with the design and manufacture of small direct current and alternating-current motors for wholesale production. The author carefully considers the latest theories for the design, without, however, encumbering the book by unnecessary mathematics. The formulæ cited, as well as most of the recommendations for the manufacture, are based on recognised authorities, and are judiciously commented upon by the author. The printing, as well as the illustrations, are excellent.

In the introduction the author deals with the general requirements for the successful wholesale manufacture, such as a strong organisation – technical as well as commercial, a factory built and equipped on the most modern lines, and a production large enough to enable piece work at low cost. The author limits his remarks to sizes up to 20 H.P. and speeds between 1,000 and 1,500. The first and longest part deals with direct-current motors. It is shown that in modern designs the specific use of the material has been greatly increased by careful ventilation of both armature and field; also that the phenomena contributing to sparking are nowadays so well understood that the limits in this direction are almost removed, leaving practically only the efficiency to be considered.

The choice of the armature diameter from the well-known output coefficient, and the most suitable ratio between the length of the machine and its diameter, is discussed at some length, showing that for the latter a value of 0·5 to 0·75 will give the best results. In regard to number of poles: For the sizes in question a four-polar design is preferred in all cases, except in the smallest sizes up to 2 H.P. A very good chapter is the one dealing with the requirements for sparkless commutation, where due consideration is given to the various formulæ of Arnold, Fischer Hinnen, Hobart and Niethammer. In connection herewith, recommendations as to the shape and most suitable material for pole shoes and frame are added, the former to be preferably of sheet iron and the latter of cast iron. In regard to the equipment of the motors, the author seems to prefer to have the feet cast to the end shields instead of to the frame, claiming that this would lead to greater stability. We cannot agree with him on this point.

The next part takes up in detail the question of obtaining a design which is readily adaptable for different voltages and outputs with as few different parts as possible. As an example, a complete line of machines from 1 H.P. to 10 H.P. is figured under various assumptions, giving in each case the pros and cons. It is shown that for obtaining economy it is advisable to divide the line of motors into groups which use the same armature punchings, commutators and end shields, the different sizes being obtained by a variation in the effective length of iron, and consequently in the frame, shaft, &c. In connection with the armature punchings, the author discusses the question of compound dies as against blanking dies with milling of slots. While we agree that the former method should be used wherever possible, we consider the latter method obsolete, and superseded by the process of notching the slots by means of finger dies. With a short reference to the factory cost of such a line of motors, the first part closes.

The second part deals with a corresponding line of induction motors. Again, the important relation of diameter to length is critically discussed; also the various methods of calculating the leakage, power factor, efficiency and heating. The recommendations in regard to the selection of a most favourable number of slots for various number of poles are very useful, though not all the statements are here acceptable without reserve. The line of induction motors given as an example, embodies many good features, but in general it does not seem to have sufficient margin for deviations from the standard requirements, as are always met in practice, for instance, the density in the teeth seems altogether too high.

The last part of the book gives an illustrated description of small direct-current and alternating-current motors of various Continental firms, with comments by the author which are of considerable interest, since for most of the machines the important constants giving a measure for the quality of the design are critically investigated.

Traité Theorique et Pratique d'Electricité. By H. Pécheux, with additional Notes by J. Blondin and E. Néculcéa, and Preface by J. Violle. (Paris: Ch. Delagrave.) 17fr.

This volume is written for the use of scholars studying at the national technical schools of France (les écoles nationales d'arts et métiers et l'école supérieure d'électricité) and for those seeking the certificate of industrial physics. It is written by the professor of physics and chemistry at Aix, and deals with every branch of the subject from Galvani's experiments on a frog's leg to Rontgen rays, and even includes a few lines on Hertzian waves. It is interesting to note in the preface written by Prof. J. Violle that it is the habit of Frenchmen to run down technical teaching in their country and praise what is done elsewhere. In England the same practice is very common, but we consider the work under review shows that our technical schools are probably in advance of those of our neighbours. The book teems with useful information, all the well-known laws of electrostatics and electro-dynamics are clearly given, with the higher mathematics of the subject in different type; but there appears a want of cohesion that makes the volume more fitting to the scholar reading for an examination than the student wanting to understand his subject. In the usual academic manner the laws of electrostatics with everything related thereto are first described: electrodynamics forms the second part and industrial applications the third part. The ether is ignored, so the fundamental units become defined in terms of length, mass and time—a result most confusing to the student. In the industrial section the approximate prices of apparatus are occasionally given for the use of the industrial classes. We are afraid this information given is too meagre for the purpose mentioned, but it might be advantageous for the pupil to gain an idea of the cost of apparatus he is reading about. To the English student we should not recommend this work as a volume for study, but to some the first two parts might prove useful for reference.

Fowler's Electrical Engineers' Year Book and Directory of Light, Power and Traction Stations. 1905. (Manchester: Scientific Publishing Co.). 1s. 6d.

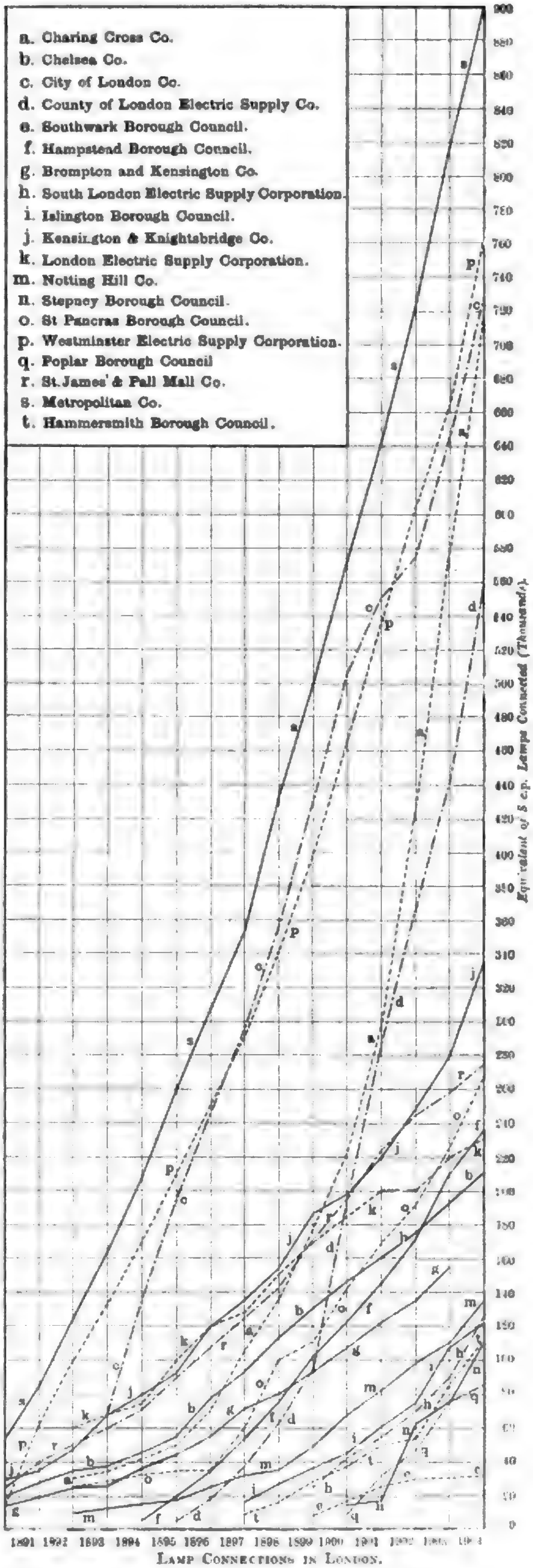
Like the "Mechanical Engineer's Pocket-book," this volume gives short descriptions of most of the latest inventions, and forms a most useful companion to it. Almost every branch of electrical engineering is touched on, and a directory of electric light and power stations in Great Britain completes the volume.

Fowler's Mechanical Engineers' Pocket-book, 1905. Edited by W. H. Fowler. (Manchester: Scientific Publishing Co.). 1s. 6d.

This work keeps its thoroughly up-to-date character, and forms a most useful volume for all classes of mechanical and electrical engineers. The most important addition to the present edition is a section on entropy and its application to steam engine problems. This subject has come into such great prominence lately that in a reference book for mechanical engineers it must almost certainly find a space, but authorities differ so widely on the meaning that should be assigned to the term entropy, that we are afraid this section cannot satisfy all. The author approaches the subject by means of a temperature-entropy diagram; the vertical ordinates represent absolute temperature, the horizontal ordinates entropy, and the area of diagram represents heat. From this simple definition a number of useful applications to steam-engine problems are worked out.

CONNECTIONS TO ELECTRICITY SUPPLY WORKS IN LONDON.

We give herewith a diagram illustrating the progress made by some of the London electricity supply undertakings during the past year. This diagram has now grown to such large proportions that its scale has had to be considerably reduced, and it will be seen that the highest ordinate represents the equivalent of no fewer than 900,000 8 c.p. lamps. It is interesting to observe that the total connections in London are equivalent to about 6·8 millions of 8 c.p. lamps, this figure showing an increase of 1·3 millions over that of last year. There is thus more than one 8 c.p. lamp for every head of population. The Metropolitan Electric Supply Co. still maintains the lead with 900,000 8 c.p. lamps. This is about as much in excess of the company's last year's figure as the latter was in excess of the previous year's. As at the end of last year, the Westminster Electric Supply Corpn. still keeps above the City of London Company, but the two undertakings now appear to be developing at practically the same rate. As usual, the Charing Cross Company easily takes the palm for the greatest increment in connections, and it looks as though the day is not far distant when it will outstrip all the other undertakings as regards actual connections. In the 12 months ended December 31, 1904, this company added the equivalent of no fewer than 141,000 8 c.p. lamps to its mains, or only 5,000 less than in the previous year.



Lamp Connections in London.

ELECTRIC TRAMWAYS IN HONG KONG.

Although little more than 60 years have elapsed since the island of Hong Kong became a British possession, its rise in importance, both as a commercial and naval centre in the Far East, has been both rapid and unique. Situated near the mouth of the Canton River, and distant about 90 miles from the ancient city of Canton, it possesses one of the finest and most beautiful natural harbours in the world. The island itself is some 11 miles long and from 2 to 5 miles broad, and consists of lofty uncultivated hills. During the summer months the humidity of the atmosphere renders the heat very trying to Europeans, but from September to March the weather is all that could be desired. The population of Hong Kong is estimated at 284,000, and of these 274,500 are Chinese. Its trade is estimated at £50,000,000 per annum; it has excellent dock accommodation, is strongly fortified, and is the permanent Naval base in the Far East.

In 1902 an ordinance was passed by the Legislative Council of Hong Kong authorising the tramways to be laid down by the Hong Kong Electric Tramways Co., an English company with its headquarters in London, and work was commenced in May, 1903, and completed last July. The detailed plans and specifications were prepared by the company's consulting engineers, Messrs. Alfred Dickinson & Co., who appointed Mr. Harold Hackwood to act as their representative in Hong Kong, and as resident engineer in charge of the construction. The contractors were Messrs. Dick, Kerr & Co., who carried out the whole of the work. There are 14½ miles of single track, laid in 9¼ miles of route. The gauge is 3ft. 6in., with rails of the girder type weighing 86lb. to the yard. Each rail joint is double-bonded with 0/0 S.W.G. copper bonds. Within the city centre-pole construction is mostly employed, but the eastern portion of the route being outside the city boundary, single line with passing places is put down, and equipped on the side-pole system. With the exception of a short branch line, which runs to the race course, the route runs parallel with the water front, and with the exception of a short length at Quarry Bay, is practically level. At Quarry Bay a short length of road grading has been done, the original grade of 1 in 10 having been reduced to 1 in 15. Beyond Quarry Bay is the eastern terminus of the line, at which the small Chinese village of Shankiwan is situated.

Owing to the varying nature of the ground, three forms of permanent way construction have been adopted. Where the ground was solid the rails were bedded on a concrete beam 18in. wide and 6in. deep; where the ground was not so good a bed of concrete 6in. deep and 7ft. 3in. in width extending under the whole track and 1ft. 6in. on either side was adopted; over doubtful ground which had been recently reclaimed from the sea this concrete bed was increased to 8in. in depth. The concrete used was mixed in the proportion of 6 to 1, Portland cement of local manufacture and exceptionally good quality being used. After the rails and the bottom concrete were laid the road surface was made up to rail level with concrete and finished off with a smooth surface to the proper camber of the road.

The overhead construction has been carried out in a very neat manner, the length of arms on the centre poles not exceeding 2ft., while the arms on the side poles vary in length, the majority of them being 6ft. long. The poles are of mild steel, 28ft. 3in. in length and 7in. in diameter at the base, tapering to 4in. in diameter at the top. They are set 6ft. in the ground in a solid block of concrete. Within the city ornamental base castings greatly add to the appearance of the poles, which are still further enhanced by the addition of wrought-iron scrolls on the bracket arms.

Section insulators are inserted in the trolley wire every ½ mile, and at each of these points the main feeder cables are tapped and current is taken to supply each section of trolley wire: this is accomplished by running the feeders through a feeder pillar containing the necessary switches and fuses, connections from the feeders to the trolley wires being made with rubber-covered 37/16 cables, carried up inside the poles and along the sides of the bracket arms. 500 volts is employed on the trolley wire. A lightning arrester is provided in each feeder pillar and also a telephone giving direct communication with the power house. The feeder cables were supplied by Messrs. Callenders Cable and Construction Co., and are laid on the solid system. In addition to the main feeders running east and west from the power station, a return 37/13 booster feeder has been laid in each direction to within a mile of the two distant termini, where it is connected to the rails; it also makes connection with the rails at each feeder pillar. A three-core pilot cable has been laid from the power station to each terminus, one core being connected up for testing purposes and the remaining two cores being used for telephone service.

As nearly as possible in the centre of the system is the generating station, a convenient site having been obtained alongside the Bowrington Canal, from which water for condensing purposes is obtained and by which coal and materials are delivered by barges directly on the site. A very few years ago this site was reclaimed from the sea, and consequently no good foundation could be obtained for either buildings or machinery; however, efficient foundations were obtained by the driving of over 5,000 piles. These were spaced so as to support the whole weight of the buildings themselves, the ground, which varied greatly in solidity, being left as an additional factor of safety. China fir poles, 15ft. in length and 5in. in diameter, were used for the buildings and machinery, special 7in. poles, 18ft. in length, being used for the chimney foundations. The depot comprises engine room and basement, boiler house and coal store, car shed and machine shop, smithy, paint shop, carpenter's shop and offices. In the engine room, which is lofty and well lighted, are two Dick, Kerr continuous-current, directly connected railway generators, of the multipolar type, compound wound, giving a potential of 550 volts, and running at 100 revs. per min. They are designed to run either separately or in parallel. Horizontal cross compound engines, each equal to a maximum load of 557 B.H.P. have been built by Messrs. Yates & Thom, and are provided with separate Wheeler surface condensers of the Admiralty pattern. The condensers are fixed in the basement below the engine room, as are all the steam and other pipes, thus leaving the engine room free and open. Circulating water is obtained from the canal. In addition to the two traction sets there are two smaller plants for arc and incandescent lighting of the depot, one set being driven by a small high-speed engine, and the other by a motor running from the 500-volt circuit. The lighting circuit is supplied at 100 volts.

The switchboard, which is of Messrs. Dick, Kerr's standard type, consists of nine panels. It includes a main station panel, two generator panels, two feeder panels, one Board of Trade panel, and three lighting panels. On the main station panel are recording instruments of the latest pattern, including a recording wattmeter showing the total output of the station. The Board of Trade panel is arranged for receiving test wires from different parts of the line and is provided with instruments for making all the tests required by the Board of Trade. An overhead travelling crane is provided capable of lifting and traversing in any direction a load of 10 tons over the whole area of the engine room.

The boiler house, which is at a lower level than the engine room, contains two B. & W. double-drum water tube boilers, arranged to burn ordinary Japanese engine slack. Each boiler has 3,654 sq. ft. of heating surface, evaporates 12,000lb. of water per hour, and works at a pressure of 160lb. per square inch. In addition to the steam and water gauges each boiler is fitted with a spring safety valve and a dead-weight safety valve. Water is supplied to the boilers by two Blake and Knowles feed pumps, which take water from either the storage tank or the hot well and feed the boilers either direct or through a Green's economiser. In case of mishap the economiser may be cut out, the flue gases being conveyed to the chimney by means of a bye-pass or auxiliary flue, and the feed water being pumped direct into the boilers without passing through the economiser tubes. Two feed-water filters are supplied and all water passes through one or other of these before entering the boilers.

The chimney, which is circular, is built of brick and is 153ft. in height. As Chinese bricklayers are unaccustomed to this class of work it presented greater difficulties in construction than any other part of the work, and as Hong Kong is subject to typhoons of noted severity extreme care had to be taken with both the foundations and the building of the shaft. With the exception of the foundations and the chimney cap, the whole of the brickwork is built in lime mortar of special composition, as is also the brickwork of the buildings. There are six lines of track in the car shed, which is a rectangular building 220ft. in length, and gives accommodation for 35 cars. The roof is of iron, in two spans, partly glazed and provided with louvres, giving plenty of light and ventilation. Inspection pits run the whole length of the shed.

There are 26 single-deck motor cars, 10 being of the combination type, with an enclosed portion in the centre and an open platform provided with seats at either end. The remaining 16 cars are of the open cross-bench type. The over-all length of the cars is 29ft., the total width 6ft. 6in., and the wheel base 6ft. 6in. The combination car has a seating capacity for 32 passengers and the cross-bench cars for 48 passengers. Each car is mounted on a truck of the Brill type, and is equipped with Dick, Kerr 25A motors, and the standard metallic shield blow-out controllers and the usual hand brakes. By the use of trolleys which are of the lateral type, 16ft. 6in. in length, provided with a swivel head, it has been possible to fix the trolley wire 10ft. away from the centre of the track where necessary. The car bodies were built at Preston by the Electric Railway and Tramway Carriage Co., and were shipped to Hong Kong in sections, where they were fitted together and connected up in a very short space of time.

At one end of the car shed is a well-equipped workshop, containing a screw-cutting gap-lathe, wheel lathe, wheel press and drilling machines, the whole being driven by a 500-volt motor. A suitable smithy, carpenter's shop and paint shop are also provided.

Before the introduction of electric traction into Hong Kong, the popular ricksha drawn by a Chinese coolie was the principal means of locomotion, and of these nearly 2,000 were licensed for hire in addition to a large number owned privately. Although rather slow, the ricksha is hard to beat for general convenience, and the fight for supremacy between it and the new electric cars will be of interest, but must of necessity end in a victory for the latter. As this is the pioneer system of electric traction in China, it is to be hoped the venture will meet with a well-deserved success, and that electrically-equipped lines will shortly be laid in other parts of the Celestial Empire.

ELECTRIC DRIVING OF TEXTILE MILLS.

The following is an abstract of the discussion on Mr. W. B. Woodhouse's Paper on the above subject, which took place at the Leeds Local Section of the Institution of Electrical Engineers on December 15th. The Paper itself appeared in our issue of last week :—

Mr. R. H. **CAMPION** said he agreed a good deal with what the author had said. In places where he had installed motors a good deal of power was still taken by belts, and it was extremely difficult to get people to go to the extra capital expenditure of putting a motor in on other floors. There was one installation driven by a 10 H.P. motor in which 5½ B.H.P. was taken in working the shafting. It was not feasible to put a motor on every machine, as the capital expenditure then overbalanced any gain in efficiency. The fluctuation of speed on different machines was considerable even with fly wheels on the shafts. Even with compressors for cold storage this was so, and it caused serious variations in pressure to other consumers. Rag-shaking machines were very easy to run, taking from 6 B.H.P. to 8 B.H.P. if driven without any shafting, but of course it depended to a certain extent on the quality of rags that were going through. Some time ago he supplied power to a corn-crushing machine taking from 10 to 12 B.H.P. and it was found on examination that there were several teeth broken in the gearing. When these were repaired it took only 3½ B.H.P. This plant had been driven by steam for some 10 or 12 years. When he was in Lancashire he went thoroughly into the question of supplying mills and found that owing to the employment of a large number of women there was very little late work and the lighting was hardly worth having from a load-factor point of view. In Yorkshire there was a good deal of competition with acetylene gas.

Mr. S. D. **SCHOFIELD** said at present it was a moot point as to whether electrical driving was economically applicable to factories, as it did not offer the same advantages as those obtained in iron and steel works, shipyards and other places where power was required over large areas. In a modern factory with a suitable condensing engine, using high-pressure superheated steam, the coal and wages cost per brake-horse-power compared very well with results obtained in central stations. There was also a better load-factor, and this had the material effect of reducing the cost. The losses from engine shaft to machinery, in well-equipped and properly maintained systems, were not very serious. The trouble as to belts had been got over in a certain weaving shed by fixing all line shafts underneath the weaving shed floor, and bringing the belts through. Thus, in a six-storied spinning mill there would be three line shafts, one on the ground floor driving the machinery on that floor and on the floor above. The machinery in the same room was driven direct, and extra pulleys were fixed on the line shaft which drove machinery on the floor above by belts passing through the floor. This process was repeated for the third, fourth, fifth and sixth storeys. From his experience of motor driving there was no difficulty in competing with any other form of prime mover in installations requiring up to 100 B.H.P. Above that, local circumstances must be considered before arriving at any decision. With modern plant taking from 500 B.H.P. and upwards, he did not think much better results could be shown when taking current from the public supply mains. In the West Riding of Yorkshire and Lancashire, the carriage of coal was less than the losses in electrical transmission through long cables. He asked the author the price at which he thought it would pay a manufacturer to take current from the supply mains, in preference to putting down his own plant.

Mr. J. W. **DAWSON** called attention to the fact that the efficiency of motors from ½ to 1 H.P. might often be less than 80 per cent., so that if one were put to every machine the loss might possibly be more than in a line of shafting. He would like to know to what extent subdivision could be carried out. It was very difficult to get machinery makers to say what power their machines required. In one case the makers said a certain machine required 100 H.P., but, as a matter of fact, 40 H.P. was quite sufficient.

Mr. P. **ROSLING** thought that the problem of electric driving in the case of a new mill was very largely one of capital charges. He considered that the money invested in the driven plant should be debited with the same interest as the driven plant was expected to return, otherwise it was a drag on the capital. If 10 per cent. were allowed for interest, 5 per cent. for depreciation and 3 per cent. for repairs and upkeep, then a mill taking power from a supply company should make a better return than a self-contained mechanically-driven mill. With electric driving, increase in friction could at once be localised and remedied and the efficiency kept practically constant.

Mr. H. **DICKINSON** asked the author for particulars of the conditions obtaining in Germany and in America with regard to electric driving. He wished it was possible to supply textile mills, as there was no doubt that a tremendous amount of power was required. If it could only be arranged with the mill owners to shut off all their machines earlier at night, and before the peak load, the problem might be solved. Only ½d per unit would have to be charged, and he did not see how it was going to be done at present.

Mr. W. **EMMOTT** was afraid it would be a long time before manufacturers could be induced to replace their engines by electrical power. With reference to the question of insurance, he had been unable to make any headway with the insurance companies, but was glad to hear that they were becoming more reasonable. In the case of a corn mill for which he thought he could get a reduction, he found that unless sprinklers were put in they would not meet them in the matter of rates.

Mr. W. B. **WOODHOUSE**, in reply, said he had not many figures giving the results obtained from electric driving of textile mills, but what he intended to indicate was that it was very difficult to compare costs, and only where the horse-power and the load-factor to be expected were well known could this be done. It was difficult to say in any one particular case just what the costs were and at what price a mill could afford to take a public supply. He had there some figures of costs of various mills and he had tried to calculate the equivalent cost of the present driving, assuming their capital charges to be 12 per cent. In one particular case with 63 I.H.P., the equivalent cost was 1·6d. per unit; another, with 26 I.H.P., was 1·84d.; a larger mill with 240 I.H.P., 0·9d; two rather smaller mills, 0·88d.; and one—rather a bad case—1·25d. If the charges were calculated for a load of between 1,000 H.P. and 2,000 H.P. the cost came out at about 0·55d., running 60 hours a week with a steady load. If the manufacturer charged his capital up properly energy cost him 0·55d. per unit, but as the majority of mills had not added this to their costs the equivalent cost per unit was something higher. Supply engineers should be able to find a good many customers at ¾d. or 1d., and the majority of small mills of 300 H.P. or 400 H.P. could afford to take current at these prices. As to recording instruments, he might say that of all the curves in his Paper there was only one drawn by a recording instrument, all the others being plotted from observations taken every few minutes, so that there was no error. He agreed that mill lighting had a very poor load-factor, but he would point out that lighting was an inducement to use a certain amount of power, and the two tended to balance one another. One speaker had stated that steam was required for other purposes than for driving engines, but there was no necessity for a mill-owner to use steam at 200lb. or 300lb. per square inch for dye pans or any purpose like that. Again, as boilers got old they had to be rated lower, and therefore it was better to get a boiler just to generate steam for heating, &c., and put in motors for driving. As to sub-division, he was afraid he had no very accurate figures, but there was undoubtedly a saving in belts, and there was no fear at all of dirt or dust getting on the material being manufactured. He did not think it paid to sub-divide smaller than, say, 5 H.P. motors except in very special cases. With regard to Mr. Dickinson's query, he had obtained some American figures, but found them no good for comparison. It seemed that they were prepared to pay more over there, the cost per indicated horse-power per annum in a modern mill being a figure that an Englishman would be surprised at. In a great many cases it might be possible to persuade mill-owners to work off the peak. In the day time they could have their motors fully loaded up, whilst at night time it would pay them to run one section of the mill only. If they could use a motor for the night's running he was sure that would be a good thing.

LONDON BOROUGH COUNCILS AND THE PROPOSED ELECTRIC POWER BILLS.

A conference of the London Borough Councils was held on Wednesday, by invitation of the Shoreditch Borough Council, at the Shoreditch Town Hall "to consider what joint steps should be taken to oppose the passing into law of the proposed bill of the Administrative County of London and District Electric Power Co. and other similar bills affecting London boroughs to be introduced in the ensuing session of Parliament."

The Mayor of Shoreditch (Mr. H. B. Bird) was elected chairman of the Conference, and Dr. H. Mansfield Robinson, town clerk to the Shoreditch Borough Council, was elected clerk to the Conference.

There were delegates from 21 borough councils, and one or two districts outside the London area present.

Councillor **HOWLETT**, chairman of the Shoreditch Electricity Committee, moved the first resolution as follows :—

"That this Conference do combine in a joint opposition to the following bills to be introduced in the ensuing session of Parliament :—

1st. The Administrative County of London and District Electric Power Co.'s bill.

2nd. The Charing Cross and Strand Electricity Supply Co. (Ltd.) (Power Supply).

3rd. The County of London Electric Supply Co. (Ltd.).

4th. City of London Electric Lighting Co. Ltd. (Extension of Powers).

5th. East London and Lower Thames Electric Power.

6th. Metropolitan Electric Supply Co. (Ltd.).

7th. Central Electric Supply Co. (Ltd.).

8th. North Metropolitan Electric Power Supply."

In moving the resolution, Councillor **HOWLETT** read extracts from one or two of the bills relating to the power to break up roads, with an appeal to the Board of Trade if the local authority refused consent, and the right to supply lighting to power consumers, also with a similar Board of Trade appeal. This latter condition, he said, simply meant that if the Board of Trade thought the consumer could be supplied at a lower rate by the company than he was already being supplied by the borough council the company would be allowed to come in. This appeared to him to indicate that, unless these bills were strongly opposed and their rejection effected, all the London municipal electricity works would be rendered unprofitable.

On the CHAIRMAN calling for a seconder to this motion no response was received.

Mr. A. B. BRYCESON, town clerk to the Woolwich Borough Council, said he could not vote for the motion as it stood. Only three of the bills mentioned affected Woolwich, and no doubt other boroughs were in the same position. The point was that the borough councils were not empowered to spend money in opposing bills that did not concern their particular locality, and there would be a legal difficulty if he pledged his Council to contribute towards the expenses of a joint opposition to the bills referred to.

Several other delegates spoke to the same effect, and after some discussion the following alteration in the first two lines of the resolution was unanimously agreed to:—"That, in the opinion of this conference, it is desirable that the Metropolitan Borough Councils affected by the bills hereafter mentioned, should jointly oppose the bills respectively affecting their boroughs."

Mr. C. NEWTON RUSSELL, electrical engineer to the Shoreditch Borough Council, next moved a resolution to the effect that an executive committee should be appointed to conduct the opposition.

The same spirit of caution on the part of the delegates not to bind their councils too definitely again manifested itself, and after numerous suggestions as to the wording of the resolution, the following was passed unanimously:—"That an executive committee be appointed to conduct the joint opposition, and, subject to the approval of the respective councils, arrange for the necessary petitions with power to engage the necessary Parliamentary agents, counsel and witnesses. Such committee to consist of [one representative of each of the authorities agreeing to join in the opposition with the clerk of such authority, the expenses incurred to be shared according to the ratable value by the authorities concerned."

Dr. H. MANSFIELD ROBINSON, town clerk to the Shoreditch Borough Council and Clerk to the Conference, proposed the following: "That it be referred to the executive committee to consider the advisability of formulating a municipal scheme for a large generating station in the most favourable position for supplying electricity in bulk to existing municipal electricity undertakings." As a justification for this resolution Dr. Robinson referred to the extraordinarily cheap prices at which both the Administrative County of London Co. and the City of London Co. were binding themselves in their bills to supply electrical energy. In the first case it worked out at about ¾d. per unit, and in the latter to ½d. per unit. No London borough could generate at this price. That these bills were no "flash in the pan" was emphasised by the position of the promoters. The promoters of the Administrative County of London Co. were some of the wealthiest men in the country, and those of the East London & Lower Thames Co. were entirely different and infinitely stronger than those connected with the bill that was rejected last year. In the Electricity Supply Bill of last year there was a provision giving local authorities power tocombine to promote provisional orders for such a scheme as he had referred to in the resolution. Unless such a scheme was embarked upon the boroughs would appear something like dogs in the manger, for they could not extend their own works, and yet wished to keep everyone else out. The difficulties of extending works had been experienced at Shoreditch, where they had to pay £30,000 per acre for land and 2s. per ton on coal for canal cartage. With a large station on the banks of the Thames these and many other difficulties would disappear. Further, if such a municipal scheme were put into operation it would be in a far better position than a power company, because all the distributing mains would be laid in the boroughs, and the supply could be taken in bulk without incurring any expense in that direction.

Mr. A. B. BRYCESON, town clerk to the Woolwich Borough Council, strongly opposed the resolution. It was asking to be allowed to do the very thing which it had already been determined they should ask Parliament not to allow a company to do. He regretted the resolution, as it would undoubtedly find its way to the knowledge of the promoters of the bills and be used against them in the Committee rooms.

Ald. SHEEHAN (Hackney) said it should be left to the County Council to carry out such scheme.

Ald. J. BUSSEY (Poplar) also strongly protested against the resolution. The borough councils could supply as cheaply as anyone. Only a short time ago the Poplar Council offered to supply the Whitechapel and Bow Railway with 3,000,000 units per year at 0·8d. per unit, but it was then found they had no power to supply. What was wanted was an increase of the local powers of local authorities so that they could combine for such cases as this.

Many other speakers also severely criticised the resolution, which was eventually withdrawn.

On the motion of Mr. C. W. Tagg, town clerk of Camberwell, it was agreed to include the Supply of Electricity Bill in the list of bills to be opposed. Mr. Tagg said he knew that the measure was to be introduced again this session and the borough councils had not secured all they required last year because the bill only came before one House.

A final resolution to leave it to the discretion of the Executive Committee, above agreed to, to consider applications from authorities outside London to join in the opposition of the London borough councils, was passed. It was stated, however, that many of the Middlesex authorities concerned with these bills intended to take independent combined action.

A suggestion was made that the London Gas bills and the Metropolitan Pneumatic Despatch Co.'s bill should be included in those measures to be opposed, but the Chairman ruled the question out of order.

A vote of thanks to the Chairman concluded the proceedings.

NEW DESIGNS IN STARTING SWITCHES AND FUSES.

The motor starter panels, switches and fuses which are described and illustrated below, are made by Messrs. Johnson and Phillips, of Old Charlton, and it is evident that considerable attention has been paid to their detail construction.

Fig. 1 represents a switch enclosed in a cast-iron box and operated by an outside handle as shown. It will be noted that the poles are mounted on separate bases and divided by an insulating partition. These switches are used for voltages up to 600 volts, and have long breaks and a quick break action. To facilitate rapid examination, the switches are provided with a removable lid instead of a hinged one, as is mostly the case. The fuse boxes are similar both in appearance and design. Each pole has its own separate base, and an insulating partition is provided, as in the case of the switch.

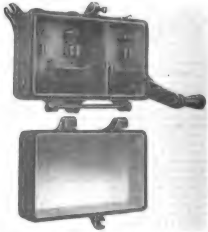


Fig. 1.—Enclosed Type of Switch.

The J. and P. motor-starting switch is shown in Fig. 2. It is made of the open and protected type (see Fig. 3), the latter being recommended for pressures above 300 volts. Attention is drawn to the fact that current is taken from the contacts on either side. This feature conduces to a more compact design than in the majority of cases, where only the upper sides of the contact studs are utilised. It will be noticed from Fig. 2 that the spindle of the starter is provided with a toothed segment which engages with a pawl. The latter is actuated by the overload relay on the left, and it is clear that the handle of the starter cannot be moved from any segment to the next before the main current has fallen to a predetermined amount. The resistances are boxed in in the usual way, the side cover being provided with a large number of openings to facilitate the dissipation of heat. The front slab is fixed to the cast-iron back

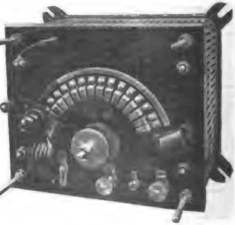


Fig. 2.—Motor Starting Switch. Open Type.

by means of four bolts. These same bolts (left longer for the purpose) are also used for fastening the protecting cover of cast iron, where this is used (see Fig. 3). This construction is as simple as it is convenient. All resistances for the large type of switches are of an ironclad type. No soldered joints are used.

Figs. 3 and 4 represent an enclosed and open type of motor-starter panel. Both types are provided with standard motor-starter switches, which are fitted with no-volt or no-volt and overload releases. The chief difference between the two types is, apart from the protecting cover, the arrangement of the switches and fuses. The arrangement is very clearly shown in the case of the open type (Fig. 4), while the switches and fuses on the protected type of motor-starting panel (Fig. 3) will be recognised as those already described above (Fig. 1). The protected type of starter may be made water-tight, and is supplied in this case with screwed glands for leads.

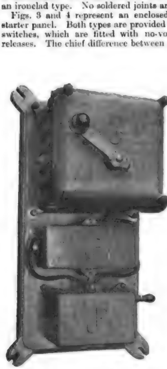


Fig. 3. J. & P. Motor Starter Panel of the Enclosed Design.

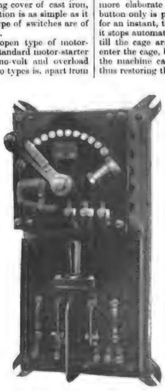


Fig. 4. J. & P. Motor Starter Panel of the Open Design.

ELECTRIC LIFTS.

There are a great number of designs of electric driving gear for lifts on the market, differing, however, mostly in arrangement and matters of detail only. The system of electric winding, described below, is that adopted by Messrs. A. Smith & Stevens, of Battersea, who have just issued an interesting pamphlet on the subject, and have given us some additional information with regard to their system. The firm uses three different systems of electric control. The first one, known as the "electric switch system," is best suited for passenger lifts running at speeds greater than 200ft. per minute, when it becomes difficult to handle the hand rope with certainty. The switch is mounted in the cage, and controls the lift motor by a number of wires running along the lift shaft. In the second electric system, called the "double-push button" system, two push buttons are fixed at each floor, and two in the cage. Pressing one button of any pair will cause the cage to ascend and the other to descend. The motion continues as long as the button is pressed, but stops immediately on release. Interlocking devices are provided to prevent two persons getting control simultaneously. This system is usually combined with automatic interlocking gates, opening only when the cage is at the same level, and with switches on the gate to prevent any motion of the cage while any gate is left open. The possible speed is somewhat limited, but as this system is generally used where traffic is small and where the lift attendant is dispensed with, this does not much matter.

Finally we have the "single-push button" system, which is a more elaborate modification of the double-button system. One button only is provided at each floor, and by pressing any button for an instant, the cage is brought to the corresponding floor, where it stops automatically and unlocks the door, which cannot be opened till the cage arrives. The passenger can now open the door and enter the cage, but so long as the door is open current is cut off and the machine cannot move. Having entered and closed the door, thus restoring the supply of current, the passenger finds in the cage a number of marked buttons corresponding to the various floors. The required button is selected and pressed for a moment, and the cage starts away to the required floor, upwards or downwards as the case may be, but in moving off it relocks the door it is leaving; on reaching the selected floor it again stops automatically and unlocks the door, thus completing the cycle; the passenger must close the door on leaving, and the lift is then at the disposal of the next comer. An additional button is fixed in the cage enabling the passenger to stop the machine at will in case the wrong button has been pressed, or for any other reason. Means are provided for preventing two persons operating simultaneously, as the first comer bars all others till the journey is completed. In the case of two persons pressing buttons precisely at the same moment, neither can get control till one releases.

Fig. 1 represents the lift gear as employed where the regulation is effected by a hand rope, while Fig. 2 represents the same lift gear, but provided with the necessary solenoids, &c., for carrying out the movements electrically. It will be seen from the illustrations that the motor, the speed reduction gear, the mechanical brake, the resistances and solenoids (where used) are mounted on a common bedplate. Messrs. Smith & Stevens are now also supplying lifts driven by single-phase motors of the repulsion-induction type. The speed reduction gear consists of a worm and worm wheel, running in oil.

A feature of Messrs. Smith & Stevens' design is that the gradual cutting out of the motor-starting resistances is done automatically by the movement of the lift itself. All the lift attendant has to do is to start the motor by putting the first resistance in series with the motor armature. This first resistance has to be proportional to the maximum load the lift is intended to carry. It is thus clear that the cage will not start should the maximum load be exceeded. When the attendent pulls the rope (or actuates the switch or button in the case of electric control) the brake shoes are lifted off the brake pulley, the motor reversing switch is set in the proper position, the first resistance is put in series with the motor armature and the main switch is closed, the operations taking place in the order named. The motor now begins to turn.

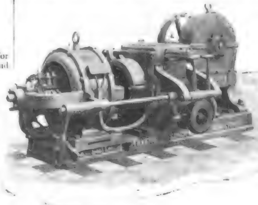


Fig. 1.—Lift Gear Operated by Hand Rope.

The device for gradually cutting out the resistances is as follows:—At one end of the shaft carrying the rope drum there is a toothed wheel which engages with a chain. This chain is wound up simultaneously with the movement of the rope pulley, and actuates the motor starter, so that the resistances are cut out one by one until none are left. By this time the starter abuts against a stop and the toothed wheel on the shaft begins to slip. For stopping, the operations enumerated above are performed in the reverse order by the pull of the rope in the opposite direction, with this difference: that the resistances are all cut out quickly.

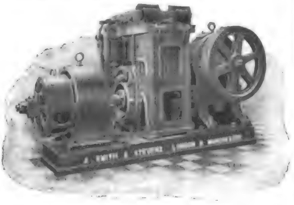


FIG. .—ELECTRICALLY-OPERATED LIFT GEAR.

Where the control from the cage is done by electrical means, the arrangement is as shown in Fig. 2. The mechanical part is much the same as in former case, but the pull of the hand rope is replaced by the pull of a number of solenoids, shown on the top and on the left of the cast-iron resistance frame (Fig. 2). The lid of this frame is hinged as shown, and the resistances may be got at from the top by simply lifting up the two parts of the lid. The resistances used are of galvanised iron wire.

In passenger and goods lifts four and two steel ropes are used respectively. The safety arrangements against breakage of the ropes are of the usual type.

The following comparative table, compiled by Messrs Smith and Stevens, is of much interest:—

Comparative Cost of Working Hydraulic and Electric Lifts.

Type of lift.	Load. Cwt.	Source of power.	Travel in feet.	Cost of av. round trip up & down in pence.	No. of trips per penny.
*Electric	7	Birmingham Corp. ..	50	0·1072	13·6
†Hyd. suspended H.P.	7	Manchester Corp.	50	0·29	3·45
‡Hyd. suspended L.P.	7	Town supply	50	0·445	2·2
§Electric............	9	Private supply	50	0·066	15·0
†Hyd. suspended H.P.	9	London Hyd. PowerCo.	50	0·237	4·22
Electric............	9	Glasgow Corporation.	50	0·066	16·4
†Hyd. suspended H.P.	9	Glasgow Corporation.	50	0·212	4·7
¶Hyd. suspended H.P.	12	London Hyd. Power Co.	50	0·287	3·48
*Hyd. suspended H.P.	9	London Hyd. Power Co.	50	0·235	4·25
*Hyd. suspended H.P.	12	London Hyd. Power Co.	50	0·344	2·9

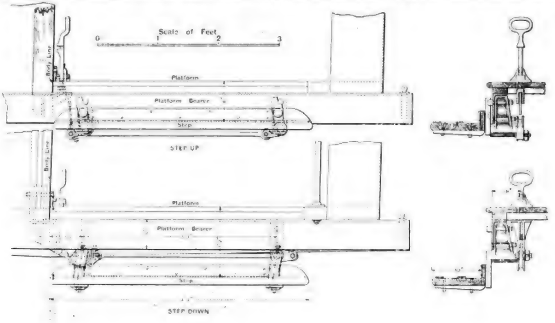
N.B.—Corrected by L. H. P. Co., 1904 Scale.

* Observed. Conditions ordinary. Current at 2½d. Test covered 40 round trips with full load. † Calculated from published scale. ‡ Calculated at 6d. per 1,000 gallons. Pressure, 50lb. § Observed. Conditions ordinary. Current at 2½d. Observed. Current 2½d. * Observed.

With regard to the economy attained with lifts operated by a single-phase motor, we are informed by the manufacturers, that a lift with a travel of 35ft. and conveying five persons (weighing 7cwt.) made 40 round trips (including 80 separate stops) per unit consumed.

A NEW FOLDING STEP.

Messrs. Hurst, Nelson & Co. of Motherwell are making a folding step for tramcars which has recently been employed at Kilmarnock and other places. In tramway cars which are fitted with lifeguards it is desirable that the lower step, by which the passengers mount on to or descend from the car platform, should be capable of folding up when out of use so as not to impair the efficiency of the lifeguard at the forward end of the vehicle. Some of the folding steps on the market, however, form a source of danger to persons inadvertently stepping from the platform. The "Hurst Nelson" step is so constructed and fitted that it may be raised from its normally "down" position, when in use at the rear of the car, to an "up" position in which, while it may still be used as a step it does not form an obstacle below the car platform such as to strike anyone falling in front of the lifeguard.



The step, which is shown in the illustration, extends longitudinally alongside the car platform as usual. It is carried by two hangers which are free to revolve in stationary brackets attached to the car platform bearer. The axes of the hangers are provided with a quadrant and a lever respectively, which are connected by a rod, as shown, so that the movement of both hangers is in unison.

A chain is carried round the quadrant on one of the hangers, the end of the chain being attached to a lever, which is raised or lowered by means of a handle connected to it and extending up through the car platform so as to be within easy reach of the driver. For the purpose of raising or lowering the step, the handle is drawn forward against the pull of a spring to release it from a holding catch, and it is then pulled upwards or allowed to descend, as the case may be, the hangers being rotated thereby about half a revolution. Stops are provided to prevent greater movement. Thus on raising the step it is brought from a position at a convenient height from the ground for ordinary use to a position parallel with that originally occupied but at a much higher level. In the down position of the step the lever operated by the handle is in contact with the quadrant and prevents lateral movement of the step.

THE DIESEL ENGINE IN ELECTRICITY GENERATING STATIONS.*

BY A. J. LAWSON.

In the present Paper the intention is to deal with the matter purely from the practical side, and to give the results of actual experience of the working of such engines over a considerable period.

To explain its operation, however, it may be here said that the Diesel engine as at present made is vertical and works on the four-stroke or Carnot cycle. On the first stroke air is taken in at the pressure and temperature of the surrounding atmosphere. The second stroke compresses this to 35 or 40 atmospheres, and to a temperature of over 1,000 F. On the third stroke downwards the combustion of the fuel is carried out at a constant pressure for a period which is determined by the amount of oil to be sprayed in, which quantity is controlled by the governor. The second part of the stroke is approximately an adiabatic expansion. The fourth stroke expels the gases from the cylinder. The fifth stroke again is the same as the first, and so on.

In the autumn of 1902, on the author's recommendation, a Diesel engine for the running of the tramways in Rothesay during the winter (when the service is greatly reduced) was ordered. This engine, built by the Augsburg Actien Maschinenfabrik, was put to work in June, 1903. During last winter, and up to the commencement of the summer traffic, it was constantly at work on the tramway service, except on such days in each week or fortnight as steam was got up to turn round the steam engine sets to keep them in good working order. Notwithstanding the fact that oil fuel at Rothesay, owing to its having to be transported in barrels, and on account of high freight rates, costs £4. 8s. 3d. per ton, the item of fuel on a special month's trial, without steam plant being used, and with a mean daily output of 370 units, was not more than 0·34d. per unit. The capacity of this engine is 70 B.H.P. to 80 B.H.P., and it is direct-coupled to a 50kw. 550-volt traction dynamo. A little later another engine of the same make was ordered for the Greenock and Port Glasgow tramways, to supply energy for the lighting of the car shed, for running the workshop motor, and moving cars about in the night time when the supply from the Corporation mains is not available. This engine has been at work almost ever since it was started in August, 1903, and with a nightly output of 60 units only, that is, with a 50 per cent. load-factor (the engine and direct-coupled dynamo having a capacity of 20 kilowatts), the total works costs amount to only 0·67d. per unit.

The results in these two stations being so satisfactory an engine of 160 B.H.P., directly-coupled to a 100kw. tramway generator, was installed by the Dudley and Stourbridge Tramways Co. in a sub-station at Lye, to supply an outlying portion of that company's network of tramways, and an official test of this engine by Mr. W. H. Booth gave 0·664lb. per kilowatt-hour, including 14·5lb. per hour for friction losses as the mean consumption, or, 0·32 per I.H.P. on steady full load, costing at 50s. per ton, 0·167d. per unit. The sets at Rothesay and Lye are run in parallel with electric storage batteries; the Greenock engine is run directly on to the main without any battery. In the early part of the present year the City of Birmingham Tramways Co. installed at Yardley two engines of 160 B.H.P., each with a direct-coupled 100kw. generator. The traction sets run in parallel without a battery reserve on a very fluctuating tramway load, the number of cars on the line being limited and the demand varying from zero to a maximum within a few minutes. Notwithstanding such fluctuations the engines govern perfectly, the consumption of crude petroleum costing on an average 50s. per ton delivered at the railway station, and exclusive of cartage and handling, as shown by a works return covering a period of four months, has been at the very satisfactory figure of a little over one-fifth of a penny per Board of Trade unit delivered at the switchboard. Two more engines of exactly the same size are now being installed in the Yardley generating station for the working of another section of the local tramway lines, and when these are erected, three of the four engines will be run in parallel, the fourth being kept in reserve.

The working results at Yardley, taken over a period of 112 days immediately preceding September 10, 1904, are given in the table below. The engines were run in this time for 2,189 hours, yielding an actual output of 54,890 units, whereas, if worked at full load, their possible output in the same time would have been 437,800 units. The load-factor was, therefore, a shade over 12½ per cent. The results are as follows:—

Fuel oil	0·220d.	per unit.
Lubricating oil	0·107d.	,,
Engine-room stores	0·011d.	,,
Water	0·030d.	,,
Salaries and Wages	0·406d.	,,
Repairs	0·111d.	,,
Total works costs	0·785d.	,,

Had the load-factor been 25 per cent. the total works cost per unit could have been reduced to 0·482d.

Even this should be reduced, as the water for cooling purposes has been down to 0·012d. or under, for two periods of 28 days each, and to 0·010d. for one period of 28 days the abnormal cost of this item for the first month, which puts the average up, being due to the whole quantity required having been taken from the water company's mains and run to waste, whereas it is now stored and used over again, a small quantity for making-up purposes only being taken from the mains. Also the lubricating oil costs are very high, and are now receiving attention, as it is evident there is preventable waste in this item.

As in tramway work the load-factor can easily be kept up to 50 per cent. of the running plant capacity, it is obvious that the above costs, good as they appear, might be brought down to not more than one third of a penny per Board of Trade unit, with plant capable of turning out in round numbers 1,400,000 units per year on a daily run of 20 hours, while supplying only 730,000 units in that time.

Comparing these costs with those of steam generating stations having outputs of millions of Board of Trade units in a year, the following are the results:—

—		Units output.	Fuel cost p. unit.	Load factor.	Tot. works cost per unit.
Yardley	oil	178,000	0·22	12·54	0·785
Glasgow Electric Lighting	steam	11,501,030	0·26	14·01	1·01
,, tramways	,,	16,291,082	0·15	..	0·51
Edinburgh lighting	,,	10,604,865	0·28	14·92	0·89
Liverpool overhead railways	,,	5,981,000	0·21	..	0·74
Liverpool tramw'ys & light'g	,,	26,015,062	0·35	23·57	0·68
Sheffield	,,	4,777,146	0·18	..	0·67
Manchester lighting and tramways	,,	28,966,624	0·31	11·88	0·82
Sunderland lighting	,,	3,508,139	0·51	19·21	0·68
Dublin tramways	,,	8,796,976	0·30	..	0·92
City of London Co. lighting and power	,,	14,806,449	0·44	21·26	1·01

As to the size of Diesel engines, a three-cylinder machine of 500 B.H.P. is already approaching completion at Messrs. Carel's works at Ghent, each cylinder to work at 166 B.H.P.; and quite recently the author was assured by Mr. Imhof Sulzer that, so far as the firm of Sulzer Bros. is concerned, they foresee no difficulty in making engines to work at 500 B.H.P. and possibly 1,000 B.H.P. per cylinder. As a matter of fact a new development of the Diesel engine—a two-stroke cycle—is now being carried out by Messrs. Sulzer.

The makers who have undertaken the manufacture of this engine are Messrs. The Augsburg Actien Maschinenfabrik; Messrs. Ganz & Co., of Budapest; Messrs. Sulzer Bros., of Winterthur; Messrs. Carels, of Ghent; and Mr. Emanuel Nobel, of St. Petersburg. In Scotland the manufacture has been taken up by Mirrless, Watson & Co., of whose engines, however, the author has had no experience, and in England arrangements have been made between the Diesel Oil Co. and Messrs. Willans & Robinson for the manufacture, by the latter, of such engines as may be required by the Diesel Company.

The advantages of the Diesel engine are many. In the first place, although the space required for the engine and dynamo—on account of the comparatively slow speed—*i.e.*, 160 revolutions for a 160 B.H.P. or 240 B.H.P. set—is relatively great compared with a steam set comprising engine and dynamo only, yet the whole space which would be occupied by boilers, feed-pumps, economisers, bunkers, &c., is saved, there being practically only the engine room and fuel storage tank space to consider. Owing to the fact that the engine can be started from rest and full speed attained in about one minute, there are no stand-by losses, such as are incurred where steam has to be raised from cold water, or where fires have to be kept banked.

With regard to the use of Diesel engines for marine purposes it must be remembered that these engines running in one direction are not quite suitable for marine propulsion, and that they can, therefore, only be successfully employed when used in connection with dynamos and motors.

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* Abstract of a Paper read before the Glasgow Technical College Scientific Society.

For smaller craft a petrol motor of the reversible type and capable of being varied in speed from dead slow to full speed, ahead or astern, is the most promising, and the author has been privileged, within the past month, to test on the Thames a boat so fitted. This is the nearest approach to a practical petrol motor for light craft that has yet been produced, but it is to be hoped that the able manufacturers who have perfected the Diesel engine for electrical purposes on land will seriously take the development of a marine type engine in hand.

As to the oil used in Diesel engines, Scotch shale oil has been found to be the cleanest and best, but its price is too high, and after it come—not in order of merit, but as showing the wide range of supply—Canadian, Pennsylvania, Texas or Trinidad oils in the western hemisphere, and Transylvania, Russian, Burmah, Borneo or New Zealand oils in the eastern; the only precautions necessary being to see that these crude oils are desulphurised, and the freer from bitumen the better, as this tends to clog the valves and renders frequent cleaning necessary. With shale oil the valves do not require cleaning oftener than once a month, but with the heavier oils they must be cleaned about once a week. Paraffin lamp oil is used after the heavy oils to be run through the valves for a few minutes before shutting down, in order to cleanse them, and may, if other supplies fail, be used in the engine exclusively, but, of course, the cost is prohibitive for commercial purposes. Creosote oil has been tried, but the analyses give a much lower calorific value than for petroleum, while the amount of tarry acid—35 per cent.—was so great as to prohibit its use.

The author has to express his indebtedness to Mr. Wilkes, resident engineer at Rothesay; Mr. Hawkins, manager at Greenock; and Mr. George Conaty, manager of the City of Birmingham Tramway Co., for particulars of costs with regard to the engines in their respective stations; and to the Diesel Engine Co. for the use of electrotypes and diagrams, and for information supplied.

POSTAL ELECTRIC MOTOR CARS IN FRANCE.

According to *L'Eclairage Electrique*, the postal authorities of Paris have recently adopted 15 electric motor cars for carrying mails. The concession for supplying the cars was given to the Société des Messageries des Postes, which is under the obligation of maintaining the cars in good working order for five years. In order to be able to give this guarantee, the firm itself entered into a similar agreement with the makers of the different parts of the car. The car body is detachable from the chassis. It provides a space of about 50 cubic ft. for the mails, and the useful full load is some 1,330lb. Access to the interior is gained by a lid at the top and a door at the back. The latter may be locked (in addition to the ordinary locking device) by a suitable mechanical arrangement operated from the driver's seat. Forty-four 150-ampere-hour accumulator cells of the Heinz type form one complete battery set. Each such set weighs 1,440lb. and is enclosed in a case. The space for the battery is in the front of the car, underneath the driver's position. In order to assist the removal and introduction of the battery, four steel rollers are fixed to the floor of the accumulator compartment and the cases, which are brought to the car and taken away by special trolleys, are thus readily pushed into the compartment or withdrawn from it.

In every-day service the first car leaves the General Post Office at 5 o'clock in the morning, and the others follow successively, each having a fully-charged battery. Between 12 noon and 4 o'clock in the afternoon the batteries of the cars are changed, this operation occupying only five minutes per battery. The cars then continue their service until 10 o'clock at night. It is stated that each charge allows the cars to run 28 miles. The principal data of the mechanical portion of the car are: Gauge, 4ft. 8½in.; front wheels, 2ft. 8½in. diameter; back wheels, 3ft. diameter; weight, empty, 4,000lb. A band brake is provided. The controller gives eight different forward speeds and three backward speeds; there are also four controller positions in which the motors are connected up as generators, thus braking the car. In two of these four positions the regenerated current is supplied to the car battery, while in the two remaining positions the current is dissipated in resistances. A switch for interrupting the current in cases of emergency is connected up to the circuit, and it opens when the driver depresses a small pedal with his left foot. A similar pedal is worked by his right foot. This pedal applies the mechanical brake and also opens at the same time the switch just mentioned. It was specified by the postal authorities that the car should be capable of maintaining a mean speed of 11·2 miles per hour, but the maximum speed which the car can attain on the level is some 17 miles. There are two motors, independent mechanically of each other, but enclosed within the same casing and having a common field. The power is first transmitted by spur-wheel gearing to a countershaft, from whence it is conveyed to the driving wheels by a chain on either side.

Experiments were made with a car of this type by M. Lacau on an excellent stretch of macadamised road with the following results: Energy expended per ton-mile, 88 watt-hours; tractive resistance per ton with plain rubber tyres, from 33lb. to 40lb.; ditto, with 3½in. pneumatic tyres well inflated, from 44lb. to 53lb.; ditto, with the same tyres badly inflated, from 53lb. to 64lb.; ditto, with 4¾in. pneumatic tyres well inflated, from 65lb. to 71lb.

CORRESPONDENCE.

RESISTANCES FOR ARTIFICIAL LOADS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was interested in Messrs. Henry Lea & Son's letter to you, which appeared in your issue of last week, describing the use of water-cooled wire coils for artificial loads. I was shown this method some years ago by Messrs. Mather & Platt (Ltd.) and used it for testing generators in the way described in Messrs. Lea & Son's letter. I had occasion to test a large battery, and endeavoured to employ the same arrangement with London water, but unfortunately found that it failed owing to the formation of a crust of scale on the wire.

It would, therefore, appear that, in the case of hard water, the temperature of the wire is high enough to raise that of the water in immediate contact with it to a sufficiently high degree to deposit the salts. The wire gets covered with quite a thick coating in a very short time, thus preventing the cooling of the wire which melts through, inside the tube of scale. Possibly, if I had tried at a lower current-density the trouble would not have occurred. It points to the necessity of using fairly soft water for cooling these wire resistances, which I have found most useful and much more compact and convenient than the ordinary water tub.—Yours, &c.,

J. S. HIGHFIELD.

London, W., Jan. 9.

CABLE LAYING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I gather from Mr. Perry's letter that he is in favour of the "solid" system of laying mains but that his trouble has been with the bitumen used for the purpose. My experience leads me to believe that either he has met with a peculiar quality of bitumen or that he has not used it in the best way. Care has to be taken not only in melting bitumen to see that it is hot enough but not too hot, but also in filling the bitumen into the troughing. The matter is not quite such a simple one as it looks. If the cables are wet the bitumen must be made hot enough to evaporate the moisture, otherwise it certainly will not stick to the cable nor will it stick to the cables if they are very dirty, but, on the other hand, care must be taken that the bitumen is not made too hot and partially carbonised as it then becomes porous. I have seen considerable quantities of "solid" system work displaced by street alterations but have not seen the peculiarity that Mr. Perry seems to have found usual, and in every case I have had considerable trouble in chipping the bitumen off the cables.

As regards the use of coal tar and sand, Mr. Perry mentions that he has used these with satisfactory results on lead-covered cables, but I think a word of warning is necessary in case anyone should try it on cables without a lead covering, as coal tar will attack most of the waxes used for insulating purposes. There is no evidence in the letter as to whether the tar and sand have been used hot or cold; I gather that they have been used cold. Some years ago experiments were made with a mixture of sand and bitumen with the idea of saving expense. Only a small portion of the work was carried out because it was found very difficult to get the sand and bitumen thoroughly mixed, and the deterioration of the pots in which the bitumen was melted, due to the sand settling to the bottom, was very great. Lately this work was disturbed by a street widening and an opportunity was afforded of examining it. It was then found to be a hard compact mass and not so brittle as bitumen but having more the consistency of asphalt. It would no doubt compare with Mr. Perry's mixture of tar and sand after it had been laid for some years.—Yours, &c.,

London, Jan. 10. W. H. PATCHELL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The cost of cables in provincial towns weighs heavily on small electrical undertakings; many engineers will be interested in the method Mr. James Perry employs of protecting the cables with a layer of sand and tar, and would, no doubt, welcome further particulars of the quantities of sand and tar, &c., he uses. Such a mixture is commonly used on the roofs of out-offices, rendering them waterproof for a number of years. The tar appears to bind the sand firmly together, making the mixture durable, and giving it power of resisting the penetrating action of moisture. I understood Mr. Perry to recommend this mixture as a protection for the lead covering, and not as a substitution for it, as Mr. Wordingham presumes.

Mr. Ward has recommended "coal-tar pitch mixed with a certain amount of shale oil for softening purposes, would be quite as suitable a material for the solid system as unrefined bitumen, while being about one-fourth the price. . . ." (I.E.E. *Journal*, Vol. XXXI., p. 876.) He further states that in Glasgow after three years the lead covered cables did not show the slightest sign of deterioration of the sheathing. It would be interesting to know if the further test of time had confirmed this view.—Yours, &c., V. RYAN.

Dublin, January 7, 1905.

LEGAL INTELLIGENCE.

Phillips v. Underground Electric Railway Co. of London.

At Brompton (London) County Court on Tuesday, before Judge Stonor and a jury, an electrical fitter named Phillips sued defendants under the Employers' Liability Act for compensation for personal injuries said to have been sustained owing to alleged negligence of defendants or their servants. On May 31 last plaintiff was engaged at the company's Lot's-road generating station, and was assisting in raising some heavy iron piping on to a temporarily constructed staging upon which he had been ordered to get by the charge hand so as to be ready to assist in placing the piping in position. The pipe had been raised a little higher than the staging when the rope suspending it suddenly broke. The fall of the pipe caused the staging to collapse, and the plaintiff and two other men fell some 30ft. on to a cement floor.

Defendants admitted that the rope was unfit for the job, but alleged that plaintiff was guilty of contributory negligence in having himself selected and used the rope.

In cross-examination plaintiff maintained that it was not a fitter's duty to select the rope in such work, except when there was no charge hand on the job. He denied having been promoted to the position of a charge hand.

For the defence, the charge hand referred to (S. Mathison), said it was the duty of a fitter to see that proper ropes were used in the work, but if the fitter had any doubt it was his duty to refer the matter to the charge hand. The plaintiff did not refer the matter to him.

The jury returned a verdict for plaintiff, damages £200, and judgment was given accordingly, with costs.

Hignett v. Fellingham.

At Brighton County Court on Friday last Judge Scully heard this action. Plaintiff (Geoffrey Hignett, trading as G. Hignett & Co., electricians) sued defendant (F. E. Fellingham, electrician) for £25 damages for alleged breach of agreement as to sale to plaintiff of the electrical business formerly carried on by defendant at King-street, Brighton, whereby defendant agreed to do no electrical work in Brighton, Preston or Hove. Plaintiff also asked for an injunction restraining defendant from any further breaches of the agreement, and particularly with regard to trading in Brighton, Hove and Preston. Defendant counter-claimed for the rectification of the agreement.

Plaintiff said defendant in 1900 was trading as Fellingham Bros., and asked him to buy his business, for which he asked £170. Witness eventually agreed to do so for £135 and to take defendant into his employ. An agreement was drawn up whereby defendant undertook not to do any electrical work in Brighton, Hove, or Preston. In the early part of 1904 defendant left his employ, and within a few days was managing a business at 10, North-street, Quadrant, which had over the basement the words "Fellingham, Electrical Contractor, Electric Lighting, estimates free." Defendant's brother said he was the proprietor; but defendant was managing it and doing electrical work. Nothing was said about a two years' limit before signing the agreement. Before setting up in business as an electrician plaintiff admitted he was a clergyman and not an electrician.

Albert Hodgson, manager to plaintiff, and Ernest Moore also gave evidence. The latter said that defendant superintended electric lighting work at a local establishment, but the cheque for the work was made out to A. E. Fellingham.

For the defence it was submitted that plaintiff had no right to an injunction owing to the delay (10 to 12 months) that had taken place before proceedings were taken; also that defendant had not worked in his own name or on his own behalf since he left plaintiff's employ, but had only worked for his brother. The agreement was wider than was necessary for Mr. Hignett's protection, and was therefore void.

Judge SCULLY characterised the agreement as a peculiar and not an ordinary one, and as a curiously drawn document. He decided that both claim and counterclaim must be dismissed. In the event, however, of his ruling being wrong and the case going further, he found that if plaintiff's construction of the agreement was correct defendant had broken it, but not for long, he having ceased to carry on business himself after he had been written to upon the subject. On the assumption that plaintiff's view was correct he assessed the damages for the breach of agreement at the nominal sum of £5, with costs.

Sumner v. Sumner and Clementson (Ltd.).

In the Chancery of Lancaster on Wednesday, before the Vice-Chancellor (Sir S. Hall, K.C.), Mr. Roby applied, on behalf of Veritys Limited, for an order on the receiver (Mr. West) appointed in this debenture-holders' action, to deliver over to Messrs. Veritys certain electric appliances which were sent to Messrs. W. E. Sumner & Co., Liverpool, on approval. W. E. Sumner & Co. was merged in Sumner & Clementson. The receiver had not got possession of all the goods given to W. E. Sumner & Co. on approval, but admitted having part of them.

Mr. LAWRENCE, for the company, contended that the moment the goods passed out of the control of the firm into that of the company, the property in them was vested in the company, and they formed part of the security of the debenture holders. The applicants must claim as creditors.

His HONOUR found that no contract of sale had been ratified, and made an order for the delivery of the goods in the receiver's possession to plaintiffs.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

"The Science Year Book." 1905. Edited by Major B. F. S. Baden-Powell. (London: King, Sell & Olding). 5s.

"How a Steam Engine Works." By W. E. M. Curnock. (London: Dawbarn and Ward.) 6d.

"Die Schwachstromtechnik in Einzeldarstellungen." Edited by J. Baumann and Dr. L. Rellstab. No. 1. Der wahlweise Anruf in Telegraphen und Telephonleitungen und die Entwicklung des Fernsprechwesens. By J. Baumann. (Berlin: R. Oldenbourg.) m 2.50.

"Etude Pratique des Courants Alternatifs Simples et Polyphasés et de Leurs Principales Applications Industrielles." By Henry Chevallier. (Paris: Ch. Béranger.)

A Short Introduction to the Theory of Electrolytic Dissociation. By J. C. Gregory. (London: Longmans, Green & Co.) 1s. 6d.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Admiralty announce that there will be on April 1 several vacancies for assistant masters in H.M. dockyard schools. Salary £150, rising by £10 per annum to £250, with pension and chance of selection for promotion to senior masterships. Candidates must be well qualified in mathematics, and applied mechanics, and those with laboratory experience and practical knowledge of electricity will be preferred. Applications to Secretary (C.), Admiralty, Whitehall, London, S.W., by Feb. 6. See also advertisement.

Applications are invited for the position of second assistant electrical engineer upon the central office staff of the Bradford city electrical engineer and manager. Salary £250 per annum. Applications by first post Jan. 19. See also advertisement.

Three additional assistants are wanted in the department of electrical engineering of the City and Guilds Central Technical College. Commencing salaries £200, £150 and £150 per annum respectively. Applications to Prof. Ayrton, Exhibition road, London, S.W. See also advertisement.

Hammersmith Electricity and Lighting committee require a technical assistant for the meter department. Applications to the chief engineer (Mr. G. Gilbert Bell), 57, Fulham Palace-road, London, W., by Jan. 18.

A teacher of electrical engineering is required one evening per week at Doncaster School of Science and Art. Applications to Mr. F. J. Clarke, Oriental-chambers, Doncaster.

Essex Education committee require an assistant instructor of physics and chemistry at the County Laboratory. Salary £150. Application to County Offices, Chelmsford, by 26th inst.

Tientsin (China) Gas & Electric Light Co. (Ltd.), require a chief engineer for their electrical business. Overhead three-wire distribution. Applications to Wm. Forbes & Co., 184, Fenchurch-street, London, E.C.

Bombay, Baroda & Central India Railway Co., require an assistant electrical engineer for their carriage and waggon department. Salary Rs400 per month. Applications by 31st inst. to secretary, Gloucester House, Bishopsgate-street Without, London, E.C.

Mr. S. Stanger has been engaged by Hammersmith (London) Council to take out quantities for the extension of the boiler house at the generating station.

Mr. G. R. Pepper, of Messrs. Drake & Gorham, has been appointed head of the publicity department of the Croydon Corporation electricity works.

Mr. R. B. Leach, of Birmingham, has been appointed electrical engineer to Farnworth District Council in succession to Mr. J. D. Pember, who has secured a similar position at Dartford.

Mr. W. R. Hederstedt has been appointed chief officer of the tramways at Exeter for 12 months at £400.

Carnegie Research Scholarships.—The Council of the Iron and Steel Institute will shortly proceed to award Research Scholarships founded by Mr. Andrew Carnegie. Candidates, who must be under 35 years of age, must apply before Feb. 28 to the secretary of the Institute (Mr. Bennett H. Brough), 28, Victoria-street, Westminster, London, S.W. See also advertisement.

Accrington.—At a public meeting on Monday the Corporation's electric tramways bill was approved.

Aldershot-Farnborough Light Railway.—Power & Traction (Ltd.) commenced the construction of the permanent way of this line last week.

Arbroath.—Just as the Council had concluded their negotiations with the Empire Electric Light & Power Co. for a transfer of the Council's provisional electric lighting order the Board of Trade have intimated the revocation of the order. The Council have now decided to make an effort to induce the Board to reconsider their decision and have requested the local Member of Parliament (the Right Hon. J. Morley) to use his good offices in the matter.

Australasia.—The "Australian Mining Standard" states that the Borough Council of Newtown (near Sydney) have declined the offer recently made by G. B. Edwards and C. G. Hatte to establish electricity works in the district.

A report prepared by Mr. L. M. Hancock, the American electrical expert called in to advise the N.Z. Government on the extent of and desirability of using the water power available in New Zealand for the generation of electrical energy for electric lighting, power and traction, presented to N.Z. Parliament states that there is no doubt about the available water power being equal to running the whole of the railways of the colony electrically, nor as to the feasibility of the proposal from an engineering point of view. In Mr. Hancock's opinion it is purely a question of business policy. He has no doubt there are numerous places, such as the suburban sections of roads near Wellington, Auckland, Christchurch, Dunedin, and the Christchurch-Lyttelton tunnel, which it would be wise to equip electrically because, as traffic increases, it would be easy to handle it. The energy for that service is abundant. Both islands have great reserves of water power which only await development to richly repay investment. The available sources of water power would (Mr. Hancock considers) supply all existing needs and all extensions that may ever be devised. For instance, Lake Coleridge could supply Christchurch and district, and the initial installation should be 10,000 H.P. The total power available at Lake Coleridge is over 94,000 H.P. The horse power that will be available from the principal sources is as follows: Wairua and Mangakahia 11,000, Okere Falls 75,000, Huka Falls 34,840, Aratiatia Rapids 62,480, Orakei Korako 56,800, Rainbow Falls 17,000, Atiamuri 28,400, Rotoaira 5,000, Rangitikei 48,710, Manawatu 5,680, Waikaremoana 78,600, Wairoa 7,384, Waimakariri 20,440, Lake Coleridge 94,677, Rakaia 56,800, Lake Heron 8,520, Rangitata 34,080, Opiha 817, Lake Tekapo 320,396, Lake Ohau 164,720, Ohau River 65,888, Lake Pukaki 38,634, Waitaki 60,321, Clutha 124,960, Manuherikia 23,288, Lake Hawea 119,961, Lake Wanaka not stated, Lake Wakatipu 68,160, Shotover 8,520, Lake Te Anau 190,848, Lake Manapouri 204,480, Waiau 24,935, Lake Monowai 17,040, Otira 9,088, Rolleston 13,632, Lake Kanieri 704, Inangahua not stated, Buller 22,720, Rotorua 34,080, Wairau 28,400, Awatere 5,680.

Mr. P. S. Hay, superintending engineer to the N.Z. Public Works Department, in a report on the same subject, testifies to the general practicability of the proposals, and calls attention to the fact that in general "the cost for hydraulic works, hydraulic and electric plant, &c., is much greater for any scheme working 8 hours or 16 hours per day than for one working 24 hours per day. In each case all the water available for the scheme being supposed to be used, the conduits required to be larger to deliver the same quantity of water in the shorter time each day. The water motors, the electric generating plant, also the transmission lines, must be of increased capacity. The gross revenue is approximately the same in each case (all the energy being sold), but in the shorter-time schemes the interest, and, perhaps, the renewal charges, will be greater. This question only affects lake schemes, or others where adequate storage is possible."

Noyes Bros., contractors for the equipment of the electricity supply works and tramways at Fremantle, have been asked to report on the question of combining a refuse destructor.

The electric lighting bill of the Globe (N.S.W.) Council, which was recently introduced in the Legislative Assembly, seeks permission to borrow money for plant and power to supply current to other local authorities.

During the recess the Railways Standing committee have been engaged in preparing a report for presentation to the Government on various proposed electric tramways in the suburbs of Melbourne.

Barrow.—Sanction to a loan of £35,000 has been received by the Council for electric lighting extensions.

Battersea (London).—The Finance committee of the Council have adjourned to 16th inst. consideration of recommendations by the Lighting committee that, as Mr. J. H. Fooks Bale has withdrawn from his appointment as chief electrical engineer, the present chief assistant electrical engineer (Mr. W. A. Kemm) be appointed at a commencing salary of £350 per annum with residence, and that applications be invited for the post of chief assistant at a commencing salary of £175 per annum.

Blaydon.—The Council have referred to the Electrical committee a communication from the County of Durham Electrical Power Distribution Co. asking if there is any prospect of the Council making an arrangement whereby manufacturers and residents in the district might have the benefit of an efficient and economical supply of energy. The company state that they have made a working arrangement with the Priestman Power Co. of such a nature as will enable them to carry out the terms of the Blaydon provisional order.

Bradford.—In presenting the minutes of the Electricity committee at the Corporation meeting on Tuesday, the chairman (Ald. G. H. Robinson) said

The recommendations included the purchase of a motor car at £325 for the use of the electricity department, the coach building for the car to be done by direct labour at the Thornbury tramcar workshop. A deputation had visited London, Dublin and Newcastle at a cost of £65. 12s. 7d., for inspecting generating stations and sub-stations on the three-phase system. The deputation had reported (see *The Electrician* for Jan. 6, p. 483) in favour of the adoption of that system in Bradford, and that report had been approved by the committee, who recommended that the work should be carried out at a cost of £40,876.

Replying to a question, Ald. Robinson said the upkeep of the motor car, allowing 20 per cent. for depreciation, would cost £225 a year. Last year the committee spent £220 on a horse and carriage. The expenses of the deputation came considerably below the amount allowed by the Corporation.

Mr. J. Freeman moved that that portion of the minutes recommending the expenditure of £41,000 upon the electricity system be referred back. Already £513,500 had been spent on capital account in connection with the electricity works, and on that expenditure the committee last March were able to declare a profit of only £10,414. He suggested that outside advice be called in.

Mr. B. North said that when he found an officer endeavouring to obtain credit by disparaging his predecessors it only reduced his confidence in that officer. He thought independent opinion ought to be obtained.

After several members had taken part in the discussion, Ald. Robinson said he had no objection to calling in an expert, but that report had been before the committee for six weeks, and they had sent a deputation to inspect different installations. The deputation unanimously recommended the adoption of the report. He would leave the question to the Council whether or not an expert should be called in. He contended that in their own engineer they had a man who was himself an expert. He believed Mr. Blackman was conversant with every system which was installed in the country. To call in another expert was a serious matter. They might get a man who was no better than their own engineer, yet who might differ from him in opinion.

The amendment was lost, 27 voting for and 35 against.

Mr. Capstick then moved that the minutes of the Electricity committee be adopted with the exception of the paragraph relating to the purchase of the motor car. Only 20 per cent. per annum depreciation was to be allowed, whereas 60 per cent. would be nearer the figure.

A long discussion ensued on this amendment, and ultimately it was carried by 30 votes to 24.

Mr. J. Freeman next drew attention to the minute, in which the resignation of Mr. S. T. Dalton, mains superintendent, was recorded, and moved that this matter be referred back. He understood that the resignation was in consequence of the explosion which occurred recently. When Mr. Dalton came to Bradford there were no plans indicating where the mains had been laid, and he (Mr. Dalton) suggested that these should be made, and in due course his suggestion was adopted. Unfortunately, the disaster occurred, Mr. Dalton was called before the committee to make an explanation, and he accepted the responsibility, but omitted to state that it was no part of his duty to mark the plans. Mr. Dalton was 60 years of age and had settled in Bradford with his wife and family. Was not the suggestion that he should retire forthwith too severe? It was evident that it was not a willing resignation, as in writing it out the words used were, "I am reluctantly compelled to send in my resignation." Bradford electricity department had for years been singularly immune from breakdown, and it was not fair to visit an offence so rigorously.

Ald. Robinson said there were so many defects in the plans that the committee came to the unanimous decision to ask Mr. Dalton to send in his resignation.

Ald. Hayhurst said there was one feature he could not overlook, and that was that a process of Americanising had got hold of the whole department, and old servants were disposed of so that new blood might come in. Mr. Dalton, even if re-instated as mains superintendent, would probably cause friction. He thought he had been badly used, and he hoped, for the credit of the Corporation, that the committee would at any rate not ruin a man who had gone through the hardest service in connection with electricity supply.

Mr. Glyde urged that it was the duty of past city electrical engineers to see that the cables were properly laid.

Ald. Peel said Mr. Dalton had admitted he was responsible for the accuracy of the plans of the electrical mains. Had those plans been accurate current could have been switched on before the end of the day on which the recent breakdown occurred.

Ald. Robinson said when Mr. Blackman assumed control of the electricity works he found them in an unsatisfactory condition. It would cost between £20,000 and £30,000 at least to put the plant into proper order, and that figure did not include the mains. There were engines at the electricity works which the officials ought never to have allowed to be put in, and foundations which the officials ought not to have had put in. Mr. Blackman was determined to carry on the works to the best interests of the city; but he had experienced great difficulties. Mr. Dalton had been responsible for keeping the plans accurate. There were cables laid under the superintendence of Mr. Dalton which were not shown on the plans at all. To find other cables try-holes had had to be resorted to. The Board of Trade regulations with regard to cable laying had not been complied with. Other officials had been at fault besides Mr. Dalton, but the committee saw no other way than to ask him to resign.

The amendment was defeated by 31 votes to 19.

Mr. Palin said there was a recommendation that an advertisement be issued for a second engineering assistant to the electrical engineer at a salary of £250 per annum, and he moved that this be referred back. There was a tendency, he said, in the Corporation trading departments to multiply highly-paid officials.

This amendment was afterwards withdrawn and the minutes were adopted.

The Electricity committee have acceded to the request of the local Drapers' Association to allow an extra discount in place of free lamps hitherto given by the committee.

Cauvery Power Transmission Scheme.—At Nov. 14 last power was being delivered to the extent of 4,000 H.P. to mines on the Kolar Goldfields from Cauvery Falls, a distance of 93 miles. The transmission works are governed by a department which has control of the distribution of power to all the mines on the Kolar Goldfields, as well as of five electric lighting plants in the district, varying from 20 H.P. to 300 H.P. The Kolar Goldfields telephone system, with 50 subscribers, is controlled by the same department, which has charge also of all electric mine signalling.

Chelsea (London).—A further report on the electric lighting of the baths was before the Council on Wednesday. The Baths committee reported that they had had an interview with Mr. Percy Still, the chief engineer of the Chelsea Electricity Supply Co., but as the Council's electrical engineer (Mr. A. G. Hansard), confirmed the conclusions previously arrived at by the Council, they recommended that the Council adhere to its decision to instal independent plant, and this was approved.

Chesterfield.—The borough electrical engineer (Mr. R. L. Acland) has been appointed borough electrical engineer and manager of the tramways department at a salary of £350, rising to £400 in 12 months.

Chingford.—The Council have decided to oppose the bill of the Charing Cross and Strand Electricity Supply Corpn. for authority to supply electricity in the district.

Coal in 1904.—The "Colliery Guardian" for Jan. 6 contained an informative review of the coal trade in 1904, including a list of ruling prices for the best known classes of Welsh and North of England coals. Also the freights for the year, and the wages ruling in the coal districts. The outlook for 1905 is regarded by no means unpromising, there being a general impression that better times are ahead.

Colne.—Application has been made by the Council for sanction to a loan of £5,000 for additional generating plant for current for the tramways.

Croydon.—The omnibus bill of the Corporation which authorises the construction of various tramway extensions and confers additional powers upon the Council in regard to electricity supply (including the supply and letting of motors, &c., on hire) was approved at the Corporation meeting last week.

Customs Decision.—Model electric railways imported into New Zealand as toys bears a 20 per cent. ad val. duty.

Dover.—Last week it was resolved to apply for a loan of £21,000 for constructing the river tramway extension.

Dundee.—The revenue of the tramways department for the year 1904 was £44,086. 9s. 8d., and the passengers carried were 11,511,716, an increase of £667. 3s. 11d. and 326,681 passengers over 1903.

Dunfermline.—The Council have decided to apply for a provisional electric lighting order, although negotiations are proceeding with the Fife Electric Power Co. for a supply of electricity in bulk.

Elba.—The extensive steel works which have been established at Portoferraio by the Elba Company, which has a capital of 12,000,000 Italian lire, are designed to supply the Italian industries and the Government with all rails necessary for the Italian railroads and with many other engineering commodities. Minerals and coals for the smelting furnaces are unloaded by means of electric cranes, current being generated by dynamos driven by engines working with furnace gas.

Electric Power in Dockyards.—The Lancashire Dynamo & Motor Co., Trafford Park, Manchester, have received from the Admiralty an order for the electrical equipment of Bull Point Dockyard, Devonport. The company has also at present in hand contracts for the equipment of Sheerness and Malta Dockyards, the total value of these orders being upwards of £75,000.

Exeter.—On Tuesday it was reported to the City council that the following terms had been suggested as the basis of an arrangement with Heavitree Council for the supply of electricity and the construction of tramways in that district by Exeter Council:—

1. Exeter Corporation to at once undertake the construction of the tramway to the terminus at Heavitree, and to complete same within 6 months.

2. Heavitree Council to apply forthwith for a provisional order to supply electricity in their district and to grant a lease to Exeter Corporation for 21 years. At the expiration of the lease Heavitree Council to take over the plant at a valuation without payment for goodwill.

3. Exeter Council to undertake to supply current to persons in Heavitree within an area to be agreed.

4. Electric current to be supplied in Heavitree at a rate not exceeding the price from time to time charged in Exeter.

5. The annual rent to be paid under the lease is to be an equal annual amount of principal and interest combined which will repay the amount expended by Heavitree Council in obtaining the provisional order in 21 years with interest at 4 per cent. (viz., £7. 2s. 7d. per cent.) on amount expended.

The Tramways committee recommended that these terms be accepted, and that Messrs. Dick, Kerr & Co., the tramway contractors, be asked to at once proceed with the work in Heavitree on the same schedule of price and on the same terms and conditions as the tramways in the city. This recommendation was approved.

Fish Shoal Locating.—A device has been patented by a German inventor which consists of an electrical apparatus whereby the presence of shoals of fish can be immediately ascertained. The apparatus comprises a microphone enclosed in a watertight case connected with an electric battery of a telephone. This is lowered into the water and so long as the telephone hangs free no sound is heard, but on the telephone coming into contact with a shoal of fish the constant tapping of the fish against the microphone causes a series of sounds which at once betrays their presence. The cord attached to the microphone is marked so that the exact depth of the shoal is ascertainable.

Gillingham.—On the recommendation of the resident engineer (Mr. A. D. Chalmers) the Council have decided to light the Brompton-road with Nernst lamps, two half-ampere lamps being fixed on each of the existing gas standards. At present there are 216 customers, with the equivalent of 13,000 8 c.p. lamps, connected, and supply has just been started to the new Naval Hospital, whose demand is equal to 600 8 c.p. lamps.

Glasgow.—A conference is being arranged between representatives of the electricity, telephone, tramways, water and gas departments with a view to discussing the laying of duplicate distribution mains in streets where tramways are running and arriving at a mutual understanding on the subject.

Great Yarmouth.—Last week a report from the consulting engineers (Messrs. Preece & Cardew) recommending the provision of additional generating plant at the electricity works was considered and approved by the Council.

It is proposed to put in an additional 300kw. steam dynamo at £2,750, boilers and piping at £1,500, and switchboard extension at £250. The condensing plant is to be doubled, and a new conduit laid to the Harbour at £3,500, or a total outlay of £8,000. Messrs Preece and Cardew considered, however, the progress of the undertaking justified the increased expenditure. They did not anticipate the extension of the tramways to Gorleston would require an increase during 1905 of the present plant, but extensions must be considered in the near future. £2,000 would be needed to provide small cables and house connections. Tenders in connection with this plant will be found on another page. The loan to be raised was thus £10,000.

Hackney (London).—The nine ½-amp. inverted type Nernst lamps experimentally fixed some time ago in Kenninghall-road have given satisfaction, and it is intended to make them a permanency. The annual charge is £4 per lamp per annum, including maintenance, cleaning and extinguishing. The cost of the 11 gas lamps displaced was £33. 8s. 1d.

Hampstead (London).—The Borough Council have decided to purchase the undertaking of the North-West London Electric Supply Co. (which our readers will best remember under its original title of the Hampstead Electric Supply Co., Ltd.) for £12,000. The purchase money will, it is stated, be provided out of a reserve created from the previous profits of the Council's electricity undertaking.

Islington (London).—At the meeting of the Council on Friday the proposal to hold an electrical exhibition was approved. Further particulars are given on p. 525.

On the recommendation of the Lighting committee it was decided to proceed with the erection of arc lamps in Newington Green road, on Newington Green, in Mildmay Park and in Ball's Pond-road (from Essex-road to Mildmay Park). Provision had been made in a previous loan for lighting these thoroughfares and the cost of the work now recommended, together with the laying of conduits and mains in Mildmay Park, was estimated at £1,745.

A recommendation of the Finance committee was adopted without discussion recommending

a scheme for borrowing money for capital expenditure on "short-term mortgages" The minimum amount to be accepted on loan is £10; the rate of interest £3 per cent., payable half-yearly: and the period for which loans are accepted is either 18 months, three years or five years, at the option of the lender, and loans are repayable by three months' notice on either side.

Kirkcaldy-Leven Tramway.—Fife County Council have expressed approval of the scheme of Mr. R. G. E. Wemyss, of Wemyss, to make and maintain this line.

London County Council Tramways.—We referred last week to a difficulty which had arisen in connection with the run of a new type of covered car on the Tooting section of the L.C.C. Tramways. Alterations in the structure of the top deck permitted satisfactory trial runs on Wednesday under Clapham-road station bridge, and the following day the new type of car was permanently placed on the service between Blackfriars and Tooting.

Lowestoft.—The Council last week instructed their consulting engineers (Messrs. Hawtayne & Zeden) to prepare specifications, &c., for providing a new Babcock & Wilcox boiler for the electricity works with brickwork settings, pipework, &c. The Council are recommended to authorise the Electric Lighting committee to accept a tender for the work and to apply for sanction to a loan. Some extensions of the street lighting by 32 c.p. incandescents have been authorised.

Lymington.—The Council have renewed the contract for public electric lighting on condition that the local electric light company substitute Nernst lamps at various important corners of highways and increase the candle power of the remaining lamps.

Maidstone.—On the recommendation of the Finance committee the Council are borrowing for tramway extensions £25,000 from the Royal Insurance Co. at 4 per cent. interest, repayable by equal annual instalments in 40 years.

Macclesfield.—The question of the revocation of the Macclesfield electric lighting order, 1901, is deferred until June.

Municipal Telephony.—Swansea Telephone committee have decided to engage Mr. A. R. Bennett as consulting engineer on the usual terms for the proposed extensions of the telephone system, the cost of which is estimated at £2,000.

Portsmouth Telephone committee have received notification from the Postmaster-General that application has been made by the National Telephone Co. for a further extension of their telephone area to include Wickham, Hambledon, Swanwick and Locks Heath, and that he was prepared to grant the application, asking whether the Corporation wished their licensed area to be extended in similar manner. The committee recommended that application be made for a similar extension, and this recommendation was approved.

Several interviews have taken place with representatives of Newport (Mon.) Council and the National Telephone Co.

"With a view to obtaining a reduction of the company's charges to subscribers and of getting the company to grant inter-communication between their subscribers and those of the Post Office at Newport." The company would not agree to inter-communication, but offered reduced terms to the Corporation, and a committee which reported on the subject recommended that these terms be accepted. The report was, however, referred back.

Northfleet.—The Council will oppose the application of the Gravesend Corporation for a provisional order for Northfleet.

Norwich.—The Corporation electricity department is advertising its readiness to undertake "free" wiring work. The charge for current for private lighting has been reduced from 5d. to 4½d. per unit.

Peru.—The Cia del Ferro-Carril Electrica de Lima y Callao, at Lima, have been supplied with electric power since July 27 last by La Empresa Electrica of Santa Rosa for a system of electric tramways constructed and equipped by Messrs. W. G. Grace & Co., of New York, Lima and Valparaiso, on a 4ft. 8½in. gauge, and comprising 8 miles of double and 4 miles of single track. Eighteen motor cars are running on this service. The line forms the principal link for passenger traffic between Lima and Callao, and runs from the centre of Lima to the centre of Callao. A portion of the track is along the coast, and handles a large summer traffic of bathing visitors. This is the second electric railway in operation in Peru. The capital has been found locally, and the line runs in competition with two steam railways, the traffic upon which is very seriously affected by the electric line. Current is supplied from a water-power station at Chosica, 30 miles up the river Rimac, the sub-station being at Lima.

The Empresa Company, which has been supplying current for the past four years on the three-phase system, has now a day load of 2,000 H.P., including two railways which have been started during 1904. The company's supply is now wholly generated by water power. The Lima tramways are shortly to be converted, and it is probable that the Santa Rosa Company will supply current to this also. The company will shortly employ the whole of the available water power of the Rimac, which equals about 6,000 H.P. The great development of the electrical industry in this country is due to Dr. M. J. Predo y Ugarteche, who is manager of the company, and Mr. A. L. Kenyon, general engineer to the company.

American manufacturers have got a firm hold of the business so far in this country, but the conversion of the Lima tramways to electricity may possibly offer an opportunity for British enterprise. In Peru enquiries are made for electrically-driven power hammers and also for water-driven electrical plant for sugar and cotton factories.

Presentation.—Mr. W. Rathbone, the retiring general manager of the Middleton Electric Traction Co., has been presented by the employés with a tantalus and gold ring. Mr. Rathbone's successor is Mr. W. F. Endean, of Devonport.

Reading.—The Board of Trade have sanctioned a loan of £2,500, repayable in 30 years, for the acquisition of additional premises for the electric tramways department.

Retford.—The Board of Trade have again asked the Council what steps have been taken to comply with the terms of their provisional electric lighting order, 1899.

St. Pancras (London).—On Wednesday the Council decided to lay a feeder main, at an estimated cost of £2,850, from the King's-road works to Hawley-road, for equalising the pressure of supply in one district. It was also decided to take up the balance (£7,515) of the electricity loan of £28,580.

The chief electrical engineer (Mr. Sydney W. Baynes) presented a report upon the charge for electric current for power.

From a curve accompanying the report it would be seen (he said) that for 16 out of the 24 hours the current passing from the station only averaged some 600 units per hour, whilst the maximum call upon the station reached 3,200 units per hour, and they were compelled to provide and maintain generating machinery and cables capable of supplying the higher rate. The present rates for electricity were based on that condition of affairs and naturally covered all charges for interest and sinking fund. Were it possible to increase the day load between 11:30 a.m. and 4:30 p.m. they could do so so without any additional capital outlay on extra generating plant and mains or any charge to revenue in manipulating the existing plant, except for coal 0·61d., oil, waste, &c., 0·07d., and repairs and maintenance (say) 0·15d., or in all 0·83d. per unit sold. He had taken repairs and maintenance at an estimate of one-half the actual figure because the actual wear and tear was only due to the running of the machinery. There was no depreciation brought about on their mains, whether they were doing full duty throughout the 24 hours or not, and consequently no charges for extra repairs on the mains would occur. The wages at the station were in no way increased by the day load, and consequently did not enter into those costs. He proposed, therefore, (1) that they should establish a system of day-load supply for lighting at the same rate as motive power, provided that supply be not taken between 4:30 p.m. and 8:30 p.m., any current drawn from their mains during the hours of peak load to be charged at 6d. per unit; (2) that day load should only be available to customers who would guarantee to burn during the business hours of the day not less than 10 lamps in their cellars or at the back of their shops as the case might be; (3) charges for extra meters and switching-over gear to be borne by every consumer availing himself of those specially low rates; (4) all customers receiving current under those special rates would be liable to be cut off at any time that circumstances might necessitate, in a similar way to which they reserved the right in giving the special low motor rates now in force. There were a few consumers who closed their premises as early as seven o'clock in the evening throughout the year. He had carefully investigated the number of hours such a consumer would draw from their supply between 4.30 p.m. and 7 p.m. in order to ascertain (assuming those low rates were in operation) whether they would prove profitable to the undertaking at the proposed new rates. He found their load between 4.30 p.m. and 7 p.m. would average 1½ hours per day throughout the year and that would be at the higher rate of charge proposed, 6d. per unit. The total cost at 1½ hours per day, including all capital charges, &c., was slightly over 6d. per unit, so that although they would not make any profit from the peak load supply to such a consumer, the day load drawn at the lower rate of 1d. per unit would yield a profit of 0·17d. per unit, the cost of generating the day-load supply being 0·83d. per unit. Should the proposition for day-load charges be approved it would be possible for such large firms as Shoolbred's, Maple's, Oetzmann's and others to provide secondary batteries which could be charged during the hours of day load from their supply at the low rate, and these batteries could be utilised to maintain their lighting during the peak load. Such customers would be profitable to their undertaking even at 1d. per unit, because they would be in the position of being able to supply them with current without involving any capital charges whatever. He felt confident, with such a low rate available, that there were a number of ratepayers possessing their own generating plant who would find it a distinct advantage to draw current from them during the daytime rather than generate their own, and, taking it on the whole, he was sure they would not only popularise the use of electricity but that it would be a distinct advantage financially to the undertaking. There was a further possibility of long load in the development of electric signs, and since they could never contemplate a large load due to those signs, he did not consider there would be any risk incurred if they allowed these electric signs to go on at the

1d. rate between 7:30 p.m. and 4.30 p.m. Should it be found desirable to burn those electric signs during the prohibited hours, of course customers would be at liberty to do so through a separate meter at 6d. per unit.

Without discussion or dissent the recommendations of the committee for carrying out Mr. Baynes' suggestions were approved.

Shanklin.—The public lighting contract with the Isle of Wight Electric Light Co. has been renewed until Dec. 31, 1907.

Sheffield.—Several increases of salary to officials of the electric lighting and tramways departments have been granted.

Shrewsbury.—Last week the Council approved the plans and estimates of the borough electrical engineer (Mr. C. M. Johnston) for extensions to the electricity works to meet the next winter's demand. It is proposed to put down an additional steam dynamo, a Lancashire boiler, piping, &c., at a total cost of £5,295.

South Africa.—The "British and South African Export Gazette" states that the electric lighting contract for the new Capetown municipal buildings has been secured by Messrs. Cunningham and Gearing.

At Lennoxton Collieries, Newcastle, Natal, electric coal-cutting plant has recently been installed.

Dundee Coal Co. have put in electric coal cutters and also electric locomotives for underground haulage.

The adoption of electric haulage at Daggafontein gold mine is contemplated.

The Intercolonial Council have referred back to the Railway committee the proposal to convert the Springs Randfontein railway to electric traction. The scheme, which was estimated to cost £430,000, will probably be brought forward again.

Suburban extensions of Durban tramways are being carried out and the track of one section is being doubled. A sub-station is being constructed at Greyville and tenders for new plant have been let.

Only a portion of Pietermaritzburg tramways has been opened, but it is stated that the whole system will be at work in a month or two. Twelve cars are at present running and it is anticipated that instructions to order a further four cars will shortly be given to the London agents, Messrs. Ford Bros.

Klerksdorp electricity supply proposals have been referred back.

Gwelo, situated amongst the Rhodesian goldfields, is said to require electricity supply and it is thought probable a company might negotiate with success.

Recent tramway proposals by a syndicate have been rejected by Bloemfontein Council who have begun to consider the necessity for re-organisation and conversion to electric traction of the lines in the city.

Heidelberg (Transvaal) Council are seeking the ratepayers' mandate to borrow money for various public improvements, including the establishment of electricity works.

Kingwilliamstown (Cape Colony) Council have decided to acquire the undertaking of the King Electric Lighting Co.

The De Beers Gold Mining Co.'s electric tramway from Kimberley to Alexandersfontein is now completed, and only awaits the arrival of rolling stock

Although the Greytown (Natal) electricity works have only recently been opened, the capacity of the plant will shortly have to be greatly increased.

Messrs. Hampson & Cato, Durban, are about to apply for legislative sanction to the construction of a tramway from the railway at Hillarys (Natal) to the Bellair estate, six miles distant, and for the supply of light and power on the proposed route.

Sanction has been received for an expenditure of £15,000 upon an extension of Cape Town Corporation's Dock-road electricity works.

Surbiton.—On Monday the Council approved the application for a provisional order to extend the area of supply so as to include those portions of the district not embraced in the 1891 order. It was reported that a balance sheet would probably be received in a few days from Callender's Cable & Construction Co. (who are working and maintaining the electricity undertaking) showing the results of the past year's working.

Swansea.—At a town's meeting on Tuesday the tramway portion of the Corporation bill, which authorises the Corporation to purchase the undertaking of Swansea Tramways & Improvements Co., was rejected.

Swindon.—Application has been made for sanction to a loan of £2,000 for the purchase of motors and arc lamps to be let on hire.

Switzerland.—A concession for the construction and working of a narrow-electric railway from Menziken to Emmenbrücke has been granted to MM. Stocker and Esterman, the former secretary of the municipality of Neudorf and the latter mayor of Hildisrieden. The cost of the work is estimated at 1,950,000fr., of which rolling stock stands for 820,000fr.

Tasmania.—At Devonport a supply of electricity has been given since 1903 by the municipality. There are 150 consumers on the mains with a total connection of about 3,600 8 c.p. lamps. Merryweather electrical feed pumps are installed, lamp renewals are free, and motors are obtainable on hire purchase and rental systems.

Telegraphic Addresses.—The Postmaster-General has authorised the use of abbreviated registered telegraphic addresses of firms or individuals sending wireless telegrams to or from ships at sea, subject to the regulations governing the use of such addresses in inland telegrams.

Telephone Wires Over the Thames.—It was reported at the meeting of the Thames Conservancy Board on Monday that the National Telephone Co. has now accepted the legal position of the Conservators with regard to wires over the river up to the City Stone, Staines. The Conservators agreed that, as the company had executed the agreement, the wires should be allowed to remain during pleasure on the conditions of the Board dated May 30 last.

Toronto.—It is announced that preparations are being made to deliver to Toronto electric power generated at Niagara Falls, and that the power transmission scheme will be completed within three months.

Tottington (Lancs.)—Bury Corporation will oppose the application of the Lancashire Electric Power Co. for a provisional order for this district.

Urmston.—A committee has been appointed to open negotiations with Manchester Corporation for the construction of tramways in Urmston. A conference will take place on Monday between the parties.

Valencia (Venezuela).—This city has had a service of electricity supply since February, 1887, and there are now 200 consumers on the mains, taking current to the equivalent of 1,300 8 c.p. lamps. The system is now owned by Stelling & Co., successors to the Thomson-Houston International Co.

Vienna.—The Municipality will shortly invite tenders for, amongst other works, extensions of the tramway system in the city, upon which nearly £260,000 is to be expended, and an extension of the electric lighting at a cost of about £250,000.

Village Lighting.—Whitwell Parish Council have been informed by the Local Government Board that the Council have no power to put down electric lighting plant, and a public meeting has been convened to form a company to establish electricity works in the district.

West Ham.—The Corporation have decided to build, by direct labour, two additional underground transformer chambers at an estimated cost of £238. 16s. each.

West Hartlepool.—In order to provide for the increasing demands for electrical energy the Council have adopted a report of the borough electrical engineer (Mr H. F. Friederichs) recommending the purchase of an additional 250kw. steam dynamo. Application has been made for sanction to borrow £2,200.

Westhoughton (Lancs.)—The Council have sealed the agreement with the Lancashire Electric Power Co. for the supply and distribution of electricity in the district. The charge for current is to be 4d. per unit for lighting and 2½d. for motors of small power. The Council are to have no responsibility in regard to the working of the undertaking, but have to provide a certain sum towards capital cost, which is to be repaid.

Whitby.—The Electric Lighting sub-committee recommend the Council to appoint an assistant electrical engineer at £104 per annum.

Willesden.—The District Council have presented a memorial alleging non compliance with the standing orders by the promoters of the Metropolitan Railway Bill. Clause 35 provides that "the Company may enter into and carry into effect agreements with any railway or other company for the supply of electricity for traction, lighting or other purposes," and the Council contend that the clause proposes to repeal, without proper notice, the portion of clause 31 of the Metropolitan Railway Act, 1902, which provides that the company shall not use or supply for use in Willesden, electricity or electrical power except for its own undertaking.

Wrexham.—Extensions of the public electric lighting have been authorised by the Council.

Concert.—The staff of the telephone department of the General Electric Co., at Peel Works, Salford, indulged in a smoking concert at Manchester on Saturday, the occasion being the approaching marriage of the popular general manager, Mr. A. Brooker. Mr. A. Eckstein, managing director of the company, was present, as were also Messrs. Bayley and Wilson of the National Telephone Co., and Mr. W. Slingo of the G.P.O. Engineering Department, Liverpool. Not the least interesting item on the programme was the presentation to Mr. Brooker of a silver fruit and flower epergne, the presentation being made by Mr. G. C. Vyle, after Mr. Brooker's health had been proposed by Mr. A. Trafford.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Handsworth Urban District Council invite tenders for power and lighting circuits and fittings in generating station, pipework, feed pumps, economiser, &c., and electricity meters. Specifications, &c., from the clerk (Mr. H. Ward), Council Offices, Handsworth. Specifications can also be seen at, but not obtained from, the offices of the consulting engineers (Messrs. Kennedy & Jenkin), 17, Victoria-street, Westminster, London, S.W. Tenders to the Council House, Handsworth, before noon Feb. 2. See also an advertisement.

Great Yarmouth Corporation invite tenders for supply and delivery of tramcars, complete with motors, controllers, trolleys, &c., steel poles, trolley wires, insulators, feeder and section pillars, &c. Specifications from the consulting engineers (Messrs Preece & Cardew), 8, Queen Anne's-gate, Westminster, S.W. Tenders to the Town Hall, Great Yarmouth, by noon Feb. 2. See also advertisement

The Town Council of *Porto* (Portugal) notify a competition, which will close on March 15, at 3 p.m., for a concession for the exclusive right of working tramways in the town, on the terms of "Conditions" approved by the Council. Conditions of the competition can be obtained at the Portuguese Consulate, 6, South-street, Finsbury, London, E.C. Some further particulars are given in an advertisement.

Grimsby Corporation invite tenders for motors (from ½ H.P. to 10 H.P.) with starters (two years' contract); water-purifying plant for separating oil from condensed water; and 12 months' supply of oil, stores, arc lamp carbons and globes, incandescent and Nernst lamps, tools, rubber goods and cables, &c. Tenders to Mr. W. A. Vignoles, Electricity Works, Grimsby, for motors and purifier by Jan. 23, and for stores by Feb. 1.

The Directors of the *South London Electric Supply Corpn. (Ltd.)* invite tenders for supply and erection at their works, Bengeworth-road, Loughborough Junction, London, S.E., of one 750kw. steam alternator and pipe connections and sundry iron work. Tenders to the secretary (Mr. H. H. Boyer), by noon Jan. 16.

London County Council require tenders by 24th inst. for road-work and plate-laying for their conduit system of Northern tramways in Rosebery-avenue, and a portion of the authorised tramway in St. John Street-road.

The Guardians of *Whitechapel* (London) Union invite tenders for the electric lighting of section 2 of the infirmary. Tenders to the Guardians' Offices, 74, Vallance-road, N.E., by noon Jan. 16.

Ilford Council invite tenders for extensions to switchboard gallery and steel gangway from engine room to boiler house. Tenders by noon 24th inst.

South Shields Corporation invite tenders for permanent way construction, supply and laying of conduits and cables, overhead equipment, &c., of their projected tramways. Tenders by Feb. 20.

Swindon Corporation want tenders by 10 a.m. of 24th inst. for Lancashire boiler, with superheater, piping, &c.

The Municipal Council of *Johannesburg* is prepared to receive tenders for 100 electric tramcars, two electric water cars, one 5-ton travelling crane, one electric car traverser and various workshop tools, including erection at Johannesburg, to specification No. 10 of the consulting engineers (Messrs. Mordey & Dawbarn, 82, Victoria-street, London, S.W.), to whom tenders by March 6.

Johannesburg Municipal Council also invite tenders for Vignoles rails, fishplates, angle steel guard-rails, bolts, nuts, coach-screws, and dog-spikes. Tenders to Messrs. Mordey & Dawbarn, 82, Victoria-st., Westminster, S.W., by noon Jan. 26.

The *Prussian* State Railway Authorities, Erfurt, invite tenders (until 25th inst.) for 430,000 arc lamp carbons and 3,000 incandescent lamps. The same authorities at Altona, require tenders (until Jan. 21) for 330,000 arc lamp carbons and 4,800 incandescent lamps. Particulars from and tenders to Die Konigliche Eisenbahn Direction, Erfurt, or Altona.

TENDERS RECEIVED AND ACCEPTED.

The tender of the British Insulated and Helsby Cables (Ltd.) has been accepted by Swansea Telephone Committee for telephone cables and extensions to switchboard. This is how the "S. Wales Daily News" puts it:—

> "The tenders of the British Insular and Elbe Company, for the supply of telephone cables and an addition to the switchboard, was accepted"

Leyton Council have accepted the tender of Oliver & Co. for four arc lamps at £44, and that of the Western Electric Co. for 6 miles of street lighting cable at £546. For the latter Johnson & Phillips tendered at £540 and W. F. Dennis & Co. at £543. 9s.

Lincoln Council have accepted the tender of the Chloride Electrical Storage Co. for maintenance of storage battery at the electricity works for five years, and that of Mr. G. A. Howard for wiring the waterworks offices.

Canterbury Council have accepted the following tenders:

Dick, Kerr & Co., 300kw. steam dynamo.
Davey, Paxman & Co., boiler and superheater.
J. G. Statter & Co., switchboard.
E. Green & Sons, extensions to economiser.
F. J. Philpott, electric wiring for six months.

West Ham Corporation has accepted the following tenders:—

Windsor & Co., resetting two boilers, £278. 10s.; British Thomson-Houston Co., equipping of two panels on traction board, £180; Ferranti Limited, supply and repair of coils, 300kw. coils, £25 per pair, re-winding and re-building £5. 5s. per pair, 600kw. coils £29 per pair, re-winding and re-building £6. 10s. per pair; Babcock & Wilcox, reinstating chain grate stokers in three boilers, £180 per boiler.

Great Yarmouth Corporation have accepted the tender of Askham Bros. & Wilson, Sheffield, for supply of points and crossings, and that of the Albion Clay Co. for conduits at 5s. 6d. per yard for the Gorleston and Southtown electric tramways.

Whitby District Council have accepted the tender of C. A. Parsons & Co. for a 200kw. steam turbine at £1,550, and that of Johnson & Phillips for an additional panel to the switchboard at £92. 10s.

Rhymney Council have accepted the offer of the Tredegar Iron & Coal Co. to supply electric current for lighting the village of Abertysswg at £3. 6s. per lamp per annum.

J. G. White & Co. have secured the contract for the extension of the electric tramway from St. Peter's-street to the Market Place, Derby, at £3,000.

Durban tramways department have placed orders with the Lancashire Dynamo & Motor Co. for a booster and with the Tudor Storage Battery Synd. for a battery of 250 cells of 770 ampere-hours capacity

Salford Corporation have accepted the tender of the British Westinghouse Co. for a booster at £478.

Bedford Council have accepted the tender of the British Thomson-Houston Co. for 300 a.-c. meters.

Hackney (London) Council have placed an order with the Tudor Accumulator Co. for repairs to their storage battery at £120.

BUSINESS NOTICES.

Messrs. Thomas L. Scott & Co. have commenced business as contracting engineers at 3, London Wall-buildings, London, E.C. Mr. T. Scott was until recently engineering director to Messrs. Macartney, McElroy & Co. (Ltd.).

Messrs. G. V. Llewelyn and E. M. Ashley (trading as the Southport Electric Lighting Co.), 189, Lord-street, Southport, have dissolved partnership. Debts by Mr. Ashley, who continues.

Messrs. Penman & Co., Caledonian Iron Works, Glasgow, have appointed Messrs. Andrew Brown & Co., 110, Cannon-street, London, E.C., their agents for London and district.

The Lancashire Electric Power Co. announce that they have decided to open a hire-purchase branch in the Lancashire district, and have appointed Mr. Philip C. Pope, lately with the British Westinghouse Co., in the capacity of engineer to the hire-purchase and development department. From the way the company's customers have received the opening of this department there are good prospects of a considerable amount of hire-purchase business.

The Stirling Boiler Co. (Ltd.) and the Stirling Co. of U.S.A. have come to an arrangement whereby litigation which had been pending for nearly a year has been satisfactorily disposed of. We understand that the Stirling Boiler Co. (Ltd.) have acquired all the British and European patents of the American company, and in future all boilers sold in these markets will be of British manufacture. The Stirling Boiler Co. are well equipped for dealing with a large volume of trade, having large works at Motherwell, Lanark. Both the American four-drum type and the British five-drum Stirling boiler will be sold in this country. The Stirling boiler is already well known here, and has been fully described and illustrated in our columns. It is always satisfactory to record the settlement of disputes likely to hinder industrial development.

LIQUIDATIONS, &c.

A receiving order has been made against H. E. Parris (trading as the St. George Electrical Mfg. Co.), 134, Upper Thames-street, London, E.C., and 29, High-street, Sydenham, Kent.

The examination of John Hill, electrical engineer, 87, Minard-road, Glasgow, took place last week. Bankrupt commenced business as a partner in Sykes & Richardson. The partnership was dissolved, and when he left the firm was £550 in debt to him, for which sum bills were given. He attributed his insolvency to lack of capital. Liabilities £1,981. 17s. 6d., assets £165

An application for the discharge of Dr. F. H. Bowman, electrical engineer, 39, Victoria-street, London, S.W., will be heard on 25th inst. at Bankruptcy-buildings, London, W.C.

The New Zealand Electric Light & Traction Co. (Ltd.) is being wound up voluntarily. Mr. R. W. Blackburn, 35, New Broad-street, London, E.C., is liquidator.

The British Autovolt Co. (Ltd.) is to be wound up voluntarily. Mr. St. John Winne, 7, Laurence Pountney-hill, London, E.C., is liquidator.

British Columbia Telephones (Ltd.) is to be wound up voluntarily. Mr. M. Brewer, 49, Queen Victoria-street, London, E.C. is liquidator.

Plant for Sale.—A number of electric motors are advertised for sale in another column; also four electric drum hoists, complete with controllers. Applications to Messrs. Mavoh & Haley, America Wharf, Townmead road, Fulham, London, S.W.

Old P.O. Stores Sale.—Tenders are invited for the purchase of about 45 tons of gutta-percha, 75 tons of copper, a quantity of other metals, gutta-percha-covered copper wire, tools, lamp tops, &c. Forms of tender from Controller of Stores department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders by 10 a.m. Jan. 18.

Premises for Sale.—A freehold factory is to be sold, complying with L.C.C. requirements, and provided with up-to-date improvements, fireproof construction, electric lift, &c., space about 15,700ft. The floor area (five storeys) is about 68,000ft. super. Particulars from Messrs. Leage, auctioneers and surveyors, 10, City-road, Finsbury, London, E.C. See also advertisement.

Electrical Exhibition.—An electrical exhibition will be held at Islington (London) Baths, Hornsey-road, N., from Feb. 27 to March 11 inclusive. It is proposed to include electric lighting and power machinery, heating and cooking apparatus, fittings, launches, fountains, illuminations, novelties of all kinds, &c. The space available for exhibitors is about 4,000 sq. ft. A rental will be charged for space, but current will be supplied free. Particulars from the electrical engineer (Mr. Albert Gay), 50, Eden-grove, Holloway, N. See also advertisement.

Condensing Plant Contracts.—The Mirrlees-Watson Co., Scotland-street, Glasgow, have recently received orders for condensing plant from the following :—

British Thomson-Houston Co., two sets for dealing with 29,250lb. of steam per hour and one set for 27,000lb. (for London); Mr. A. Parry, one set for 7,500lb. of steam per hour (for Calcutta); Trafford Power & Light Supply (through Messrs. Lacey, Sillar & Leigh), one set for 24,000lb.; J. & P. Coats, one set for 25,500lb. (for Barcelona); Crewe Corporation, one set for 20,000lb.; and Gwynnes (Ltd.), one set for 6,000lb.

"**Modern Telegraphy.**"—With this title an exhaustive pamphlet relating to the London Telegraph Training College at Saltoun-road, Brixton, is issued. The pamphlet contains much information and many particulars of interest to those who contemplate entering their sons (and daughters) for the telegraph service. The London Telegraph Training College can point to a large number of appointments obtained by pupils.

Faraday House.—The January issue of the "Faraday House Journal" contains articles on "Artificial Lighting of Picture Galleries" and the "Best System of Alternating-Current Traction for Long Distance Lines," as well as descriptions of engineering works associated with Faraday House. The college is moving to its new quarters in Southampton-row, Holborn, at Easter.

Siemens' Publications.—Messrs. Siemens Brothers & Co., York-street, Westminster, London, S.W., have filed into one binder the complete series of leaflets, specifications, &c., now current dealing with their manufactures, so far as these relate to plant. These documents will be found to give contractors and others an excellent idea of the large range of machines which the company are in a position to supply. Diagrams of connections relating to compound and shunt generators and motors are included, as well as instructions for the erection of many of the machines.

"**Lockwood's Price Book.**"—The new edition of "Lockwood's Price Book," which has been published annually for very many years by Messrs. Crosby Lockwood & Son, London, is now ready and is a bulky volume of about 500 pages, supplemented by 230 pages, setting out certain Acts of Parliament, bills, &c., which relate to building matters in every branch. The book is too well-known to require exhaustive reference here. The published price is 4s.

Catalogues, &c.—New small three-phase motors are described in list No. 28 issued by the Lahmeyer Electrical Co., 109-111, New Oxford-street, London, W.C. The company have taken these motors in hand in very large quantities.

A useful catalogue of portable electric safety and portable accumulators for all purposes has been prepared and issued by the Bristol Electric Safety Lamp Works, 40, Great Smith-street, Westminster, London, S.W. The list includes a handy form of electric torch lamp for the inspection of motor-car machinery, &c., which can be used in conjunction with an ignition cell. As is shown in the illustration (Fig. 1) the bulb is well protected and the lamp will pass through an aperture of less than 1½in. diameter. Electric cycle lamps, inspector lamps, head and collar lamps for horses, and the Andrew suspension fitting for reading lamps, &c., are shown. Fig. 2 illustrates the reading lamp and Andrew fitting. The latter consists of an adjustable clamp to which a socket for the lantern hook is fixed by means of a universal ball joint. This can be fitted to the top rail of a bedstead or in any position where a rail or rod is available.

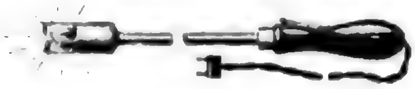


FIG. 1.

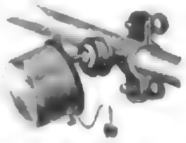
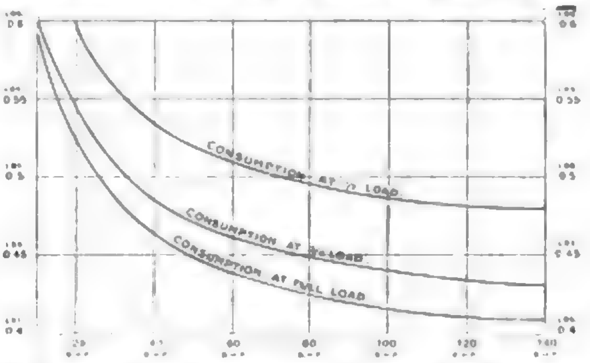


FIG. 2.

A new price list for 1905 has been prepared by the Simplex Steel Conduit Co., Westinghouse Building, Norfolk-street, London, W.C., and contains a list of reduced prices of all Simplex conduits and fittings. As is customary with the Simplex publications, no expense has been spared in making the list acceptable to contractors and all engaged in installation work. In the illustrations and text everything is as clear as print can make it, which enables the busy man to find with the smallest expenditure of time the particulars he requires from such a list.

A price list and particulars of the Diesel oil engine has been issued by the Diesel Oil Engine Co., 179, Queen Victoria-street, London, E.C. The company claim that, since the engine was first placed on the market in 1898, 900 engines had been put into work up to 1904, and that during that year 1,200 engines, with a total output of 75,000 B.H.P. have been added. Among the illustrations in the list is the accompanying diagram showing the fuel consumption in pounds per brake-horse-power.



The above diagram represents the consumption of a single cylinder and multiples thereof. For instance, a 40 B.H.P. single cylinder engine consumes ·46lbs. per B.H.P. hour at full load, and a double cylinder engine of 80 B.H.P. and a three cylinder engine of 120 B.H.P., made up of cylinders of 40 B.H.P., will also consume ·46lbs. per B.H.P. hour.

The Electrical Co., 121-125, Charing Cross-road, London, W.C., have ready a new sheet list (No. 84/1) of carbons for flame arc lamps.

The St. Helens Cable Co. are making the most of the picture postcard phase of advertising, and are issuing some excellent interior views of their Warrington works, &c.

Messrs. Hunt & Hess, of Hackney, London, N.E., have ready new sheets 4, 5 and 6 showing standard Litholite bushes and handles, and also a revised price list No. 1. A large assortment of these goods is shown in outline to scale.

Messrs. R. W. Blackwell & Co., 59, City-road, London, E.C., have a new list ready of I. T. E. limit switches for the protection of travelling cranes and motor-driven machinery.

The fourth edition of "Street Lighting," issued by the Improved Electric Glow Lamp Co., 7, Great Newport-street, London, W.C., is to hand, and is a well illustrated pamphlet relating to the various manufactures of the company in connection with the I.E. system of street lighting.

Messrs. Nalder Bros. & Thompson issue a hanging calendar sheet containing particulars of their gold medal motor gauge with patent shield.

Imports.—The following are official values of imports of electrical machinery, material and apparatus into this country during December:—Electrical machinery, £37,381 (a decrease of £11,994 compared with December, 1903); telegraph cables and apparatus, £6,464 (increase £5,085); other electrical goods, £86,236 (decrease £733). The total imports of the three classes during the 12 months ended Dec. 31 were £55,074 (decrease £2,286), £558,971 (increase £4,328) and £790,799 (decrease £28,230).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Jan. 4 to 10, with the ports of destination :—

Africa—Alexandria, £117; Beira, £32 (including £20 telegraph material); Cape Town, £406; Delagoa Bay, £383; Durban, £2,031 (including £377 telegraph material); East London, £37; Mombasa, £12; Port Elizabeth, £56 (telegraph material); Port Said, £60; Suez, £29. *Argentina*—Buenos Ayres, £229 (including £40 telegraph material). *Australasia*—Adelaide, £2,027; Auckland, £38; Brisbane, £34; Christchurch, £80; Fremantle, £8; Melbourne, £410; Napier, £24; Perth, £110; Sydney, £554; Wellington, £271. *Belgium*—Antwerp, £280; Brussels, £416. *Brazil*—Rio Janeiro, £136 (telegraph material). *Canada*—Montreal, £21; Toronto, £91. *Ceylon*—Colombo, £58. *Cochin China*—

Saigon, £92. *France*—Paris, £388. *Germany*—Hamburg, £42. *Holland*—Amsterdam, £42; Flushing, £128; Rotterdam, £33. *Hong Kong*, £800. *India*—Bombay, £823 (including £52 telegraph material); Calcutta, £1,076; Madras, £325. *Japan*—Tokyo, £6,295; Yokohama, £74. *Malta*, £92. *Russia*—Reval, £482; St. Petersburg, £105. *Siam*—Bangkok, £89. *Spain*—San Sebastian, £42. *Straits Settlements*—Penang, £67. Total £18,880, against £15,499 in the corresponding week last year (Jan. 6 to 12).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

22,423 Hindle. Electric generators and motors.
22,465 B.T.-H. Co. (Clinker, Wedmore & Whitcher). Safety devices for alternating current distributing systems.
22,847 M. G. Waggott, M. Rozenberg and W. Smyth. Electro-mechanical automatic switches for surface contacts, also applicable for automatic signalling.
23,483 Anton. Electrical transmission of energy through space. (Date applied for, Sept. 12, 1903.)
23,715 Roddam. Operating railway signals and points by electricity.
24,864 Chandler and Bonniksen. Electric clocks.
25,122 Fournier. Arc lamps.
25,146 Laird and Todd. Controllers for electric motors.
25,235 Smart. Apparatus for commuting currents passing through combined arc and incandescent lamp circuits.
25,382 Fleming & Marconi's Wireless Telegraph Co. Signalling keys.
25,382 Fleming and Marconi's Wireless Telegraph Co. Transmitting instruments for wireless telegraphy.
25,698 Ladd. Electric lighting.
25,550 Clotten. Electrolytic recovery of metals.
25,669 Brown. Electric cables.
25,854a B.T.-H. Co. (G.E. Co., U.S.). Suspenders for overhead conductors.
25,970 Griffiths and Bedell. Current collector for stud-contact systems.
26,180 Hepke, Diener and Ascher. Fuses or cutouts.
27,497 Duckham. Lighting gas burners by electricity.
28,252 Sunderland. Electric lighting batten.
28,632 Waterhouse and Simplex Steel Conduit Co. Metallic conduits.

1904.

45 Richmond and Carey. Electrically-controlled lifts.
214 Kamperdyk. Batteries.
295 Blackmarr and Willford. Converting oxygen into ozone.
574 Rees. Construction of armatures of dynamos and motors.
628 Schwab and Vogel. Incandescent lamps.
660 Plato. Electric alarm bells.
699 Bauer. Electric heating and cooking apparatus.
820 B.T.-H. Co. (G.E. Co., U.S.). Switches.
1,011 Laing. Electric winches.
1,027 Beldam. Switches, bell pushes, &c.
1,036 Pescatore. Secondary batteries.
1,044 Alltree. Electrical contact maker for internal combustion engines.
1,069 Drake & Gorham (Ltd.), Drake and Gorham. Ray bath.
1,325 Hope, Sugden and Gardner. Switches.
1,481, 1,482 and 1,483 B.T.-H. Co. (G.E. Co., U.S.). Alternating-current motors.
1,625 Gross. Arc lamps.
1,642 B.T.-H. Co., Wedmore and Whitcher. Switchboard.
2,496 Hewitt. Producing oscillatory electric currents. (Date applied for, Feb. 9, 1903.)
2,676 Schaeffer (Bastians & Wehrmann). Electric couplings for arc lamps.
3,328 and 22,287 Lundberg and Lundberg. Switches.
3,357 Marks (Gurney). Rapid trembler for induction coil.
4,953 Aktiebolaget Svenska Elektriska Urfabriken. Automatically interrupting an electric current. (Date applied for, March 3, 1903.)
6,429 Lake (Risso). Electric insulating clutches for dynamos and motors.
6,972 Gerard and Fiedler. Electrodes for arc lights.
11,168 Elektrizitats-Act.-Ges. vorm W. Lahmeyer & Co. Safety devices for protecting electric machinery against excessive voltage occurring when switching in or out. (Date applied for, June 27, 1903.)
14,136 Foot. Brush holders for rotary electrical machines. (Date applied for, June 24, 1903.)
14,380 Stauger. Electro medical baths.
15,258 Arnheim. Electromagnetic switch devices for telephone stations. (Rights under Patents, &c., Act, 1901, not granted.)
17,741 Fairweather (Arnold Magnetic Clutch Co.). Alternating current transmitting apparatus.
17,672 Dymond (Watson & Wheeler). Induction coils.
17,768 Claremont and Stratton. Carriages for cable drums.
18,561 Linkleter. Live rail protections.
19,125 Lamme. Brush-holders for rotary electrical machines. (Date applied for, Sept. 16, 1903.)
19,419 Chapman. removing static electricity from articles.
20,000 Fortescue. Coils for electrical apparatus. (Date applied for, Sept. 30, 1903.)
20,003 Birkeland and Eyde. Process and furnace for subjecting solid materials to action of electric arc. (Date applied for, Sept. 19, 1903.)
20,478 James (Crehore). Telegraph systems.
20,531 Bouet (Elektricitats-Ges. Zschockelt m.b.H.). Protectors or polishers for commutators, &c.
20,689 Schneider. Regulation or control of dynamos and motors.
20,896 Bosquet. Manufacture of water jackets, casings, &c., by electrolytic means.
21,403 Jungner. Increasing activity in electrode masses of badly conductive metallic oxides or hydrates in accumulators with invariable electrolyte. (Date applied for, Oct. 31, 1903.)
21,795 Von Lieben and Reisz. Dynamic-electric clutch or electromagnetic gearing.
21,913 Ziegenberg. Manufacture of galvanic cells.
22,535 Siemens Bros. & Co. (Siemens Schuckertwerke G.m.b.H.). Appliance for the prevention of excess pressures on switching on and off installations of high voltages; applicable also for testing.
23,031 Render. Fuse heads for electric blasting.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

GENERAL ELECTRIC DE FRANCE (LTD.) (83,156.)—Reg. Jan. 7, capital £10,000 in £1 shares, to acquire from L. Espir on the terms of an agreement between the vendor and others and N. Gunz, the entire business of a dealer in electrical apparatus and appliances carried on at 11bis Rue de Maubeuge, Paris, to adopt an agreement with L. Espir, and to carry on the business of electricians, electrical and mechanical engineers, dealers in dynamos, motors, telephones, bells, electroliers, arc and other lamps, electric fittings, heating and cooking apparatus, insulating materials, &c. First directors, L. Espir, H. Hirst, Max Byng and H. Bevis. Reg. office, 67, Queen Victoria-street, London, E.C.

SHANGHAI ELECTRIC TRAMWAYS (LTD.) (83,109.) Reg. Jan. 2, capital £10,000 in £1 shares, to acquire, equip, maintain and work by electrical or other power, tramways, railways, boats and other means of communication in Shanghai or elsewhere in Asia, and to carry on the business of electricians, generators, accumulators and distributors of electrical energy, &c.

STATUTORY RETURNS.

CHELMSFORD ELECTRIC LIGHTING CO. (LTD.)—In return to Dec. 15 capital is £50,000 in £1 shares, of which 35,000 have been taken up. £35,000 has been paid. Mortgages and charges, £7,870.

ELECTRIC SUPPLY CO. OF VICTORIA (LTD.)—Return to Nov. 24 gives capital as £200,000 in £1 shares, of which 1,207 have been taken up. £7 has been received, and £1,200 is considered as paid. Mortgages and charges, £75,000. (£25,000 debentures issued since date of return.)

MORTGAGES AND CHARGES.

ELECTRIC SUPPLY CO. OF VICTORIA (LTD.)—Issue on Dec. 10 of £25,000 5 per cent. debentures, part of series created Oct. 16, 1900, to secure £200,000. Property charged, company's undertaking and property, present and future, including uncalled capital. No trustees. Previous issue of same series, £75,000.

MINEHEAD ELECTRIC SUPPLY CO. (LTD.)—A memorandum of satisfaction in full of a debenture and mortgage dated April 24, 1903, securing £700, has been filed.

CITY NOTES.

MEMORANDA (Jan. 12).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 27⅝d. per oz. Consols 88⅜—88½ for money, 88½—88⅝ for account; 2½ per cent. annuities 87—87½. Consols Pay Day, Feb. 1. Stocks and Shares Continuation Days, Jan. 25 and Feb. 7; Ticket Day, Jan. 27; Pay Days, Jan. 13 and 28; Mining Share Carry-over Days, Jan. 24 and Feb. 6.

BAHIA BLANCA & NORTH WESTERN RLY. CO.—On Friday a special resolution was passed altering the memorandum of association to enable the company to generate and supply electricity for lighting, power, &c. The chairman (Mr. J. W. Philipps, M.P.), said that when the company was formed the number of purposes to which electricity would be commonly applied was not foreseen, and therefore they did not take certain powers which they now found it necessary to have. It was proposed to put up an electricity generating station sufficient to enable them to light their markets and their station at Bahia Blanca; also to increase the electric lighting plant at the mole, as it was now being lengthened, and it was probable that before long, as the tramway business of Bahia-Blanca was developing, it might be thought advisable to have sufficient electric power to work the line by that means. It was possible that they would make some arrangement by which they would supply electricity to the public in Bahia-Blanca.

CHILI TELEPHONE CO. (LTD.)—An interim dividend of 3s. per share (payable 16th inst.) has been declared.

CLAYTON & SHUTTLEWORTH (LTD.)—Mr. H. F. L. Orcutt, M.I.Mech.E., A.M.S.Mech.E., has been appointed managing director of this company.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Jan. 7	1,583	+ 796	38	45,750	+ 5,801
Airdrie	Dec. 30	192	...	47	9,892	...
Ayr Corporation	Jan. 7	217	+ 57	31	11,039	+ 592
Barnsley	Dec. 30	201	+ 27	51	9,768	− 578
Barrow	,, 30	202	...	47	9,270	...
Bath Electric Trams, Ltd.	Jan. 4	560	+ 178	1	560	+ 178
Bexley District Council	...	...	...	...	...	...
Birkenhead	...	...	...	...	...	...
Birmingham Corporation	,, 7	367	...	53	16,246	...
Birmingham Tramways Co.	,, 7	5,544	+ 497	1	5,544	+ 497
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 5	226	+ 49	40	43,949	+ 5,996
Blackpool and Fleetwood	,, 7	160	− 8	1	160	− 8
Blackp'l, St. Anne's & Lytham	,, 5	135	+ 1	¶10	1,245	− 277
Bolton Corporation	,, 5	2,151	+ 496	41	75,565	+ 445
Bournemouth Corporation	,, 4	537	+ 116	‡40	41,184	+ 2,128
Bradford Corporation	,, 7	4,022	+ 740	39	151,186	+ 27,985
Brighton Corporation	,, 8	727	+ 51	40	41,250	+ 3,495
Brisbane Tramways	...	...	...	...	...	...
Bristol Trams & Carriage	,, 6	4,579	+ 131	27	169,895	+ 2,801
Buenos Ayres & Belgrano	...	...	...	...	...	...
Burnley Corporation	,, 7	1,090	+ 274	14	14,972	+ 2,230
Burton Corporation	,, 8	312	+ 18	¶40	11,929	
Calcutta Tramways Co.	,, 7	a48,838	+ a9,746	1	a48,838	+ a9,746
Camborne-Redruth	,, 9	101	+ 6	10	1,107	− 201
Cardiff Corporation	,, 7	1,910	+ 116	40	82,632	+ 2,190
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 7	7,015	− 89	1	7,015	− 89
Chatham & Dist. Lt. Rys.	,, 5	588	+ 13	1	588	+ 13
City & South London Rly.	,, 8	3,179	+ 16	2	6,400	− 5
Colchester Corporation	,, 5	108	...	23	5,570	...
Cork Electric Trams Co.	‡ ,, 5	305	− 110	‡1	305	− 110
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	Dec. 30	535	+ 79	51	27,489	+ 3,257
Dover Corporation	Jan. 7	190	+ 9	41	9,229	− 120
Dublin & Lucan Railway	,, 6	80	+ 4	1	80	+ 4
Dublin Southern District	,, 6	667	+ 64	‡1	3,915	+ 111
Dublin United	,, 6	3,248	+ 113			
Dudley—Stourbridge	Dec. 30	955	+ 59	52	44,742	+ 1,321
Dundee Corporation	Jan. 4	1,208	+ 82	§52	28,177	+ 172
East Ham Council	,, 7	629	+ 43	40	28,920	+ 1,564
Gateshead & Dist. Trams	Dec. 30	976	− 32	52	47,309	+ 1,192
Glasgow Corporation	Jan. 7	17,069	+ 2,470	†32	457,766	+ 22,455
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	Dec. 30	245	+ 25	52	12,852	+ 272
Gt. Northern & City Rly.	Jan. 7	1,555	...	1	1,555	...
Greenock & Port Glasgow	Dec. 30	490	− 81	52	29,722	+ 1,434
**Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 30	279	− 14	52	15,100	+ 926
Huddersfield	Jan. 7	1,219	+ 125	40	51,814	+ 3,543
Hull Corporation	,, 7	2,180	+ 143	40	88,496	+ 10,705
Ilford District Council	,, 7	358	+ 37	*40	13,410	+ 191
Ilkeston Corporation	,, 4	91	− 14	14	1,551	− 247
Ipswich Corporation	,, 7	336	− 3	40	19,400	...
Isle of Thanet Co.	,, 7	214	− 8	14	4,297	− 93
Keighley Corporation	,, 7	102	...	*12	1,369	...
Kidderminster & District	Dec. 30	138	+ 12	52	6,491	+ 1
Kirkcaldy Corporation	Jan. 4	347	− 8	1	347	− 8
Lanarkshire Trams Co.	‡ ,, 5	813	− 60	‡1	813	− 60
Leeds Corporation	,, 7	6,298	+ 499	41	236,884	+ 13,446
Leicester Corporation	,, 7	1,752	...	1	1,752	...
Liverpool Corporation	Dec. 31	10,867	+ 681	§52	540,916	+ 16,407
Liverpool Overhead Rly.	Jan. 8	1,305	− 93	2	2,956	− 228
London County Council	Dec. 31	13,514	+ 3,635	§49	501,292	+ 100,643
Lowestoft	Jan. 7	136	...	1	136	...
Maidstone Corporation	,, 6	96	...	25	3,607	...
Manchester Corporation	,, 7	11,996	+ 1,247	40	491,433	+ 21,064
Mersey Railway	,, 7	1,664	+ 94	1	1,664	+ 94
Merthyr	Dec. 30	269	+ 54	52	10,443	+ 7
Metropolitan Elec. Trams	...	...	...	...	...	...
Middleton	,, 30	193	+ 5	52	16,616	+ 318
Nelson Corporation	Jan. 7	105	+ 12	41	4,896	+ 1,314
Newcastle-on-Tyne Corp.	,, 7	3,744	+ 272	1	3,744	+ 272
Newport (Mon.)	Dec. 31	619	+ 199	13	6,619	+ 472
Oldham, Ashton & Hyde	,, 30	517	− 56	52	25,201	− 1,233
Oldham Corporation	Jan. 8	1,354	+ 332	41	50,847	+ 2,566
Perth (W. A.) Elec. Trams	,, 6	1,626	+ 103	1	1,626	+ 210
Peterborough	Dec. 30	144	+ 11	51	7,644	− 354
Poole and District	,, 30	209	+ 11	52	15,544	+ 18
Portsmouth Corporation	Jan. 7	1,515	+ 143	§39	73,952	+ 6,282
Potteries	Dec. 30	1,924	+ 376	52	89,571	+ 6,303
Reading Corporation	Jan. 5	594	− 79	1	594	− 79
Rochdale Corporation	...	...	...	...	...	...
Rothesay	Dec. 30	31	− 22	52	6,679	− 49
Salford Corporation	Jan. 9	3,997	+ 428	40	145,271	+ 2,116
Sheerness	Dec. 25	61	+ 6	51	3,316	− 453
Sheffield Corporation	Jan. 8	4,567	+ 519	§41	197,194	+ 4,691
Southampton Corp'ation	,, 5	859	− 14	40	39,516	− 2,302
Southend Corporation	,, 4	319	+ 20	40	14,635	+ 1,161
Southport Tramways	Dec. 30	235	− 4	52	16,451	+ 367
S. Staffordshire Trams	,, 30	821	− 265	52	39,403	− 9,099
Stockport Corporation	Jan. 6	452	+ 106	40	22,572	+ 5,063
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	Dec. 30	658	+ 11	52	27,594	+ 561
Taunton Trams	,, 30	69	+ 13	52	2,555	− 218
Tynemouth and District	,, 30	197	− 4	52	14,767	− 1,063
Tyneside Trams Co.	†Jan. 4	209	− 44	†1	209	− 44
Wallasey District Council	,, 7	670	+ 103	§41	39,447	+ 2,048
Walsall	,, 7	435	...	1	435	...
Warrington Corporation	,, 5	319	+ 33	40	13,804	+ 470
West Ham Corporation	,, 5	1,076	...	45	43,115	...
Weston-super-Mare	Dec. 25	33	+ 7	51	6,272	+ 541
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 30	466	+ 43	52	20,193	− 20
Worcester	,, 30	330	+ 223	47	14,657	+ 7,437
Wrexham	,, 30	135	+ 10	52	5,634	− 1,049
Yorkshire Woollen District	,, 30	693	+ 38	52	30,131	+ 5,253

(a) These comparisons are with the corresponding period last year.

† Minus 6 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. ** Fortnight.

CLEVELAND & DURHAM COUNTY ELECTRIC POWER CO.—An extraordinary general meeting has been called for the 18th inst. for creating £156,000 5 per cent. debenture stock, part of the £333,333 which the company is empowered to borrow by their 1903 Act.

DEUTSCHE SEE - TELEGRAPHENGESELLSCHAFT. — This company having been purchased by the Deutsche-Atlantische Telegraphengesellschaft has gone into liquidation as from Dec. 29. The liquidators are Messrs. C. W. Guilleaume (Cologne), W. Hibberdine (London) and O. Moll (Cologne).

DIRECT UNITED STATES CABLE CO. (LTD.)—An interim dividend of 3s. per share, tax free at the rate of 3 per cent. per annum) has been declared for the quarter ended Dec. 31, payable 31st inst. £10,000 is put to reserve and about £2,876 carried forward. The transfer books are closed from 10th to 24th inst. inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.) The interest on this company's 4 per cent. mortgage debenture stock for the half-year ending 31st inst. will be paid by warrant on Feb. 1. The register will be closed from 27th to 31st inst. inclusive.

GLOBE TELEGRAPH & TRUST CO. (LTD.) Interim dividends at the rate of 3s. per share on the preference and 2s. per share on the ordinary shares are announced.

NATIONAL TELEPHONE CO. (LTD.)—Rumour has been busy this week with the heads of an agreement said to have been entered into between the above company and the Postmaster-General for the acquisition by the latter of the company's undertaking. On the basis that there is no smoke without fire, the rise in the quotation for the company's deferred stock which took place immediately upon the rumour being circulated, has in great part remained, and the price of the stock, which before the rumour stood at 102-104 and has been as high as 113-115 during the week, was at closing time yesterday 109½-110½. The rumour of an agreement has been categorically denied by both sides, but it is generally understood that negotiations are proceeding, and it is thought that a pronouncement on the subject may shortly be made.

SCHATTNER ELECTRICITY METER CO. (LTD.) At an extraordinary meeting on Thursday last week the resolution passed on Dec. 21, altering the name of the company to Engineering Instruments (Ltd.) was confirmed.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO. (LTD.)—Mr. Wm. May has been appointed a director of this company.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee have been asked to allow 50,000 £5 fully paid Vendors' Ordinary shares of the *Anglo-Argentine Tramways Co. (Ltd.)* to be quoted.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—Lord George Hamilton, M.P., and Mr. J. Clifton Robinson, J.P., have been elected directors of this company.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., Jan. 11.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Jan. 11. High est.	Business, Week to Jan. 11. Low est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	2/0	Anglo-Argentine Ord. Shares	8⅜−8⅝	3 12 1	Ap, Oc	8¼	7¾
5	2 6	Do. 5% Cum. Pref.	5⅛−5¼	4 7 9	—	5¼	5⅛
St.	6%	Do. Permanent 6% Deb. Stock	140 −145	4 2 11	—	105	104½
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 −106	4 15 3	—	..	..
10	6%	Barcelona Tramways Ord.	12 −12½	2 9 0	—	12½	12⅜
10	6 0	Do. 6% Cum. Pref.	9½−10	6 0 0	—	9⅞	..
St.	4½%	Do. 4½% Deb. Stock (red.)	98 −100	4 10 0	—	98	..
100	5%	Do. 5 per Cent. Debs.	99 −102	4 19 2	..	..	..
1	..	Brisbane Electric Trams. Invest Ord.	1½−2	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅞−4¼	5 17 5	—	4	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	94 −98	4 11 10	..	..	..
St.	6%	British Columbia Elec. Rlwy Def. Ord.	100 −108	5 16 6	—	..	..
St.	5%	Do. Pref. Ord. Stock	100 −103	4 17 2	—	..	..
St.	5%	Do. 5% Cum. Perp. Pref.	101 −106	4 12 0	..	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Dbs	102½−104½	4 6 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 −101	4 11 6	..	..	..
5	1/6	Buenos Ayres and Belgrano Ord	2⅞−3⅛	5 10 5	—	3⅛	3
5	5/0	Do. 6 per Cent. "A" Cm. Pref	5¼−5½	5 3 6	—	5⅜	..
5	3/0	Do. "B"	5⅛−5⅜	5 11 6	—	5⅛	..
St.	5%	Do. 5 per Cent. Debs.	105 −107	4 13 5	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov Certs.	101 −104	4 16 2	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	94 −97	5 3 1	..	..	..
5	3 0	Calcutta Tramways	6½−6¾	3 9 9	—	6¾	6⅝
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 −109	4 3 4	..	107½	..
1	1/6	Cape Electric Tram Shares	1½−1⅝	5 0 1	..	1⅝	1½
St	5%	Colombo Trams & Ltg. 5% 1st Mt Deb. (red)	101 −104	4 16 3	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk	101 − 103	4 17 3	Ja, Jul	..	..
100	5%	Montreal St. Ry. St'g 5% Mort Debs. (1908)	100 −103	4 17 3	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 −106	4 5 0	..	..	..
St.	5%	Perth (W.A.) Elec. Trams, 1st Mt. Deb. Stk.	101 −104	4 16 2	..	..	..
		ELECTRICITY SUPPLY.					
5	2/0	Calcutta Electric Supply Ord.	5½ 5¾	3 11 4	..	5¾	5⅝
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	86 −91	*5 9 11	..	..	..
10	..	Havana Electricity Co. Shares	9½−10½	—	—	..	—
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	⅞−1⅛	..	—	..	..
1	..	Rand Electric	⅞−1⅛	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	100 −102	4 8 9	Ap, Oc	..	..

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* In calculating the yield, allowance has been made for accrued interest but not for redemption.

ELECTRICAL COMPANIES' SHARE LIST.

ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share.	Last Dividend	Name.	Price Wed., Jan. 11.	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business Week to Jan. 11. Highest.	Lowest.
1	5%	Bath Elec. Trams Pref. Ord.	½—¾	..	..	..	..
1	[illegible]	† Do. 6% Cum. Pref.	¾—1	6 0 0	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19 —20	4 0 0	Feb, Aug	..	—
10	6%	† Do. Cum. Pref. (fully paid)	10 —10½	5 18 2	..	..	..
St.	4%	† Do. 4 per Cent. Debs.	105 —106	3 14 0	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	9¾—10¼	5 14 4	..	10¼	[illegible]
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —11½	5 8 8	Feb, Aug	11⅛	11
St.	5/0	Do. 5 per Cent. Perpetual Debs	118 —120	4 3 4	—	119½	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	97 —99	4 10 11	..	98	..
St.	4%	Central London Ordinary Stock	91 —93	4 6 0	June, Dec	92½	..
St.	4%	Do. 4 per Cent. Pref. Stock	101 —103	3 17 9	..	103	102
St.	4%	Do. Deferred Stock	85 —87	4 12 0	—	86½	84½
100	4%	Do. 4 per Cent. Debs.	108 —110	3 13 4	—	109½	..
5	2/6	City of Birmingham Trams 5% Cm. Prf.	4¾—5¼	4 17 6	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	46 —47	4 15 9	Feb, Aug	47½	47
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 3	Feb, Aug	..	..
St.	5%	Do. (1896)	117 —120	4 3 6	..	..	..
St.	5%	Do. (1901)	116 —119	4 4 10	..	116½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 —107	3 14 9	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13 —14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	—	..	..
10	3/0½	Gt. Northern & City Rly. Prf. Ord. (4%)	6½—6¾	4 8 10	—	6⅝	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8½—9½	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19 —20	4 0 0	Mar, Sept	..	..
10	6%	‡† Do. 6 per Cent. Pref.	15 —15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡† Do. 4½ per Cent. Debs.	110 —112	4 0 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¾—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89 —91	4 7 11	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3½—3¾	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 5	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10¼—10¾	4 14 1	..	10¾	10⅜
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 —105	3 16 2	..	104½	..
St.	..	Mersey Con. Ord. Stock	8 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10 —13	..	—	..	..
1	..	Metropolitan Electric Trams Def	¼—½	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	—	1	..
St.	4½	Do. 4½ Deb. Stock	103 —105	4 5 9	..	103½	103¼
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—1½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	8½	8½
10	5 0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —102	4 8 3	—	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	—
..	[illegible]	Underground Elec. Rys. Co. of London	97 —98	5 2 0	..	97½	..
St.	3%	Waterloo and City Ord.	90 —92	3 5 3	June, Dec	92	..

TELEGRAPHS.

Share.	Last Dividend	Name.	Price Wed., Jan. 11.	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business Week to Jan. 11. Highest.	Lowest.
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	99 —102	4 0 0	Jan, July	..	..
10	..	Amazon Telegraph	½—1	..	Jn, Dec ..	..	..
St.	12/6	Anglo-American	57 —59	4 10 8	F,My,Ag,N	57½	57
St.	25/0	Do. Preferred	103½—104½	4 16 3	F,My,Ag,N	104½	102½
St.	2/0	Do. Deferred	13½—13¾	0 14 11	F,My,Ag,N	13¾	12¾
100	82	Commercial Cable Capital Stock	170 —190	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	93 —96	4 4 2	Jn,Ap,Jy,O	95½	95
10	5/0	Cuba Submarine Ord.	8½—9½	5 3 0	Feb, Aug	9½	8½
10	10/0	Do. Preference 10 per Cent.	16¾—17½	5 14 3	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3¼—3¾	5 11 9	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7¾—8¼	6 1 3	April Oct	..	..
100	4½%	Do. 4½ per Cent. Deb.	100%—102%	4 10 0	Jan, July	..	..
20	8/0	Direct United States Cable	10¾—11	6 9 1	Ja,Ap,Jy,O	11	10¾
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 —101	4 9 1	Jn, Dec ..	..	..
St.	26/0	Eastern Ordinary	135 —138	5 3 8	Ja,Ap,Jy,O	137½	135½
St.	17/6	Do. 3½ per Cent. Pref. Stock	88 —90	3 18 0	Ja Ap,Jy,O	89½	89½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —107	3 14 9	May, Nov	106½	105½
10	2/6	Eastern Extension	13½—14	5 0 0	Ja,Ap,Jy,O	13¾	13½
St.	4%	Do. 4 per Cent. Deb. Stock	106 —108	3 14 3	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	101 —103	3 18 0	Feb, Aug	101½	101
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 5	May, Nov	101	100
10	5/0	Great Northern (of Copenhagen)	28½—29	6 3 5	Jan, July	—	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	99 —101	4 9 1	June, Dec	..	..
25	12/6	Indo-European	44½—46½	5 7 6	May, Nov	46½	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	[illegible]	4 10 11	June, Dec	..	—
10	4/0	West African Telegraph Shares	7½—7¾	5 9 2	..	7⅝	..
2½	..	West Coast of America	[illegible]	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 —99	4 10 11	Jan, July	..	..
10	..	West India and Panama	½ —1	..	May, Nov	..	..
10	7/6	Do. 6 1st Pref. ex 7 on act. of arrears	7½—8½	7 17 6	May, Nov	7½	7¼
10	..	Do. 6 per Cent. 2nd Pref.	6½—7½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 —103	4 17 1	Jan, July	101½	..
10	3/0	Western Telegraph	13½—14	5 0 0	Mr,Jn,O,D	13¾	13½
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —103	4 17 1	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	100 —102	3 18 5	—	..	..

TELEPHONES.

Share.	Last Dividend	Name.	Price Wed., Jan. 11.	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business Week to Jan. 11. Highest.	Lowest.
5	4/0	Chili Telephone (fully paid)	5¾—6¼	6 16 6	August ..	6	5¾
1	0/7½	Monte Video Telephone Ord.	1¼—1½	2 11 9	..	..	..
St.	6%	National Co. Pref. Stock	105½—106½	5 9 7	..	106½	106
St.	6%	Do. Def. Stock	112 —114	4 7 9	..	113½	108
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	15 —16	4 0 0	Feb, Aug	15½	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12 —13	4 12 4	Feb, Aug	12⅞	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½ —5¾	4 18 0	Feb, Aug	5¾	5½
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	96 —98	3 11 5	June, Dec	97½	96½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101 —103	3 17 8	..	102½	101½
..	24/0	Do. Do. Prov. Certs. all paid	101 —103	3 17 8	..	101	..
1	0/7½	Oriental	1—1½	5 18 6	April, Oct	1	—
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼—1⅜	4 16 0	..	1¼	..
St.	50/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	99 —102	..	..	100½	..
5	5/0	United River Plate	6½—6¾	6 15 6	July.....	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5¼	4 17 9	June, Dec	5⅛	5⅛
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104 —106	4 14 4	June, Dec	105½	..

FINANCIAL, INVESTMENT, &c.

Share.	Last Dividend	Name.	Price Wed., Jan. 11.	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business Week to Jan. 11. Highest.	Lowest.
5	3 0	Elec. & Gen. Investment 5% Cum. Pref.	4¾—5¼	5 17 1	—	..	..
10	2/0	Globe Telegraph and Trust	10½—10¾	5 4 9	Ja Ap,Jy O	10½	10½
10	6/0	Do. 6 per Cent. Pref.	14 —14½	4 3 9	Ja Ap,Jy,O	14½	..
100	6%	Submarine Cables Trust (Cert.)	120 —123	4 18 6	April, Oct	122½	121½

ELECTRICITY SUPPLY.

Share.	Last Dividend	Name.	Price Wed., Jan. 11.	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business Week to Jan. 11. Highest.	Lowest.
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12 —12½	6 8 0	..	12¼	12
10	[illegible]	Do. 4½ per Cent. Cum. Pref	9½—10	4 10 0	..	..	—
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 —105	4 5 9	—	104½	103½
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5¼—5¾	3 9 7	..	..	..
St.	4½%	Do. Do. 1st Debs	101 —104	4 7 0	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..	10¾	..
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 5 1	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105 —108	3 14 1	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8¼—8¾	4 11 6	Feb, Aug	8½	..
5	2/3	Do. 4½ per Cent. Pref.	5⅛—5⅜	3 17 5	Feb, Aug	5¼	..
St.	4%	Do. 4% Deb. Stock (red.)	101 —103	3 17 8	..	101½	..
5	[illegible]	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	—	4⅞	..
5	2/3	Do. Do. (1903)	4¾—5	4 10 0	..	5	4⅞
5	2/3	Chelsea Electric Supply Ord.	6¼—7	4 2 2	March ..	6½	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109 —110	4 1 10	Jn, Dec ..	110½	110
10	5/0	City of London Electric Lighting Ord.	11 —11½	4 7 9	Feb, Aug	11⅝	11½
10	6/0	Do. 6 per Cent. Cum. Pref.	13½—14	4 5 9	Jan, July	13½	13⅜
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —125	4 0 0	Jn, Dec ..	123	—
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —103	4 7 3	..	101½	..
10	4/0	County of London Elec. Supply Ord.	9 —9½	4 4 2	..	9¼	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —12½	4 16 0	Mar, Sept	12¼	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 —110	4 1 10	..	108½	107½
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 —103	4 7 5	..	102	101½
5	2 0	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 9	—	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	102 —105	4 7 0	—	..	—
5	2/6	Hove Electric Lighting Ord.	7½—8	5 6 3	..	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	100 —102	4 8 9	..	101½	..
5	5/0	Kensington & Knightsbridge Ord	12½—13	4 12 4	..	12¾	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	—	..
St	4%	Kensingtn. & Kngtbg. Co & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —104	3 17 3	—	..	..
5	..	London Electric Supply Ord.	2¼—2¾	..	..	2½	..
5	3/0	Do. 6 per Cent. Pref.	5⅛—5⅜	5 3 3	..	5¼	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 —97	4 2 6	Mr,Jn,S,D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	18 —18½	5 0 0	April, Oct	18¼	18⅛
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅛—5⅜	4 1 0	Jan. July	5¼	[illegible]
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —115	3 18 3	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 —98	3 11 3	..	97½	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	92 —95	4 15 0	..	..	—
10	[illegible]	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	13½—13¾	6 7 1	Feb, Aug	..	..
5	[illegible]	Newcastle Elec. Supply Ord.	8⅛—8½	4 [illegible] 5	Feb, Aug	..	..
5	[illegible]	Do. 6 per Cent. Non-Cum. Pref.	6⅛—6⅜	4 0 0	Feb, Aug	..	..
1	[illegible]	Northern Counties Elec. Sup. 17/- paid	15/3—16/9	3 6 8	Mar Sep	..	..
10	6/0	Notting Hill Electric Ord.	14½—15	4 0 0	March....	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	102 —104	3 17 0	..	..	..
5	2/6	Oxford Electric Ord.	6½—6¾	4 2 2	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99 —101	4 0 0	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	13½—14	5 3 7	Feb, Aug	13¾	13½
5	2/6	Do. 7 per Cent. Pref.	8½—9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98 —100	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	7¾—8¼	6 3 1	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	83 —87	4 12 6	..	..	..
5	2/0	South London Electric Supply Ord.	4½—4¾	3 8 8	—	4⅝	..
1	..	South Metrop'n Elec. Lt. & Power Ord.	¼—½	..	—	..	..
1	0/8½	Do. 7% Cum. Pref.	1⅛—1¼	4 16 9	—	..	..
St.	4½	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	107 —110	4 2 3	—	109	..
5	2/6	Urban Electric Supply Ord.	5 —5½	4 17 6	..	5¼	..
5	2/6	Do. 5% Cum. Pref.	5⅛—5⅜	4 16 6	..	5¼	..
St.	..	Do. 4½% 1st Mort. Deb.	105 —107	—	..	106	..
5	6/6	Westminster Electric Supply Ord.	12¾—13¼	5 1 11	Mar, Sept	13⅛	13
5	2/6	Do. 5 per Cent. Cum. Pref.	6½—6¾	3 14 0	—	6⅝	6½

ELECTRIC MANUFACTURING, &c.

Share.	Last Dividend	Name.	Price Wed., Jan. 11.	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business Week to Jan. 11. Highest.	Lowest.
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	½—¾	5 16 2	..	..	..
1	6d.	Aron Elec. Meter 6% Cum. Pref.	[illegible]	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5 —5½	6 19 2	July, Feb	5⅜	..
5	3 0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..	—
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —104	4 6 6	—	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101½—103	4 3 9	..	..	..
5	3/0	British Westinghouse 6% Pref.	2¾—3¼	..	—	2¾	2¾
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	86 —88	4 11 0	..	86½	86
2	..	Brush Electrical Engineering	¾—1	..	March ..	..	..
2	[illegible]	Do. 6 per Cent. Pref. Non-Cum.	1⅛—1⅜	7 12 2	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	93 —95	4 14 6	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	73 —76	5 18 5	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	8½—9	5 5 0	Jan, July	9	8½
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5¼	4 15 3	Jan, July	5⅛	5
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —106	4 4 11	Nov, May	105½	105½
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	[illegible]	4 13 9	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	95 —96	4 13 4	..	..	..
1	[illegible]	Chadburn's (Ship) Telegraph Ord.	¾—1¼	8 17 6	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	2 —2¼	3 6 10	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	98 —99	5 2 0	Jan, July	98½	..
5	10/0	Dick, Kerr & Co. Ord.	8 —8½	5 17 8	Sept	8½	8½
5	3/0	Do. 6% Cum. Pref.	5¾—6	5 0 0	Sept	5¾	5¾
St.	4½%	Do. 4½% Deb. Stock	106—107	4 4 0	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —1½	..	Feb, Aug	..	—
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 —82	4 17 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 —84	6 0 6	..	..	—
5	4/6	Emmundson's Elec. Corp. Ord.	6½—6¾	5 5 8	H'lf-yearly	6⅝	6½
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6¼	4 16 0	—	6¼	6⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	108 —110	4 3 3	..	109	..
2	1/7½	Electric Construction Co.	1½—1¾	6 3 0	July	..	..
2	2/0½	Do. 7 per Cent. Cum. Pref.	2½—2¾	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	95 —100	4 0 6	Jan, July	98½	[illegible]
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	—	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10	5 0 0	—	9¾	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91 —93	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½—10¾	6 10 3	Feb, Aug	10½	10½
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4 3 9	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	110 —112	4 0 10	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	15 —16	6 5 0	Feb, Aug	15½	15
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 5	Mar, Sept	99½	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11 —11½	4 7 0	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	38 —40	5 18 6	Mar, July	39½	[illegible]
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	[illegible]	3 17 3	Jan, July	..	..
5	—	Willans and Robinson Ord.	1 —2	..	Apr, Oct	..	..
5	—	Do. 6 per Cent. Cum. Pref.	2 —3	..	Apr, Oct	2¼	2¼
..	4%	Do. 4 per Cent. 1st Mort. Debs	74 —79	5 1 3	May Nov	76½	74½

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

THE Fisher-street sub-station, described in this issue of *The Electrician*, is, we believe, the largest sub-station with rotary machinery running in this country. Its present capacity is 3,000kw., there being six synchronous motor-generators with an output of 500kw. each, and it is to be increased to 5,000kw. by the addition of four more machines of the same size. On the other hand, one of the sub-stations for the District Railway will contain four 1,500kw. sets, and largest of all will be the Duke-street sub-station of the Westminster Electric Supply Corporation which will, we believe, be equipped with no less than twenty nine 400kw. units. Apart from its size, however, the Metropolitan Electric Supply Co.'s Fisher street sub-station possesses several features of interest, particularly in the design of the switch-gear. The three-tier construction, with the single operating platform, on which the high and low-tension gear of each motor generator is controlled from one set of handles, is an extremely practical arrangement, and the use of concentric cable 'bus bars contrived in such a way that the whole of the extra high-tension parts are completely enclosed in metal may also be noted with approval. Mr. J. S. HIGHFIELD, the company's engineer-in-chief, is to be congratulated on the job, which bears evidence of excellent workmanship, both on the part of the contractors who supplied the switch gear and motor generators, and by the company's own staff, who carried out the whole cable work in the sub-station and erected the bare copper strip low-tension conductors in almost record time.

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IN this issue will be found an abstract of two important Papers recently issued by the United States Government with regard to wireless telegraphy. One is an Inter-Departmental Report, dated July, 1904, by a Board appointed to consider the entire question of wireless telegraphy in America; it contains a series of most comprehensive conclusions and recommendations for rules and legislation upon the subject. From the second Paper, dated November 22nd, it appears that effect has already been given to the recommendation of the Committee. Both publications are of great international interest, and show that almost every possible contingency in connection with the practical application of this new means of communication has engaged the attention of the United States Government.

◆

THE right to control existing Government wireless stations and to construct and equip new ones on the American seaboard is now vested exclusively with the Navy Department, and powers are acquired for regulating the establishment of commercial stations among the different States of the Union and between nations. To summarise the chief points: (1) All coast-wise stations are henceforth to be built, equipped and manned at the expense of the Navy Department. (2) All such stations are open to the free and unrestricted use by vessels of all nationalities equipped with suitable wireless telegraph apparatus; subject to the provision that these stations do not come into competition with commercial stations. Except as provided for under this condition the Department will pass on to or accept from any inland telegraph system, *all* messages from or to any American or other vessels without, however, undertaking responsibility for collection. (3) At a pre-arranged hour daily, a time signal is sent through the ether, thus enabling equipped vessels within range to verify their chronometer ratings and thereby ascertain their exact latitude. (4) Under certain conditions of co-operative assistance, storm warnings are transmitted free of charge from all Government stations to ships within their range.

It will be specially observed that the Government stations are to be equipped for all the approved systems, and it is pointed out that by simply adopting a uniform wave length (320 metres is recommended), different systems can be made readily inter-communicable, so that the above-mentioned beneficent and valuable privileges are open to ships of all nationalities, howsoever equipped. A signalling speed not greater than twelve words per minute has been fixed. The erection and installation of private wireless stations outside of Government reservations is in no way prohibited, provided that they do not interfere with the working of the naval stations. Evidently, the policy of the United States Government has been to acquire the strategic control of wireless telegraphy in war time and in national emergencies, whilst at the same time encouraging invention in this field, and safeguarding themselves and the world at large against any attempt to create a monopoly of this method of signalling.

The interest which electrical engineers took in refuse-destructors has waned considerably during recent years. They were among the first to utilise the waste heat generated by the destructor furnace, but it did not take them long to realise that the refuse collected in an ordinary town will only produce a small part of the steam necessary for the electric lighting of the town. A dust-destructor is also an undesirable neighbour, and the large ground space covered makes it uneconomical to place it on the expensive site with good coal and water supply which is needed for an electricity works. Mr. NEWTON RUSSELL has pointed out that at Shoreditch and Stepney, for instance, the interest and redemption of capital alone works out at no less than 1s. per ton of refuse burnt.

In these circumstances it was no matter for surprise that Mr. ADAMS' Paper was keenly criticised at the Institution of Electrical Engineers. We would call attention particularly to Mr. W. R. COOPER'S figures, published in our report of the discussion, this week, which show that Mr. ADAMS' claim amounts to saying that the heat value of refuse is more than one-third that of the same weight of coal. This alone points to an error of considerable magnitude in Mr. ADAMS' data, or at any rate in his estimate of the number of kilowatt-hours generated from refuse and coal respectively in the destructor works where both are used. As he did not state clearly what method he employed to differentiate between the refuse-generated and coal-generated units, it is impossible to accept his figures without further explanation. If he measured the feed-water supplied to the refuse-fired and coal-fired boilers respectively, we shall be open to conviction that his figures are correct; if, on the other hand, they are merely estimated from average results with the coal-fired boilers at the electricity works, his records have little value as real quantitative tests.

The action brought by the Jandus Arc Lamp & Electric Co. against Arc Lamps Limited is an extremely interesting one, since it involves the principles governing the working of enclosed arc lamps. Owing to the fact that the matter is still *sub judice* we are, of course, unable to pass any comment upon it, but it may be mentioned that the plaintiffs rely upon a patent (No. 15,479) granted to LOUIS EMERSON HOWARD (an American) in 1893, and that they allege infringement of this patent. HOWARD'S patent had for its object the enclosing of the arc so as to keep fresh air from it and thereby lengthen its life. It is also argued by the plaintiffs that HOWARD was the first to demonstrate the utility of the smallness of the globe in preventing influx of air. The defendants, on the other hand, maintain that previous patents constitute anticipations of the device of the enclosing globe, and that the smallness of the globe was not intended by HOWARD to prevent influx of air, but for quite another purpose, which was struck out of the specification when the latter was amended.

MR. H. W. SULLIVAN has succeeded in devising a new application of his moving-coil galvanometer equal in merit to its predecessors. In applying his knowledge of the conditions obtaining in cable-ship testing rooms to the d'Arsonval galvanometer, he first succeeded in bringing out a modification of this instrument which has now taken the place of the moving-magnet type of marine galvanometer to a considerable extent. Having perfected his method of balancing the coil of the instrument, he next turned his attention to the question of electromagnetic and mechanical damping, and arrived at a most successful modification of his galvanometer for "speaking" purposes. Mr. SULLIVAN'S latest product is the out-going signal recorder (described on another page), which may be looked upon more or less as an improved and simplified moving-coil syphon recorder. By adding a recording attachment to the moving coil of his galvanometer and an ingenious adjustment of the static and electromagnetic methods of damping, he has made it suitable for use at the sending end in series with the cable on long cable lines; and the resistance of the instrument is so low that it does not interfere in any way with the efficiency of transmission. If Mr. SULLIVAN'S new instrument fulfils his anticipations—and we see no reason why it should not—it will prove a most useful adjunct to submarine cable working.

The *Illustrated Official Journal* of the Patent Office for January 11th contains a number of amendments which Mr. COOPER-HEWITT proposes to apply to his principal patent for mercury vapour lamps (No. 11,562, of 1900). At first glance it might be supposed that these amendments had been suggested by Mr. H. J. DOWSING'S patent, No. 4,261, of 1896, relating also to mercury vapour lamps—a patent which was rescued from oblivion by a letter from Mr. DOWSING and the reproduction of the original specification of 1896 in our columns (*The Electrician*, Vol. L., pp. 656 and 681). The amendment tends towards a restriction of the original claims, of which Nos. 1 to 12 inclusive have been replaced by three re-worded claims, while Nos. 14 to 17 inclusive and also No. 19 have been entirely struck out. As far as the amendment relates to the lamp itself, it is now clearly stated that only such vapour lamps as possess a mercury cathode fall within the range of the patent. The remainder of the amendments include the omission of the methods of starting vapour lamps by producing or procuring auxiliary high pressures, and by heating up; the claim in the original specification covering a steadying resistance in series with the lamp is also to be dropped, and the reference to the non-conductive covering of electrodes is to be omitted. A broad claim for a vapour lamp with a mercury cathode still remains, however, in spite of Mr. DOWSING's patent (now common property, as it has been allowed to lapse), describing in very clear terms a lamp based on this principle.

IN the Paper read by Mr. A. M. TAYLOR at the Birmingham Local Section, the necessity of supply undertakers making immediate and active efforts to secure an output for motor load is prominently brought forward. The suggestion is made that, as electricity has to compete in price with other sources of power, it would be well to extend its use by low rates of charge before further improvements in the efficiency of its competitors reduce the balance of advantages at present in its favour. In the development of a motor load, the possibility of making special terms for customers who require a supply during daylight hours only, should not be overlooked. This class is distinguished as "non-interest-paying," as in their case there is no proportionate charge for the use of the plant and mains, and their consumption is regarded as a bye-product. However much opinions may differ as to the ethical side of this method, and the possible objections of the lighting customers, it is certain that there is a large class of power users who can so arrange their working hours as to avail themselves of this opportunity of obtaining cheap power. In the Paper, it is proposed to control the customer's use of his motors by periodical inspection, but the most effective plan in practice is to cut off the supply automatically when the lighting peak begins. Obviously this system is less applicable in towns where fogs are a common occurrence, as the amount of peak caused by them diminishes the plant available for "bye-product" customers.

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THE graphical method adopted for proving that with this system it is possible to charge a lower price for motors than for lighting is needlessly complicated. It follows naturally from first principles that the only cost for this class of business is that part of the coal and other works costs which is independent of the stand-by costs. The author illustrates what he calls "the stand-by loss" for the various kinds of generating plant, but the diagrams, if we understand them aright, merely represent synthetically the different efficiencies, and the real stand-by loss cannot be calculated without a full knowledge of the load-factor. The proposition has often been discussed—in the case of stations which have spare plant, or are over-capitalised—of fixing at once a price which, though unprofitable for the time being, will cause a rapid increase in business, and will, in a few years, produce a good profit on the greater turnover. Unquestionably this policy of anticipation, if reasonably applied, will give stability to any business, but the "Bermondsey clause" has, in some places, to be reckoned with. It is a policy which any undertaking, desirous of expanding, might assume, whether suffering from "unproductive capital" or not, although the author recommends it only for the former case. The generalisations which conclude this Paper are far too sweeping. For instance, few of the Power Distribution Companies could exist if it were "not safe to offer current for motor supply for day use at anything below 1d. per unit, except to non-interest-paying customers."

Brest–Dakar Cable.—The c.s. "François-Arago," carrying the last section of the Brest–Dakar cable, left Calais on the 10th inst. for the Atlantic, where she will connect up the fourth section to the third section already laid off Madeira, and will then pay out the last portion of the cable up to Dakar. It is anticipated that the cable will be open to traffic in a few weeks.

Erratum.—In Fig. 2, p. 496 of *The Electrician* of last week in the article on "Direct Wheatstone Working between England and Teheran" the switches T_1, T_2 and T_3 were shown in the wrong position. Each of these should connect the receiver coils F to earth instead of to the "LT line."

Long Tramcar Run.—It is announced by the *Street Railway Journal* of New York that officials of the Lake Shore Electric Railway and the Detroit, Monroe & Toledo Short Line recently made a trip over the two lines from Detroit to Cleveland in six hours. The companies are making arrangements to run through cars from Cleveland to Detroit, and it is expected that the schedule time will be seven hours for the 177 miles.

Cable Interruptions and Repairs.

	Date of Interruption.		Date of Repair.
Cayenne—Pinheiros	Aug. 18, 1902	..	—
Beissi-Issa (Yemen)—Camaran	Oct. 22, 1902	..	—
Tarifa—Tangier	Jan. 18, 1904	..	—
Cayenne—Paramaribo	July 18, 1904	..	—
Sitka—Valdez (Alaska)......	Nov. 11, 1904	..	—
Trinidad—Demerara	Dec. 20, 1904	..	Jan. 19, 1905
Assab—Perim	Dec. 26, 1904	..	Jan. 14, 1905
Cap Haytien—Puerto Plata ..	Dec. 27, 1904	..	—

Telephones at Johannesburg.—The *African World* states that all overhead telephone wires at Johannesburg are to be replaced by underground wires. Each cable, consisting of from 104 to 612 wires, will be laid in an earthenware duct of 3½in. diameter. The number of ducts in a route varies between 3 and 45, and a certain number of orders for them have already been placed. There will be about 7 route miles of ducts altogether.

Institution of Electrical Engineers.—The following are the arrangements which have been made for the meetings of the Institution until the end of February:—January 26th, discussion on Messrs. Booth and Kershaw's Paper, "Fuel Economy in Steam Power Plants"; February 9th, Paper by Mr. G. L. Addenbrooke on "The Value of Overhead Mains for Electric Distribution in the United Kingdom"; February 23rd, Paper by Mr. Donald Murray on "Type Setting by Telegraph."

The Tramways and Light Railways Association.—A party of members of the Tramways' and Light Railways' Association paid a visit last Monday afternoon to the Central London Railway, to its power station at Shepherd's Bush and to the sub-station at Bond-street. They were most courteously conducted over the system by Mr. G. Cuningham, the general manager, assisted by the engineers and officials at the various places. There were no important developments to record, but the guests were shown one of the new steel cars and reference was made to the aluminium panelling of cars, which has been tried and found satisfactory. A novel and instructive experience was accorded to those who travelled in the motorman's compartment at the head of the train on the return journey.

Electrical Engineers' Ball.—This function having proved so great a success last year, it has been decided to hold the next on Friday, January 27th, at the Hotel Cecil, London. The following gentlemen form the committee:—

H. Alabaster, Ll. B. Atkinson, W. Worby Beaumont, C. Bright, T. Browett, T. O. Callender, E. A. Carolan, J. Irving Courtenay, Thomas Cushing, A. L. Dearlove, E. C. De Segundo, S. T. Dobson, H. A. Earle, R. S. Erskine, W. P. J. Fawcus, A. L. C. Fell, S. Z. de Ferranti, G. Flett, E. Garcke, T. E. Gatehouse, J. Gavey, W. Geipel, R. Kaye Gray, G. Grindle, R. Hammond, H. E. Harrison, H. Hirst, H. R. Kempe, J. E. Kingsbury, E. M. Lacey, W. E. Lane, H. M. Leaf, G. C. Lloyd, W. L. Madgen, Sir Henry C. Mance, C.I.E., E. Manville, W. H. Massey, W. M. Mordey, F. H. Nalder, G. W. Partridge, W. H. Patchell, Sir William Preece, F.R.S., John S. Raworth, J. H. Rider, Martin F. Roberts, Mark Robinson, Sidney Sharp, Alex. Siemens, A. M. Sillar, Fredk. Smith, G. Sutton, Sir J. W. Swan, F.R.S., C. D. Taite, James Taylor, R. J. Wallis-Jones, W. H. Wells, H. D. Wilkinson.

Executive Committee: J. E. Kingsbury, R. J. Wallis Jones, W. Geipel, M. F. Roberts, Percy Swan. *Hon. Treasurer*: R. Hammond. *Hon. Secretaries*; A. M. Sillar and H. Alabaster.

New York Power Schemes.—A Paper on this subject was recently read by Mr. P. S. Sheardown before the Dublin Local Section of the Institution of Electrical Engineers and was published in abstract in *The Electrician* of January 6th, p. 454. The discussion was taken part in by Mr. Mark Ruddle (in the chair), Mr. W. J. U. Sowter, Mr. C. P. Coote Cummins, Mr. G. Cummins, Mr. A. T. Kinsey, Mr. Brekmann and Mr. W. Tatlow.

With regard to the reason why the Edison Company still adhered to continuous current, some held that it was due to the great expansion of the company at a time when alternating-current systems and plants were not sufficiently developed, while another speaker thought it might be due to the superiority of continuous current over alternating current for lift work. Mr. Ruddle thought that insufficient attention was paid by manufacturers to the safety and ease of cleaning of H.T. switchboards. Mr. Sowter was surprised that rubber cables were apparently so largely in use, as his experience with these cables had been somewat unfortunate. Mr. Brekmann mentioned that storage batteries were used to a greater extent in America than in this country. He instanced the case of a station in Chicago, where the capacity of the accumulators amounted originally to 30 per cent. of the total station capacity, but had recently been increased to 60 per cent., the actual capacity being now 30,000 ampere-hours at a two-hours discharge rate. The cost of maintenance amounted to from 5 to 6 per cent. per annum. In his reply Mr. Sheardown pointed out that one of the chief advantages claimed by the Edison Company for continuous-current distribution lay in the direction of better regulation. He also agreed with the other contributory reasons suggested in the discussion. As to the free supply of lamps to the consumers by the company, he had made inquiries, and had found that the company insisted on supplying lamps, and sent round inspectors at regular intervals. This was necessary especially on account of the severe competition by the gas interests. Although rubber cables had lasted better in America than in this country, all new cables over there were, nevertheless, of the paper-insulated type.

Wireless Telegraph Notes.—A most interesting Paper entitled "Wireless Telegraphy and War Correspondence," was read by Capt. Lionel James, war correspondent to *The Times*, at the Society of Arts on Wednesday evening. He described the difficulties which were encountered and the troubles which were experienced owing to the aerial wires being blown down by gales, the land receiving station being situated on a bleak coast in proximity to Wei-hai-wei. In one instance, six hours after the dispatch boat "Haimun" left Shanghai, the whole of the wireless tackle which had been put up there was carried away by a gale of wind. Much of the matter related by Capt. James has already appeared in *The Electrician*, and the remainder, although extremely interesting, contained very few technical details. It was mentioned that the height of the antenna on shore was never more than 165ft., and on the boat 105ft. Referring to the report of an action before Port Arthur, Capt. James said:

We commenced to send the message, which was 1,400 words in length, from 130 miles. The message was sent in four sections of 350 words each. At the end of the first section the operator on the ship listened in for a reply. At last he took off the telephone and said in his quiet, quaint American way, "Captain, we will deliver the goods. Wei-hai-wei says that it is coming in like a drum." The remaining sections were sent at once at the rate of 30 words a minute, and although we took the precaution to repeat each section, yet we might have saved ourselves the trouble, since on my return to Wei-hai-wei I compared my written message with the message that was handed in at the Eastern Extension Cable, and I assure you there was not one word that had been taken wrongly.

Referring to another occasion, Capt. James said:

Just as day was breaking the chief officer on the "Haimun" woke me to say that the Japanese fleet was on our starboard beam. We had hit it off exactly, and keeping abreast of Togo's squadron, we witnessed the operations which cost the Russian cause a first-class battleship and Admiral Makaroff. We saw most of the operations, and when the Japanese battle squadron hoisted its fighting flags and steamed in to engage the fortress, as the flagship, the "Mikasa," fired her first 12in. gun, my operator despatched my brief message announcing the fact to Wei-hai-wei. That message was sent at express rate, and consequently was in *The Times* office a couple of hours later, and making allowances for the difference of time, the newspaper office knew that an engagement was taking place six hours before that engagement began. The full descriptive details of this action, which were contained in a message of nearly 2,000 words, were sent correctly from Choda Island, 145 sea miles from the receiving station.

Sir WM. PREECE, who occupied the chair, thanked Capt. James for the first authentic account of this practical use of wireless telegraphy—he was afraid it would also be the last—as no Government would allow information to be gained and published in such a manner in the future. Capt. James had done the thing too well, and had thus shown how dangerous it might be. Not so much importance was attached to the height of the antenna as to the electrical equipment. In referring to the great speed and accuracy of the de Forest system, he doubted whether any telegraphic circuit in Europe could transmit 2,000 words without error, either in copying, sending or receiving.

Mr. CUTHBERT HALL said he failed to understand the point of the Paper. Thousands of words were sent by the Marconi system daily, and distances of 1,500 miles were covered. So far as he could gather, it was only the character of the news transmitted that was interesting.

Gen. STERLING said he did not think commanders would allow wireless telegraphy to be used for such purposes in the future. Would Capt. James give a little more information regarding disturbances?

In his reply to the discussion, the author said that he knew nothing of the scientific merits of the system, but had absolutely proved its practical utility. Although Italian, Russian and Japanese systems were working all around them no disturbances were experienced except when they were within a mile of a foreign spark. He had chosen the De Forest system because of its immunity from interference and its great superiority in point of speed. They frequently worked at between 30 and 40 words per minute, whereas no other system that he knew could accomplish more than 10 or 12. A vote of thanks to Capt. James was then proposed by the Chairman, who said that the sphere of wireless telegraphy was not land work at all, but it was eminently suitable for communication at sea.

We are informed that the Oceanic Steam Navigation Co. has entered into an agreement with the Marconi International Marine Communication Co. for the equipment with Marconi telegraph apparatus of six of the White Star liners—viz., the "Oceanic," "Baltic," "Celtic," "Cedric," "Majestic" and "Teutonic."

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, January 20th.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when the following Papers will be read: (1) "Some Impressions of American Workshops," by A. J. Gimson. (2) "Waterworks Pumping Engines in the United States and Canada," by John Barr. (3) "Some Features in the Design and Construction of American Planing Machines," by Archibald Kenrick, jun. (4) "Engines at the Power Stations and at the St. Louis Exhibition," by Alfred Saxon.

ELECTRO HARMONIC SOCIETY.

8 p.m. Smoking Concert, Holborn Restaurant (King's Hall).

ROYAL INSTITUTION.

9 p.m. Evening Discourse by Prof. Sir James Dewar, F.R.S., on "New Low Temperature Phenomena."

SATURDAY, January 21st.

GLASGOW UNIVERSITY ENGINEERING SOCIETY.

8.45 a.m. Visit to Messrs. Bruce, Peebles & Co.'s Works. Train leaves Central Station (Caledonian Railway) for Edinburgh at 8.45 a.m.

MONDAY, January 23rd.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7.30 p.m. General Meeting at the Literary and Philosophical Society, Westgate-road. Included in the business of the evening will be Mr. W. R. Cummins' reply to the discussion on his Paper: "A Comparison of Vertical and Horizontal Tubes in Water Tube Boilers"; and a paper on "Petrol Motor Cars," by F. Little.

TUESDAY, January 24th.

SOCIETY OF ARTS: COLONIAL SECTION.

4.30 p.m. Ordinary Meeting. Paper to be read: "British Commercial Prospects in the Far East," by Byron Brenan, C.M.G.

WEDNESDAY, January 25th.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.

7.30 p.m. Meeting in the University. Paper to be read: "The American Tour of the Institution of Electrical Engineers," by Dr. D. K. Morris.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "London Electric Railways," by the Hon. Robert P. Porter.

THURSDAY, January 26th.

GLASGOW UNIVERSITY ENGINEERING SOCIETY.

7.45 p.m. Meeting at the Glasgow University. Paper to be read: "The Commercial Efficiency of Prime Movers with Special Reference to Large Gas Engines," by A. M. Downie.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when the discussion on Messrs. Booth and Kershaw's Paper, "Fuel Economy in Steam Power Plants" will be taken.

FRIDAY, January 27th.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda:—(1) "Action of a Magnetic Field on the Discharge through a Gas," by Dr. R. S. Willows. (2) "Action of Radium on the Electric Spark," by Dr. R. S. Willows and Mr J. Peck. (3) "The Slow Stretch in Indiarubber, Glass and Metal Wires when subjected to a Constant Pull," by P. Phillips. (4) Determination of Young's Modulus for Glass," by C. A. Bell. (5) "Some Methods for Studying the Viscosity of Solids," by Dr. Boris Weinberg.

ELECTRICITY METERS.[*]

BY C. H. W. GERHARDI.

(Continued from page 458.)

ALTERNATING-CURRENT METERS—*(continued)*.

Fig. 7 shows the stationary portion of the motor in plan with the disc in position. The arrangement is that adopted by the Westinghouse company in their integrating wattmeter. The varying resultant field generates eddy currents in that portion of the disc lying in and near the horizontal air-gap, and the action between the fields created by the eddy currents and the field which induces them produces the torque which causes the disc to rotate.

Reference has been made to compensating devices for creating the 90deg. phase difference between the main and shunt fluxes when the load is non-inductive. The compensation may be effected by (1) causing a resultant shunt flux which lags slightly behind that produced by the shunt winding or (2) by producing a second main flux by means of a coil wound oppositely to the first and possessing more self-induction than it.

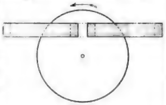

FIG. 7.

Suppose in diagram 8 the flux due to the main coil be represented by MF and that due to the shunt coil by SF$_1$, lagging by an angle, a, behind MF (a in practice is usually between 70 and 80deg.).

If a second shunt winding is placed on the shunt core, having in series with it a non-inductive resistance in order that its self-induction may be small compared with that of the first one, it can be so adjusted as to produce a flux SF$_2$, so that SF$_1$ and SF$_2$ produce a resultant RF, which lags 90deg. behind the flux MF due to the main coils.

As in practice it would not be desirable to have two shunt windings, on account of the extra cost and the increased shunt loss, the same effect is usually produced by winding closed secondary coils on the shunt core, these being insulated wire or simply copper rings, and vanes in the air-gap, in which secondary currents are generated. These coils or rings sometimes have resistance in their circuit, and final adjustment is made by varying this resistance. The disc also has some effect.

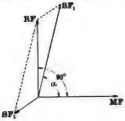

FIG. 8.

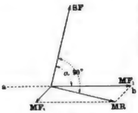

FIG. 9.

In the second case compensation is obtained by a second main coil usually in parallel with the first but wound oppositely. If in diagram 9, MF$_1$ and SF represent the main and shunt fluxes produced without compensation, and if MF$_2$ be the flux produced by the added coil which is wound in the reverse direction, the resultant main flux MR is created, which will be 90deg. ahead of SF when the two main circuits are correctly adjusted. From the diagram it is apparent that the circuit which produces MF$_2$ must have greater self-induction than that which produces MF$_1$, for if their self-inductions were equal, MF$_2$, and consequently the resultant MR, would all be in the line *ab* with MF$_1$, and no difference would be produced in the angle a. The circuit producing MF$_1$ usually includes an adjustable resistance, by which the final regulation is effected.

The Foucault or eddy-current brake is now so well known that it hardly needs description. It is a most important factor in motor meters, being made use of in the majority of meters of this class.

A disc of metal rotates in the field of a permanent magnet, and in consequence of the movement eddy currents are generated in the disc. The torque thus created is proportional to the speed, and therefore prevents acceleration after the disc has obtained a definite speed.

This form of brake is so simple yet so perfect, that no better can be wished for, and the only point against it is the uncertainty of the strength of the magnets remaining constant. To ensure uniformity in the strength, it is important that the magnets be made of a very hard steel and tungsten alloy; that their length and section should be great compared with the length and area respectively of the air-gap, so that a strong flux may be maintained; that they be properly aged artificially, so that after the ageing processes they are left at just the right strength which the quality of the alloy is capable of retaining permanently; and, finally, that the air-gap does not alter by the magnet tending to warp, and so opening out or closing up the air-gap by a slight amount. A very small alteration in length of the air-gap makes a great difference in the brake torque and, consequently, in the speed of the meter.

The "Bat" Meter.[*]—Fig. 10 shows a view of the "Bat" meter, which is also shown diagrammatically in Fig. 11 with the dial, train and top bearing removed. The meter is provided with a neat clamping gear. The screw L (Fig. 11) when unscrewed allows the collar P to rise and lift the spindle off the jewel. Referring to Figs. 10 and 11, the brake magnet is seen on the left, and the stationary portion of the motor on the right; the disc F (which is of copper) being just under the registering train. The adjustment of the meter at high load is rendered very easy, and is done by screwing or unscrewing the milled-headed iron screw V after having loosened the clamping screw S. The screwing up of V increases the leakage or reduces the magnetic field of the brake magnet passing through the disc by making a second path for it through V, and the back plate (which is of iron) to the top pole of the magnet. In this way a very delicate adjustment can be made to the brake field. Should the curve require raising or lowering at low load, this is easily done by moving the iron screw E 2 (Fig. 11) forward or backward as required by means of the knob E 1. If E 1 is brought forward the speed will be increased.

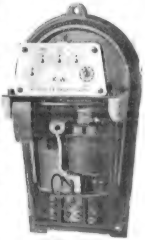

FIG. 10.

The motive part is seen in Fig. 12. The two shunt coils are wound on a U-shaped iron core, the upper ends of which are split to form two poles. A laminated yoke is placed above the shunt coils, there being small air-gaps between this yoke and the core. Upon the four horns of the core are wound the series coils in reversed directions (Fig. 12), thus causing a time lag in the fluxes through the two horns of each pole. The resultant shifting field in this meter passes twice through the disc, once at each pole. It starts from the first and third horns and shifts to the second and fourth, when it again starts at the first and third and so on, passing up through the disc along the iron bar E (Fig. 11) and down at the other pole. The meter possesses a fairly high torque, it being about 2·3 gr.-cm. at full load. The curve of the meter on non-inductive load is a fairly straight line, drooping about 1 per cent. at full load. On inductive load of power factor 0·44 a difference of 2·6 per cent. has been found, the meter under-registering, as would be expected. The starting current is low. The shunt current of 100-volt meters is 0·06 amperes, and, assuming the lag of this current to be 80deg., the true watt loss in the shunt circuit would be 1·04 watts. Single-phase meters of this make are made up to 500-amperes capacity and for pressures up to 300 volts. For circuits above 300 amperes series transformers are employed and above 300 volts potential transformers, the meter used in conjunction with them being a 100-volt 10-ampere one.

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[*] From a forthcoming book to be published by "The Electrician" Printing and Publishing Co. All rights are reserved.

[*] In order to observe strict impartiality, the meters are described in alphabetical order.

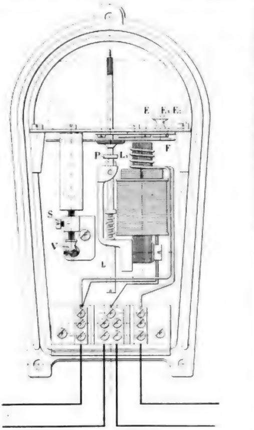

Fig. 11.

Two and three-phase meters are also made; they are somewhat similar to the single-phase meter, but are provided with two driving portions and an additional disc, one of the discs being used as the armature and the second as the brake disc. The Bat meter is made in France and Switzerland. The workmanship is all that can be desired. The watt-hours per revolution of the disc is marked on the name-plate of each meter and a number, which when multiplied by 500 is the watt-seconds per revolution, is stamped on one of the gear pillars.

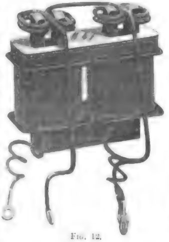

Fig. 12.

(*To be continued.*)

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* This constant is incorrectly called the watts per disc revolution on the meter.

UNITED STATES GOVERNMENT REPORT ON WIRELESS TELEGRAPHY.

The President of the United States appointed Rear-Admiral Robley D. Evans, Rear-Admiral Henry N. Manney, Brig.-Gen. A. W. Greely, Lieut. Commander Joseph L. Jayne and Prof. Willis L. Moore, last June, as a Board to consider the entire question of wireless telegraphy in the service of the National Government. The Board having duly considered the whole question issued the following report, which has been approved by the President. He has directed that the several Departments concerned shall put its recommendations into effect.

The following was found to be the status regarding Government wireless telegraph stations :—

(*a*) The Department of Commerce and Labour has established no stations, but permission has been granted to other departments to erect 10 on light-house reservations and on the Nantucket Shoal lightship and its relief.

(*b*) The Army has operated six stations and is preparing to instal two others in Alaska. The urgent necessity for the stations in Alaska has caused the temporary removal of the apparatus from two of the first-mentioned, but it is in process of replacement. Four other Army stations have been proposed, but for two of these the chief signal officer thinks that the proposed naval stations in the same localities, if available to the Army, would make duplication unnecessary. The Army also has one portable train for use in manœuvres or for other military purposes.

(*c*) The Department of Agriculture made valuable and extensive experimentation, and has established two stations and contemplated establishing others at prominent points along the coast lines

(*d*) The Navy Department has established 20 shore stations. The apparatus has been removed from one of these but will be replaced in a few days. Arrangements are being made for the establishment of 10 more in the near future—a complete equipment, or some portion of it, having been ordered for each one. This includes the two lightships that take turns on Nantucket Shoals. In addition to these 30 stations it is proposed to establish about 50 more on shore and to start on the more important of these at an early date. The Navy Department has entered into a very important contract for the equipment of long-distance stations at Key West, Guantanamo; points to be determined in Porto Rico and on the Panama Canal Zone, and Pensacola. Satisfactory communication is to be established between all of the first four and between Key West and Pensacola. Communication from any one of these stations to ships at any points between it and a communicating station is also to be established.

Twenty-four naval ships have already been equipped, and 10 others are to be equipped immediately, or before the completion of the repairs which they are undergoing. It is proposed to equip 68 others after the report of the Board which is now conducting tests of various systems has been acted upon, making a total of 102. One torpedo-boat outfit has been ordered for trial. If this apparatus is successful a number of torpedo-boat destroyers and small gunboats may be equipped, making the total number considerably larger. With these small vessels provided with wireless apparatus there would be about 200 naval stations on shore and afloat.

(*e*) The Treasury Department, while having under consideration wireless installations for the Life-Saving Service and the Revenue-Marine Service, has established no stations, but has relied on a leased commercial wireless system.

The following was found to be the status of private stations :—

The Marconi Company has a long-distance station on Cape Cod for communicating across the Atlantic, and two others of comparatively short range on Long Island. The Board understands that that company proposes to establish numerous stations along the Atlantic and Pacific coasts.

The *New York Herald* Co. has a station on the lighthouse reservation on Sankaty Head, Nantucket Island, and has been permitted to maintain stations on the two lightships which relieve each other on Nantucket Shoals. These privileges have been withdrawn, however, owing to the refusal of the Marconi Company, which operated them for the *Herald*, to receive wireless messages from vessels using other systems

The American De Forest Wireless Telegraph Co., and the National Electric Signal Co. (Fessenden system) have stations in the vicinity of New York, and both propose to establish a chain of them along the coast. The former company has already begun operations at Cape Hatteras and at Key West, and has announced that they propose to establish several stations to bridge the Pacific and make foreign connections. It has also established several stations away from the sea coast, especially on the Great Lakes, and is planning to have a regular interior system, according to one of its officers.

The Fessenden system has stations in Philadelphia and Washington. Fessenden states that his company is negotiating for permission to establish communication with Bermuda.

The Providence *Journal* maintains several stations in the vicinity of Narragansett Bay, and there are several other systems which are at present not very active.

On the Pacific coast the Pacific Wireless Telegraph Co. has several stations, and has been making persistent efforts to obtain authority to establish stations on the lighthouse reservation, Farallon Islands, and at other prominent Government reservations along the Pacific coast

There is an inter-island system operated in Hawaii.

A number of transatlantic liners are using the Marconi apparatus. Few coasting vessels are using any system, but the indications are that this method of communication will come into quite common use when the shipowners feel that conditions are favourable.

The Navy Department has at times been very seriously interfered with in the vicinity of New York and Boston, and there are already so many stations in the vicinity of Newport that an effort has been made by the officer in charge of the torpedo station to establish a tentative arrangement whereby the various stations will interfere as little as possible with each other.

Reports from the naval wireless station on Cape Cod indicate that on one occasion that station was temporarily crippled, very probably by heavy sending at the Marconi long-distance station a few miles away.

It would appear that the Weather Bureau already has a station at one of the most important points on the Pacific coast, where the Navy Department desires to erect one and equip it with more powerful apparatus than now in use by the Weather Bureau. The Weather Buraau also intended putting in new apparatus, it having been demonstrated that that now in use is unable to communicate with the nearest naval station in San Francisco Bay, although the latter has sufficient power to reach far beyond the Farallons. This is one of the places where the Pacific Wireless Telegraph Co. is so anxious to locate.

The Weather Bureau also contemplated establishing stations at prominent points where the Navy Department already has stations in operation or proposed to establish them. Most of the stations proposed by the wireless-telegraph companies are to be located at prominent points where Government stations are already established or proposed. This state of affairs seems to demand prompt action to avoid most unfortunate confusion and unnecessary duplication

As a first step toward avoiding this condition the Board adopted the following resolution :—"*Resolved.* That all installations of Government wireless-telegraph stations be suspended except at stations now under contract, until the final report of the Board is acted upon by the President. That all departments of the Government interested in wireless telegraphy should refuse to allow any private company to instal a station on any Government reservation until so authorised by proper authority."

Conclusions.

The conclusions of the Board are :—

That the science of wireless telegraphy has been advanced by the able and persistent work of the Signal Corps of the Army and the Weather Bureau of the Department of Agriculture, as well as by the experimental work of the Navy Department.

That wireless telegraphy is of paramount interest to the Goverment through the Navy Department, and that its use by the Signal Corps of the Army for communication between military posts of the Army and other necessary links will be necessary both in peace and war, and that such use shall be unrestricted. When interference seems probable between stations of the Navy and War Departments, the question involved shall be mutually settled by representatives of the two departments.

That coastwise wireless telegraphy is not a necessity for the work of the Weather Bureau of the Department of Agriculture, provided that the necessary meteorological data for that department can be collected by the stations of the Navy Department from ships at sea and by them sent to the Weather Bureau of the Department of Agriculture.

That the maintenance of a complete coastwise system of wireless telegraphy by the Navy Department is necessary for the efficient and economical management of the fleets of the United States in time of peace and their efficient manœuvring in time of war.

That the best results can be obtained from stations under the jurisdiction of one department of the Government only, and that representatives of more than one department should not be quartered at any station.

And finally the Board concludes that the Government must take the necessary steps to regulate the establishment of commercial wireless-telegraph stations among the States and between nations.

Recommendations.

In order that the above conclusions may be carried into effect, the Board recommends—

That the Signal Corps of the Army be authorised under its chief to establish from time to time such wireless stations as he may deem necessary, and that they do not interfere with the coastwise wireless-telegraph system of the Government under control of the Navy Department, and further, that the chief signal officer be requested to inform the Navy Department what stations of its system may be utilised to transmit messages for the Signal Corps or other bureaus of the War Department, and that representatives of the Signal Corps of the Army and the Bureau of Equipment of the Navy Department be at once requested to draw up such rules as will ensure the efficient and harmonious carrying into effect of the above recommendations.

That the necessary steps be taken to have the Weather Bureau of the Department of Agriculture turn over to the Navy Department all coastwise wireless-telegraph apparatus now under its control, and such material as it may have in its possession which can be utilised by the Bureau of Equipment of the Navy Department, and that proper transfers of funds for this purpose be made.

That the Weather Bureau of the Department of Agriculture furnish to the Hydrographic Office of the Navy, and to the naval wireless-telegraph stations, or to other portions of the public service, such meteorological data as it or they may desire at no cost to them.

That the Department of Agriculture shall continue the work of its meteorological vessel-reporting and storm-warning stations, as now constituted and provided for by law, and continue the control of sea-coast telegraph systems, except wireless systems.

That the necessary steps be taken that the Navy Department may equip and instal a complete coastwise wireless telegraph system covering the entire coasts of the United States, its insular possessions, and the canal zone in Panama.

That the Navy Department be directed to receive from the Signal Corps of the Army, at such points as may be requested by the chief signal officer of the Army, all messages for Army posts within their radii, and transmit them, under such rules as may be agreed upon by the representatives of the Signal Corps and Bureau of Equipment, without cost to the Signal Corps of the Army.

That all meteorological reports from vessels of war or commerce or other sailing craft, now being forwarded direct to the Hydrographic Office of the Navy, shall be forwarded direct to the Weather Bureau, and the control of ocean meteorology be transferred to the Department of Agriculture, which already has ample law for doing this work.

That the estimates for the support of the Hydrographic Office of the Navy, or any other office of the Navy, for the next and succeeding fiscal years, do not contain any provision for the making of ocean forecasts, or for the publication of meteorological data, other than such as may be needed by the Hydrographer of the Navy for use on the pilot and other charts, which data shall be furnished by and credited to the Weather Bureau.

That it is the opinion of this Board that no meteorological work need or should be done by any portion of the Navy for the purpose of publication, or for the making of forecasts or storm warnings; that all such duties, being purely civil, should devolve upon the Weather Bureau of the Department of Agriculture in accordance with the organic act creating that Bureau

That the wireless stations of the Navy Department shall, without charge to the Agriculture Department, receive and promptly transmit to the ocean or to islands, or to other places where the information can be made useful, the storm warnings of the Weather Bureau.

That the Navy Department shall request all vessels having the use of its wireless stations for the receipt of messages, to take daily meteorological observations of the weather when within communicating range and to transmit such observations to the Weather Bureau, through naval wireless stations, at least once daily, and transmit observations oftener when there is a marked change in the barometer; and that there shall be no charge against the Agriculture Department for these observations, or for the transmission thereof.

That representatives of the Department of Agriculture and the Bureau of Equipment of the Navy Department be directed to prepare the necessary rules for the harmonious and efficient carrying on of the above recommendations.

We recommend that as fast as the naval wireless-telegraph stations are put in operation the Navy Department be directed to receive and transmit through these stations, free of charge, all wireless messages to or from ships at sea, provided such stations do not come in competition with commercial stations, until such time as Congress may enact the necessary legislation governing the subject.

In asking for legislation on this point, the Board desires to invite attention to the fact that where wireless stations are needed for the merchant marine, as a rule the Navy will also require them. The Board believes it to be in the interest, not only of governmental, but public economy and efficiency, to permit the naval stations to handle the public service, for in the present state of the art but one station is desirable for the public interests in such places. As the needs of the Navy are paramount on account of the problem of national defence, private stations should not be allowed to locate to the disadvantage of the former. Moreover, there is at present no public need for multiplication of stations at these points.

It is admitted, however, that there may be special cases where private stations can serve a useful purpose, and the Board believes that the Department of Commerce and Labour should have the duty of issuing licences in such cases under such regulations as will prevent interference with stations necessary to the national defence. All private stations in the interior of the country should also be under supervision of the Department of Commerce and Labour.

This method of placing private stations under full Government supervision is desirable in order to regulate them for their mutual and the public welfare, as well as from considerations of national defence. Aside from the necessity of providing rules for the practical operation of such stations, it seems desirable that there should be some wholesome supervision of them to prevent the exploitation of speculative schemes based on a public misconception of the art.

It is believed that invention and private enterprise should be encouraged in every legitimate way, and it is the policy of the Navy Department to do this. It has the means of assisting inventors that no other department has, and it believes that in order for it to lead the navies of the world in this matter, which is of great importance to the national defence, that every reasonable facility should be given inventors, while at the same time it is working out the problems of the application of their inventions to its requirements in times of peace and war.

To prevent the control of wireless telegraphy by monopolies or trusts, the Board deems it essential that any legislation on this subject should place the supervision of it in the Department of Commerce and Labour.

Because international questions may arise, due to the fact that the use of wireless-telegraphy stations in our own possessions may affect the use of similar stations in foreign countries, it is desirable for the Congress to enact legislation which will enable the Government properly to handle such cases; a failure to do so may seriously embarrass the Government at some future time.

It is thought that the legislation recommended in placing private stations under the supervision of the Department of Commerce and Labour will also cover this case.

In conclusion, the Board deems it essential that the Executive take such action as in his judgment seems wise to prevent the erection of private wireless-telegraph stations where they may interfere with the naval or military operations of the Government until legislation may be had by Congress on this subject.

U.S. NAVAL WIRELESS TELEGRAPH SERVICE.

The following regulations governing the use of the U.S. Naval Coastwise Wireless Telegragh Stations have been issued as a "Special Notice to Mariners":—

1. The facilities of the naval coastwise wireless-telegraph stations (including the one on the Nantucket Shoal Lightship), for communicating with ships at sea, where not in competition with private wireless-telegraph stations, are placed at the service of the public generally and of maritime interests in particular under the rules established herein, which are subject to modification from time to time, for the purpose of :—

(*a*) Reporting vessels and intelligence received by wireless telegraphy with regard to maritime casualties, derelicts at sea and overdue vessels.

(*b*) Receiving wireless telegrams of a private or commercial nature from ships at sea for further transmission by telegraph or telephone lines.

(*c*) Transmitting wireless telegrams to ships at sea.

2. For the present this service will be rendered free. All messages will, however, be subject to the tariffs of the ship stations and land lines. Arrangements have been made with both the Western Union and Postal Telegraph Companies for forwarding messages received from ships at sea. When a message is not prepaid the company delivering it will collect the charges. Ship owners should arrange with companies operating the land lines as to tariffs and the settlement therefor. Messages will not be accepted for transmission to ships whose owners have not agreed to accept unpaid messages, unless a sufficient sum is deposited to cover all charges.

3. The Nantucket Shoal Lightship Station will report vessels and transmit messages from them if the signals are made by the International Code, or any other known to the operators on the lightship.

4. When notified by the Weather Bureau of the Department of Agriculture, naval wireless-telegraph stations will give storm warnings to vessels communicating with them by wireless telegraphy. Storm warnings will soon be sent to the Nantucket Shoal Lightship by wireless telegraphy and storm signals furnished by the Weather Bureau will be displayed therefrom to warn passing vessels.

5. All vessels having the use of the naval wirelesstelegraph service are requested to take daily meteorological observations of the weather when within communicating range and to transmit such observations to the Weather Bureau by wireless telegraphy at least once daily, and transmit observations oftener when there is a marked change in the barometer.

6. Arrangements for a time signal service by wireless telegraphy are now being made.

7. All ship owners desiring to use any special code of signals for communicating with the Nantucket Shoal Lightship Station or any of the shore stations, or make any other special arrangements are requested to communicate with the Bureau of Equipment, Navy Department, Washington, D. C.

8. All Chambers of Commerce, Maritime Exchanges, newspapers, news agencies, and others desiring to have vessel reports and general marine news forwarded to them regularly are requested to communicate with the Bureau of Equipment in order that necessary arrangements for the service may be made. In no case will an operator attached to a station be allowed to act as an agent for any individual or corporation, but all vessel reports and marine news not of a private nature will be supplied to all applicants, so long as this service does not too greatly tax the personnel of the stations, when it will be necessary for those desiring information involving much time for its distribution to appoint agents who will be allowed access to the station bulletins.

9. Naval wireless-telegraph stations are equipped with apparatus of several systems and can communicate with all the principal wireless-telegraph systems now in use, if tuned to the same wave length. The department is desirous of co-operating with all ship owners wishing to avail themselves of its wireless-telegraph service, and, judging from its experience with numerous systems, it is believed that there will be little or no difficulty in arranging for communication between its stations and ships equipped with apparatus of other systems, if the owners of the apparatus as well as the owners of the ships are desirous of establishing such communication.

10. Vessels desiring to make use of this service regularly must agree to transmit and receive all Government messages free.

The following stations are fully manned and will be prepared to receive messages at all hours, except in case of accidental breakdown, which is not apt to occur because of precautionary measures which have been taken. The call letter is given opposite the name of each station :—

Stations.	Call letter.	Stations.	Call letter.
Navy Yard, Portsmouth, N.H.	PC	Highlands of Navesink, N.J.	PV
Cape Ann (Thatchers Island).	PE	Cape Henry, Va.	QN
Highland Light, Cape Cod, Mass.	PH	Navy Yard, Norfolk, Va.	QL
Nantucket Shoal Lightship ..	PI	Dry Tortugas, Fla.	RF
Torpedo Station, Newport, R.I.	PK	San Juan, P.R.	SA
Montauk Point, L.I.	PR	Culebra, W.I.	SD
Navy Yard, New York	PT	Yerba Buena Island, Cal.	TI
		Navy Yard, Mare Island, Cal.	TG

It is expected that the following stations will be in operation in a few weeks fully manned to receive messages at all hours :—

Stations.	Call letter.	Stations.	Call letter.
Cape Elizabeth, Me.	PA	Naval Station, Guantanamo, Cuba	SI
Navy Yard, Boston, Mass ..	PG	Farallon Islands, Cal.	TH
Naval Station, Key West, Fla.	RD	Naval Station, Cavite, P.I. ..	UT
Navy Yard, Pensacola, Fla. ..	RK	Cabra Island, P.I.	UY
Panama Canal Zone	SL		

The following stations are equipped with apparatus, but are not yet fully manned; they will receive and transmit messages when operators are on duty:

Stations.	Call letter.
Naval Academy, Annapolis, Md	QG
Navy Yard, Washington, D.C.	QI

The Bureau of Equipment expects to erect wireless-telegraph stations at the principal points along the coast of the United States and at points in its insular possessions. As fast as they are completed they will be open for public use under the regulations established herein.

Notice will be given in the "Notices to Mariners" when stations are put in operation or withdrawn from the service for any reason.

Messages for the Cape Ann station should be forwarded via the Navy Yard, Portsmouth, N.H.

The Nantucket shoal lightship will transmit its messages to the Torpedo station, Newport, R.I. All messages intended to be sent via this lightship to ships at sea should be sent to the Torpedo station.

Messages for the Montauk Point wireless-telegraph station will also be sent via the Torpedo station, Newport, R.I.

Arrangements have been made with the Weather Bureau for the transmission of messages between Cape Henry wireless-telegraph station and Norfolk. All messages intended for the Cape Henry station should be sent via the Weather Bureau, Norfolk, Va.

All messages intended for Dry Tortugas should be sent via the Naval Station, Key West, Fla.

The station at Yerba Buena, Cal., can be reached by either the Postal Telegraph or the Western Union system and the one at Mare Island by the Western Union.

The Farallon station will communicate with Yerba Buena Island, Cal.

INSTRUCTIONS TO GOVERN COMMUNICATION BY WIRELESS TELEGRAPHY BETWEEN WIRELESS-TELEGRAPH STATIONS AND SHIPS.

I. A vessel wishing to communicate with a station and having ascertained by "listening in" that she is not interfering with messages being exchanged within her range, should make the call letter of the station at a distance not greater than 75 miles from it.

II. The call should not be continuous, but should be at intervals of about three minutes in order to give the station a chance to answer.

III. After the station answers the vessel should send her name, distance from station, weather and number of words she wishes to send; then stop until the station makes O. K., signals the number of words she wishes to send to vessel and signals go ahead.

IV. Then the vessel begins to send her messages, stopping at the end of each 50 words and waiting until the station signals O. K. and go ahead; when all messages have been she will so indicate. If the sender desires to designate the Western Union or Postal Telegraph system for further transmission of his message he should do so immediately after the address, as for example: "A. B. C., Washington, D. C., via W. U. (or P. T.)."

V. When a vessel has indicated that she has finished the station will send to the vessel such messages as she may have for her in the following order :—

(*a*) Government business—viz., telegrams from any government departments to their agents on board.

(*b*) Business concerning the vessel with which communication has been established—viz., telegrams from owner to master.

(*c*) Urgent private dispatches, limited.

(*d*) Press dispatches.

(*e*) Other dispatches.

VI. In the case of the Nantucket Shoal Lightship, it will, immediately on receiving the vessel's call, acknowledge, and (after receiving vessel's name, distance, weather report and number of words she wishes to send) transmit the first three to Newport, and then tell the vessel to go ahead with her messages.

VII. After receiving these and sending the vessel any message on file for her, the lightship will transmit to Newport messages received from the communicating vessel in the following order :—

(*a*) Government business.

(*b*) Urgent private dispatches, limited.

(*c*) Press dispatches.

(*d*) Other dispatches.

VIII. A naval wireless-telegraph station has the right to break in on any message being sent by a vessel at any time, and the right of way may be given at any time to a government vessel or one in distress.

IX. When two or more vessels desire to communicate with a naval wireless-telegraph station at the same time, the one whose call is first received will have right of way, and the others will be told to wait and will be taken up in turn. Vessels having been told to wait must cease calling.

X. In case communication is not established with any ship for which messages are on file, the naval wireless-telegraph station will notify the telegraph company from which the messages were received, giving sufficient information for them to identify the telegrams and notify the sender.

XI. In order to obtain the best results, both sending and receiving apparatus should be tuned to wave length of 320 metres.

XII. Until further notice the speed of sending should not exceed 12 words per minute.

XIII. In order that all messages received at naval wireless-telegraph stations may be forwarded to ships for which they are intended, and in order that all ships equipped with wireless-telegraph apparatus may receive storm warnings, they should always report when in signalling distance of a naval wireless-telegraph station.

XIV. The service being without charge at present, the Government accepts no responsibility for the reception or transmission of messages from or for passing vessels. Every effort will be made to transmit all messages without error and as expeditiously as possible. It must be remembered that errors are not uncommon in ordinary telegraph and cable messages, so that due allowance should be made.

XV. In order that the service may be made as good and as useful as possible, it is requested that complaints should be promptly reported to the Bureau of Equipment as soon as possible after the cause therefor, giving date, hour and other details, to enable the Bureau to investigate the case.

XVI. Information regarding the Naval wireless-telegraph service will be published in "Notices to Mariners."

and Traction Co. … Lanes 40.000 Refuse 8.0

92	*SHIPLEY* …………… [25,670]	1899	July, 1901	Shipley Urban District Council…	*a*S. D. Schofield	*a*R. C. Qu
93	*SOUTHAMPTON* …… [104,911]	1895 1897	1891	Southampton Corporation ………	*a*H. F. Street	*a*Kincaid, and
94	*SOUTHEND-ON-SEA* [28,857]	1891	June, 1902	Southend-on-Sea Corporation……	*a*W. E. J Heenan	
95	*SOUTHPORT*………… [50,800]	1891	Nov., 1894	Southport Corporation …………	*a*R. S. Downe…	*a*Geo. V
96	*STALYBRIDGE, HYDE, MOSSLEY & DUKINFIELD* [91,223]	1901	May, 1904	Joint Board of the Four Corporations	R. Blackmore	A. H.
97	*STOCKPORT*………… [78,871]	1891	Dec., 1898	Stockport Corporation …………	*a*A. J. H. Carter	*a*J. N.
98	*STRETFORD* ………… [30,346]	1897	Oct., 1903	Stretford Urban District Council	R. Rowland…	*a*C. H. ba
99	*SUNDERLAND* ……… [146,565]	1891	Mar., 1896	Sunderland Corporation …………	*a*John F. C. Snell	*a*A. B ne
100	*SWINDON* …………… [47,000]	1895	May, 1903	Swindon Town Council …………	*a*J. G. Griffin…	Lace
101	*TAUNTON* …………… [21,078]	1893	1886	Taunton Corporation ……………	Ed. B. Thornhill	*a*J. A. *b*Kinc M
102	*TYNEMOUTH* ……… [62,060]	1891	Feb., 1901	Tynemouth Corporation…………	*a*C. Turnbull …	*a*Lac
103	*WALLASEY* ………… [56,600]	1896 1897	Feb., 1897	Wallasey Urban District Council	J. A. Crowther	*a*J.
104	*WALSALL*…………… [86,440]	1890	Dec., 1895	Walsall Corporation ……………	*a*Alexr. Wyllie	*a*F.
105	*WALTHAMSTOW*…… [115,000]	1895	Sept., 1901	Walthamstow Urban District Council	J. H. Fooks-Bale	*ab*J
106	*WARRINGTON* ……… [67,000]	1898	…	Warrington Corporation…………	*a*F. V. L. Mathias	*a*A.
107	*WEST BROMWICH* … [65,172]	1898	May, 1901	West Bromwich Corporation … …	*a*J. H. Wray …	*a*R.
108	*WEST HAM* ………… [267,308]	1892	Dec., 1898	West Ham Corporation …………	W. J. W. Bullock	
109	*WESTON-SUPER-MARE* [19,047]	1891	May, 1901	Weston-super-Mare and District Electric Supply Co.	Marcus Nash	*a*Jc
110	*WIGAN* ……………… [82,430]	1890	Dec., 1900	Wigan Corporation………………	James Slevin	
111	*WOLVERHAMPTON*… [94,179]	1890	Jan., 1895	Wolverhampton Corporation ……	*a*C. E. C. Shawfield	*a*F.
112	*WORCESTER* ……… [46,623]	1890	Oct., 1894	Worcester Corporation …………	*a*C. M. Shaw …	*a*Si
113	*WREXHAM* ………… [14,966]	1897	Mar., 1901	Wrexham Corporation …………	*a*W. Sillery …	*a*Ti
114	*YARMOUTH* ………… [50,636]	1890	1894	Yarmouth Corporation …………	Gordon Bryant	*a*Sir *b*Fre

DESCRIPTIONS OF ELECTRICITY W

Descriptions of some of the works mentioned in the above Tables have appea Reference is given below to the volume and page.

STATION.	VOL.	PAGE.	STATION.	VOL.	PAGE.	STATION.	VOL.	PA
Aberdeen …………	51	320	Cork………………	42	289	Lowestoft ………	46	6
Barking ……………	43	184	Croydon ……………	38	244		51	5
Barrow-in-Furness…	43	518	Darwen …………	43	798	Maidstone …………	48	3
Bexley ……………	51	977		31	652		31	6
Bolton …………	41	809, 849	Derby ………	33	123	Manchester………	40	1
	50	299		53	301, 342		46	9
Bootle ……………	43	8	East Ham ………	47	515		50	672
Bournemouth ………	50	462	Erith… …………	60	504	Mansfield …………	51	1
	29	834	Exeter ……………	52	280	Middleton …………	48	9
Bradford …………	47	817	Gloucester …………	46	627	Newcastle-upon-Tyne Elec. Supply Co. ……………	47	319
	50	215	Great Grimsby ……	47	127			3
Brighton ……………	33	123	Greenock… ………	44	888		49	701
Burton …………	33	123	Ipswich ………	52	196	Newport …………	37	6
	52	298	Keighley ……………	47	318	Oldham …………	51	4
Carlisle ………	42	294	Kilmarnock………	54	368	Peterborough ………	46	7
Cleckheaton ………	50	172	Kirkcaldy ………	50	415	Plymouth …………	43	8
Coatbridge …………	29	42	Liverpool …………	45	953	Rochdale …………	51	5

PUBLISHED ANNUALLY SINCE 1889.

FED KINGDOM.—1904–1905.

Continued. *Copyright.*

Charg per Stree Lam per nnut	METERS.	PRICE PER UNIT. Small figs. (1) indicate first hour, (2) first two hours, &c. Lighting.	Power. Private.	Power. Trams.	TARIFF SYSTEM. W. indicates the Wright system of charging. D. indicates Discounts.	Price of Gas in District.	Gasworks owned by L.A. = Local Aut. Co. = Company.	—	REMARKS.
[illegible]	Aron, Reason, Bastian & O.K.	7d.$^{(1)}$—2d. or 5d. shops and 4d. private	2d. to 1d.	2d.	W.	2/4 light 2/2 power	Co.	64	No economisers. Natural draught. Hand firing. Duplicate steam driven feed pumps. Duplicate pipes. Motors on hire. Free wiring by Corporation.
Arcs. £19	Aron, Hookham, Thomson	5½d. or £7 10s. per kw. per ann. & 1·75d. p. unit	150 H.P. 1½d. beyond 450 H.P. 1d.	1·36d.	Hopkinson system	2/4	L.A.	65	Green econ. 3,040 tubes. Nat. draught. B. & W. chain grate and Vicars stokers. Weir and Blake steam feed pumps exhausting into feed-water heater. Superheaters at Broom-st, Dickinson-st, and portion of Stuart-st.
Inc 36	Hookham, T. H. Elec. Co.; Schattner prepayment	4d.$^{(1)}$—1½d.	1½d.$^{(1)}$-½d.	...	W. & D.	3/0	Co.	66	Nearly all power. Load factor 40 per cent. Mond gas generating plant. [illegible]-tube Green economiser. Natural draught. Mechanical stokers. Elec. and steam feed pumps and injectors. No free wiring, &c. 150k.w. tramway load.
Ar £2	Hookham ...	7d.$^{(1)}$—2d.	6d.$^{(1)}$-1d.	...	W.	2/6 to 2/10	L.A.	67	[illegible]-tube Green econ. Natural draught for Lancs. boilers. Electric fan for B. & W. (dust destructor) boilers. Comp. Hall feed pumps and injector. Proctor stokers. Free wiring 6d. lamp per quarter. Motors on hire purchase. Third generating set to double capacity in hand.
...	Reason......	6d.$^{(1)}$—3d.	3d.	...	W.	2/6	Co.	68	Power house at St. Peters. Traction (Margate to Ramsgate, &c.) 60 cars. 9 miles track. Hand stoking. Pump own water. Dup. Blake-Knowles feed pumps. Clay-cross econ. Nat draught.
Arc £16	B.T.H. & Reason electrolytic	7d.$^{(1)}$—2½d.	4½d.$^{(1)}$-1½d.	...	W. & D.	3/6 & 4/0	Co.	69	216-tube econ. Induced draught. Davidson fan: Hand stoking. Town water. Two Weir, one elec.-driven and one "Smith Vaile" feed pumps. One feed water heater. One Gwynne circulating pump.
£2	Ferranti ...	4d.	2d. to 1½d.	1½d. to 1d.	...	...	L.A.	70	256-tube economiser. Nat. draught. Elec. feed pumps and injector all in duplicate. Cur. supplied to the Middleton Elec. Trac. Co. Hick-Hargreaves superh's. Hand stok'g. Motors on hire at 15% per an. on cost.
...	...	...	...	...	...	...	...	71	......
Non	Ferranti, Hookham & Thomson	4½d. to 3d.	2½d., 2d. between 8a.m. & 4 p.m.	...	D. 5%	3/-, less 3d. per 1,000 dis.	L.A.	72	Meldrum dust destructor. Economiser, river water. Battery day-load for lighting. Motors on hire.
rcs & Inc. 15s.	B.T.H., Hookham and Reason	4½d.$^{(2)}$—1d. Free-wired, 7d.$^{(1)}$—1d.	1¼d. to ¾d.	...	W.	2/2	Various Cos.	73	354-pipe Green econ'r. Natural draught. B. and W. stokers. Current supplied to Tyneside Tramways Co. and to Durham County Electrical Power Distribution Co. Prov. Order granted in 1902 for Newburn.
[illegible]	...	2d. up to 200,000 un. From 200,000 to 300,000 10% disc. Above 300,000 20%	...	...	...	...	Co.	74	Street lighting and lighting of Municipal buildings only at present. Two Green econs. Nat. draught. Vicars stokers. Steam and elec. feed pumps. M. & P. high lift motor-driven rot. pumps for circ. water to cond.
...	Thomson, Aron and Hookham	5½d.—2d.	2d. & 1d.	1½d.	D.	3/6	Co.	75	190-tube Lowcock economiser. Natural and forced draught. Underfeed stokers. For connections, *see* also Table I.
2½d r u	Ferranti, Bastian and Reason	4d.$^{(2)}$—1½d. and slidg. scale	2d.$^{(2)}$-1½d.	...	W. & D.	2/4 net	L.A.	76	96 and 132-tube Green econ'rs. Nat. draught. Hand stoking. Two stations. Worthington & Weir feed pumps. 2 Berryman feed-water heaters. Power also 2d. 1st 500 units per qr.; 1¾d. 2nd 500; 1½d. after.
£2	Aron, Thomson and Schuckert	4d.	2½d.	200,000 2d. 100,000 1¾d. 100,000 1½d. after 1¼d.	None	2/7	L.A.	77	Street lighting by 15 ampere arcs from rectifiers. Two 288-tube Green economisers. Nat. draught. Vicars stokers. Steam-driven Cameron, one Weir and one Tangye feed pumps. B. & W. superheaters.
3d. [illegible]	Bastian, Hookham, Wright & Ferranti	3d.	1½d.	...	D.	3/0	Wigan Corp'n.	78	192-tube Green econ. Duplicate feed arrangements. Nat. draught. Hand stoking. Pump and injectors. Supply of current to Wigan Corporation Tramways in Pemberton.
£12	Hookham, Thomson and Ferranti	4½d. & 4d.	...	1½d.	...	2/11	Co.	79	192-tube Green econ. Natural draught. Hand stoking. Motor and steam pumps and injectors. Well water.
£21 arc	Shallenberger, Aron and Westinghouse	4d.	2½d.	2d.	...	1/9	Co.	80	Two 256-tube economisers. Vicars stokers. Two 3-throw Hayward-Tyler feed-pumps with E.C.C. motors. Town water. Batteries used for tramway supply.
...	Reason Ferranti	6d.$^{(2)}$—1½d.	...	...	Time switch	3/2	L.A.	81	Dust destructor. B. & W. superheaters. 96-tube Green economiser. Natural draught. Hand firing. Motor and steam feed pumps. Free wiring by Council. Motors on hire.
peci tra	Hookham, Thomson and Mordey-Fricker	4d.	1d.	1⅝d.	D.	3/8	Co.	82	480-tube economisers. Natural draught. Hand stoking. Weir and Worthington pumps and injectors. Town and own water. Free wiring.
Arc 10 Inc.	Thomson ...	8d.$^{(4)}$—3d.	8d.$^{(4)}$-3d.	...	W.	4/2	Co.	83	No econs. Nat. draught. Hand stoking. Blake & Knowles feed-pumps & injec's. Town water. Free wiring of long-hour lamps. Short-hour lamps at 8d.$^{(4)}$—3d. No trams, but supplied for combined station at Cork.
...	Ferranti ...	5d. and sliding scale	2d. and sliding scale	...	5% discount	3/4	Co.	84	McPhail s'heater. Green 192-tube econ. Natural draught. Hand firing. One Weir steam pump, one Mather & Platt elect.-driven pump. Free wiring under consideration.
...	Hookham and Reason electrolytic	4½d. or 6d.$^{(1)}$—2d.	1½d.-1d.	2d.—1d.	W.	2/0 & 2/10	L.A.	85	Town or river water. 2 236-tube Green econ. Proctor & Bennis stokers. Nat. dr'ght. 2 mot.-driv. and 1 steam feed-pumps and inject. 70kw. mot. gen., bet. light'g and tract'n. Motors on hire. Hire purchase by Co.
...	Hookham, Ferranti, Bastian, Reason, & Elec. Co.	4½d. & 4d.	1½d. & 1d.	1½d.	D.	2/9 to 3/0	L.A.	86	Two Green economisers. Natural draught. Hand stoking. Two Worthington compound vertical & 1 Weir feed pumps. Duplicate feed pipes. No free wiring, &c.
3½d u	Hookham, Ferranti	7d.$^{(1)}$—2d. and 5¼d.	2½d.	2d. to 1⅜d.	W. & Flat Rate	3/9	Co.	87	No econs. Proctor stokers on two boilers. One Worthington and one Weir pump. Exhaust steam, feed water heater and injec. Town water. Induced draught. Station partially condensing.
£1 llus	Aron, Hookham, Thomson, Vulcan and Wright	4½d.	2d.$^{(2)}$-1d.	...	W. & D. 2½ per cent. on motor accounts	2/3	L.A.	88	300-tube econ. Lancs. and 2 B. & W. boilers hand fired; B. & W. destructor-fired. Wilson Hartnell blower. Two flywheel type pumps. Two injectors. One 3-throw pump. Motors, &c., on hire.
4 1	Hookham, Thomson, Ferranti, Westinghouse	3½d. or 1s. per 8 c.p. and 1½d. per unit	2d. to 1½d.	...	...	2/7	L.A.	89	Four Green economisers, each with 400 tubes. Electric feed pumps. Hodgkinson stokers. New station at work. Alternators driven by continuous-current motors. Motors on hire.
...	Hookham, Thom[illegible] and West[illegible]	7d.$^{(1)}$—3d. & 6d.	2d.	1·4d.	W. & D.	3/0	Co.	90	2[illegible]-tube Green econ's. Meldrum & Crossthwaite forced draught. Hand firing. 2 Worthington and motor driven 3-throw variable stroke feed pumps. Alternators on separate circuits. No street l't'g. Motors on hire.
	[illegible] and [illegible]	7d.$^{(1)}$—2½d.	4½d.$^{(1)}$-1½d.	...	W. & D.	3/9	Co.	91	Superheaters. Natural draught. Hand stoking. Two Weir feed-pumps. Free wiring by Co. Motors on hire.

THE FISHER-STREET SUB-STATION OF THE METROPOLITAN ELECTRIC SUPPLY CO.

The Metropolitan Electric Supply Co. have built a motor-generator sub-station in Fisher-street (Southampton row), the present capacity of which is 3,000kw., and whose ultimate capacity will be 5,000kw. This sub-station takes the place of the Sardinia-street generating station, and the 1,000-volt network fed from this station is gradually being converted to a 2 × 100-volt, three-wire, continuous-current network, and changed over to the new sub-station. Power is supplied from the company's Willesden generating station at 10,000 volts two-phase and 60 ~ per sec. frequency, and is employed at this pressure to drive the synchronous motors of 500kw. motor generators. These machines are built on standard lines, but the arrangement of the building and, more especially, the design of the switch gear present many points of considerable interest and some novelty.

Before describing the sub-station itself, however, it will not be out of place to give a sketch of the general scheme of which it forms a part. The supply area of the Metropolitan Electric Supply Co. is shown in the map, Fig. 1. Until the year 1899 it was fed from five generating stations at Manchester-square, Amberley-road, Sardinia-street, Rathbone-place and Whitehall-court. For the first four, a single phase system at 1,000 volts was adopted, transformers being placed to some extent on consumers' premises: the Whitehall-court station supplied a small district around it with continuous current. As soon as the new works at Willesden were started, with an initial capacity of 4,500kw.,[*] the Manchester-square, Amberley-road and Rathbone place stations were gradually partially transformed into sub-stations, the first step being the replacement of the alternators by stationary transformers reducing the pressure from 10,000 volts to 1,000 volts so that the supply could be continued in the first place through the old mains. A new 2 × 100 volts continuous-current three-wire network is, as we have already said, replacing the old single-phase mains, and motor-generators are taking the place of the transformers. In view of the transfer of the Manchester square and Rathbone-place stations to the Marylebone Borough Council as soon as the Council's new station is completed, the total conversion of these into sub-stations has not been proceeded with. This will leave the Amberley-road station the only generating station in addition to the Willesden works; the small continuous-current station in Whitehall-court is now only used as a switching station. The new Fisher-street sub-station is on the north side of High Holborn, almost opposite the Sardinia-street station on the south side, which will be swept away to make room for the London County Council's new thoroughfare, Kingsway. Another sub-station, which is greatly added to, at Tower-street, supplies the more southern portion of the Company's area (including the district formerly supplied from the Whitehall-court station), its present capacity being 2,560kw.

In addition to these two motor generator sub-stations the company possesses several other sub stations from which alternating current is distributed on the 2 × 100 volts three-wire system: Marylebone Passage sub-station, which receives current at 1,000 volts from Rathbone-place; Brook Mews (Lancaster Gate), which receives current at 1,000 volts from Amberley-road; and Norfolk-crescent mews (Edgware-road) which is supplied partly from Amberley-road at 1,000 volts and partly from Willesden at 10,000 volts two-phase. In addition to these, a large sub-station and stores is being built at Moscow-road, Bayswater.

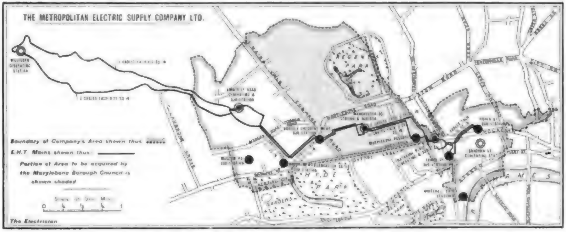
THE METROPOLITAN ELECTRIC SUPPLY COMPANY LTD.
REGENT PARK
HYDE PARK
GARDENS
Boundary of Company's Area shown thus
E.H.T. Mains shown thus:
Portion of Area to be acquired by the Marylebone Borough Council is shown shaded
Scale of One Mile
0 ¼ ½ ¾ 1
The Electrician

FIG. 1.—MAP SHOWING POSITION OF STATIONS, SUB-STATIONS AND E.H.T. MAINS.

The following is a Table showing the present generator transformer, motor-generator and battery capacities of the various stations and sub stations:—

STATIONS.

Willesden.—Two-phase generators, 13,500kw.

Amberley-road.—Single-phase generators, 2,500kw.
Transformers, 10,000 : 1,000 volts, 2,100kw.

Manchester-square.—Single-phase generators, 700kw.; continuous-current generators, 1,400kw.
Transformers, 10,000 : 1,000 volts, 3,600kw.
Motor-generators, 1,000 volts alternating : 200 volts continuous, 3,300kw.
Battery, 240kw. at 3 hour rate.

Rathbone-place.—Continuous-current generators, 825kw.
Transformers, 10,000 : 1,000 volts, 2,000kw.
Motor-generators, 1,000 volts alternating : 200 volts continuous, 420kw.
Battery, 110kw. at 2 hour rate discharge.

Whitehall-court.—Continuous-current generators, 230kw. (standby.)

Sardinia-street.—Single-phase generators, 350kw.; continuous-current generators, 2,640kw.
Motor-generator, continuous-current : alternating-current, 200kw.
Battery, 220kw. at 2 hour rate discharge.

SUB-STATIONS.

Fisher-street.—Motor-generators, 10,000 volts alternating : 200 volts continuous, 3,000kw.
Battery 240kw. at 3 hour rate.

Tower-street.—Motor-generators, 10,000 volts alternating : 200 volts continuous, 1,000kw.; 1,000 volts alternating : 200 volts continuous, 1,560kw.
Transformers, 10,000 : 1,000 volts, 2,200kw.
Battery, 320kw. at 3 hour rate discharge.

Norfolk-crescent-mews.—Transformers, 10,000 : 1,000 volts, 1,400kw.; 1,000 : 200 volts, 1,400kw.

Brook-mews.—Transformers, 1,000 : 200 volts, 790kw.

Marylebone-passage.—Transformers, 1,000 : 200 volts, 1,000kw.

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[*] A detailed description of this station will be found in *The Electrician*, Vol. XLIV., pp. 691 and 783.

From the first part of this Table, it is seen that the Metropolitan Electric Supply Co. has a generator capacity of 22,000kw., or, taking into account the overload capacity of the generators and the capacity of the batteries, it can supply 29,000kw. or 970,000 8 c.p. lamps as a maximum. The total connections to the mains up to December 31st last aggregated 27,000kw., or the equivalent of 900,000 eight c.p. lamps. The motor load is small, and the load-factor is about 21 per cent. The maximum load on the combined system last year was in the neighbourhood of 14,600kw. The company's undertaking is by far the largest of the thirty-three electricity undertakings supplying Inner London, and at present it covers the widest area. When the Marylebone area, shown shaded in Fig. 1, is transferred, the territory will be considerably reduced, but the company will still have one of the largest outputs in the metropolis.

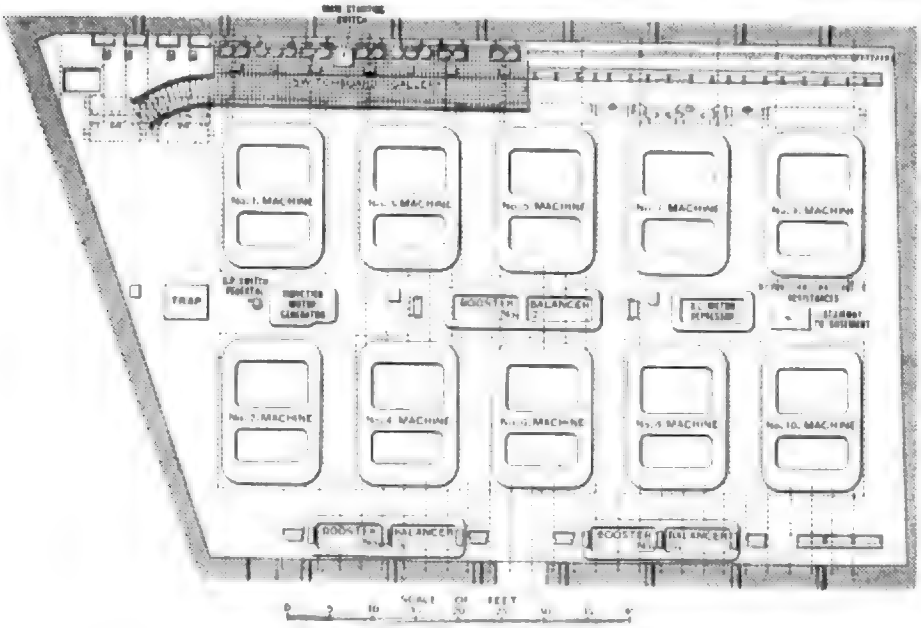

Fig. 2.—Floor Plan of Sub-Station.

The map shows the route of the E.H.T. mains supplying 10,000 volts two-phase current from the Willesden works. It is seen that the Fisher-street sub station is supplied by four pairs of concentric cables from two different sides. These are 0·25 sq. in. and 0·09 sq. in. lead-covered concentric cables, one cable for each of the phases; the larger cables come by the more direct route. The cables were supplied by the British Insulated & Helsby Cable Co., and are all laid solid in iron ducts. They were partly laid by the contractors and partly by the Supply Company. The method of laying was fully described in our article on the Willesden works of the Metropolitan Electric Supply Co.*

The cables on entering the sub-station pass through main line switches, which connect them to the 'bus sections, one section for each cable. Each inner conductor has its separate oil-break switch, but each pair of inner conductors are controlled by the same lever. On the other hand, the two outer conductors of each pair of cables are joined together and have one switch which is interlocked in such a way that it must be closed before the inner switches can be closed, and then cannot be opened until the inner switches have been opened. The outers are all earthed at Willesden; at Fisher-street the outer switches are left on to the 'bus bar, all switching being done on the inners.

There are at present six 500kw. motor generators receiving current directly at 10,000 volts, but the ultimate capacity of the station is 10 motor generators, and the switch gear has been arranged for the complete equipment. Two or, in some cases, three machines are therefore allotted to each 'bus section. Section switches are provided between adjacent sections so that the sections can be joined up together. By this arrangement the usual isolating plugs are dispensed with.

The arrangement of the sub-station is seen in Figs. 2, 3 and 4. The motor-generators are disposed as shown in Fig. 2, and are overlooked by the gallery from which the main switches (both high and low tension) are worked, and on which are all the necessary instruments and regulating gear. Below the gallery, on the floor level, is the low-tension feeder board, and below this again, in the basement, are the E.H.T. oil switches. The feeder cables enter these directly, but the 'bus bar arrangement differs from usual practice. Instead of 'bus bars ordinary concentric cables are used, and at each E.H.T. feeder or motor-generator switch there is a junction box from which the cable is T'd off into the switch. This is clearly seen in Fig. 5. In this figure, the cells containing the oil switches are seen on the left with the junction boxes above them. Where the concentric cable 'bus bars cross over the passages to the other parts of the basement between the foundations of the motor-generators they are carried in flat, troughs, as seen in the illustration. The switches for the outers with discs which interlock with the levers working the switches, are also shown. On the right are the L.T. feeders.

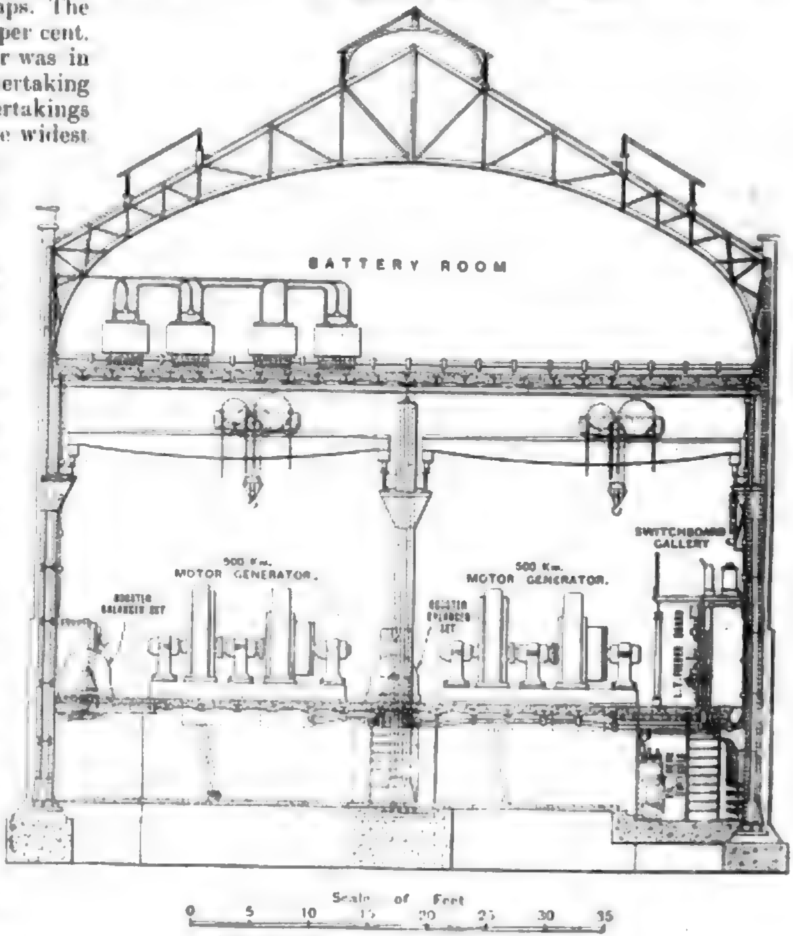

Fig. 3.—Cross-section of Sub-Station.

Fig. 4 and Fig. 6 show clearly the general arrangement of the switchboard gallery, and Fig 7 is a closer view of some of the panels on the gallery. The four panels controlling the line switches of the E.H.T. mains are placed below the stairway to the gallery, as seen in Fig. 4. The switches, in the basement below, are worked directly by levers in front of the panels. On the extreme left of the gallery is the first motor-generator panel, and, as seen in Fig. 4, this is repeated at intervals along the gallery, each of these panels controlling one of the motor-generators. Two of these are seen to the left of Fig. 7 and several on Fig. 6. The middle of the three handles on the gallery floor in front of the panel connects the E.H.T. motor of the machine to the 'bus bar. On either side of this handle are two handles for the main + and – D.C. switches, which connect the generator part of the machine to the D.C. bars below the gallery. On the front of the pillar switches is fixed a three-pole switch for connecting the D.C. side of the machine to the starting panel, which will be referred to again presently. On the pillar switch there is also a plug to actuate the tripping coil of the E.H.T. switch. On the gallery floor just behind the pillar switches are two rheostats, one for the motor field and the other one for the generator field. Above, on the panel itself, are the field switches, and a time limit relay on the A.C. side, then the two field ammeters, a voltmeter for the E.H.T. side with an ammeter on each phase fixed on either side of it, and above all an ammeter and a voltmeter (with illuminated dials) for the generator side of the machine. These are all clearly seen on the left-hand panel shown in Fig. 7, in the order named from bottom to top.

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* *Loc. cit.*

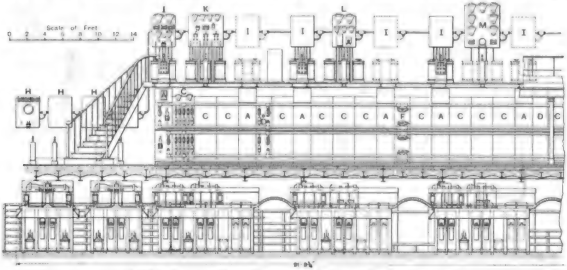

FIG. 4.—LONGITUDINAL SECTION, SHOWING GALLERY SWITCHBOARDS, AND BASEMENT.

H H H, E.H.T. Line Panels. *Gallery.*—**I I I, Generator Panels. K, Motor Starting Panel. L, Balancer and Booster Panel. M, Voltmeter Panel.**
L.-T. Feeder Board.—**A A A, Generator Panels. C C C, Feeder Panels. D, Balancer and Booster Panel. F, Connector Panel.**

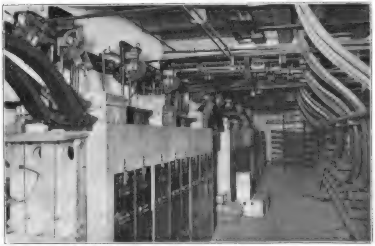

FIG. 5.—E.H.T. 'BUS BARS, SWITCHES AND L.T. FEEDERS IN THE BASEMENT.

Next to the left (Fig. 4) is the starting panel, which is not seen in Fig. 7, but is visible to the extreme left in Fig. 6. This panel serves for starting all the machines. There are three methods of starting the machines, which, it will be remembered, are synchronous motor-generators. The first method is to start the D.C. side as a motor direct off the D.C. 'bus bars in the usual way. This is simple, and as there is a battery it is always available, but it has the disadvantage that a large current is taken. To obviate this, Mr. J. S. Highfield, the Metropolitan Electric Supply Co.'s engineer-in-chief, has devised a method in which a "depressor" is employed. This is practically an inverted booster,—that is to say, it adds an opposing E.M.F. to the 'bus bar pressure. The motor driving this depressor is first started in the ordinary way, and the field of the depressor itself is excited from the 'bus bars until the voltage of its armature is equal to the D.C. 'bus bar volts. It is then switched in between the D.C. part of the main motor - generator and the 'bus bars, and the field reduced until the depressor volts are zero and the main generator volts are equal to the 'bus bars volts. Then the motor-generator is switched in in the ordinary way. The depressor is a B.T.-H. 400-ampere 250-volt dynamo driven by a partially-enclosed 150 H.P. motor at 650 revs.

The third method of starting is by means of an induction motor, which is connected by means of a pillar switch in front of the starting panel to the E.H.T. mains, there being a rheostat in the rotor circuit of the motor. This motor drives a 100kw. D.C. generator, which is connected to the D.C. side of the main motor-generator to be started.

There are three booster and balancer panels; for three combined booster-balancer sets will be put down when the sub-station is fully equipped. At present there is only one (Fig. 10). These machines are not automatic reversible boosters, but have ordinary booster, the fields of which can be reversed so as to boost up or down. One of these panels is fitted with a recording ammeter connected to record the out-of-balance current supplied to the network. The voltmeter panel marked M in Fig. 4 is connected to the L.T. feeder 'bus bars below the gallery which are divided into three sections that can be maintained at different pressures, if desired.

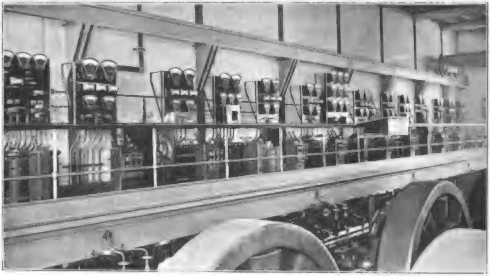

FIG. 6.—GENERAL VIEW OF SWITCHBOARD GALLERY.

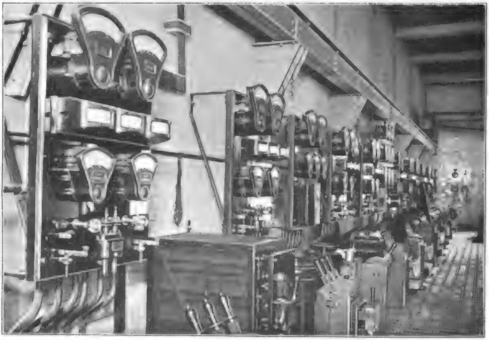

FIG. 7.—VIEW FROM ONE END OF THE SWITCHBOARD GALLERY.

The feeder panels below the gallery are shown in Fig. 8. They accommodate 90 feeders, some of which are 1·0 and 0·5 sq. in. concentric cables feeding the outers of the three-wire system and others 0·4 and 0.8 sq. in. triple concentric cables. The board is divided into positive and negative halves by a shelf running the whole length, the upper part being for the positive and the lower for the negative pole. The feeders are divided among three sections with separate 'bus bars, which can be interconnected, and each section has duplicate 'bus bars, one bar on either side of the feeder fuses, so that the feeders can be plugged on to either bar. The feeders are connected to the bars straight through fuses without switches. The switches to connect each part of the 'bus bar with the L.T. motor-generator bars have tripping coils for excess current.

At the far end of this board there is the usual local lighting panel, and an emergency board is provided, distinct from the other board, the function of which is to supply duplicate mains to any of the larger consumers of the company, so that, in the event of the main supply failing, there will be this duplicate supply to fall back upon. This board accommodates 15 concentric feeders, some of which are of 0·5 sq. in. section and some of 1 sq. in. section. The board is connected direct to the battery and also to the main 'bus bars, so that it can be fed from either side.

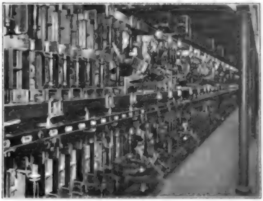

Fig. 8.—Feeder Panels.

Both the switchboards and the entire switch gear have been supplied and erected to Mr. Highfield's specification by the British Thomson-Houston Co., who have made an exceedingly good and sound job of it. The general appearance is neat, and the switching operations are simple. Every precaution has been taken for safety; the external metal covering of all the H.T. cables and 'bus bars is continuous and earthed, and no high pressure is brought to the switchboard gallery at all, the instruments being all connected to current and pressure transformers, and finally the flooring of the gallery is made up of roughened glass tiles.

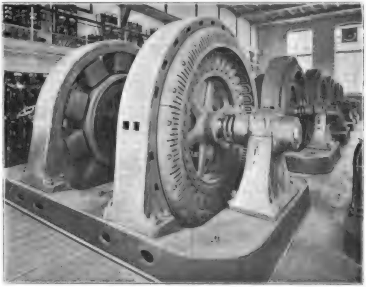

Fig. 9.—The Motor Generators.

Five of the six motor generators are seen in Fig. 9. They have an output of 500kw. each, running at 200 revs. per. min. The alternating-current side of each is a two-phase 36 pole synchronous motor of about 750 H.P., 10,000 volts per phase, and the direct-current side is a 500kw. 200-volt ten pole D.C. generator. The frequency is 60 ∼ per sec. Two concentric cables are brought to each machine from the switches in the basement, ending in a special cable box bolted to the synchronous motor frame, the stator of the motors being built up on a strong cast-iron frame supporting the iron laminations. The winding is carried in rectangular open slots. The coils are former wound, insulated with mica, and are held in position by means of wedges, the construction being in some respects a departure om the makers' standard construction machine, due care being taken of the insulation for the special high tension machine.

The rotating portion is composed of a strong cast iron spider, carrying a laminated ring, in which spaces are left radially for ventilation. The outside of the laminated ring is dove-tailed to receive the poles, which are keyed to it and are composed of iron laminations. Special attention has been paid to the shape of the polar extension, to have as much as possible a sinusoidal wave shape. Damping rings are not provided, but the field coils are supported in spools with solid brass flanges, the winding being composed of edge-wound copper strips, insulated by means of a special fibrous material and the outside being left bare.

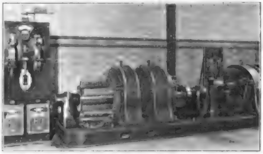

Fig. 10.—Booster Balancer Set.

The voltage of the exciting circuit is 220, and in the design of the field winding enough margin has been left to permit, by means of a rheostat in series with the field, a variation of the excitation. The machines are excited from the 'bus bars.

The performance of the machine when running has been satisfactory, we understand, the synchronous motor running very steadily, free from hunting and being remarkably noiseless. Special attention has been paid to the ventilation of this machine, and the makers find that the temperature rise after continuous running at full load is much below what is customary for this type of machine. Fig. 11 gives the open-circuit curve of this synchronous motor, the calculated excitation at full load being dotted. Fig. 12 gives curves showing the efficiency of the machine, from which it will be seen that the commercial efficiency is as high as 95·2 per cent. at full load, including rheostat and friction losses.

These motor generators were supplied by Messrs. Dick, Kerr & Co., and are calculated in every way to do justice to the reputation of the Preston works.

The same firm supplied the booster-balancer sets shown in Fig. 10. Each of these consists of four six-pole machines, directly coupled and mounted on one bed-plate, with three bearings. The machines are built on similar lines to the standard Dick-

Kerr direct-current generator construction. The boosters are capable of dealing continuously with a current of 1,200 amperes in each machine, with a maximum pressure of 35 volts. They are also capable of dealing with a steady current of 3,000 amperes for one hour without sparking or injurious heating. The two balancers drive the two boosters at 600 revs. per min., and are rated at 92kw. each (and to withstand an overload of 25 per cent. for one hour). Our illustration shows the wide commutator of the booster, necessary for the large current it has to carry.

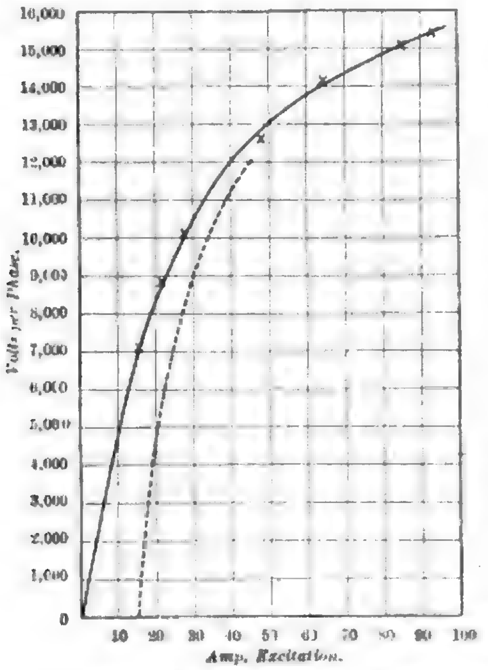

FIG. 11.—OPEN-CIRCUIT EXCITATION OF MOTOR-GENERATOR.

The engine room is spanned by two overhead cranes each of 15-ton capacity, supplied by Messrs. Fielding & Platt.

A battery of 110 E.P.S. cells has been put in. These have a capacity of 2,000 ampere-hours at a 1-hour discharge rate, 3,600 at a 3-hour rate, and correspondingly greater capacity at slower rates of discharge. Two more batteries of similar size are to be erected in the battery room, which is on the top floor.

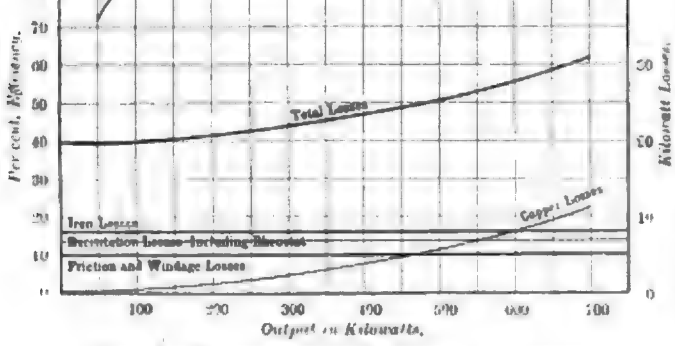

FIG. 12.—MOTOR-GENERATOR EFFICIENCY AND LOSSES.

The building was constructed by Mr. J. Carmichael, the switchboard platforms were supplied and erected by Messrs. Hayward Bros. & Eckstein, and the steel work by Messrs. Drew-Bear, Perks & Co. The architects were Messrs. Bourchier, Burmester & Galsworthy.

The building was commenced at the end of January, 1904, the first machine turned over the middle of September, and was on load by November 4.

In concluding our article we wish to express our thanks to Mr. J. S. Highfield, the company's engineer-in-chief, Mr. R. H. Bryans, the company's head draughtsman, and Mr. A. C. Power, engineer-in-charge at the sub-station, for placing all the information they could at our disposal, and granting us every facility to inspect and photograph the sub-station.

THE COMBINATION OF DUST DESTRUCTORS AND ELECTRICITY WORKS ECONOMICALLY CONSIDERED.

At the Institution of Electrical Engineers on Thursday last week, January 12th, the discussion on Mr. W. P. Adam's Paper on the above subject, read December 15th, was concluded. The Paper and first portion of the discussion appeared in our issues for December 16th, p. 348; December 23rd, p. 387; December 30th, p. 428, and January 6, p. 467.

Mr. H. N. LEASK said that greater attention should be given to the planning of combined destructors and generating stations and to the use of forced draught in them. The destructor at Mansfield, which worked with forced draught, had run for three months absolutely on refuse, generating about 1,500 units per day. There was certainly a coal-fired boiler in the station in addition, but this was solely because there were not ring mains from the destructor boilers. The destructor generated over 50 units per ton of refuse. As much as 120 units per ton had been obtained on one occasion. At Gloucester, where the load was 250kw., in about half an hour they generated between 20 and 30 units per ton of refuse, and successfully carried the whole of the load on a two-cell destructor. About 1½ to 2 tons of refuse per hour were burned. At Northampton, where there was a traction load, they burned 5·5lb. of coal per unit, but when the destructor was used only 2·5lb. of coal was used per unit generated.

Mr. W. R. COOPER could not accept all that was put forward in the Paper. The Paper showed rather the inefficiency of generating stations than the virtues of destructors. One of the main disadvantages of combined works was that destructors and electricity works did not grow up together. The refuse came all at once at the start, and then the destructor might supply all the necessary steam for a town of 100,000 inhabitants, say, as the load on the electricity works was light and in its early stages. In the second stage of the life of the station, coal firing might be necessary for some of the load; and in the third stage the electricity works outgrew the destructor, and two lots of boilers had to be employed. Consequently, there was a fair amount of complication, and the question was whether the greater complication was worth going in for. As to site, something of course was gained at first, but the proportional gain went down with time. In a country town, the destructor should be put as far away from the residential part as possible. This was quite the reverse with the electricity works. As to chimneys, there was a certain amount of saving, but it could scarcely be said that the whole chimney was saved, because the destructor chimney was very large in proportion to the amount of power. The figures in the Paper dealing with stations burning refuse only could be accepted, but in the case of the works at which both coal and refuse were burnt some assumption had to be made, and the assumption was made with regard to the coal. In Fig. 12 the final result at Hackney was given as 104·3 units per ton of refuse. Hackney was a very economical station, and as far as refuse was concerned, there were no stand-by losses. It had to be burned, whether you wanted to or not. At Woolwich, for which 100 units per ton was given, the refuse was unusually good. But take Fig. 9, Fulham. Here one had to assume that 8lb. of coal were used per unit generated, and from that it followed that 91·5 units were generated per ton of refuse. But 8lb. was an average figure, and he did not think the author was justified in assuming that an average figure could be applied to half a curve when the load was heavy. That being so, the figure for the refuse would go down. Further, the fuel was not proportionate to the power; for example, if the load were raised one-tenth it would not be necessary to have one-tenth more fuel. The comparison of the refuse and coal in the Paper was, therefore, to some extent misleading. One ought to compare the refuse under best conditions and the coal under best conditions. A glance at the steam-raising values showed that they did not support the author. On p. 387 (*The Electrician*, December 23, 1904) the author was sceptical as to figures based upon getting from 1lb. to 2lb. of steam per pound of refuse. Everyone would admit that 1·5lb. was a high figure, and the usual was between 1lb. and 1·5lb. Taking 1·25lb. of steam per pound of refuse, this meant 2,800lb. per ton, and if 100 units could be generated with that ton it meant that it would only be necessary to use 28lb. of steam per unit generated on the average. This was an extremely good result, but he was afraid that it would not often be obtained. At Fulham, 1·15lb. of steam was said to be the average per pound of refuse, which gave 2,580lb. of steam per ton of refuse. From the author's curves this worked out at 29·6lb. of steam per unit generated, but it was really less because a certain amount of steam was used for other purposes. Yet the author took 8lb. of coal per unit generated. If they took it that 8lb. of steam was obtained per pound of coal, this gave 64lb. of steam per unit from the coal, as against 29·6lb. of steam per unit generated from refuse. He did not see why one should be so much better than the other. Hackney obtained 1lb. of steam per pound of refuse, and in the same way, if it were possible to obtain 120 units per ton of refuse, as the author said ought to be obtained, then the result would be 18·7lb. of steam per unit in the case of refuse, and, from what the author said, 30lb. per unit from coal. The author also mentioned 5lb. of coal per unit at Hackney. This naturally gave 6lb. of steam per pound of coal. He thought there must be some mistake here. Apparently all through the Paper the author obtained very good results from refuse and comparatively bad results from coal. But if 8lb. of coal per unit were used at Fulham, and if 100 units were obtained per ton of refuse, then 8lb. of coal was equal to 22·4lb. of refuse. This made the coal only 2·8 times the value of the refuse. Another way was to say that the refuse should evaporate 2·3lb. of steam per pound. Unfortunately a result of this sort, or anything like it, was never obtained. It seemed to him that the only valuable basis of comparison was the heat obtainable from the destructor. But this was almost impossible. Then they must take the steam raised per pound of refuse. This involved an inefficiency, but still it was about the best that could be done. He did not mean to say that he was a disbeliever in using steam from a destructor, but too rosy a view of the subject should not be taken.

Mr. G. WATSON, of the Horsfall Destructor Co., thought there was a danger in the Institution—which ought to be avoided—of two opposing camps being formed, one consisting of the enthusiasts and the other consisting of those gentlemen whose business it was to pour cold water on the whole attempt. Mr. Highfield, at the previous meeting, had spoken of refuse as if it consisted solely of rotten cabbages and stinking fish, but it should be remembered that there was a certain amount of cinder and rubbish and other things, which made town refuse into a very good low-class fuel, which was capable of giving from 1lb. to 1¼lb. of steam for every pound of material. The local authority had the material on its hands and had to get rid of it, and if it was not burned at once it had to be got rid of in a more expensive manner—costing about 2s. per ton—but everyone agreed that the refuse should be burned, and the higher the pressure at which it was burned the more satisfactory was the process, because then there was an entire absence of nuisance, more steam, and a harder clinker which was capable of being sold. A modern destructor could be placed in a convenient position in the centre of any town without being a nuisance, and the object of bringing the cost of cartage as low as possible was equally as important as avoiding long lengths of electricity mains. The fact that the destructor did not grow at the same rate as the electricity works did not seem to be a serious bar. It indicated that the destructor should be designed to be self-contained as well as to work in conjunction with the electricity works. Another objection which had been raised to the combination was the question of dust. His own experience was that the dust did no harm to the machinery, and if anyone would visit Fulham they would be convinced that the machinery did not suffer from dust. In reply to Mr. Cooper's criticisms, he ventured to say that the Paper recorded actual facts. The refuse was burned at a regular rate throughout the 24 hours, but the coal, on the other hand, was burned during a period of high load as quickly as possible, and during the rest of the 24 hours it was simply burned in banked fires, and most of it in his opinion was thrown away. The diagrams showed that the refuse appeared to be much more valuable during the period of high load than otherwise; that was simply because of banked fires. He ventured to urge that there were three ways of avoiding the waste of coal which he had referred to. First; to trust the destructor altogether and not have banked fires. The destructor had such a mass of hot brickwork that it was quite impossible to lose its heat suddenly and there would always be plenty of time to get up steam in an auxiliary boiler. It was also possible to fire one or two of the destructor furnaces nearest the boiler with coal in case of emergency or a sudden call for steam. The coal could not be burned efficiently on destructor grates but they would start with hot furnaces and the amount of coal lost would be nothing as compared with keeping banked fires throughout the day. Another suggestion was—for the purpose of getting up steam quickly—that one or two boilers might be fired with petroleum fuel. In that way steam could be raised very quickly in an emergency, and such boilers could be kept for the purpose of an emergency only. Another way was the method of storing the heat by the use of Mr. Druit Halpin's thermal storage, by means of which very satisfactory results had been obtained at the Kensington and Knightsbridge Co.'s works. But the results there were nothing compared with what they would have been in a combined station where the refuse was available all day, and where the station was not naturally big enough to absorb the whole power. There was another low class fuel which could be utilised in many an electricity works where there was no refuse, and that was the clinker which left the mechanical stoker. In large stations with mechanical stokers burning at a rapid rate, the clinker and cinder contained from 5 to 7½ per cent of fuel if not more. If that clinker were burned in suitable destructors, enough steam could be generated to drive the whole of the auxiliary machinery, whilst the clinker would be reduced in bulk and weight and made into a marketable product. Electrical engineers were the first to take an interest in the destructor trade, long before the more likely industries for using destructors gave the matter much attention. The real reason was that electrical engineers were more enterprising and more ready to take up the destructor, and therefore they should not now attempt to throw cold water on a business which they had themselves started.

Mr. J. H. THWAITES, referring to the Hackney destructor, said that its total capacity had been placed very low in Fig. 11. It was only 39,000 tons per annum, whereas the plant was capable of burning about 180 tons a day. He was fully in accord with Mr. Watson concerning destructors, but he also thought that the destructor was worked on a wrong principle in this country. If the plants were kept working under the best possible conditions of combustion, better results would not only be obtained from the sanitary point of view, but also from the steam-raising point of view. A plant was being worked in Denmark on these lines, and was giving much better results than had been expected. At the end of the Paper it was stated that Christchurch, New Zealand, was the only combined works outside the United Kingdom. This was not the case, because Messrs. Stirling put up one three times as large at Frederiksberg in 1903. This had been working successfully for 15 months, and supplied also steam for disinfecting, heating, &c., for a large hospital.

Mr. HORACE BOOT referred to the use of air-channel bars for destructors. He had used these for some years for boilers, and they had six times as long a life as ordinary solid bars. Electrical engineers took very great pride in keeping their electricity works clean and free from smell and dust. Unfortunately, no matter how thick a brick wall was put up between the boiler house and the engine room they must still have ventilation in the engine room, and it was a well-known fact that there was always a certain quantity of very fine particles of dust somewhere near a refuse destructor works which would blow into the engine room through the skylights, at any rate. He believed that at Fulham they were in the habit of making a fairly large quantity of bricks with the clinker. Could Mr. Fuller or Mr. Adams kindly supply the figures for the cost at which these were turned out per thousand? A point in which he was interested was whether it was advisable to add destructors to existing electricity works where the ordinary fuel was at present being burned. This was not dealt with in the Paper. He noticed, in looking through the analysis of the accounts at Hackney, that the wages for the destructor plant were considerably over £3,000 per year, but that the wages charged for running the electricity works were only just over £1,000 per year. This seemed a rather large discrepancy, because to run a works of the size of those at Hackney upon £1,000 a year for workmen's wages seemed to be exceedingly economical.

Mr. W. G. ADAMS, in replying to the discussion, said that the selection of refuse suggested by Mr. Highfield as the reason for obtaining good results on the peak of the load in many of his curves would be quite impossible in large works like those in London. He believed there was a little difficulty with the dust nuisance mentioned by Mr. Highfield so far as the engine room was concerned, and one quite sympathised with the electrical engineer in charge of a combined works, because the dust and smell was more than would be experienced in a works run in the ordinary way. At the same time he thought the disadvantages were rather over rated. For instance, Mr. Highfield himself, in his Paper before the Municipal Electrical Association at Glasgow in 1901 said[*] :—"Considerable care was taken to prevent the dust from the destructor getting into the power station. It is almost impossible to do this quite successfully, but no serious harm was done by the small amount that did enter," and he took this as a very fair statement of the actual facts. Mr. Robinson also mentioned this matter, but he would ask to have the question considered on the basis of repairs to machinery because he thought that if it was looked at from this point of view it would be found to be a very negligible set-off against the value of the refuse. He had been misunderstood with reference to some remarks he had made in the course of the Paper about storing the refuse. There had been such expressions of opinion on this point that he might almost have advised the storing of some refuse for burning on the winter load. Of course, this was not in his mind. The storing referred to was the daily storage, which was quite possible for short periods, and was actually carried on at many works. Mr. Russell, of Shoreditch, had spoken of a method he had been testing of reducing the clinker to smaller proportions. This was a very important question indeed. A study of the Tables at the end of the Paper would show that the disposal of clinker was only second in importance to the question of obtaining the whole fuel value from the refuse. The difficulties of getting rid of clinker would be largely overcome by these methods. Mr. Russell had stated that he had reduced the quantity of clinker to as little as 17 per cent., whereas the average amount of clinker obtained from refuse was about 33⅓ per cent. He might add that Mr. Russell's fluid clinker had been called Shoreditch "treacle." Mr. Robinson had suggested that there were legal difficulties in the way of a local authority working up and selling clinker. If this were so he thought that every such legal difficulty should be disposed of in view of the importance of the question. He could not give Mr. Boot any particulars about the clinker bricks at Fulham except that at Fulham during the last financial year the clinker revenue was about £500, and that the cost of working it up also cost about the same sum. Still to get rid of the clinker without any charge was an economy. Every credit was due to Mr. Robinson for the simple way in which his accounts were kept. He quite agreed with Mr. Robinson that any method of account keeping which could possibly reduce the apparent cost of the destructor was to be deplored. But generally the tendency was the other way—viz., for the electricity works costs to be reduced at the expense of the destructor. With regard to capital charges, Mr. Robinson had stated that it was not fair to include the loan charges in the costs, but he did not agree, because the capital expended on the destructor, if it happened to be large in any one particular case, was large because of the desire to save working expenses. Therefore, it was only fair that capital charges should be included in comparing the destructor costs of the combined works. Besides, the figures given in the Paper in this connection were Mr. Robinson's own figures. There had been a good deal of exception taken to the figure of 100 units per ton. He himself had never heard the possibility of reaching this figure mentioned before he undertook the investigation for the purpose of the Paper; there was no question about it, however. For instance, if refuse could be found to give 1¼lb. of water per pound of refuse—and this was not an unusual figure—in a station where 35lb. of water were used per unit generated, the result would be 96 units per ton. He had abstracted some very interesting figures from *The Electrician* from a table in a Paper by Mr. Giles who read a Paper in 1904 on "Coal Consumption in Central Stations."* Exception had been taken to the peak value which he had assumed for the Fulham works—viz., 8lb. Referring to Mr. Giles' table he found that this was not at all an unusual figure in works which were condensing with a good load-factor. At Bootle it was 9lb., Halifax 9·6lb., Bristol 8·6lb., Leeds 8·4lb., and Edinburgh 6·35lb. Then again, with regard to Hackney, the assumed figure of 5lb. was quite a fair one, he thought. Mr. Robinson's figures given at the previous meeting were extremely creditable when it was remembered that in Mr. Giles' table, referred to, there were only four works which had so low a coal consumption—viz., Bradford, 12½ million units output and load-factor 0·209; Sheffield, 4 million units and 0·119 load-factor; Sheffield tramways, 9¼ million units and 0·37 load-factor; and Glasgow, tramways 15 million units and 0·47 load-factor. He need hardly say that these load-factors and outputs were greatly in excess of those at Hackney. There was a misunderstanding with regard to the value taken on the peak for coal. Mr. Watson was rather under a misapprehension regarding that. When it was stated that he was not justified in taking the average value of the works for the peak, it must not be forgotten that in the case of the Hackney works the whole of the coal appeared on the top peaks. There was nothing taken off for banking, and, therefore, the average value was the peak value. He had before him a curve from Partick for December 16, 1904. This showed that nearly the whole of the value of the refuse was now obtained, and Mr. Maxwell, the resident engineer, was obtaining over 60 units per ton, and as his water consumption was 56lb. per unit generated, and he was running non-condensing, it would be seen that there were possibilities even there. He hoped the Paper would have the effect of directing greater attention to the design of combined works.

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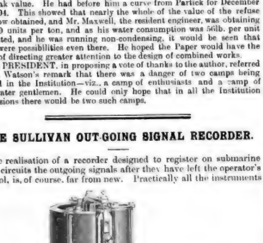
[*] *The Electrician*, Vol. XLVII., p. 607.

The PRESIDENT, in proposing a vote of thanks to the author, referred to Mr. Watson's remark that there was a danger of two camps being formed in the Institution—viz., a camp of enthusiasts and a camp of cold-water gentlemen. He could only hope that in all the Institution discussions there would be two such camps.

THE SULLIVAN OUT-GOING SIGNAL RECORDER.

The realisation of a recorder designed to register on submarine cable circuits the outgoing signals after they have left the operator's control, is, of course, far from new. Practically all the instruments which have been devised for the purpose, however, have been of the "leak" type—*i.e.*, instruments applied at some part or other of the transmitting circuit as a leak or "derived current," through which a certain portion of the departing current in its passage to the cable is diverted through the instrument to earth. The objection to this type is the fact that in order to prevent the currents entering the cable from being injuriously weakened, the recorder must be joined in series with a high resistance, and this in its turn necessitates the use of a highly sensitive and consequently expensive instrument, besides a high resistance box. On the other hand, if such recorders be placed directly in the main signalling circuit of a long cable, the discharge from the cable after each outgoing impulse will carry the syphon across the zero line, and thus, for each unidirectional impulse transmitted, double and more or less illegible signals are recorded. This disturbing effect is aggravated in duplex working, on the double block system, in which condensers of large capacity form the ratio arms of the duplex arrangement, and is further intensified in automatic curb transmission.



THE SULLIVAN OUTGOING SIGNAL RECORDER.

In his new recorder, Mr. H. W. Sullivan has endeavoured to overcome in a practical and inexpensive manner the various difficulties enumerated above. The instrument has a resistance of a few ohms only, and can therefore be placed directly in the line circuit. It is of the pivoted coil type, and is supplied with or without motor to drive the paper band. The last mentioned form is illustrated below. At first sight it is evident that this recorder follows on the lines of the Sullivan speaking galvanometer, as originally described in *The Electrician*, Vol. XLIII., p. 919, the employment of which has been much extended since the publication of our article. In that galvanometer two means are applied simultaneously for damping the swing of the moving part—namely, the magnetic damping of the metal frame on which the coil is wound, and two camel-hair brushes bearing with more or less force against the wires by which the coil is suspended—and these two effects are so regulated as to give the best results for a "speaking" galvanometer, which requires greater static and less electromagnetic damping than an ordinary galvanometer. Similarly, in the Sullivan Recorder, the electromagnetic damping of the coil frame, the controlling force exerted upon the moving parts, and the friction of the syphon point upon the revolving paper band are adjusted in relation to each other until a critical point is reached which allows the coil, when energised, to deflect instantaneously and yet prevents it from perceptibly crossing the zero line at each discharge from the sending condensers, thus cancelling the distorting effect of the abrupt discharge currents to any requisite extent. With the battery applied directly to the instrument and cable, however, a troublesome wandering from the zero line was experienced, but this was successfully overcome by the device of flexible and adjustable springs pressing on either side of the moving system. Still with automatic curb sending, more marked distortion effects showed themselves, and these gave much trouble. Considerable experiment was devoted to remedying these defects, with the result that similar springs have been applied to the other face of the coil system at its outer sides; and we are informed that perfect signals are now obtained under all conditions of working. The compensating springs perform a further and important double function, inasmuch as they can be adjusted both to regulate the amplitude of the signals without the necessity of shunting the coil and they enable the usual controlling devices of the moving system to be entirely dispensed with.

Mr. Sullivan asks us to state that through the kindness of the Eastern Telegraph and other cable companies the apparatus was tried and proved on artificial lines and also cables whilst under design and after its completion.

STAND-BY CHARGES AND MOTOR LOAD DEVELOPMENT.*

BY A. M. TAYLOR.

(Concluded from page 506.)

General "Stand-by Loss" Diagram.—It is likely that most engineers responsible for the running of stations have felt that if the whole of the losses which occur in the station, and those in sub-stations in addition, from the putting in of the coal into the boilers to the delivery of current to the 'bus bars, could be added together graphically, and if the relative effect which each has upon the general efficiency of the station under the varying conditions of load could be so shown, we should have a guide which, if adhered to, would materially improve the coal consumption account in many stations in this country. The diagram shown in Fig. 6 is an attempt to represent the hourly rate of burning coal in terms of the kilowatts of output of that part of the load-curve of the station which may be under consideration. The principle of the diagram is as follows; Starting with direct-current kilowatts at 'bus bars, plot a curve connecting this with indicated horse-power, and a little below this curve plot another curve, nearly parallel to it, connecting kilowatts with electrical horse-power. The space enclosed between these two curves will then obviously represent the combined electrical and mechanical losses of the generator for different proportions of its load. Next, use the indicated horse-power scale as the scale of abscissæ, and for the scale of ordinates take pounds of steam delivered by the boiler per hour to the main steam range. Plot first a curve connecting steam consumed by the engine with indicated horse power; then draw above this (in Fig. 6 it is shown at foot) a line representing excess steam necessary on account of steam feed pumps, then a line above this (also shown at foot in Fig. 6) representing condensation losses in steam pipes to boiler and engine and in main steam range, then again a line above this representing steam consumed by the air and circulating-pump engines. Lastly, take the scale of steam per hour and use it as a scale of abscissæ and set off a scale of pounds of coal per hour as ordinates, and draw a curve connecting these. To settle what scale to employ for the total pounds of coal per hour we must first decide what evaporation to allow per pound of coal at full load of the boiler. The author has taken a figure of 7·68lb. for feed, as received from economiser, to pressure at, say, 160lb.; but this is a figure which each engineer must determine for himself, as it of course depends on the coal used and the economiser and boiler efficiency. We now have a combination of three diagrams, and starting with any output in kilowatts we can readily trace round through the three diagrams to the coal consumption per hour. We can also see the exact effect of "stand-by losses" in engines, dynamos, pipework, condensers, feed-pumps, boilers, &c. Suppose, now, that we had no battery in the station, and that at a certain hour of the night we had only a few amperes leaving the station—fortunately an unpractical condition—requiring, however, that at least one boiler be kept under full steam and one dynamo maintaining 'bus-bar pressure, we find from the diagram that the stand-by losses are: indicated horse power = 120; steam per hour = 6,000lb.; coal per hour = 900lb. This is for a boiler whose characteristic power is given on Fig. 8 (labelled "St Pancras test"), and an engine of 375kw. triple expansion by W. H. Allen & Co. The author does not put forward any of the figures in Diagram 6 as final. He suggests that each station engineer may construct diagrams to suit his own plant, and obtain from the engine, boiler and pump makers curves for the apparatus they supply. If he then combines these and finds that the pounds of coal per hour, taken for any convenient part of his load curve whatsoever, differ *radically* from that which he is really burning, he will be justified in commencing a search to know the reason why. It is here that the diagram will help him, for there are certain losses in it which must be substantially correct, or their cause would be easily detected. Again, there are others, such as steam-pipe radiation, which cannot be materially different from the plotted values; others, again, whose values, of themselves, are too insignificant to account for his discrepancies, and so on.

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* Vol. LII., pp. 530 and 655.

* Abstract of a Paper read before the Birmingham Local Section of the Institution of Electrical Engineers on Dec. 14th.

Lighting and Power Combined Development.—Another direction in which, it seems to the author, the electric supply has not been, in most cases, developed for all it was worth, lies in the fact that many of the supply concerns in this country have, from some cause or another—whether, through an unforeseen development of the demand, the site of the station has had to be shifted, or whether the mains necessary for one part of the town have been over-estimated, or whether the plant has been purchased at a premium, or whether the plant is obsolete and hence more costly than newer plant may be—whatever the cause may be, many of them have paid rather highly for their plant, and in this sense the system is burdened by what the author suggests may well be called "unproductive capital" charges. He would go further, and would frame his definition of "unproductive capital" as: Any capital expenditure, whether in plant or in mains, which, if the station were started *de novo* at present prices (and with present plant overload capacities) and put down with only sufficient margin to carry it safely over the next year or two, might be avoided, is "unproductive capital."

If, for example, the feeders of a station are examined one by one at the time of the mid-winter peak, and the currents traversing them and the distributors are noted and compared with the currents which they could carry if *all* loaded to, say, 90 per cent. of their full capacity, and if such proportion were found to be only 50 per cent., then one-half of the capital locked up in mains is unproductive. Again, if these same mains could be relaid, at present prices, for one-half of what they originally cost, no less than 75 per cent. of the capital on which interest has to be paid is unproductive.

The capital cost per kilowatt of maximum demand for both generating station (complete) and feeders may, for a station of 2,500kw., perhaps be put at about £70 per kilowatt, but there are hardly a dozen stations in the country that have reached this figure, and £140 and £150 per kilowatt are quite common figures.

In Fig. 7 the author shows how that, *apart from* any reduction in "works costs" or total costs, one would be justified, in the case considered, in offering right away a reduction of 1d. per unit *if only* the demand would develop sufficiently rapidly in consequence thereof to compensate in a few years' time for the losses entailed during the first year or two. Fortunately, however, the case is not so improbable as would appear from a consideration of the "unproductive capital" item by itself. The costs of all the other items go down with increased output as, year by year, the improved prices produce their effect in getting more business; with the result that in Fig. 7 we could make an *annual* reduction in price of about ¼d. during five years, or a total of nearly 1¼d. per unit, apart altogether from improvements in the economical working of the station which any capable engineer would be sure to effect in such a period.

The curve shown is based on a 15 per cent. lighting increase and a 30 per cent. power increase, or a 20 per cent. combined increase in the sales during each year, a development which I believe I am right in saying has been far exceeded in several towns, notably at Bradford.

In view, then, of item (4) of the opening statement of this Paper, would it not be expedient in the case considered in Fig. 7 to secure as many lighting and motor consumers, on ordinary terms, at the present time by offering such a lump sum reduction as would recoup itself in, say, five years' time at the probable rate of growth of the combined load? The author throws out the suggestion for what it is worth, but it does seem to him that no stone should be left unturned to get hold of consumers *now*, for the same reasons that he has already urged in connection with a motor load.

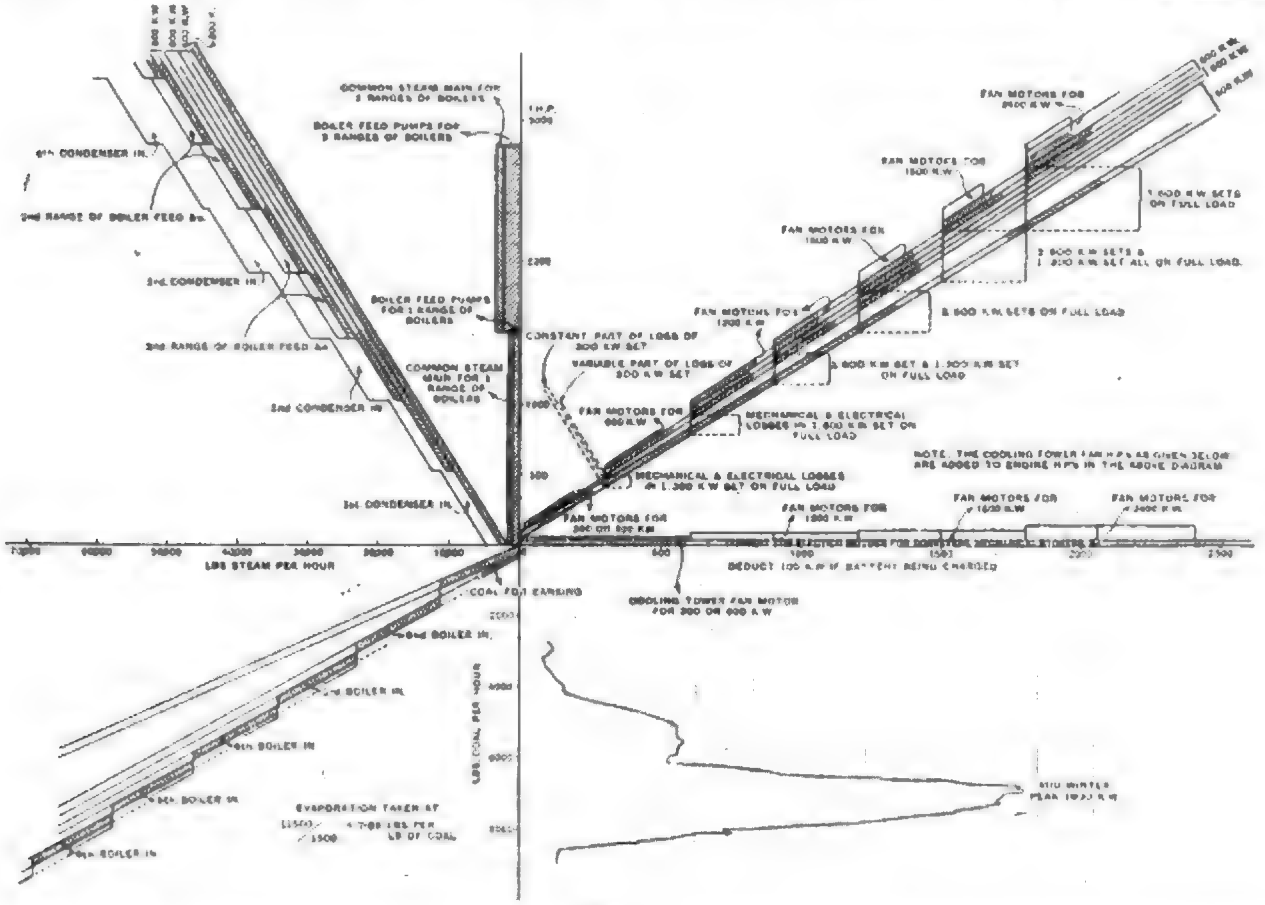

COMMON STEAM MAIN FOR 3 RANGES OF BOILERS
BOILER FEED PUMPS FOR 3 RANGES OF BOILERS
I.H.P.
3000
4th CONDENSER IN.
2nd RANGE OF BOILER FEED &c.
3rd CONDENSER IN.
BOILER FEED PUMPS FOR 1 RANGE OF BOILERS
CONSTANT PART OF LOSS OF 300 K.W. SET
VARIABLE PART OF LOSS OF 300 K.W. SET
3rd RANGE OF BOILER FEED &c.
COMMON STEAM MAIN FOR 1 RANGE OF BOILERS
2nd CONDENSER IN
1st CONDENSER IN.
LBS STEAM PER HOUR
COAL FOR BANKING
FAN MOTORS FOR 600 K.W.
MECHANICAL & ELECTRICAL LOSSES IN 1,300 K.W. SET ON FULL LOAD
FAN MOTORS FOR 300 OR 600 K.W.
MECHANICAL & ELECTRICAL LOSSES IN 1,600 K.W. SET ON FULL LOAD
FAN MOTORS FOR 1200 K.W.
FAN MOTORS FOR 1800 K.W.
FAN MOTORS FOR 1500 K.W.
FAN MOTORS FOR 2400 K.W.
600 K.W.
600 K.W.
600 K.W.
1,600 K.W. SET & 1,300 K.W. SET ON FULL LOAD
2,600 K.W. SETS ON FULL LOAD
2,600 K.W. SETS & 1,300 K.W. SET ALL ON FULL LOAD.
3,600 K.W. SETS ON FULL LOAD
NOTE. THE COOLING TOWER FAN H.P.'s AS GIVEN BELOW ARE ADDED TO ENGINE H.P.'s IN THE ABOVE DIAGRAM
FAN MOTORS FOR 1200 K.W.
FAN MOTORS FOR 1800 K.W.
FAN MOTORS FOR 2400 K.W.
500
1000
1500
2000
2500
DEDUCT 100 K.W. IF BATTERY BEING CHARGED
COOLING TOWER FAN MOTOR FOR 300 OR 600 K.W.
2nd BOILER IN.
3rd BOILER IN.
4th BOILER IN.
5th BOILER IN.
6th BOILER IN.
EVAPORATION TAKEN AT 7·08 LBS. PER LB. OF COAL
LBS. COAL PER HOUR
MID WINTER PEAK

FIG. 6.

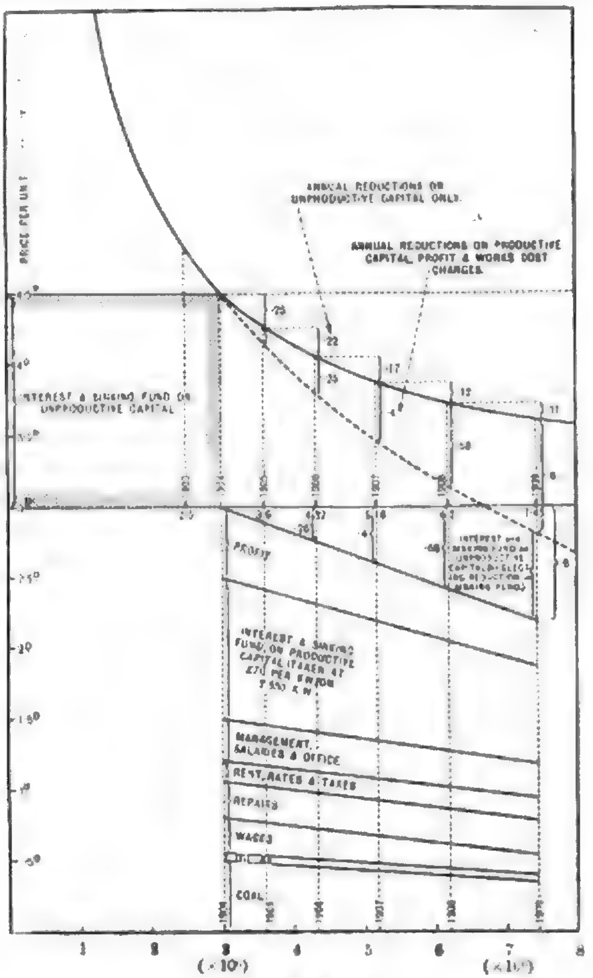


Fig. 7.—Diagram showing rate of development of station necessary to warrant reduction in price on account of unproductive capital.

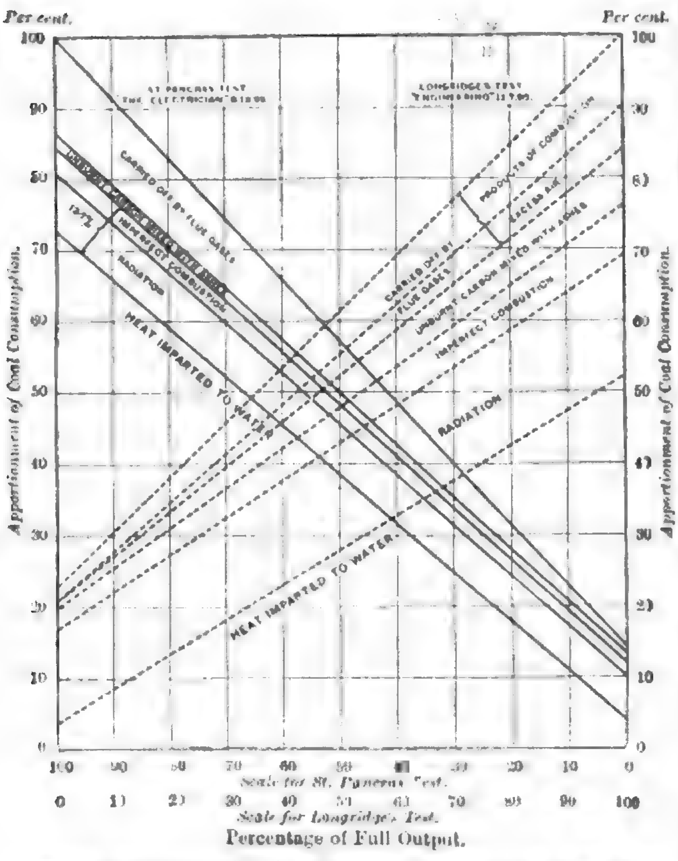


Fig. 8.—Stand-by and Full Load Losses of Babcock and Wilcox Boiler.

It is perhaps worth pointing out in this connection that if the author's suggestion for giving the "non-interest-paying" motor customers a means of tiding over the evening peaks and the occasional day fogs should prove to be practical, the same arrangement could be used to offer to lighting consumers a "non-interest-paying" rate which, by comparison with present rates, would undoubtedly prove attractive in spite of the fact that it could not, from the nature of the case, be anything approaching the motor charge in cheapness.

Sub-station "Stand-by" Losses.—These can be treated in the same manner as already indicated. A case for a sub-station with three 300kw. asynchronous motor-generators, driven from a high-tension three-phase supply, with 5 per cent. loss in feeders, is shown in Fig. 9, in which kilowatts at the sub-station direct-current 'bus bars are plotted with kilowatts at the alternating-current high-tension 'bus bars at the main generating station.

Suppose there were three or four sub-stations so worked, each having its own diagram of stand-by losses and its own curve of outputs, then for any particular hour in the day the alternating-current high-tension 'bus bar kilowatts at the main station can be added together and the rate of coal consumption read off just as for a continuous-current generating station.

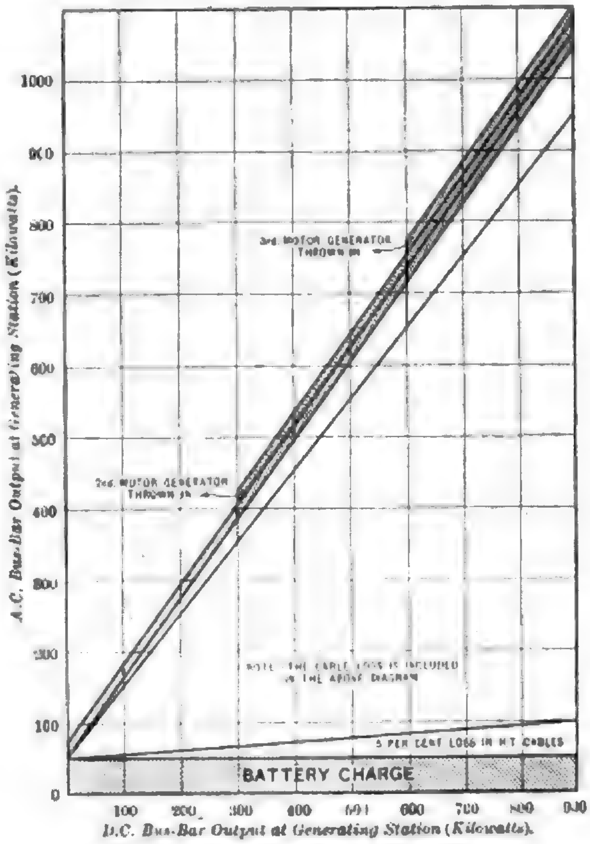


Fig. 9.—Sub-station Stand-by Loss Diagram.

It should be mentioned that the fact of the cable losses being proportional to (C^2) and not to (C) has been ignored on the above diagram. The difference in results is very trifling, but the correction can easily be made if the cable losses are added, in the diagram, on the top of the machinery losses, as can be done with equal facility.

Conclusions.

1. It is not safe to offer current for motor supply for day use at anything below 1d. per unit except under the restrictions indicated.

2. It is worth while making the offer to consumers of current at exceptionally low rates subject to these restrictions, no matter how greatly opinions may differ as to their being accepted.

3. Such an offer it is in the capacity of any and every lighting station in the country to make immediately without having to wait till they can lay down additional plant and mains: it being understood that the consumers pay for the cost of service connections.

4. Stand-by losses can be turned to account by reducing that part of the works cost which is chargeable to coal by some 30 per cent. in the case of supply for motors.

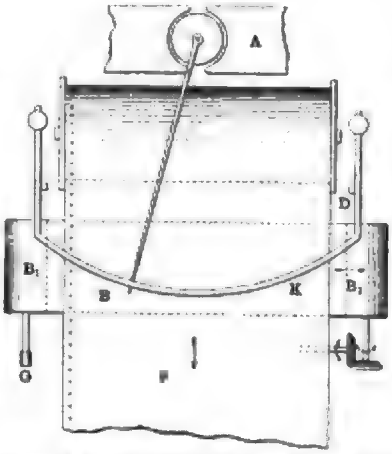
5. Investigation of "unproductive capital" charges, more especially when combined with a reduction to motor users on the lines indicated, may enable the cost of the lighting supply to be also reduced.

6. The diagram of stand-by losses will, it is hoped, enable engineers to better appreciate the relative importance of the various losses at different periods of the load, as well as to fix an individual standard up to which each station should attain, and thereby to effect reductions in "works cost" over and above those considered in connection with the motor load.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

New Registering Pyrometer.—Siemens & Halske have brought out a new electric registering pyrometer whose action is not, like that of Callender's, based upon the resistance of platinum, but upon the thermo-couple. The obvious objection to this type of instrument is that the directing couple is too feeble to overcome the friction of the recording pen, but this objection is met in the new instrument by an ingenious contrivance which will be understood from the diagram. A is the millivoltmeter, whose pointer is perfectly free to move. It moves underneath a stirrup, K, poised at D, and over a band, B, which moves in the direction of the arrow. The mechanism which moves the paper band also lifts the stirrup at intervals which may be timed at will, and drops it for an instant upon the pointer, which thereupon hits the band and leaves an impression by means of the band of carbon paper B_1B_2 which underlies the paper band. It is quite practicable so to contrive the intervals that the curve traced by the point is apparently continuous.



[Siemens & Halske, *Zeitschrift für Instrumentenkunde*, December, 1904.]

Variation of Magnetic Hysteresis with Frequency.—T. R. Lyle has investigated the iron losses in transformers by means of his wave-tracer, and has obtained some new data with respect to the distribution of the various losses. His experiments were made on two rings of laminated annealed iron, in one of which the radial breadth of the iron was considerable relative to its mean radius. These rings were magnetised by alternate currents of different strengths and periods. Both the magnetising-current wave and the magnetic-flux wave were quantitatively determined by the wave-tracer, and the wave-forms so obtained were subjected to harmonic analysis. From the analytic expression for each pair of associated waves the total iron loss per cubic centimetre per cycle was calculated, and it was found, when the magnetising current is approximately sinusoidal, that the total iron loss I is given with considerable accuracy by the formula—

$$I=(0{\cdot}00186+0{\cdot}00026n)G$$

for ring I., and by the formula—

$$I=(0{\cdot}001684+0{\cdot}000272n)G$$

for ring II., where n is the number of periods per second, and G is a function of the effective induction. When from the total loss I the statical hysteresis obtained by Ewing and Klaasen's method is subtracted, and also the value that theory assigns to eddy-current loss, the author finds that a considerable quantity remains, which increases both when the frequency and the flux density increases. This is Fleming's "kinetic hysteresis." The author draws attention to an interesting case of transformation and what he calls reflection of energy. If the E.M.F. impressed by the magnetising circuit on the iron ring be sinusoidal, the flux wave produced contains third, fifth, &c., harmonics. These higher flux harmonics induce currents in the magnetising circuit which are dissipated as heat in it. Thus we have a transformation of electric energy due to alternating currents of frequency n to energy of currents whose frequencies are $3n$, $5n$, &c., which is reflected back into the magnetising circuit. This the author believes to be a hitherto unnoticed source of transformer loss.

[T. R. Lyle, *Philosophical Magazine*, January, 1905.]

Radio-activity of Mineral Springs.—The researches made by Sella, J. J. Thomson, Himstedt and other physicists have shown that ordinary tapwater generally contains a radio-active gas or emanation that can be easily obtained by boiling the water or by drawing air through it. Mineral waters, and the deposits which they form, have hitherto generally shown considerable radio-activity. G. A. Blanc describes the results obtained in the case of the materials deposited by a certain number of mineral and thermal waters belonging to the Alpine region. He shows that, besides the activity and emanation probably due to traces of radium which several physicists have observed in the sediments of a great number of mineral and thermal springs, some deposits contain a radio-active constituent, in all probability thorium, the emanation of which loses half its activity in about one minute, and is capable of producing excited activity that falls to half its value in about 11 hours. The author noticed a curious fact in connection with the diminution of the activity of the deposit with increasing distance from the source. The waters at the "Source d'Alun" of Aix-les-Bains show at their surface a viscous substance, partly organic, called "barégine," which has a considerably greater activity than any other material collected in that particular spring. The theory of the origin of this substance, as given by naturalists, states that it is formed at the spot where the water emerges from the soil. On determining its rate of decay, he found that it differed from that which would be due to radium compounds, and suggests the presence of thorium in this and similar cases.

[G. A. Blanc, *Philosophical Magazine*, January, 1905.]

Mean Spherical Candle-power.—The fact that a nominal 16 c.p. incandescent lamp may give from 12 c.p. to 20 c.p. in different directions in a horizontal plane, corresponding to a variation in so-called efficiency of from 5 to 3 watts per candle, shows that some improved method of measuring the efficiency of electric lamps is needed. Such a method has been pointed out by Prof. Fleming, and consists in stating the whole flux of light in lumens per watt, which gives a figure of about 3·5 for glow lamps. The expression of the efficiency in this manner involves the determination of the mean spherical candle-power. G. B. Dyke has determined this quantity by a new method, which, he claims, affords accurate results with no greater expenditure of time than is required for one, or at most two, measurements by existing methods. The objects aimed at were to obtain a series of curves showing the variations of candle-power in incandescent lamps in a horizontal plane; to obtain reduction factors by which the mean horizontal candle-power may be calculated from the maximum horizontal candle-power, for different types of filament; and to obtain reduction factors for calculating the mean spherical candle-power from the maximum or mean horizontal candle-power. The first two objects were met by designing a carriage to run on the existing photometric bench in the Pender Electrical Laboratory, provided with a scale of degrees and means of rotating the lamp. To obtain rapidly the relation between mean spherical and mean horizontal candle-power, a modification of the method devised by Mathews was employed. This method consists in placing several pairs of mirrors round the circumference of a semicircle, and so arranging them that light emitted from a source placed at the centre of the system shall be incident on a white screen, also situated at the centre, at the same angle with the vertical as that which it made on emission from the source. Then, if the source is symmetrical about the diameter of a semicircle, and if Lambert's cosine law holds for the screen used, it can be shown that the intensity of the illumination on the screen is proportional to the mean spherical candle-power. In the Ediswan triple-looped doubly-anchored filament, which was studied more in detail, the ratio of the mean spherical candle-power to the mean horizontal candle-power remained practically constant at 0·78 in seven specimens. The ratio of the mean spherical candle-power to the "candle-power" varied from 0·71 to 0·79, which shows the unsatisfactory nature of the commercial designations. Arc lamps do not require revolution about the vertical.

[G. B. Dyke, *Philosophical Magazine*, January, 1905.]

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THE ELECTRICAL DRIVING OF TEXTILE FACTORIES.

At a time when the electrical industry is passing through a period of unparalleled depression, it is refreshing to observe that those who are engaged in its various branches are doing their utmost to stem the ebb and bring about a substantial and, it is to be hoped, permanent revival. These efforts are already having their effect, for one hears on every hand that business is really becoming brisker and that there are hopes of a more promising future. Whatever may be the cause of the regrettable slackness of trade it goes without saying that the electrical industry is far from being "played out," and that its possibilities are, even now, beyond calculation. Attention is being drawn at the present moment to an application of electricity which, so far, has only been touched on the merest fringe: the driving of textile factories. There are thousands upon thousands of horse-power installed in these factories, and only a very minute portion indeed is electrical. The vast majority are driven by steam engines—in some cases old inefficient machines which have long ago qualified for the scrap heap, and in others modern engines of unquestionable economy and efficiency. For electricity to oust the former should not be a matter of extreme difficulty, but the process will not be so easy in the case of the latter.

Two excellent Papers on this subject have recently been presented to the Institution of Electrical Engineers—one by Mr. W. B. WOODHOUSE, read before the Leeds Local Section and published in *The Electrician* of January 6th, and the other by Mr. H. W. WILSON, read before the Manchester Local Section on Tuesday and abstracted on another page of this issue. Mr. WOODHOUSE expressed the opinion that there are really two reasons why the adoption of electrical machinery in textile factories has been so slow: one is that there is a lack of accurate knowledge as to the results to be obtained, and the other, that there has been an absence, until recently, of a public supply of electrical energy at a reasonable price. Mr. WILSON, on the other hand, places most of the responsibility upon the depression which has existed in the textile industry during the last three years. The natural conservatism of the country takes second place, and a third contributory cause is alleged to be the number of contradictory statements which the advocates of electrical driving have put forward. Doubtless, each of these causes has been effective in delaying the desired consummation, to a certain extent, and, combined, they have for a time rendered almost nugatory the efforts of those who have advocated electrical driving. Now, however, the time is ripe for the removal of misconceptions and most of the obstacles should disappear automatically.

The problem of driving textile factories is so entirely different to that of driving ordinary engineering workshops, that it calls for a special study of the conditions attendant, and the devoting of a large amount of time to what is little more than purely experimental work. Many machines require only a fraction of the power taken by a small lathe, some run almost continuously, while others are frequently stopped and started and take power varying very greatly in extent. This is well known to managers of textile factories who have been familiar with the conditions for many years, and are more or less content with the existing state of affairs. Before contemplating change they must be convinced that it will be for their benefit. The only persons who can convince them are electrical engineers, and they, unfortunately, are not yet possessed with an abundance of the experimental data necessary for the purpose. The most powerful argument that can be used for the adoption of electrical driving is reduction of cost. Now, as a matter of fact, it is by no means certain that the supersession of the steam engine would bring about this result in every case as far as actual working costs are concerned, although in the majority of existing factories it undoubtedly would. It is quite certain, however, that it would bring about an increase of production and improve the quality of the finished article owing to the very exact speed regulation which can be obtained and the steadiness of drive, to say nothing of superior cleanliness. In dealing with this question Mr. WILSON asserts that "electrical driving permits of greater production, because the machinery can be run on the average nearer the maximum possible speed than when operated mechanically. It cannot be run at a higher maximum speed, as the manufacturing conditions do not permit of this; but the average speed is higher." Thus, should there happen to be in some rare cases a slight increase in the cost of power as compared with factories driven by modern efficient steam engines working under the most favourable conditions, this would probably be more than offset by the increase in production. The same author shows that there is a good deal in favour of textile factories taking energy from a power company, as against generating it by independent plant. He takes as an instance a mill of 100,000 mixed mule and ring spindles costing about £140,000, which brings the cost per spindle out at 28s. Assuming the main generating plant to cost £10,000, its elimination would mean that the price per spindle works out at only 26s., and hence it would be possible to put in an additional 7,500 spindles, which, of course, would increase the capacity of the mill by 7½ per cent. By a further assumption that the standing charges represent 12 per cent. of the production costs, the increase in the number of spindles would reduce the cost per pound by 0·9 per cent., as the fixed charges would remain practically unaltered. As to whether a mill could generate its own energy cheaper than a power company could supply it, is a moot point, and Mr. WILSON inclines to the opinion that after allowing 5 per cent. for interest and 10 per cent. for depreciation, a mill ought to be able to generate its own energy at 0·3d. to 0·35d. per unit. If this be so, then the task of the power companies is by no means an easy one. Of course, it follows that by taking supply from a power company, the mill owner is relieved of many responsibilities and worries which are inseparable from an electrical generating plant and, as has been shown, an increase of production may result, although this latter advantage only accrues in the case of a new mill.

One important point brought forward by both authors is the excellent check which overseers and managers have upon their employés when electrical driving is employed. As in all other industries there is the usual delay in starting up the machines in the morning and after meal hours; there is also a tendency for efforts to slacken several minutes before leaving off and before meal times. These idiosyncrasies naturally pass unnoticed in steam and belt driving, but they become painfully evident on the recording ammeter or wattmeter diagrams. For this reason, at all events, electrical driving will be viewed with disfavour by operatives, and conversely it should prove a useful argument in urging the adoption of electricity. There are, of course, many other points in which motor driving is superior to transmission of energy by belts, one of which is the excellent arrangement which can be made for group driving. Opinions are divided to a certain extent, but this is another matter on which there can never be unanimity simply because each example must be considered on its own merits. At the same time, figures obtained in actual practice, although not of universal application, are of enormous utility, and those gentlemen who can bring forward well-authenticated data should not hesitate to do so, as they will materially assist their professional brethren and tend to further the interests of both the electrical and textile industries.

THE ELECTRICAL OPERATION OF TEXTILE FACTORIES.*

BY H. W. WILSON.

A very large amount of work has been carried out in the United States in the electrical driving of both spinning and weaving mills, and in the beginning this development was owing to the necessity of taking advantage of water powers in the neighbourhood of the mills. All the mills first fitted up in the States had water turbines as their prime movers, and it was not until some years after the first mills were driven, and had shown the advantage of the electrical drive, that the idea of electrically operating a mill, the prime mover of which must be steam driven, was seriously considered. Experiments were then made in this direction with very satisfactory results; and, speaking generally, it may now be said that the bulk of the new mills being erected in the States are to be electrically driven. A large amount of similar work has been carried out on the Continent, particularly in Russia, Italy and Spain, with satisfactory results, but the bulk of the installations about which accurate details are available have been laid down in the United States. Experiments, however, have and are being made in this country.

The advantages which the advocates of electrical driving urge for the operation of large textile factories are stated briefly as follows:—

1. The mill and the engine house can be placed each in its most convenient situation without any regard to their relative positions.
2. The internal arrangements of the mill as regards shafting, gearing, belt and rope drives, &c., are greatly simplified and their costs reduced. The flexibility as regards extensions is, of course, obvious.
3. The grouping of the machines is much less arbitrary than in a mechanically-driven mill, as the motors and the comparatively light shafting required by them can be placed where most convenient.
4. The reduction of the chance of a breakdown, which would stop the whole mill, to a minimum.
5. The ease of running one section for overtime or on special work.
6. The reduction of the maintenance and depreciation charges.
7. The greater steadiness of drive which can be obtained under suitable conditions, with a subsequent permissible higher speed and increased output.
8. The reduction in the total capital cost of the mill per spindle or per loom with a factory of above a given size.

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* Abstract of Paper read before the Manchester Local Section of the Institution of Electrical Engineers on Tuesday.

9. The possibility of keeping a constant check upon the results obtained in each department of the factory.

Item No. 7 is the most important one, and the one about which the most discussion has arisen.

Electrical driving permits of greater production, because the machinery can be run on the average nearer the maximum possible speed than when operated mechanically. It cannot be run at a higher maximum speed, as the manufacturing conditions do not permit of this, but the average speed is higher. Exactly accurate figures are, of course, difficult to obtain, and we are again, unfortunately, compelled so use data obtained from American sources, and this shows that an increase in production of some 4 per cent. in weaving and up to 8 per cent. in spinning may be expected and obtained. As regards the statement that a considerable increase in the cost of power is of little importance if accompanied by an increase in output, it may, perhaps, be advisable to point out that the cotton spinners and weavers state their costs at so much per pound of yarn or cloth produced. In the case of a spinning mill, on most classes of counts, it may be taken that the margin over the price of raw cotton, out of which the manufacturers have to pay all their costs and make their profit, is something between 3d. and 3¾d. per pound. Assuming a price of 4d. per pound, therefore, the selling price of the yarn would be 7¾d. A considerable proportion of the 3¾d. manufacturing cost is made up of the piece work price per pound of yarn produced which is paid to the operatives, and it would not be easy to get any modification of this piece work price. What may be regarded as the standing charges of the mill—that is, the amount required to cover rent, rates, taxes, insurance, cost of power, salaries and day labour—is but a comparatively small percentage of the price of the finished article, and it therefore takes a considerable increase in output to make any considerable difference in the total costs per pound. Assuming, however, that these fixed charges represent about 12 per cent. of the price of the product, which appears to be about the correct figure, an increase in output of 5 per cent. would mean a reduction in the total cost of the goods equivalent to 0·6 per cent. In a modern spinning mill the cost of power does not usually represent more than 2½ to 3 per cent. of the production costs, and an increase of 10 per cent. in the cost of power would only represent about 0·25 per cent. increase in the total costs. The percentage margin of increased profit may, therefore, seem very small, but on a turnover of the amount which the business of a large cotton mill represents, it would be quite perceptible in the annual balance-sheet.

The first objection urged against electrical driving is that its reliability has not been sufficiently proved. The capital expenditure involved in the adoption of the electrical system is also said to be so great in comparison with mechanical driving as to put it out of court. It is also argued that it is only advantageous in special cases, or where the average load-factor is poor; also that the efficiency of a mechanical drive is considerably higher than that of an electrical one.

As regards the question of the reliability of a properly installed electrical plant, there can be no two opinions amongst those who know anything of the subject. The second objection is answered by the eighth item on the list of advantages claimed. As regards the third objection, one frequently meets persons who are prepared to admit that it may be advisable to adopt electrical driving for awkwardly arranged old mills which are being partly refitted, or for a number of small mills close together all belonging to one owner, but that in the case of a new mill the advantages of the electrical drive are mythical. A whole Paper might be written and a long discussion held on the fourth objection. It is, of course, perfectly easy to measure exactly the efficiency of an electrical plant from the prime mover to the driven machine, and to state with positive accuracy what the efficiency is. In the case of a mechanically-driven mill no one can state definitely what the actual efficiency at full load really is. The time-honoured method of taking a friction diagram with all straps on the loose pulleys, and then taking a full-load diagram and considering that the difference between the two represents the percentage efficiency, can only be a very rough approximation to the truth, and the actual efficiency must be considerably lower than the results of such an experiment would show. The author was once in charge of some experiments which involved the driving of a number of mule spinning frames by a single large induction motor. To begin with, for a period of three weeks the motor was driving the frames from a line shaft through a rope drive, and records of the power taken were obtained from an integrating wattmeter. After this the motor was directly coupled to the line shaft through a flexible coupling and run for another period of three weeks, the mules running the same number of hours per week and spinning exactly the same counts. With the rope drive eliminated the production results were somewhat increased, and the average power taken for the whole period reduced by between 12 and 13 per cent. It would seem, therefore, fairly obvious that the more belt or rope drives or other transmission gears introduced the lower must be the efficiency, and persons who argue that with the most modern forms of rope drive it is possible to obtain efficiencies of the order of 98 per cent. are exceedingly sanguine. Upon this question of efficiency accurate figures are difficult to obtain, and it must be admitted that in the most modern mills the results are probably very good; but it is very much to be questioned if a better result than 80 per cent. is ever obtained, and certain instances of even modern mills, where the result is nearer 60 per cent., are known to the author. In one mill, which recently had a new engine put in, the full-load diagram was 788 I.H.P., and the light-load friction diagram 300 I.H.P., or an apparent efficiency of 59 per cent.

The next point that arises is the consideration of the conditions to be fulfilled, and the various types of machinery to be driven. In a spinning mill there are the various preparation machines, including beaters or openers, scutchers, carding engines, drawers and slubbers, intermediate and roving frames, which, speaking generally, form a very steady load; ring spinning and ring doubling frames, which, running at a given speed and upon one class of goods, represent an almost perfectly steady load; and spinning mules, individual machines of which class, from the conditions of their working, represent one of the most variable loads it is possible to obtain. In a weaving shed, manufacturing a given class of cloth, the load should be very steady; and in a drying, bleaching and finishing factory the load on the different machines is exceedingly variable, though the load on the prime mover may be moderately constant. For spinning and weaving absolute constancy of speed is desired; for bleaching, dyeing and finishing speed variation on the machines is essential. Having regard to the conditions of the case, it will be seen that for spinning and weaving induction motors offer great advantages, and the bulk of the electrical machinery now used in this class of factory is three-phase, 40∼ or 50∼ 500-volt plant. For bleaching, dyeing and finishing, with the large speed variation called for, direct-current machinery must be employed. The most up-to-date manufacturers, who have tried electrical driving for this class of work, admit that the results obtained are very greatly superior to anything that can be done by mechanical driving, largely on account of the speed variations required. The average load-factor for work of this description is generally low, and the generator capacity is sometimes not more than 50 or 60 per cent. of the motor capacity. The

Table I.

Machine.	Motor output.			Type of drive.	Starting current.	H.P. run'g light.	Test.			Conditions of test.
	B.H.P.	Amps.	R.P.M.				B.H.P.	Revs.	Yards.	
6-bowl calender, bowl 4′ 8″ × 18	48	187	570	Hide pinion & cut wheel	250	20	25	84	132 max	Piece 3¼′ wide. ¼ w'g't. on bowl
4-bowl dry mangle, 4′ × 16″....	33·5	134	560	Hide pinion & cut wheel	100	15	10 37·5	80 80	111 max 111 max	No weight on } Piece 3′ wide. Full weight on }
3-bowl water mangle, 4′ 4″ × 16″	25	97	640	Brass pinion & cutwheel	..	..	..	..	..	
2-bowl starch mangle, 4′ 10″ × 16	18	71	680	Hide pinion & cut wheel	60	6	6	8½	111 max	Piece 3′ wide. Very thin stuff.
..	..	..	..	..	..	..	4	80	111 max	Light stuff.
..	..	..	..	..	..	..	3	..	..	At lowest speed.
23-ton drying range	8·3	34	575	Belt	25	..	2¾	43	80	Motor at 575. 2 pieces 2′ 10″ [wide.]
Damper bowl, 5′ × 18	5	20	750	Back gear and belts ..	20	1½	..	96	150	Machinery running light.
Two folders, 5′ wide..........	..	..	..	Belt	..	..	5	..	..	Maximum load. Both on.
Brush washing machine	2½	...	..	Belt	2½ B.H.P.	..	½	..	..	
Rubber Polishing machine	2½	..	..	Belt	2½ B.H.P.	..	¾	..	..	
20ft. stenter	5	..	..	Gear	5 B.H.P.	..	1¾ to 5	..	..	
Beamer	9½	..	..	Belt	7½ B.H.P.	..	5½ to 7	..	..	
Small calender	18	..	..	Gear	15 B.H.P.	..	..	..	..	
Friction calender	33	..	..	..	12½ B.H.P.	..	10 to 23	..	..	
White squeezer	11	..	..	..	12½	..	8 to 12	..	..	8 H.P. at normal speed.
White washer	11	..	..	..	13½	..	9	..	..	Top speed.
Dyer becks..............	17	..	..	..	20	..	7½	..	..	

author has collected various figures as to the powers taken by different machines used in dyeing and finishing, and gives them in Table I. herewith, as some may be of interest, and it may be mentioned that in nearly all cases each machine has its own motor.

In discussing the best arrangement for the electrical driving of a large spinning mill a number of points have to be considered. To maintain the average speed at the highest possible it is necessary to reduce all belt or rope transmission between the prime mover and the driven machine to a minimum. We are therefore brought immediately to the question: Is it better to provide for a motor directly connected to each machine or for the machines to be grouped and driven by larger motors? It is obvious, of course, in saying this that the case of the driving of mules must be considered separately. Single mules constitute such an extremely variable load that, so far as any results up to the present have shown, it is impossible to drive them singly by motors. With four mules on a single motor the writer has seen variations in demand from 15 to 90 H.P. almost instantly, and this manifestly represents a condition of affairs under which no motor can maintain an absolutely constant speed. Broadly speaking, it cannot be said to be good practice to drive less than 12 mules from a single motor of, say, 150 H.P. Under these conditions good results are being obtained. However, with the other machines, which normally give a fairly constant load on their driving machinery, these conditions do not apply. It is possible either to use a number of comparatively small motors, or in the case of looms very small motors directly connected, or driven through a single strap on to the various machines, or to group the machines and drive through larger motors. With the possible exception of ring-spinning and doubling frames there is very little doubt in the author's mind that the correct policy is to group the machines. The larger motors have a considerably higher full-load efficiency, and the total cost of the installation is much lower than if small motors were installed. With ring-spinning frames constantly on one class of counts the larger number of small motors may possibly be worth considering on account of the more even speed obtained.

In order to give some idea of the powers taken by the various classes of machines, a few abstracts from a Paper read by Mr. E. W. Thomas are given. The tests detailed were made at the Olympia Cotton Mills, Columbia. The machines driven and the various motors were as follows:—

"5 openers on the first floor of the mill are driven by a 20 H.P. motor, belted (No. 20A in Table).

"5 breakers, 10 intermediate and 10 finisher scutchers on the third floor, 45in. wide, are driven by a belted motor of 150 H.P. (No. 21).

"88 45in. revolving top cards are driven by a 150 H.P. belted motor (No. 14).

"62 45in. cards are driven by a 150 H.P. motor (No. 15).

"240 drawing deliveries, 1,140 slubber spindles (12 by 6), 3,432 intermediate frame spindles (10 by 5), and 608 fine frame spindles (7 by 3½) are all driven by a belted 150 H.P. motor (No. 9).

"13,984 fine frame spindles are driven by two belted 150 H.P. motors (Nos. 3 and 4).

"100,320 ring spindles are driven by 10 150 H.P. motors, each motor being directly connected to the shafting it operates, thus obviating the use of counter belts, and between the engines generating the power and the spinning frame there is only a 2⅞in. belt, that being the belt from the line shaft to the frame direct. The motors operating the frames are numbered 1, 2, 7, 8, 10, 11, 16, 17, 18, 19. Six slashers and an exhaust fan on the second floor of the mill are driven by a 30 H.P. belted motor (No. 20C).

"The 2,250 40in. Draper looms, as well as the necessary spooling and warping, are driven by four belted 150 H.P. motors and one 75 H.P. belted motor, the numbers of the motors being 5, 6A, 6B, 12 and 13. The looms are located on the first and second floors, and the spoolers and warpers on the second floor. The cloth room, containing six sets of cloth-room machinery, is driven by a 50 H.P. belted motor (No. 20B) located on the first floor.

"Table II. shows the various motors in this mill with the horsepower developed by each under full-load and also without the load on the machinery. The numbers of the various motors correspond with the numbers given in the description of their location and distribution above."

Summing up, we find that the combined rating of the motors in the mills was 3,175 H.P., that the total load was 2,580·45 H.P., to which should be added 66·88 H.P., the equivalent of the machinery not in operation when the tests were made. This makes the total power required at the switchboard 2,597·33 H.P. Again, in considering the power required to drive each motor without machinery load, it must be borne in mind that the figures given not only cover the friction of the rotating shafts, couplings and pulleys, but also all losses, great or small, between the motor and switchboard, the instrument making the records being located in the engine room, and its connections being made at the switchboard. Again, consideration should be given to the fact that in some cases the larger size motor drives but a small amount of shafting, while in other cases a small motor may drive a very much larger amount of shafting than its larger neighbour. We find that the amount of power for the motor and shafting, including all losses, was 552·1 H.P. for the entire mill; but in some cases, as noted before, some machinery on motors numbered 1, 3, 4, 5, 8 and 13 was unavoidably in operation. Taking, then, the actual power that would have been required to operate all the machinery at the same time—namely, 2,597·33 H.P.—then the total percentage of the power required to drive the motor, shafting and line losses was 21·25 per cent.

Table II.—*Horse-powers, Full-load and No-load.*

Motor No.	Size motor H.P.	H.P. full-load.	H.P. no-load.	Per cent machinery on full-load.	Department.
1	150	119·6	26·0	89·76	Weft spinning.
2	150	123·5	32·5	100·0	
3	150	61·75	13·0	89·13	Fine roving.
4	150	58·5	13·0	82·63	
5	150	156·0	29·25	96·60	Draper looms.
6A	150	136·5	29·9	100·0	
6B	75	91·0	19·5	100·0	
7	150	135·20	28·60	100·0	Weft spinning.
8	150	126·10	26·0	85·15	
9	150	97·50	24·7	100·0	Rov'ng, draw'ng
10	150	183·90	26·0	100·0	Warp and weft spinning.
11	150	180·0	24·7	100·0	
12	150	120·9	36·4	100·0	Spooling, warping & draper looms.
13	150	132·6	39·0	95·51	
14	150	84·5	15·6	100·0	88 cards, 45in.
15	150	52·0	13·0	100·0	62 " "
16	150	139·1	26·0	100·0	Warp spinning
17	150	143·0	28·4	100·0	
18	150	148·2	26·0	100·0	
19	150	165·1	31·2	100·0	
20A	20	19·5	8·45	100·0	Openers.
20B	50	19·5	10·40	100·0	Cloth.
20C	30	26·0	10·0	100·0	Slashers.
21	150	110·5	19·5	100·0	Scutchers.
	3175	2580·45 *66·88	552·1	21·81	
		2597·33			

* This item, 66·88 H.P., is the estimate of power required for the machinery stopped during the test on motors 1, 3, 4, 5, 8, 13.

Table III.—*Spindles per Horse-power.*

Motor No.	Spindles per H.P. full-load, including friction of motor and shafting.	Spindles per H.P. full-load and deducting friction of motor and shaft.
WARP SPINNING.		
16	68·3	84·0
17	66·4	79·4
18	68·3	82·2
19	60·7	75·9
Average	65·92	80·12
WEFT SPINNING.		
1	75·0	96·0
2	81·2	110·2
7	78·1	99·0
8	71·3	90·0
Average	76·4	98·8

Table IV. gives the looms per horse-power under conditions as in Table III.

Table IV.—*Looms per Horse-power.*

Motor No.	Looms per H.P. full-load, including friction, load of motor and shafting.	Looms per H.P. full-load after deducting H.P. of motor and shafting.
5	3·0	3·68
6A	3·55	4·56
6B	3·56	4·53
12	3·68	5·26
13	3·70	5·23
Average of last four tests	3·62	4·87

Table V. gives the weights of the shafting, couplings and pulleys, as also a list of the number of the bearings. This Table is interesting from the fact that this mill has undoubtedly less weight of rotating material per spindle for its shafting, couplings, and pulleys than any mill that has ever been put in operation, that is complete in itself, and is a cloth producing mill. The weight per spindle is 8⅜lb. The diameter of the shafting in the scutching room is $2\frac{15}{16}$in. and $2\frac{11}{16}$in. In the card room it is $2\frac{7}{16}$in. and $2\frac{3}{16}$in. In the spinning room, $2\frac{15}{16}$in., and in the weaving room, $2\frac{7}{16}$ and $2\frac{15}{16}$in. The $2\frac{15}{16}$in. shafts are the receiving shafts for the belts from the motors, and also those where one shaft is belted from another, as in the case of the carding and weaving rooms. All the pulleys in the mill above 20in. diameter have wood rims. The bays of the mill are 10ft. 8in. from centre to centre.

Table V.—*Weights of Shaftings, Couplings and Pulleys.*

Motor No.	Shafting.	Coupling.	Pulleys.	Totals.	Number bearings and diameter.
1	1,912	354	2,660	4,926	11 × $2\frac{11}{16}$
2	1,912	354	2,660	4,926	11 × $2\frac{11}{16}$
3	6,018	920	5,970	12,908	38 × $2\frac{11}{16}$
4	6,018	920	5,970	12,908	38 × $2\frac{11}{16}$
5	18,080	3,750	14,467	36,297	100 × $2\frac{7}{16}$ — 15 × $2\frac{11}{16}$
6A	18,080	3,750	14,617	36,447	100 × $2\frac{7}{16}$ — 15 × $2\frac{11}{16}$
6B	11,219	2,250	8,928	22,397	60 × $2\frac{7}{16}$ — 9 × $2\frac{11}{16}$
7	2,105	442	2,800	5,347	12 × $2\frac{11}{16}$
8	2,105	442	2,800	5,347	12 × $2\frac{11}{16}$
9	10,228	1,380	9,424	21,032	78 × $2\frac{11}{16}$
10	1,893	354	2,840	5,087	11 × $2\frac{11}{16}$
11	1,893	454	2,840	5,087	11 × $2\frac{11}{16}$
12	23,613	4,631	14,725	42,969	129 × $2\frac{7}{16}$ — 18 × $2\frac{11}{16}$
13	23,408	4,742	17,147	45,296	136 × $2\frac{7}{16}$ — 21 × $2\frac{11}{16}$
14	17,758	2,328	5,784	25,870	37 × $2\frac{11}{16}$ — 8 × $2\frac{15}{16}$
15	6,882	1,746	4,562	13,190	30 × $2\frac{11}{16}$ — 8 × $2\frac{11}{16}$
16	1,918	354	2,880	5,152	11 × $2\frac{11}{16}$
17	1,918	354	2,880	5,152	11 × $2\frac{11}{16}$
18	1,898	354	3,040	5,292	11 × $2\frac{11}{16}$
19	1,898	354	3,040	5,292	11 × $2\frac{11}{16}$ — 5 × $5\frac{1}{2}$
20A	2,001	88	2,406	4,495	7 × $2\frac{11}{16}$ — 29 × $1\frac{15}{16}$
20B	2,899	230	1,273	4,402	6 × $2\frac{7}{16}$ — 12 × $2\frac{11}{16}$
20C	1,999	370	774	3,143	3 × $2\frac{11}{16}$ — 8 × $2\frac{7}{16}$
21	2,890	115	1,695	4,700	12 × $2\frac{11}{16}$ — 6 × $2\frac{11}{16}$
	179,545	30,936	136,182	337,643	
lb. per spindle	1·70	3·09	1·361	3·376	

The following shows some tests made on motor No. 17 operating warp spinning frames. There were 18 frames of 272 spindles, and 18 of 256 spindles, making a total of 9,400 spindles.

Per cent.	Frames.	Spindles.	H.P.	
Full-load	36	9,504	143·0	66·4 spindles per H.P.
83⅓	30	7,920	124·8	63·4 ,, ,,
66⅔	24	6,336	104·0	60·9 ,, ,,
50	18	4,752	84·5	56·2 ,, ,,
33⅓	12	3,168	61·75	51·3 ,, ,,
16⅔	6	1,584	42·25	37·5 ,, ,,
No. ,,	0	..	23·40	or 16$\frac{1}{3}$ per cent. of full-load.

Deducting 23·40 H.P. in each case above, we have for nett power of the frames the following:—

143·0 H.P. = 23·40 + 119·6 H.P. or 79·4 spindles per H.P.
124·8 ,, = 23·40 + 101·4 ,, 78·1 ,, ,,
104·0 ,, = 23·40 + 80·6 ,, 78·6 ,, ,,
84·5 ,, = 23·40 + 61·1 ,, 77·7 ,, ,,
61·75 ,, = 23·40 + 38·35 ,, 82·6 ,, ,,
42·25 ,, = 23·40 + 18·85 ,, 84·0 ,, ,,

The following shows some tests made on motor No. 1 and represents the power required for driving 38 ring weft spindles, 19 of 272 spindles and 19 of 256 spindles, equalling 10,032 spindles. In this test a portion of the spindles were not run during any part of the time.

Full load	8,976 spindles	119·6 H.P.	or	75·0 spindles per H.P.
83⅓ per cent.	7,392 ,,	104·0	,,	71·8 ,, ,,
70·6 ,,	6,336 ,,	93·6	,,	67·6 ,, ,,
52·9 ,,	4,752 ,,	75·4	,,	63·0 ,, ,,
35·3 ,,	3,168 ,,	58·5	,,	54·1 ,, ,,
17·6 ,,	1,584 ,,	41·6	,,	38·1 ,, ,,
0·0 ,,	— ,,	26·0	,,	21·7 per cent. of full load.

This percentage would have been materially reduced had the test for full-load included the full number of spindles—viz., 10,032. Taking out the 26 H.P. from each of the above amounts, then:—

119·0 H.P. = 26 + 93·6 H.P. or 96·0 spindles per H.P.
104·0 ,, = 26 + 78·0 ,, 94·8 ,, ,,
93·6 ,, = 26 + 67·6 ,, 93·7 ,, ,,
75·4 ,, = 26 + 49·4 ,, 96·1 ,, ,,
58·5 ,, = 26 + 32·5 ,, 99·3 ,, ,,
41·6 ,, = 26 + 15·6 ,, 101·5 ,, ,,

This frames are 2¾in. gauge, 1¾in ring, 9,058 revs. per min. spindles, running on No. 40½ weft. The motor is 150 H.P. directly connected.

The following shows some tests made on motor No. 14 driving 88 45in. revolving top cards. With the shafting, motor, &c., the H.P. was shown as follows:—

Full load, 88 cards, 84·5 H.P. or 0·96 H.P. per card.
Half ,, 44 ,, 48·75 ,, 1·10 ,, ,, cards.
No machinery 15·6 ,, 18·4 per cent. of the full load for all

Deducting the friction load of motor and shafting, &c., from the total loads, we have:—

84·5 H.P. = 15·6 H.P. + 68·9 H.P. .... 0·783 H.P. per card.
48·75 ,, = 15·6 ,, + 33·15 ,, ... 0·783 ,, ,,

The following shows some tests on motor No. 5 driving 420 40in. Draper looms on two-harness work, 16 of these looms being unavoidably stopped throughout the entire test. Practically one-half of these looms were on the first floor of the mill and one-half on the second floor, but all were driven from the lower floor. As has been noted, the 2,250 looms in the mill are driven by five motors, but only one motor is given below:—

With 466 looms H.P. required 156·0 or 3·0 looms per H.P.
345 ,, ,, 106·6 ,, 3·23 ,, ,,
223 ,, ,, 78·0 ,, 2·86 ,, ,,
120 ,, ,, 78·0 ,, 2·20 ,, ,,
No. ,, ,, 29·25 ,, 18·8 per cent. of full load.

Deducting the load of the motor and shafting from the load in each case above, we have:—

156·0 H.P. = 29·5 + 126·5 H.P. or 3·68 looms per H.P.
106·6 ,, = 29·5 + 77·1 ,, 4·47 ,, ,,
78·0 ,, = 29·5 + 48·5 ,, 4·60 ,, ,,
54·6 ,, = 29·5 + 25·1 ,, 4·78 ,, ,,

This motor was a belted one of 150 H.P. driving five lines of shafting, each line being 214ft. 4in. long, and $2\frac{7}{16}$in. diameter, except the lengths having the counter pulleys upon them. These are $2\frac{11}{16}$in. diameter. The total weight of shafting, couplings, and pulleys is 36,207lb. There are 100 bearings, $2\frac{7}{16}$in. diameter, and 15 of $2\frac{11}{16}$in. diameter. This test was made on July 12, 1904. The temperature in the room was 88deg. and outside the mill 82·6deg. The speed of the shafting was 300 revs. per min. and the speed of the looms 163 revs. per min. On the tests of the other motors operating looms, after deducting the powers required for the motors and shafting:—

Motor 6A ran 4·71 looms per H.P.
,, 6B ,, 4·93 ,,
,, 12 ,, 4·92 ,,
,, 13 ,, 5·16 ,,

A point which, to the author, seems of the greatest importance, and upon which very few figures are available, is the actual cost for power at the present time in modern mechanically-driven mills. The author has collected a considerable amount of information on this subject, and though the figures may at first seem somewhat startling, there is no doubt as to their approximate accuracy. Cotton manufacturers nearly always state their power costs in terms of indicated horse-power, which, naturally, is the most convenient unit for them to use, and sometimes reckon in terms of the I.H.P.-hour, and sometimes the I.H.P.-year. The average of the results which the author has come across show that in a modern spinning mill of good size it may generally be taken that the generation costs per I.H.P.-hour upon the basis of calculation mentioned below, in the case of a mill running full time, amounts to about one-twelfth of a penny, or, say, approximately, about £1 per I.H.P.-year. Repairs, interest and depreciation being taken at about 10 per cent., the total cost per I.H.P.-year comes out to something of the order of £2. 5s. to £2. 10s. In the case of a weaving shed, which is normally a smaller undertaking with less engine power, and in which, of course, the proportion of the standing charges per I.H.P. comes higher, the cost may be taken as between £2. 10s. and £3. 5s. per I.H.P.-year. The figures represent, of course, remarkably good results, and will take a great deal of beating; in fact, it is obvious that upon the question of economy only it would be very difficult to improve upon the figures which a modern cotton mill can show. The amount allowed for interest and depreciation of 10 per cent. on the steam plant may be criticised, and it may at once be said that great difficulty exists in obtaining exact figures as to the allowances made by the different mills, and it appears to depend, in some cases at all events, on the requirements of the balance-sheet for a given year. Many of the mill owners, however, consider 10 per cent. interest and depreciation allowance on their steam plant as too high, and point out that in some cases engines have been running for periods of 30 or 40 years without any serious breakdown. This may be the case, of course, with old, slow-running low-pressure engines, but with the much higher piston speed now adopted and the higher pressures of working, the man who anticipates the effective life of his plant to be anything of this order is exceedingly sanguine. It is customary with a privately-owned electrical installation to allow 5 per cent. interest and 7½ or 10 per cent. depreciation on the plant, and the author considers that in order to bring out the costs on the same basis that the same allowance ought to be made in the case of mechanically-driven plant.

A point of great importance in arriving at the power costs is the consideration of what may be termed the working load-factor—that is to say, the ratio of the average power demanded to the maximum. It is customary among some mill managers to assume that the stated I.H.P. of the engine represents the actual average load, and to calculate their estimated I.H.P. hours from this figure. As a matter of fact, owing to a variety of causes, including the percentage of machinery standing idle at a given time, the class of work being put through and the state of the weather, the actual load both in a spinning mill and in a weaving shed varies considerably from time to time, and the working load-factor is generally something considerably below 100 per cent. There are very few figures available for determining this quantity, but the author has been able, through the courtesy of the British Thomson-Houston Co., to publish some diagrams which show the variations in load in a linen-thread spinning mill, both on the engine, as shown by the indicator diagrams, and also on the generator, as shown by a recording wattmeter, and from these it is apparent that the average load-factor in this case is something of the order of about 90 per cent. In this case, of course, the mill, being electrically driven, the transmission losses are small; but, as pointed out by Mr. Woodhouse in a Paper about a month ago, the greater the steady transmission losses the higher the apparent working load factor. The conditions in a linen-thread spinning mill are not quite the same as in the case of a cotton mill, but the author anticipates that the working load-factor would be no better in the case of a cotton mill, and when more accurate data are available, this fact would have to be taken into account in calculating the cost per unit. It is unlikely that the load-factor represents anything better than 90 per cent., and 85 per cent. is probably more usual. A considerable number of calculations which have been gone into at various times show that a properly-arranged mill generating plant of fair size in this country should be able to produce energy, after allowing 5 per cent. interest and 10 per cent. depreciation in the capital cost of the plant, at about 0·3d. to 0·35d. per unit.

A matter upon which the author considers there should be room for profitable discussion is that of the advisability of mills taking power from a large power station. In America the tendency, where mills are fairly closely grouped, is certainly towards the supply being given from one large station. It is obvious from the figures given before that a cotton mill in this country is producing its own power very cheaply, and the question which becomes of importance is, can a large power station, allowing for the capital charges on its mains, supply energy at sufficiently low rates to make it worth the while of a mill company to take power from it? It certainly would appear as if, in a district, say, like Bolton and the surrounding townships, or Oldham, it should be possible for a very large generating station to be able to work more cheaply than individual mill plants can, and in consequence to be able to supply the mills with energy. As, of course, the mills are only running during the day time the load-factor on the station from the mills alone would not be very high; but, if, by the offer of special terms, other manufacturers could be induced to take power when the mills were stopped, such a station should be able to produce at extremely low rates per unit. It might be mentioned in this connection that arrangements have been made with a number of the jute factories in Dundee whereby they undertake to take energy from a power company, whose station it is proposed to build, and which station, it is anticipated, will eventually supply the whole of the power for all the jute factories throughout the district. The advantages of the centralisation of power such as suggested are, of course, obvious, particularly in the reduction of the capital cost per spindle of the mill, which would enable the manufacturer to make the mill itself larger; the reduction of the chance of stoppage through breakdown to an absolute minimum; the doing away with the need of the manager looking after the power plant, and freeing him from anxiety about fluctuations in the price of fuel, strikes, &c. If the mill were able to purchase current at a price as low as it could generate it, the question would have the very serious consideration of all persons building new mills or having to consider the question of installing new plant.

TRAMWAY OVERHEAD EQUIPMENT MATERIALS.*

BY H. M. SAYERS.

The first mechanical condition to be satisfied in a satisfactory overhead equipment is evidently that of safe and stable support. The trolley wire has to resist, in addition to the stresses on a suspended wire, the repeated upward thrust of the trolley pole and the friction of the trolley wheel. The attachments are exposed to reversed stresses of the nature of blows in both vertical and horizontal directions, and the wires being necessarily carried at a distance of several feet from the poles any unbalanced longitudinal stress produces considerable couples upon the supporting structure. The effects of wind and snow are of relatively small importance as regards trolley wires, but must be given full weight in the erection of guard wires. It is easy to show that there is no electrical necessity for using any wire larger than No. 0 S.W.G. (0·324in. diameter), where the trolley wire is fed as usual from underground feeders at half-mile intervals, unless the traffic is extremely heavy. Heavy traffic, especially over curves of short radius, may afford a reason for the use of larger wire in order to increase the life and remove the risk of breakage on account of heavy mechanical wear. It is probable that where the conditions are very severe it is better to employ one of the harder bronze alloys than a copper wire of larger size. One reason for this is that the wearing qualities of hard-drawn copper wire are not directly proportional to its weight, the hardness diminishing from circumference to centre. This is well shown by the fact that the Post Office specification for such sizes as Nos. 12 and 14 calls for a breaking strain of 28 tons per square inch, whilst the usual trolley wire specification is equal to 22 tons, over 20 per cent. less. The effective thickness of the hard skin varies with the details of the manufacturing process, and very little seems to be known about the subject by users; but, from the behaviour of trolley wire under long wear, it seems probable that the hardness diminishes gradually and, up to such sizes as No. 0, a considerable thickness is appreciably hardened. It is also possible that the rolling of the trolley wheel has a further hardening effect, but where the wheel rubs or grinds hard abrasion removes the hard exterior and the softer metal inside is soon reached. On these facts it is clear that a material that is hard right through should be preferred. Very little experience with these bronze wires has been made public and, as some are brittle and some pit badly under arcing, they should not be extensively adopted without trial. They are all of higher electrical resistance than copper, and therefore require feeding at shorter intervals if the traffic is heavy. Very high tensile strengths should be regarded with suspicion as probably indicative of brittleness, and bending and falling weight tests should be made in such cases.

The next point in order after the size of the wire is its position in relation to the track; the choice lies between side and central wires. Assuming that centre wiring, which gives the best working, is adopted, the approximate position of the wire is given at once by the centre lines of the tracks, as shown on the permanent way plans, or as actually laid. There are sometimes material differences between track plans and execution, and it is often wasted labour to plan out overhead work in full detail from construction plans. It is far better to let the permanent-way construction get a good long start of the overhead, then pole positions can be laid out from the actual track centres, and the overhead work can be carried through continuously, and with the certainty of correct position. As overhead work does not take more than a fifth of the time required for track construction, there need be no difficulty in arranging for practically simultaneous completion of the two. Although exact positions cannot be taken from permanent-way plans, the number and size of poles and the general arrangements can be got out sufficiently well to order all necessary materials in good time. The maximum distance apart of supports is settled by the Board of Trade regulations at 40 yards; on straight lengths there is no reason for diminishing this, and it is therefore taken as the standard. But at curves, junctions and termini the positions of poles have to be carefully considered, and so arranged as to take the longitudinal pulls of the straight lengths or tangents as directly as possible, to hold the trolley wire closely and firmly to the required curves, and to hold "special work" to its correct place. There is often but a limited choice for pole positions, especially at junctions where streets cross, and in all such cases an accurate large scale survey should be made, the trolley wire and special work laid down on it, and the best arrangement of span and pull-off wires that will suit the possible pole positions worked out. The labour of drawing several alternatives will be well repaid by the workmanlike and satisfying appearance of the completed work, and by the absence of working troubles.

One essential point at these places is to anchor the straight lengths as directly as possible to a heavy pole. If such a pole can be placed at the intersection of the tangents it can take both anchor wires. The ends of the curves should also be anchored in the usual way. This anchoring is very important, because it makes the straight lengths and the curve-work mutually independent, the span wires are not distressfully pulled out of line, and the pull-off wires intended to shape the curve have not to take indefinite components of the pull of the straight lengths. Most important of all, if any accident happens to the overhead work on either the curve or one of the straight lengths, its effects will be stopped by the anchoring. Anchoring is also necessary at section insulators, and it is advisable to anchor every quarter of a mile, even on a perfectly straight line, in order to localise the effect of a trolley wire breaking. Termini, curves and junctions are the keystones of the whole structure, and when the pole positions at these places have been worked out, the tangents between have only to be divided up into equal lengths of as near 40yds. as circumstances permit, but never exceeding that distance. Side poles with brackets can rarely be used to carry wires central to the track as the bracket-arms would be unduly long; the choice lies between span wires and central poles. Where there is room central poles have certain advantages, especially that of neat or even ornamental appearance, and their cost is somewhat less than that of span wire construction. But as the clearway between the tracks has to be from 2ft. to 2ft. 6in. wider to give the regulation clearance between cars and standards, the total cost to the tramway undertaking is rather increased than diminished. They also have to be lighted sometimes at the tramway expense. On even slight

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* Paper read before the Tramways and Light Railways Association last Friday, slightly abridged.

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curves centre poles are insufficient as there is no means of "pulling off" the outside wire, and, if side poles are added for that purpose, they look very odd. Section insulators should be kept out of the junction special work, and, where this is complex or important, it is best to insulate it on all sides and feed it separately. Section insulators should not be put on curves or on steep gradients.

If the central wire has been decided upon span-wire construction will be the prevailing type, excepting where central poles may be possible and preferred. It is just possible in some cases to carry a central wire from a side pole and bracket-arm. In the case of a double line these will be required on each side of the street, and it is hard to see what is gained in appearance by the substitution of two sets of bracket-arms for one set of span wires. Bracket-arm poles should always be on the outside or convex side of the road.

Generally speaking three grades of strength of poles will suffice. The Engineering Standards committee has recently issued a standard specification for tubular tramway poles in which the three strengths are classed as light, medium and heavy, and the strength defined by the loads needed to produce a temporary deflection of 6in. and a permanent set not exceeding ½in. under conditions fairly representing the working loads. The temporary deflection load may be regarded as the maximum safe working load, and the permanent set load as marking the commencement of danger by deformation. The loads are as follows :—

Class of pole.	Load for temporary deflection of 6in.	Load for permanent set not exceeding ½in.
Light.............	750lb.	1,000lb.
Medium	1,250lb.	1,750lb.
Heavy	2,000lb.	2,500lb.

Occasionally heavier poles than the standard "heavy" class may be needed, but these occasions are rare, and may often be avoided by dividing the load between two "heavy" poles. The choice as between sectional and taper poles is mainly one of taste and price. At present, for equivalent mechanical tests, taper poles to standard dimensions are dearer than sectional poles and somewhat heavier. The absence of the swaged joints is put forward as a mechanical advantage, but it is very rarely found in practice that a sectional pole fails at the joints. If taper poles are used it is desirable to have them solid rolled, as a lap weld the whole length of the pole may prove a line of weakness. Solid rolled tube is an improvement in sectional poles, but there is not a great risk of poor welds in these comparatively short lengths, and if the joints are set at 120deg., in plan, as they should be, the pole as a whole will show no line of weakness. Wooden poles have been very little used in this country, but are somewhat extensively employed in the United States and some Continental countries. Wooden poles should be chosen to give the same temporary deflection as would be called for in steel poles. The first cost will generally be lower than for steel poles, but the ultimate economy is somewhat doubtful and should be considered with full knowledge of the special conditions, especially the probable life of the wooden pole in the local soil and climate. In any case, the poles should be creosoted to the Post Office specification, and they should not be set in concrete. Lattice poles can be purchased, and are sometimes used on the Continent. They are said to be cheaper than tubular poles of equal strength, but are very ugly, and it is probable that the painting necessary to preserve them from rapid corrosion in this climate will neutralise the initial saving.

The type, positions and sizes of poles being settled, the intermediate supports between poles and wires claim attention. The choice lies between span-wire and bracket arms, but it is frequently necessary to use both constructions in different parts of a tramway network. If the central wire has been chosen span-wire work will generally predominate, but there are many exceptions, especially on systems which are mainly composed of single lines with turn-outs. Where bracket arms are employed it will be wise to use the short span-wire arrangement generally known as the "bowstring." The older construction, in which the hanger is clamped directly to the bracket arm, is probably obsolete. The rigidity of the attachment is a serious evil, imposing upon the hangers and the trolley boom a considerable blow, detrimental to every part, especially to the insulation of the hanger and clamp. It may further be said that it is not possible to provide a satisfactory permanent insulating sleeve for the clamp in this climate, all materials tried, so far, failing in a comparatively short time. The "bowstring" suspension is an improvement, but it is still far more rigid than the span-wire, and therefore, results in greater wear of wire and trolley wheels, and in deterioration of insulators, besides leading to de-wiring at speeds much lower than can be run with safety on span-wire work. This detrimental effect of rigid or semi-rigid attachments is sometimes overlooked. The trolley wheel of a moving car presses the trolley wire upwards with a force which usually equals or exceeds half the weight of the span of wire. At the centre of a span it will therefore lift the wire considerably, possibly to the height of the points of support; from the centre onwards it is, however, depressed with increasing rapidity as the stiffness of the wire comes into play, and will be below the level of the ear some distance before it arrives there. It therefore meets the rigid ear while rising rapidly, and delivers a blow the force of which is the product of the effective mass of the whole boom and head, and the square of its upward velocity. At some speed the rebound will take the wheel flanges clear of the ear and, if there is any side pressure, de-wiring results. After passing the ear the wheel at first descends, but soon commences to rise again up to about the middle of the next span. Its path is therefore a wave-like one with a high crest in the middle of each span and a small steep one at each ear. Besides the effect of the blow upon the ear, the insulating materials, and the trolley wheel and boom, the wire is worn by arcing and damaged by bending. It is therefore not extraordinary that failures of insulators and breakages of wire at ears are more common on bracket than on span-wire work. If bracket-arm construction is used the bowstring should be made as long as practicable in order to get the maximum flexibility. The flexibility of a span-wire construction greatly reduces the blow upon the ears, as the span-wire also rises to the trolley pressure, and the ear more readily aligns itself with the wire but, at high speeds, the effect is quite perceptible and, for railway speeds, the longitudinal suspending wire carrying the trolley wire by hangers at short distances and so approximating to a system with a constant vertical rigidity from point to point is essential.

Span, bowstring, and pull-off wires are generally of galvanised steel, but in many towns this material has but a short life on account of atmospheric pollution and, in such cases, phosphor or silicon-bronze wire should be used. This applies equally to guard wires and their supports; whichever is used the metal parts of the suspension fittings should be of similar metal. There is no means of preventing galvanic corrosion where dissimilar metals are in contact, and such contact should be avoided. The use of iron insulated bolts screwed into brass ears is almost universal, and frequent trouble results at this point. Gun-metal bolts would be better, but there is some difficulty in getting them made.

The size of span wire should not be less than 7/14 S.W.G. There seems no reason for using larger wire, but such use is quite common even up to the monstrosity of 19/12. This wire should have a breaking point equal to from 35 to 40 tons per square inch after stranding; the galvanising should be carefully examined and tested in the manner prescribed by the Post Office. Galvanising that is originally defective, or that cracks and peels off in erecting, is useless, the wire will rust through at the unprotected points in a brief period. To secure the wire at the poles it should be laid around a horse-collar thimble of size proportioned to the size of strand, and properly bound with galvanised charcoal wire—not twisted up. Better than the thimble is a shackle or reel of porcelain with a central hole to take the strap bolt. Porcelain is a far better, more durable, and cheaper insulator than any of the compounds used in turnbuckles, globes, strains, &c. There is no need to provide any tension adjustment at the ends of span wires—insulated turnbuckles, Brooklyn strains, &c., are quite unnecessary, and represent wasted money. With a dynamometer on the drawvice, or by the measurement of the sag from the ground, span wires can be put up with the greatest uniformity, and the certainty that the trolley wires will be carried at their correct level. This level can be checked, if desired, by loading the span wires at the correct points with weights representing the working load, but this only needs to be done once for each width of street.

(To be concluded.)

IMPROVED COMPENSATED SPEED INDICATOR.

Many attempts have been made in the past to provide motor vehicle builders and owners with a reliable and easily managed speed indicator. The difficulties in the way of the extensive adoption of these devices have been high cost, expensive maintenance, or intricacy of movement. Messrs. S. Smith & Son, of 9, Strand, London, are noted all the world over for their watch and clock movements, and it is not, therefore, surprising that they have succeeded where others have failed with speed indicators, which, to be of real service, require all the nicety of design of a watch. The dial and its actuating mechanism is, of course, the prime factor in the accuracy of a speed-recording instrument, and here it is where the vast experience of Messrs. Smith & Son has served them in devising a thoroughly satisfactory piece of apparatus, easily attachable to all classes of motor vehicles by any chauffeur of average intelligence.

We illustrate herewith the Smith speed indicator, Fig. 1 showing the dial and Fig. 2 the actuating mechanism at the wheel. This mechanism consists essentially of a ring B, screwed to the wheel of the car, and of a disc D which is pressed against B by a spring (totally enclosed, and therefore not visible in Fig. 2). Disc D is provided at its periphery with a layer of india rubber, which not only ensures silent running, but also serves the very useful purpose of increasing the friction between B and D. As the same speed indicating mechanism (Fig. 1) is used for all sizes of car wheels, means must be provided for altering the ratio of gear between B and D to meet the various conditions. These means consist in changing the diameters of B or D or of both. It is generally found possible to obtain the proper ratio of transmission by changing D only. When the car is in motion the disc D is rotated by friction and transmits its rotation by means of a flexible steel wire to the speed indicator proper (Fig. 1) which may be placed in any position convenient to the driver. The steel wire is enclosed in a flexible metal tube, the ends of which are seen in the two illustrations. Within the gun-metal box of the speed indicator (Fig. 1) there is a small centrifugal regulator, which is driven from the steel wire above referred to through a train of toothed wheels. The axle of this centrifugal device is horizontal, and consists of three parts, which telescope within each other. There are also three springs of different size, which successively come into action as the speed increases, the weakest spring being compressed first. After a certain speed has been attained, the weakest spring is prevented by a suitable stop from being compressed further, and the next size of spring comes into action. After a further increase of speed, the third spring is also used. The three-spring device just described forms the special feature of Messrs. Smith & Son's instrument, and its advantage lies in the fact that it permits of an open scale, not cramped at one end as is often the case. The movement of the centrifugal regulator is transmitted to the dial hand by a grooved sleeve and a pinion, and any backlash is taken up by a spiral spring, which continually tends to move the hand back to zero. The latest form of indicator is fitted with a mileage register up to 10,000 and a trip recorder which can be set to zero at will. The indicating hand is (as shown) placed in the centre of the dial, and indicates in the standard design all speeds from 10 to 60 miles per hour. Lubrication is simple, and the indicating hand is unaffected by vibration. Instructions for fitting are issued, and these are explained by the lettering on Fig. 2 :—

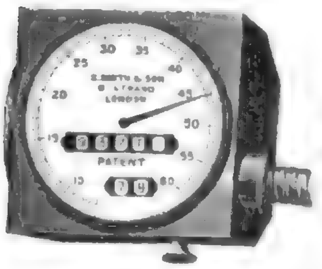


FIG. 1.

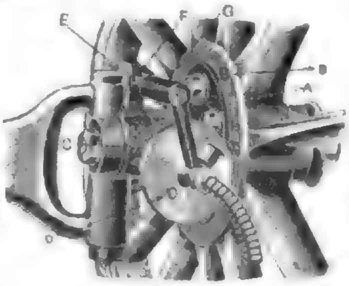


FIG. 2.

Screw the brass ring B close to inside plate (A) of front offside wheel, screw to wheel in at least six of spokes and countersink screws. Tap two $\frac{1}{16}$in. holes (to coincide with screw holes in bracket C) in the back of axle bracket, as shown in illustration, and screw bracket C in such a position as to cause the pulley D to run in the centre of fibre ring B—*i.e.*, the pulley D should be central with the axle. Adjust the pulley to centre of fibre ring B by loosening nut E and moving rod F to required position. Before tightening up nut E turn spindle F towards the wheel until the spring in box G gives the necessary tension to the pulley D on fibre ring. Attach flexible shafting and cover, and place indicator in required position. Fix case of indicator by means of bolts supplied. See that the flexible tubing is not bent at too acute an angle, and fix to car with straps.

The indicator has been in satisfactory practical work for some time, one car out of about 60 fitted with this attachment has run over 3,000 miles without any injury whatever to the indicator, which is completely dust proof. The demand for these indicators, which has come from the highest in the land, is already in excess of Messrs. Smith & Son's present capability of supply, and this before the new apparatus has been seriously placed upon the market. A working model of the apparatus is on show at 9, Strand, London, W.C. Numerous important testimonials as to the reliability of the indicator have already been received.

These indicators are now being made for use on tramcars and trains, and can be applied for the speed indicating of high-speed vehicles of all kinds. We understand that Messrs. Smith & Son are in negotiation with the Metropolitan Railway Co. for supplying speed indicators for their new electric trains.

A 6,000 h.p. Gas Engine.—According to the *Western Electrician* of Chicago, the California Gas and Electric Corporation, San Francisco, Cal., has placed an order with the Crocker-Wheeler Co. for three 4,000kw., three-phase, 13,200-volt, 25-cycle, 83-revolution, revolving-field alternators, to be driven by 6,000 H.P. gas engines built by the Snow Engine Co. The sets are to furnish reserve capacity for working all the street railways in San Francisco and vicinity.

DINNER TO MR. H. A. C. SAUNDERS.

On his retirement from the position as Electrician-in-Chief of the Eastern and Associated Telegraph Companies, and to celebrate his 50 years' connection with submarine telegraphy, Mr. H. A C. Saunders was entertained at dinner by his friends and colleagues at the Trocadero Restaurant, Piccadilly, on Wednesday evening. The occasion was also availed of to present him with a handsome testimonial, consisting of a tea tray, sets of waiters and fruit dishes, hot water kettle, pair of candlesticks, clock, and other pieces of silver, together with a model in copper of Cleopatra's Needle, all bearing inscriptions commemorative of the function. A choice pair of diamond and pearl earrings was subscribed for Mrs Saunders. The card inviting Mr. Saunders to the dinner was specially designed and beautifully decorated, above the invitation being a representation, hand-painted, of four cable ships, including the celebrated "Great Eastern" and the "Patrol," the latter being the latest of the companies' vessels.

The chair was taken by Sir J. Denison-Pender, K.C.M.G., who had on his immediate right the guest of the evening, and the company included Rear-Admiral Sir W. J. Wharton, K.C.B., Sir John Wolfe Barry, K.C.B., Mr. A. Siemens (President of the Institution of Electrical Engineers), the Hon. George Peel, the Hon. A. G. Brodrick, Mr. F. Alex. Johnston, Mr. Kenneth Anderson, Mr. John Ardron, Mr. G. Von Chauvin, Mr. John Gavey, C.B., Mr. D. H. Goodsall, Dr. Ducat, Mr. R. Kaye Gray, Mr. C. W. Adye, Mr. H. Ansell, Mr. J. W. Barnes, Mr. W. C. Barnes, Mr. Charles Bright, Mr. F. Broadbent, Mr. A. C. Brown, Mr. R. T. Brown, Mr. S. G. Brown, Mr. W. H. Burman, Mr. P. Burrell, Mr. J. Cambrook, Mr. T. Clark, Mr. S. Collett, Mr. F. Dawes, Mr. J. C. Denison-Pender, Mr. A. De Sauty, Mr. E. Dickens, Mr. W. Dover, Mr. G. Draper, Mr. G. Dudley, Mr. W. J. Finnis, Mr. F. Fischer, Mr. A. Fraser, Mr. A. Y. Gahagan, Mr. D. Gair, Mr. A. Gardner, Mr. J. I. Geddes, Mr. G. Gibson, Mr. Jas. Gibb, Mr. E. W. Glover, Mr. S. S. Goodman, Mr. W. P. Granville, Mr. H. Gurney, Mr. C. Haines, Mr. J. F. Harrap, Mr. A. C. Hesse, Mr. H. F. Hesse, Mr. A. W. Hibberdine, Mr. R. L. Hibberdine, Mr. F. H. W. Higgins, Mr. W. W. Howell, Mr. B. S. Hunt, Mr. P. Isaac, Mr. G. C. Jack, Mr. H. Jamieson, Mr. W. Claude Johnson, Mr. W. Judd, Mr. W. C. Langdon, Mr. R. London, Mr. F. R. Lucas, Mr. W. R. Lyne, Mr. B. D. Mellor, Mr. G. R. Neilson, Mr. G. B. Osborn, Capt. G. Pattison, Mr. E. D. Payne, Mr. H. W. Pinnell, Mr. H. E. Plank, Mr. H. F. Porter, Mr. A. E. Powell, Mr. F. T. Preddle, Mr. F. C. Raphael, Mr. J. Reid, Mr. G. F. Rogers, Mr. F. Ryan, Mr. Horace Saunders, Mr. H. St. L. Smith, Mr. W. O. Smith, Mr. W. S. Smith, Mr. J. H. Stephens, Mr. C. E. Stuart, Mr. H. W. Sullivan, Mr. F. A. Taylor, Mr. L. P. Trenaman, Mr. G. Tucker, Mr. J. Tucker, Mr. A. A. Wallet, Mr. F. Ward, Mr. A. C. M. Weaver, Mr. H. D. Wilkinson, Mr. J. E. Young, Mr. J. G. Youngson. The vice-chairs were occupied by Mr. F. E. Hesse, Mr. A. R. Hardie, Mr. W. Hibberdine, Mr. T. A. Bullock, and Mr. E. Steer Hodson.

After the loyal toasts had been duly honoured.

The CHAIRMAN proposed, amid cheers, "The Guest of the Evening," and prefaced his remarks by reading telegrams from Admiral Sir Leopold Heath (who the chairman remarked was in his 84th or 85th year, and whose age alone prevented him from being present), from Mr. F. C. C. Nielsen (Great Northern Telegraph Co., unavoidably absent), from Mr. H. V. Browne (Barcelona), from Mr. W. Bolton (Liverpool), and from Prof. A. Jamieson. Resuming, the Chairman said he felt that his position on that occasion ought to have been taken by Sir John Wolfe Barry, but Sir John was contemplating a trip and a short holiday, and he might not have been able to be with them. Sir John was also suffering at the time from an attack of influenza, from which they were all glad to see he had recovered, and was able to be with them after all. When the committee asked him (the speaker) to preside, it was not without feelings of sincere regret that he accepted the honour conferred upon him —regret that the time had arrived when Mr. Saunders had found it necessary, although more active and as energetic as many a man 20 years his junior, to consider the question of his retirement. He knew perfectly well that what had influenced their friend in coming to his final decision was to make way for his juniors. They were met to honour one who had taken a very considerable part in the development of submarine cables over a period exceeding 50 years (cheers). He would not himself detain the company because Mr. Saunders would, he was sure, recall to them incidents connected with the enterprise which all present were associated with—incidents which would interest them very greatly. He would, however, give a brief outline of the career of their guest, and call attention to certain points which Mr. Saunders' modesty would prevent him from referring to. They had to go back many years to start with their friend's first introduction to cable enterprise, for it was in 1854 that he was called upon by Mr. Whitehouse to assist him in designing an instrument which would work the then proposed Atlantic telegraph cable. Shortly afterwards Mr. Saunders came to London, and was placed in charge of a workshop established by Mr. Whitehouse and Mr. Brett, who was also well known to them, and they were engaged in working out what he believed was called "the Roman Type Printer." In 1857 Mr. Whitehouse was appointed electrician-in-chief to the Atlantic Cable Co., which was also joined by Mr. Saunders, and it was in this year, too, that the latter first saw a cable laid in Atlantic waters. But these were the very early days, and after some 300 or 400 miles of the cable had been laid, the ship—the "Niagara"—returned to Plymouth, and he believed that the cable was lost and never recovered. In 1858 Mr. Saunders found himself—in succession to Mr. de Sauty—in Newfoundland, where his duty was to organise a station; but he had again to suffer disappointment, for the cable having been laid and landed, he watched and watched for the signals which never came. Two years later Mr. Saunders entered the service of Messrs. Glass and Elliott, the famous firm of cable makers and layers, now known all over the world as the Telegraph Construction and Maintenance Co. For the next four years their friend was occupied in laying and repairing cables in shallow waters in the Mediterranean; and he (the speaker) believed that at that time there was a great deal more repairing than laying (laughter). In 1865 Mr. Saunders returned to his first love, the Atlantic, and in that year he went out in an expedition on the "Great Eastern," under the command of the late Sir James Anderson. This particular expedition proved—he thought he might say—the turning point in submarine telegraphy, as far as its commercial side was concerned, because the cable when it was lost was lifted. It was true that it was not lifted very far, but what was done showed that cables could be successfully raised from the deep. This fact made the financiers come forward. In 1870 the Telegraph Construction & Maintenance Co. lost the services of Mr. Saunders, who took a position with the British India Co., which was one of the companies that formed later on the Eastern Telegraph Co. Five years afterwards—or just 30 years ago—their guest was appointed as head of the electrical staff of the Eastern Company. Subsequently, when the Associated Companies became practically one undertaking as far as management was concerned, Mr. Saunders took charge of all the work in connection with his position. For 30 years, therefore, to the end of December last, their friend had the full control of the electrical establishment of their companies, and they knew how well he had done his work and of the success which had attended their enterprise (cheers). He (the chairman) had given them but a very brief history of their guest's career, as he had not wished to detain them unduly. He might have said a great deal more, but his association with Mr. Saunders, although a long one, had been entirely confined to the years in which their friend had been associated exclusively with their companies; and he was sure that Mr. Saunders would agree with him that with the gentlemen who had honoured them that night as their guests—all men who had made their mark in the cable world—it would ill befit him to dwell upon any special work which had been done by the companies with which they were associated. There was, however, one fact which he felt he must mention, as it was only fair to Mr. Saunders to do so—namely, that when their guest first took charge of the electrical department in 1875, the company owned barely 2,000 miles of cable (he believed the exact length was 1,700 miles), whereas when he resigned his charge, a few weeks ago, the Associated Companies had over 100,000 knots of cable laid—knots, not miles (cheers). As they could all understand, Mr. Saunders must feel deeply the severance of his active connection with the companies which he had served so ably and so long, but he was very fond of painting and extremely fond of studying Egyptian history, and these and his other tastes would occupy him in his retirement, which would also be rendered easier for him by the knowledge that the reins which he had held so long were to be handed over to Mr. Walter Judd, who had had great experience in many parts of the world, both in connection with the electrical and commercial sides of the company's business, and who for some years had acted as second in command to their friend. He was sure that all present would join him in hoping that Mr. Saunders, after his long and busy life, would enjoy his well-earned retirement with Mrs. Saunders (cheers). He might also say that when Mr. Saunders retired the directors made arrangements by which he could feel that he had the right to attend at the offices in connection with the electrical part of their work (cheers).

The Chairman then presented Mr. Saunders with the testimonial above referred to.

Mr. WALTER JUDD then expressed the regret of the members of the electrical department, over which Mr. Saunders had presided so long, at that gentleman's retirement, and said that this feeling was held by no one more strongly than by himself. They all felt that they had lost a considerate chief and a kind friend (cheers). Their numbers had laterly increased very considerably, and they proposed later on to ask Mr. Saunders to accept an album containing the portraits of those working at home and abroad. Their friend might rest assured that whenever he opened the album he would see the faces of none but the sincerest friends who would remember him in his retirement with the kindest and most affectionate regard (cheers).

The toast was then drunk with musical honours.

Mr. SAUNDERS, who, in rising to respond, was received with prolonged cheers, expressed his heartiest thanks for the great kindness which had been shown to him. He thanked Sir John Denison-Pender for presiding, and remarked that their chairman had for the last 12 years been in almost daily communication with him, and therefore knew his work. The fact that he was presiding on that occasion might, he thought, be regarded by himself as an indication that he had done his duty (cheers). Of course, on such an occasion as that, regret was felt by the man who had joined the ranks of the veterans, but his own regret had been removed by the kindness of Sir John Denison-Pender in having taken the chair and by the high compliment which Sir John Wolfe Barry and the Directors of the Associated Companies had shown him in still retaining his services as consulting electrician (cheers). He afterwards cordially thanked the chairman for the kind manner in which he had proposed the toast and the company generally for the cordiality with which they had drunk it. In regard to his relation to his colleagues he doubted whether there was another large company in the City where the heads of the departments worked so harmoniously together, and the remark applied not only to the Eastern but also to the Allied Companies. The staff ashore and afloat had always been on the best of terms, and as regarded the electrical department the members had been loyal to him as their immediate chief, they had done their duty in the interests of the service, and he was sure that they would work as well with Mr. Judd, his able successor (cheers). Mr. Saunders then referred to many interesting incidents in what he termed the "romantic period of submarine telegraphy," touching on the leading features of his connection with the enterprise, and alluding to many of those who had been prominently identified with its inception and development. In conclusion, he again cordially thanked those who had honoured him on that occasion, and remarked that he had been treated with the utmost kindness by everyone concerned. In one respect he might say that he was like the Gothic chief in that he had no enemies (cheers). But whereas the Gothic chief was in that position because he had killed all his enemies; he himself had never had any (laughter and renewed cheers)

Sir J. WOLFE BARRY afterwards proposed "Electrical Engineering." He remarked that if Sir John Denison-Pender were not presiding, he would himself have liked to do so, in order to do honour to Mr. Saunders; but from the outset he had felt that there was no one so fit to express the sentiments of all those who were associated with the cable companies as their chairman of that evening (cheers). He joined heartily in their congratulations to Mr. Saunders, and wished him every happiness in the retirement which he had so well earned. With respect to the toast which had been entrusted to him, it was one of the highest importance. It was a remarkable feeling which came across one, when reflecting on electrical engineering, to think of how young the whole business was. It all seemed to have been crowded, as far as they knew, in a few decades of the 19th century, so far as regarded the application of electrical knowledge to the use and convenience of mankind. Those, however, who remembered the early stages of electricity, when they contemplated what had been done, could not help feeling how old they were. Electricity had been of inestimable advantage in promoting the convenience, the comfort, and the happiness generally of mankind; and looking at it from a national point of view, it was impossible to exaggerate the influence it had had in removing misunderstandings between nations and in promoting peace and goodwill throughout the world (cheers). How many wars in former times might have been prevented by the clearing up of mistakes and misunderstandings, which it was now possible to do, but in the past was impossible when communications from one place to another took weeks and even months to effect. It afforded him the utmost pleasure to couple with the toast the name of Mr. Alexander Siemens (cheers)—a name so well known in all electrical matters that it was quite a household word. He referred to the importance of the discoveries of the late Sir William Siemens and to the great services rendered by him to England, the country of his adoption. In Germany, too, the name of Siemens was one of the most prominent in connection with electrical matters. Their friend, Mr. Alexander Siemens, was a most worthy representative of a most worthy family. Before sitting down, he desired to add that it had been a great pleasure to those who had been desirous of doing honour to Mr. Saunders to know that his Majesty's Post Office was also represented at their gathering by Mr. Ardron and Mr. Gavey. He felt sure that when Mr. Siemens responded, he would not only tell them something of what had been done by electrical engineering in the past, but that he would turn his "prophetic eye" on the twentieth century, and tell them, from his knowledge as President of the Institution of Electrical Engineers, what their position in the matter would be later on (cheers and laughter).

Mr. A. SIEMENS, in the course of a humorous response, observed that Sir John Wolfe Barry had already referred to what had been done in connection with electrical engineering. Their friend, however, wanted him to prophesy, but this was too dangerous a thing for him to do (laughter). He assured them that the Institution of Electrical Engineers (which, he reminded them, began as the Society of Telegraph Engineers), would continue to do their utmost in connection with the promotion of electricity to the welfare of mankind (cheers).

The health of the chairman was afterwards cordially drunk, on the invitation of Rear-Admiral Sir W. J. L. Wharton.

During the evening a selection of vocal and instrumental music was given. It may be added that the details of this interesting function were admirably carried out by a committee, which was presided over by Mr. F. E. Hesse, and of which Mr. A. R. Hardie acted as treasurer.

CORRESPONDENCE.

COMPENSATING ALTERNATING-CURRENT GENERATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There is a slight error in your very fair review of my method of compounding alternating-current generators. You say that at no-load the unsaturated pole has a polarity which is opposite to that of the main pole and partially counteracts its effect. This is not so. The error has perhaps arisen through looking at my diagram, which illustrates only one pole. When all the north and south poles of a generator are encircled with the same number of ampere-turns, there is no difference of magnetic potential between a point on the field iron midway between two poles and a point on the armature iron midway between two poles. Hence, a projection of iron between two poles will not be magnetised at all. I have made very careful measurements of the field distribution in this type of machine, and find that it is just what might be expected from theoretical considerations. In practice there is at no-load a very slight field under the unsaturated pole of the same polarity as the main pole. This appears to be due to the residual magnetism of the pole.

As a good deal of scepticism was expressed at the Manchester meeting as to the operation of so simple an expedient as that described, I wish to put upon record some tests that were made in the presence of Mr. Fuller, the engineer for the borough of Fulham.

As is well known, the Fulham Council advertised for tenders for a 1,000kw. alternator. One of the conditions to be met is as follows :—"The regulation is to be such that with a speed variation of 3 per cent. between no load and full load the variation of the generator voltage shall not exceed 3 per cent. With full load 0·8 power-factor thrown on, the generator running light, the drop in voltage shall not exceed 8 per cent., speed and excitation remaining constant."

This calls for a machine having no drop at full-load unity power-factor and a very slight drop on a power-factor of 0·8. Mr. Fuller is to be congratulated on being well up to date in his requirements. All good engineers will insist upon as good regulation for lighting generators, and they will insist upon the regulation being instantaneous.

The tests made were the following:—A small string of incandescent lamps was placed across the terminals of a generator which was otherwise unloaded and running at normal voltage. Full load (an iron-wire rack) was then suddenly thrown on the machine by closing the main switches. Not the slightest blink was observed in the lamps, the only effect being that the lamps became a little brighter. When the power factor of the load was reduced to 0·82, the voltage fell only 6 per cent.—Yours, &c., MILES WALKER.

Old Trafford, Jan. 17.

BATTERY METERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your report of my Paper on "Batteries with Reversible Boosters," I find that my remarks on the Aron meter have given the impression that the Aron meter was defective in its reversing arrangement. What I wished to convey, however, was simply that I understood that there was more lost motion on the Aron reversing arrangement, due to the size of the teeth on the ratchet wheel, than was desirable for a battery meter which was to be used on a rapidly reversing current. Under such circumstances, the loss experienced at each reversal may add up to a considerable amount at the day's end.

Otherwise the Aron meter is very suitable for this kind of work, and we have six of them metering traction current in this station in a highly satisfactory way. I have no doubt that the makers could rectify the slight defect for meters to be used with reversible boosters.—Yours, &c., C. TURNBULL.

Electricity Works, Tynemouth, Jan. 12.

PARLIAMENTARY INTELLIGENCE.

The period for lodging memorials against bills passing the Standing Order stage expired on Monday. In addition to those already announced, the following additional memorials were presented as set out below:—

Metropolitan Electric Supply Co. Bill.—Willesden District Council. (The hearing of this petition by the Examiners has been postponed until Jan. 25).

Heckmondwike Improvement Bill.—Yorkshire Electric Power Co., Batley Corporation and the Liversedge Urban District Council.

Hammersmith, City & North-East London Railway Bill.—Great Northern, Piccadilly & Brompton Railway Co., Pilkington Bros. and others and S. C. Lambert and others.

Great Northern, Piccadilly & Brompton Railway (No. 2) Bill.—Marquis of Salisbury and Sir Walter Phillimore and others.

The Examiners sat for the first time on Wednesday and again yesterday, when the following bills were passed as having complied with Standing Orders, there being no opposition:—South Lancashire Tramways, Morley Corporation, Great Berkhampstead Gas, Metropolitan Pneumatic Despatch, Bolton Corporation, London United Tramways, Whitby Urban District Council, County of London Electric Supply Co., Southend & Colchester Light Railways, Administrative County of London & District Electric Power, Charing Cross & Strand Electricity Supply Corporation (Power Supply), Dublin United Tramways, London County Council Tramways, Cork Junction Railway.

The Aberdare Tramways Bill has been reported as not having complied with Standing Orders.

The East London & Lower Thames Electric Power Bill, which was to have been considered yesterday, will not come before the Examiners until Feb. 16.

Petitions praying to be heard against the following Scotch provisional orders have also been lodged:—

Esk Valley Power Gas Bill.—Lothians Electric Power Co., Sir Robert Dundas, Bart., North British Railway Co., Midlothian County Council and the Edinburgh & District Water Trustees.

Paisley District Tramways Bill.—Renfrew County Council, Paisley Burgh Commissioners, National Telephone Co., Glasgow & South-Western Railway Co., Barrhead Burgh Commissioners, Glasgow Corporation, Caledonian Railway Co. and the Glasgow & Kilmarnock Joint Lines Committee.

Wemyss Tramways Bill.—North British Railway Co. and the Kirkcaldy & Dysart Water Works Commissioners.

Glasgow Corporation Tramways Bill.—National Telephone Co., County Council of Lanark, County Council of Dumbarton, County Council of Renfrew, Pollokshaw Burgh Commissioners, Lanarkshire Tramways Co., Rev. J. E. Campbell Colquhoun, North British Railway Co., Glasgow & South-Western Railway Co., Glasgow Ratepayers' Federation, Glasgow Landlords' Association, Sir Archibald Spencer Lindsey Campbell, Bart., Barrhead Burgh Commissioners, Glasgow & Renfrew District Railway Co., Caledonian Railway Co., Lanarkshire & Dumbarton Railway Co., Glasgow & Kilmarnock Joint Line Committee, Glasgow & Paisley Joint Line Committee, Partick Burgh Council and the Airdrie & Coatbridge & District Water Trustees.

LEGAL INTELLIGENCE.

Jandus Arc Lamps & Electric Co. v. Arc Lamps (Ltd.)

This case came before Mr. Justice Kekewich in the Chancery Division on Friday last.

Mr. TERRELL, K.C., opened the plaintiffs' case and said the action was brought for alleged infringement of three patents, but his Lordship would only be troubled with one. The patent alleged to have been infringed was No. 15,479, of 1893, granted to Louis Emerson Howard (an American) in respect of electric arc lamps. It was an invention for protecting the carbons from being rapidly consumed. The patentee enclosed his two carbon points in a cylinder of glass which was very small, and this cylinder of glass was as nearly as possible hermetically sealed, and the result was that the life of the carbon was increased to a very considerable extent. The patentee found that the nearer he could get his glass to the carbon the longer the life of the carbon. First of all he fixed the bottom of his glass cylinder fast to the bottom carbon. At the top of his cylinder he arranged a metallic cap tight to the glass cylinder. In the top he bored a hole and then he was able to get a tight fit between the upper carbon and the containing vessel. He gave in his specification general directions indicating what the invention was, and said that the nearer you got to his *criteria* the more perfect it was. Counsel proceeded to read extracts from the amended complete specification. In this the inventor made the following claims:—(1) An arc lamp having its arc enclosed in a transparent or translucent envelope provided with a metallic plug having a closely fitting opening to permit feed of the positive carbon and means for permitting escape of the gases produced by the arc. (2) An arc lamp having its arc enclosed in a transparent or translucent envelope, closed airtight at all points below the arc, and provided with a plug at the top having a closely-fitting feed opening for the positive carbon. (3) An arc lamp having its arc enclosed within a transparent or translucent envelope, an auxiliary transparent or translucent envelope closed on all sides surrounding said arc enclosing envelope and feed openings in the envelopes whereby the two sides of the arc-enclosing envelope are maintained at a comparatively uniform temperature, and fracture is avoided. Counsel said it was not necessary to emphasise the other claims in the patent.

Mr. BOUSFIELD, K.C., for the defendants, in answer to his Lordship, said the main defences relied on were want of novelty and subject matter and no infringement. There was no provisional specification, therefore no question as to disconformity was raised.

Mr. TERRELL said what the defendants had done was this. First of all they had a cylinder of small diameter, and made it tapered instead of parallel. They had got it about an inch in diameter at the bottom and 4in. in diameter at the top. They had got the top sealed with a metallic cap, as in Fig. 5 of Howard's specification. They had got the carbon passing through a very close fitting hole in the metallic plug, and the bottom hermetically sealed. When the action was brought the plaintiffs' specification was unamended. Defendants at that time had got the bottom hermetically sealed as specified. But when the present action was brought and his lordship made an order that no action should be brought for past infringement, defendants made a variation and introduced into the bottom a minute hole $\frac{1}{32}$in. in diameter. The whole object of the invention was to keep the carbons in a regular atmosphere as much as possible—to keep the carbon enclosed in as small a vessel as possible. Defendants set up against the plaintiffs certain anticipations, but his learned friends must deal with that matter in their cross-examination. There was enormous utility in, and enormous sales under, the plaintiffs' patent.

Mr. BOUSFIELD said defendants also relied to some extent on the plea of non-utility.

Mr. JAMES SWINBURNE, examined by Mr. MOULTON, K.C., for plaintiff, said he had carefully examined Howard's patent, and had made himself master of the matured object of the invention. This object was to make an arc lamp in which the trouble and expense of frequent renewal of the carbons was very much reduced. That was a material item in arc lighting. Howard obtained the results by making the enclosing globe as small as he possibly could. An enclosing globe was common knowledge at the date of the patent, but it was not successful before the date of the patent. Before the plaintiffs' patent two mistakes were made—first they made the enclosing globe far too large and next they did not close it enough. The two things which Howard had indicated were the essence of success. The globe must not break, must be transparent, and must practically be airtight. It must be of such material that you could seal it airtight at the top. Howard sealed the glass globe to a metallic cap. There was a comparatively close fit between the carbon and the metal. That was to prevent any circulation of air, and it was so close that there was just enough passage to enable any such a pressure in the globe to relieve itself through the orifice. It prevented the circulation of external air into the globe. The effect was to increase the life of the carbon very considerably. The external globe need not be small. It prevented anything falling on the smaller globe. The outer globe was a repetition of the inner. The outer reservoir became a reservoir of exhausted air. In his opinion the directions given for carrying out the invention were clear and practicable. He had seen the infringing lamp. The globe was a small globe made substantially according to the instructions in plaintiffs' specification. It was closed in the way described in plaintiffs' specification—at the top by a metallic cap which had a hole through which the carbon worked. It was closed at the bottom, but they had a small hole there. What the hole was there for he could not make out. It was practically stopped up by some copper, which really covered up the hole. It was not an effective hole at all. With regard to the fitting of the carbon as it passed through the cap, it was such as was described in plaintiffs' specification, and could do all that was described as essential to success. In his opinion the defendants' lamp was made in accordance with the plaintiffs' invention and according to the instructions given. He had read the prior specification, and he thought that the plaintiffs' invention was a novel one and useful.

Cross-examined by Mr. BOUSFIELD: The outer globe served as a reservoir of the burnt air. In Brewer's specification of 1882 the arc was more or less enclosed by two glass envelopes. Then the smaller globe was balloon-shaped and the outer globe was open top and bottom. Brewer had got the idea of preventing the consumption of the carbon, and also that the outer globe protected the inner from draughts and variations of temperature. In Beardsley's there was a small globe. At the bottom this was tightly fitted and the carbon came down through a narrow opening. There the opening was not nearly narrow enough and the globe was too large. People for the last 20 years had the idea of diminishing the consumption of the carbons by burning them in a confined space. Beardsley's patent was no good and would not work. Stait, in his specification (Fig. 1), had the same object, to prevent the burning of the carbons. He distinguished Andre's specification from plaintiffs' mainly on the ground of the size of the globe. In his view the size made a very material difference as a practical invention. In Lake's there was an enclosed vessel which included the whole thing. Alison enclosed the arc in practically an airtight receiver. He had the idea of preventing the carbon burning. Alison employed packing where the carbon came in to make the thing closed. All these people failed because they did not keep the globe small enough, and did not keep it sufficiently closed. He gave practically the same answers will regard to Baxter's patent. The main distinction between Justice's specification and the plaintiffs' was the size of the globe. In Justice's there was also the distinction of there being a carbon holder. Justice had the idea of preventing the burning of the carbon by oxidation. In Barton's specification of 1891 the reservoir was turned upside down, and he made it airtight at the top and fed each carbon at the bottom.

I put it to you that if you take a particular carbon and a particular lamp which you can fit an enclosure on, if you work that without an enclosing globe and work it with an enclosing globe so as to get the same light, you will find that to get the same light with an enclosing globe takes a higher voltage than if it is without an enclosing globe?—I think not.

Re-examined by Mr. MOULTON, Witness said that, in his opinion, not one of the prior specifications to which his attention had been called taught the public how to get the advantages which were obtained by the means described by plaintiffs.

Answering a question by his LORDSHIP, Witness said he had never heard of any of the specifications produced by the defendants having been embodied in practice until Howard invented and introduced the modern enclosed lamp. As far as he knew none of them ever got beyond the experimental stage.

Mr. MOULTON: Carrying out the invention claimed in plaintiffs' specification by the light of the directions, do you think a man would fail to get these results in increased life and better light?—No, he would certainly get them. The size indicated in plaintiffs' specification for the enclosure was a new departure. In Barton's the thing is apparently shown, but that is open, and there was another open lamp in the early days, but for an enclosed globe it was a new departure.

Mr. P. V. CASTELL EVANS, examined by Mr. TERRELL, said he was employed by plaintiffs at their works and had carried out experiments with arc lamps for the past five years. He first experimented with a Jandus single enclosure lamp of the 1903 pattern and he found that the duration of the carbon in the lamp was 170 hours. The ordinary duration of the same length of carbon in an open lamp was about eight to 10 hours. A Jandus double-enclosure lamp fitted with recent improvements and a 2⅞in. diameter H-globe gave 227 hours' life. The ¾in. and 1in. enclosing globes were made of porcelain because he could not get glass to stand long enough against the heat. The length of envelope in all his experiments was about 7in. Witness then gave details of all his experiments. The ¾in. porcelain globe burned for 380 hours. The total length of the carbon that was burned would be about 9½in. That he had taken as his standard through all his work. The 1in. size gave 180 hours life. There was thus from the ¾in. to the 1in. a sudden drop of 200 hours. The next size he tried was 2¼in., and that gave 100 hours' life. The 3½in. globe gave 60 hours. The 5½in. gave 41 hours. A globe between 7in. and 8in. gave 31 hours, and a globe 10½in. gave 26 hours, and the 11½in. globe gave 18½ hours. He thus found a regular scale depending upon the diameter of the globe, ranging from eight to nine hours, when it was an open arc altogether to 380 hours when it was a ¾in. globe. For the ¾in. and the 1in. globe he took an absolute tube, quite parallel up and down, and for the 2⅞in. parallel for the greater part of its length, and finished off in a dome form, and at the bottom the usual finish for the Jandus globe. For the next size he took the globe the nearest approaching theirs (Allison's); in fact, it followed Allison's, and then for the series up to 11½in. it was simply the Allison globe varying in size. He did not take a parallel globe because the Allison globe was the nearest in the whole of the specifications he could find, and it conformed more with the big outer globe than the parallel globe would have done. There was no such thing as a big parallel globe. He took Howard's globe and got 90 hours' life with Figs. 2 and 3. Fig. 5 of Howard's gave a life of 86 hours. With the sleeve turned off the cap practically with a flat plate between 1/16in. and ⅛in. thick he got 107 hours' life. With the sleeve fully on and fitted tight and the same carbons he got 134 hours' life. With the sleeve turned off—with the sleeve fitting loosely—he got 107 hours. He had tried a Brewer inner globe, putting it inside an ordinary outer globe so that he could follow the Brewer specification as closely as possible and he found that the life was only 17 hours. He had considerable difficulty in getting it to burn at all, because it cracked with the heat. He had tried a series of experiments with Beardslee. They made the model from the drawing, took the carbon as being a 13mm. one, and followed out that proportion as closely as possible. Beardslee did not say one word about burning the oxygen of the air. For the experiments the bottom end of the lamp was sealed and the top was left open for the carbon to pass through. For some time he could not get it to burn at all without cracking the globe round the top and bottom, but especially round the top, so that he had to take the carbon a good way from the neck to begin with, and he had to prevent it going very far down into the bottom of the globe for the same reason. When he got the arc it burnt only for a little over six hours, because it got to the bottom part and cracked. In that time he burned 2½in. of carbon. If he had burned all his carbon it would probably have given him 30 hours. He made a series of experiments with the alleged infringing lamp with the inner globe only on, and in these he got a life of about 75 hours. Then he put the outer globe on and the life went up to 77 hours. He did the same experiments over again out of doors and in fairly windy weather. He got a life of 65 hours with the inner globe only and 80 hours when he put the outer globe over.

Cross-examined by Mr. BOUSFIELD, Witness said he had done some 400 or 500 tests of carbons. He was aware that with lamps of the enclosed arc type with only one globe that both the plaintiffs and the defendants within the last three years had increased the size of the globe enclosing the arc. The only reason why a globe bigger than 3in. was wanted was that when they had an unenclosed globe—where there was no outer globe to protect it from the weather—they could not get glass to stand if they made it too small, unless they had an outer protecting globe. There was the fact also that they got a better looking lamp. Within the last three years the sale of lamps with a single enclosure had greatly increased in proportion to the sale of lamps with double enclosures. He took the same size of carbon in all his experiments. The company had improved on Howard's patent now, as they had now fuller knowledge. During his experiments he did not vary the current at all. He kept the voltage fixed as well as he could. According to his experiments with the Jandus 1903 lamp, the duration of the life of the carbon was 173 hours. That lamp was a single enclosed lamp. He took the Jandus enclosed lamp with all recent improvements. He used 75 volts. That was the commercial voltage. That particular lamp had all their recent improvements. He did not use an outside globe for their experiments.

Are you prepared to contradict that the whole question was how much or how little leakage you got?—I say it was not the whole question. He had taken great care in his experiments, and he quite thought that the whole difference was due to the diameter and not to any question of leakage. Leakage would have an important influence.

Mr. DUGALD CLERK said Howard's specification enabled the public to make a successful enclosed arc lamp. It was well known that if one could successfully enclose an arc and keep fresh air from the carbon, it would lengthen the life of the carbon; but nobody did that successfully before Howard. In his opinion, not one of the alleged prior anticipations showed a practical enclosed lamp. Howard was the first to show that the smallness of the globe prevented the influx of air. In the alleged prior anticipations he did not find any one which pointed out those two conditions of success. The Jandus lamps were a great commercial success. He had seen defendants' lamp, it had nearly all the features of plaintiffs' lamp. He thought that altogether some 40,000 of plaintiffs' lamps had been sold. He knew that very soon after the company started in 1895 it was a financial success. It was a flourishing concern in 1897. The company, under his advice, bought Howard's patent in 1898. In some respects the Jandus patents had been anticipated by Howard, and witness advised the company to buy Howard's patent. Howard was the first to show the use of a metallic plug in connection with the glass, and to have the carbon a nice fit.

Do you mean to say that you would have had the slightest difficulty, if anybody had brought these prior specifications to you, in showing that you must make this hole as small as you could to allow the carbon going through?—Yes, I should, and I know that inventors spent years in trying to get the thing successful on these lines. He agreed generally with the evidence of Mr. Swinburne. The claims which had been cut out when plaintiffs amended the specification were claims which had reference to the luminous gases. He thought Howard's theory was incorrect. Witness advised that the patent should be amended.

At this stage a long discussion took place as to whether the learned counsel was entitled to cross-examine the witness as to the construction of the original specification, and as unamended, and in the result his Lordship held that he was not.

On the resumption of proceedings on Monday, Mr. BOUSFIELD said his Lordship would remember that a series of experiments had been referred to giving the durations of the burning of the carbon in different circumstances. Defendants had endeavoured, with all diligence since the point was made, to make experiments in order to meet those referred to in the evidence called on plaintiffs' behalf. That evidence had taken defendants entirely by surprise. When defendants came into court they had no notice that the question of size would be taken. Prof. Cormack was now making the experiments, but he found that it was impossible to complete them in such a short time. He therefore applied for an adjournment to enable defendants to complete their experiments.

His LORDSHIP thought defendants should have an opportunity of giving evidence as to the experiments they were making. He did not see, however, why that should not be done after the arguments had been completed.

Mr. MOULTON said that plaintiffs would be at a great disadvantage if at the close of the case defendants called evidence to prove what their experiments were and without giving plaintiffs an opportunity of answering.

Mr. BOUSFIELD then continued the cross-examination of Mr. DUGALD CLERK, who said that the earlier lamps could not be successfully used before the date of Howard's patent. He remembered the old Electric Lighting Act of 1882. Practically the conditions of that act were such that for some years electric enterprise in this country was almost at a standstill. The Brush Co. had arc lamps at that date. In 1882 there was practically no general system of electric lighting, and all electric lighting stations were special property, such as railway stations, and the arc lamp in series was in great demand even then. It was necessary to have good carbons to work enclosed arc lamps. Since 1893 there had been a considerable improvement all round in the quality of carbon. The Howard specification was the best at the time, but they had succeeded in improving upon it in many points. The Jandus people also widely advertised their business. Plaintiffs' lamp was first offered to the public in 1895, and the sales since then had steadily increased. Success began to come to the Jandus Co. before they had the Howard patent. There was trouble with Mr. Marks, who was the owner of Thompson's patent for an enclosed arc lamp. That was dated 1896. Actions were threatened by Marks against plaintiff's company, and eventually that company bought both Thompson's and Howard's patents, both of which were owned by Marks. Howard had contemplated a low potential lamp. He hoped to get the result of being able by his construction of lamp to get a good light with only 25 to 30 volts. He did not know that with the best carbons with voltages like that they got a deposit of carbon on the inside of the enclosure which would condemn the system. He knew that a successful lamp must work on a high voltage. Commercially successful lamps did have the higher voltage. It was quite clear from Beardsley what he intended.

Mr. BOUSFIELD opened defendants' case, and said that the case was a rather remarkable one. They had a specification which was never intended to cover anything but details.

His LORDSHIP interposed and said he thought it would be convenient for the learned counsel at this stage to argue the question of whether he was entitled to look at the erased lines in the specification or not. As then advised he was against the learned counsel on that point.

Mr. BOUSFIELD contended that his Lordship was entitled to take into consideration, in deciding the case, the whole of the specification, including what had been cut out. He submitted that his Lordship could consider the deleted parts of the specification in order to decide what was the right construction of what was left. He wished to refer to the deleted portions in order to show that the construction of the patent had not been altered by what had been struck out. The alteration which had been made could not by law extend the scope of the specification. His argument was that there was no irregularity in the amendment and that it did not in fact alter the construction. Size in the specification had only to do with luminosity and as that had been struck out plaintiffs were not entitled to turn round and say that size was the determining factor in the other part of the specification. He submitted it would be extremely detrimental to the interests of the public if his Lordship were to decide that when there was a question as to whether the construction which a patentee was putting forward was not wider and more conclusive than the construction which was in the original specification that you could not keep him within the bounds of his original specification.

Mr. GREY (for defendants) also addressed his Lordship on this point, and contended that the unamended specification was the proper thing for his Lordship to look at in construing the patent.

Mr. MOULTON contended that both on principle and authority his Lordship could not refer in any way to the deleted portions of the specification.

Mr. TERRELL and Mr. BOUSFIELD having further argued the point for their respective clients,

His LORDSHIP said the question he had to decide was whether the deleted passages in the specification could be referred to in argument for the purpose of ascertaining the limits and extent of the monopoly granted to the patentee. He did not think he was entitled to refer to those passages, and the case would have to proceed on that footing.

Mr. BOUSFIELD then continued his argument, and asked his Lordship to look at the specification without reading the deleted passages. He wished to show that in this complete specification the reference to smallness of size had nothing whatever to do with the question as to the life of the carbon. The reference to smallness of size was as to something that had gone. Howard had got claims which had no reference to smallness of size. Plaintiffs were now anxious to show that was a material part of the invention, and that that came into the claim. But if his learned friends said that, then they must take the consequences. If they were going to work these words into the claim they must do so surely with the limitations which were in the body of the specification, and must take them "not to exceed 3in., and preferably less." If they succeeded in bringing in reference to size they must do it definitely and be held to some sort of limitation. If size was the only material thing they must have some sort of definition. According to his learned friends' view, Howard was entitled to get the benefit of smallness of size without stating what the limitation of the smallness was. Defendants used three times the voltage which Howard said was going to be the result of his invention. Howard said that by having a small enclosing envelope he got greater density and less resistance, and therefore he could use less voltage. They all now knew that such voltages as that were now commercially useless. Defendants had got the fact that they did not come within his limits of less than 3in., and that they did not get the reduction in the voltage. The real essence of Howard's patent was the enclosure at the bottom and the reduction of the leakage at certain points, but now the plaintiffs said that smallness was the material thing, and that smallness saved them from being anticipated. Beardsley absolutely and thoroughly described the principle, and there was nothing left to invent, except some improvements in detail. Beardsley would give all the results which in fact followed from the plaintiff's invention.

Mr. BOUSFIELD (continuing) said he would not trouble his Lordship with all the specifications relied upon by his clients as anticipations. A number of them were important as showing how widely spread and well known the principle was of reducing the consumption of the carbons by enclosing them in a globe for the purpose of keeping them as far as possible free from outside air.

His LORDSHIP said plaintiffs' case was that everybody knew it, but that nobody hit upon how to do it until Howard's specification—that nobody knew that a small enclosing globe was the secret. That was the plaintiffs' case.

Mr. BOUSFIELD: Yes, but that is not the case made by Howard in his specification. Referring to Andrés' Fig. 2 counsel said that there they found everything that Howard described in his specification, except on the one point of size, which was said to be the distinction. He submitted that on all points judgment should be for the defendants.

Prof. S. P. THOMPSON (examined by Mr. BOUSFIELD) said he had studied Howard's specification, and did not think it made any substantial advance in the art of arc electric lighting to what was prior knowledge. As to Beardsley's specification, with the knowledge that was available in 1882, he would have no difficulty in making a working lamp to carry out in effect what was stated by Beardsley in his specification. The only doubt was whether he could have obtained at that date carbons sufficiently good. If he had been carrying out the specification he would have known that the heating effect of the electric arc was very severe. He should have known that the same precautions would have had to be taken to secure the globe surrounding the arc as for securing a globe surrounding a paraffin lamp. He had not made experiments as to prolonging the life of the carbons, but he had made experiments at various times on enclosing the arcs, and his view was that, provided equal care was taken so as to prevent the access of fresh air, the size of the enclosure had nothing whatever to do with the matter. For the success of these lamps you required a distribution of electricity at constant voltage of at least 110 volts. The earliest date at which that first became available was about 1890. Marks was the apostle of the enclosed arc both in America and in England. He spread his views about high voltage in this country about 1895. He wrote about it in the technical papers. His views about high potential were generally adopted because everybody found the same thing. Howard's specification fell absolutely flat, and produced no effect on the industry at all.

Cross-examined by Mr. MOULTON: Tell me a single improvement in arc lamps made by a theorist?—Witness referred to the regulation improvement by Prof. John Hopkinson. Many of the alleged prior publications told them to enclose and to take pains to keep out the air. Baxter, Beardsley and several others more or less told them that. To what extent they succeeded he did not know. The first occasion on which he saw a commercial enclosed lamp was on August 22, 1893, and that was Marks' lamp. Arc lamps had now to accommodate themselves to installations which were for incandescent lamps. From 1878 to 1888 they used to make their machines especially for their arc lamps. The consequence was that they chose the voltage they preferred for their arc lighting.

Mr. MOULTON: I put it to you that all the makers of arc lamps made the enclosure of the size we have said?—My impression is that from the arc lighting I have seen it is carried out more generally by globes nearer 6in. in diameter than 3in.

Prof. CORMACK (examined by Mr. GREY) said he was Professor of Engineering in University College, London, and had had considerable experience in electric arc lighting. He did not find in Howard's specification anything which added to the state of knowledge at that date. He had never seen a lamp made according to Howard's specification. In his opinion the commercial advance in enclosed arc lighting was the increase in the number of public lighting stations and this called attention to the improvements in the lamps and the production of pure carbons at a reasonable price and so raised the question of enclosed arc lamps again. Reading Beardsley and studying his drawings they were, in his opinion, sufficient to construct a commercial and working lamp. In his opinion, if leakage was sufficiently prevented as shown by André, the size of the enclosing globe was not a feature of importance. He had not yet tried the experiments mentioned by Howard, but was engaged on experiments which were not completed.

Mr. BOUSFIELD said this was defendants' case subject to the further evidence he wished to submit as to the results of the experiments now being made by Prof. Cormack.

His LORDSHIP said he would not give judgment before that day fortnight, and if Mr. Bousfield wished to produce further evidence as to the results of the experiments he must make an application before then.

Lyell v. De Tunzelman.

In the High Court, the Lord Chief Justice and Justices Kennedy and Ridley on Tuesday heard defendant's appeal from a judgment of Judge Rentoul at the City of London Court in September last. The action was for goods sold and delivered, and judgment was entered for plaintiff. Defendant appealed on the ground that he was not responsible for the goods (carbons) because there was no contract to buy them, and they were sent to another company (the Electric Welding Co.) without any order.

After argument, their Lordships dismissed the appeal with costs, the Lord Chief Justice remarking that the goods were delivered to someone to whom defendant wished them to be delivered, and there was evidence on which the judge in the Court below could come to the conclusion that the plaintiff was entitled to recover the value of the goods from defendant.

Attorney-General (at relation of Weybridge Council) v. Urban Electric Supply Co. (Ltd.)

In the Chancery Division on Friday before Mr. Justice Joyce Mr. YOUNGER mentioned this case and said the company had approached the Attorney-General who had stated that he was willing to leave the matter in the hands of the relators. He now asked that the injunction granted in November should be suspended until after a bill was presented in Parliament

Mr. HUGHES opposed any further suspension of the injunction. He sought to prevent the company from supplying electric energy to Walton from Weybridge.

His LORDSHIP decided to suspend the operation of the injunction until further order, so that there would have to be an application. Mr. Younger's clients, he said, were not to supply Walton from the station in question except in certain circumstances to be agreed upon and drawn up between counsel. The matter had better stand over until the first motion day in May on terms that had been agreed.

Mr. HUGHES asked for and was granted leave to appeal, but his LORDSHIP said defendants must compensate plaintiffs for any damage they might sustain.

Mr. CLAUSON (for the company) agreed to do so, and also to submit to a perpetual injunction and to treat the motion as the trial of the action.

Tracey and Another v. Sir Hiram Maxim Elec. & Eng. Co. (Ltd.)

In the Chancery Division on Tuesday Mr. Mark Romer moved for the appointment of a receiver. The company (said counsel) had not then gone into liquidation, but it was a case of jeopardy, as the sheriff was in possession. A receiver and manager was appointed by the vacation judge over Oct. 24. On that date the company approached the plaintiffs, and by consent no order was taken. On Nov. 29 a compulsory order was made on a creditor's petition. The weekly wages bill was £174, and there were a great number of outstanding contracts, amounting to £27,000, which required completion. It was therefore essential that someone should be appointed who could obtain the direction of the Court as to the completion of the contracts and as to borrowing money to do so. It was asked that Mr. Alfred Hardy be appointed receiver and manager, he having been nominated liquidator by an overwhelming majority of the creditors.

His Lordship made the order asked for, and gave the receiver liberty to act at once, limiting the appointment as manager to three months without further leave of the Court.

Jeffrey v. North-West London Electric Supply Co. (Ltd.)

In the Chancery Division on Friday, before Mr. Justice Farwell, Mr. JENKINS, K.C., moved for the appointment of a receiver and manager. As, however, defendants had filed some evidence, he asked that the motion might stand over for a week.

Mr. UPJOHN, K.C., for defendants, said the true issue between the parties was whether the proposed sale of the company's undertaking to Hampstead Borough Council should go forward. Hampstead Council had a rival undertaking, and negotiations had been going on for a long time as to the purchase. The proposed sale had been assented to by a resolution of debenture-holders. The prior lien mortgagees had appointed their own receiver and manager, who was also managing director of the company. The undertaking was being carried on in the best manner.

His Lordship assented to the case standing over for a week.

Earle v. South Lancashire Electric Traction Co. (Ltd.)

On Tuesday, in the Chancery of Lancaster, the Vice-Chancellor (Sir S. Hall, K.C.) delivered judgment in this action to restrain the debenture trustees and receiver of the company from acting upon resolutions passed at an extraordinary meeting of debenture holders on Dec. 30. The Hon. A. Stanley's motion to sanction the proceedings and to allow the promotion of a bill in Parliament was heard at the same time.

His Honour found that the stockholders had modified their rights against the company in accordance with their powers, and he refused Mr. Earle's motion, granting that of Mr. Stanley. Costs were ordered to be paid by the trustees.

Workmen's Compensation.

At Southwark (London) County Court on Monday, the Coaling Synd. (Ltd.) applied for the discontinuance of an award of 15s. compensation per week made in favour of a porter named Dwyer, who had been injured whilst in the company's service. Evidence was given that Dwyer would not be able to resume his former employment until an operation had been performed upon his arm, and it was submitted that his refusal to undergo the operation was good reason for the discontinuance of the award.

The Judge said he had no power to discontinue it for such a reason, and dismissed the application.

On Saturday last the Master of the Rolls and Lords Justices Mathew and Cozens-Hardy gave judgment in an appeal against a decision by the Judge of Flintshire County Court awarding compensation in respect of the death of Joseph Ellis, and payable by Joseph Ellis & Co. Deceased entered in 1903 into partnership with J. Taylor and T. Roberts to work clay or minerals. Deceased was a practical quarryman, and the other partners were not, and left the control of the workmen to deceased, who also performed manual labour and drew wages independently of his interest as a partner.

The MASTER OF THE ROLLS said in his opinion it was the intention of the act to exclude cases in which the same person occupied the positions of employer and employed. Therefore, he thought the Judge had arrived at a wrong decision, and the appeal must be allowed.

The Lords Justices concurred.

At the Court of Appeal the Master of the Rolls and Lords Justices Mathew and Cozens-Hardy on Saturday upheld an award of the Judge at Bow County Court of £1 per week compensation made in May last against the Gas Light & Coke Co. (Ltd.) in favour of a former coal porter named Clark. At the time of the accident (Dec. 16, 1899) Clark's wages were 41s. 9d. per week, and it was agreed that he should have £1 per week compensation. In January, 1901, the company offered Clark employment as gatekeeper and timekeeper at 27s. per week, and this employment he refused. On April 1, 1901, the County Court Judge reduced the award to 14s. 9d. Clark subsequently accepted the position offered to him, and was dismissed for not carrying out his instructions. On March 13, 1903, Clark applied unsuccessfully to the County Court Judge for an increase of the award, but as the result of a further application on May 13, 1904, the Judge acted as arbitrator, and decided to restore the order for £1 per week.

The MASTER OF THE ROLLS said the County Court Judge was right in his decision of 1904 in not visiting on the man the permanent consequences of his default in not keeping the place given him in the company's service. Applicant had tried to find work and had been unsuccessful. He thought it was competent to the County Court Judge to hold that the applicant's opportunity of finding employment had been narrowed in consequence of the accident, and that it was impossible for him to earn the same wages as he might have earned if he had had a wider choice. The Court could not interfere with the decision, and the appeal must be dismissed.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Battersea (London) Borough Council require an electrical engineer, to take entire charge of their electricity department. Commencing salary £400 per annum. Applications by Jan. 31.

A draughtsman is wanted for transformer design by Ferranti Limited, Hollinwood, Lancs.

Three additional assistants are wanted in the department of electrical engineering of the City and Guilds Central Technical College. Commencing salaries £200, £150 and £150 per annum respectively. Applications to Prof. Ayrton, Exhibition road, London, S.W. See also advertisement.

The Admiralty announce that there will be on April 1 several vacancies for assistant masters in H.M. dockyard schools. Salary £150, rising by £10 per annum to £250, with pension and chance of selection for promotion to senior masterships. Applications to Secretary (C.), Admiralty, Whitehall, London, S.W., by Feb. 6.

Essex Education committee require an assistant instructor of physics and chemistry at the County Laboratory. Salary £150. Application to County Offices, Chelmsford, by 26th inst.

Mr. Walter Reeve has been appointed demonstrator in mechanical engineering at the Municipal Technical Institute, West Ham.

Mr. Richard Lees has been appointed superintendent of postal telegraphs at Manchester.

Aberavon Tramway Scheme.—Representatives of the promoters of this scheme (including the engineers, Messrs. Herbert Lewis and Fletcher) on Thursday last discussed the project with deputations of the Aberavon and Margam Councils. The scheme, which is estimated to cost £32,000, is intended to provide tramway facilities between Taibach and Baglan, with a branch through Water-street to the beach and docks. The Councils' representatives agreed to support the scheme.

Acton.—The inauguration of electricity supply took place on Wednesday. The Council take current in bulk from the Willesden station of the Metropolitan Electric Supply Co.

Barrow—Recently the Town Council obtained sanction to a loan of £35,000 for electricity extensions, the period for repayment being fixed at 22 years. This, however, the Council consider too short, and the chairman of the Electricity committee (Ald. Smith) and the town clerk (Mr. C. F. Preston) have been deputed to wait upon the Local Government Board in London in order to induce them to extend the time.

Battersea (London).—The Council were recommended, last week, by the Lighting committee to appoint Mr. W. A. Kemm, the present chief assistant, as borough electrical engineer. After discussion it was decided to refer the recommendation back and to re-advertise the position.

Bermondsey (London).—On Tuesday the Borough Council considered a communication from the Board of Trade, enclosing a copy of a report by the Board's electrical adviser (Mr. A. P. Trotter) on the explosion which took place in Bermondsey-street on Dec. 3 last. Mr. Trotter, in his report, refers to the grossly exaggerated accounts of this explosion which were published in the daily newspapers of Dec. 5, and proceeds to detail the results of a minute enquiry into the causes of the explosion. We extract the following from Mr. Trotter's "Conclusions":—

> The large cubic contents of the street box conduced to the severity of the explosion, and while it was difficult to avoid the use of such boxes where provision had to be made for drawing in additional mains, it is questionable whether it would not be better to evacuate the necessary amount of ground to allow room for such work when mains have to be drawn in and to fill it in solid when the work is completed. The presence of any large chambers under the street should be avoided if possible. I consider that the practice of putting switch fuses in pillar boxes above ground is preferable to placing them under the pavement. The pillar box in this case was placed upon the curb of a wide pavement, and its dimensions—19in. by 22in. in plan—do not make it objectionably large, but these dimensions might be reduced where such boxes are used on a narrower pavement. I found that there was practically no provision for ventilation in this box, and if inflammable vapour entered it in large quantities from the mains an explosion having serious results might ensue. It is probable that on such occasions inflammable vapour is generated so fast that it would be almost impossible to prevent an explosion by any practicable amount of ventilation. The foregoing suggestions deal with the reduction of the severity of such explosions. It appears that the heavy short circuit which led to this accident might have been prevented altogether if the network had been divided into districts corresponding approximately to the different feeders, and if these districts had been inter-connected only through fuses of moderate capacity the faulty main would have been cut off before and the large current which destroyed it would not have passed. Such an arrangement of mains has been imposed as a condition for the earthing of the intermediate conductor of the three-wire system for some time, but was not so imposed when the Bermondsey system was sanctioned. This arrangement forms the subject of one of the new regulations of the Code now in draft.

Accompanying this report is one from Mr. W. H. Vincent, electrical engineer to Bermondsey Borough Council, from which the following extract is made:—

> There is no doubt that the large cubical contents of the street chamber conduced to the severity of the explosion, but in many cases these chambers, apart from their utility for drawing in cables, are used to contain joint and disconnecting boxes which entail a large amount of space, more especially as it is desirable to arrange these in positions easily accessible for localising and isolating a faulty cable. I do not consider the suggestion to excavate the necessary amount of ground to allow room for drawing in the cables and to fill in solid when the work is completed quite a practical one, as the street would have to be excavated each time it was necessary to gain access to the boxes. I consider the same object would be achieved by filling in the chambers with loose material, such as ballast, which would be easily removable. I agree that the practice of putting switch fuses in pillar boxes above ground is preferable to placing them under the pavement, and in all instances throughout the borough that has been done. The size of the pillars might be kept down but in my opinion it is preferable to have them slightly over than under size, as in the event of a fuse blowing there is always a possibility of the arc extending to the body of the pillar and seriously damaging it. The pillar mentioned as being defectively ventilated is one of four similar supplied under the original mains contract. The remaining pillars in the borough have been specially designed by me, and ample ventilation has been provided. The introduction of fuses to divide the network into districts frequently results in their blowing without any apparent reason, thus cutting off sections of the mains from the supply and putting consumers to unnecessary inconvenience, but due regard should first be given to the prevention of explosions, and I had under consideration a similar proposal to inter-connect the network through fuses, which, I am of opinion, if carried out would almost entirely prevent a recurrence. I recommend that the necessary work to efficiently ventilate the four feeder pillars be taken in hand.

The committee reported having instructed Mr. Vincent to have the necessary work for ventilating the feeder pillars carried out and to bring up an estimate of the cost of providing fuses inter-connecting the network.

A further report was received from Mr. Vincent on the breakdown on the mains which occurred on Dec. 30:—

> Mr. Vincent reported in this case that the short circuit which occurred at 11:50 a.m. in the distributor cable was apparently due to the breaking down of the insulation of the cable, the cause of which there was insufficient evidence to determine. The faulty section was duly isolated and the supply restored by 1:35 p.m. On the same date at 8:20 p.m. Messrs. Enthoven telephoned to say that the feeder pillar outside their works was very hot and smoking. The matter was duly attended to, and on examination the pillar was found to contain a large quantity of water which had gained access during flooding at the time of exceptionally high water. That had caused excessive leakage from the connections in the pillar to earth which blew the fuses and disconnected the supply to Messrs. Enthoven. The water was also found to have flooded a number of brick chambers and to have entered some joint boxes contained in these, causing the insulation of the mains to fall. Those boxes were being dried out, and so far as at present ascertained the moisture had not extended to the cables themselves.

Birkenhead.—Prepayment electricity meters are being introduced by the Corporation electricity department, the charge for current supplied through these meters being 5½d. per unit.

Bradford.—The question of the right of tramway employés to appeal to the Tramways committee after dismissal from the service by the general manager was discussed on Monday by the committee, who decided to allow the principle of appeal, and appointed a sub-committee to formulate rules under which such appeals may be made.

Cable Thefts.—At the Guildhall on Monday, before Ald. Sir James Ritchie, Frederick Burgess and Leonard Howell pleaded guilty to stealing various fittings from the Electric & General Engineering Co. On the night of 12th inst. Burgess, a foreman wireman, was given into custody for stealing 24yds. of electric cable. At his home a quantity of short pieces of cable, globes and fittings, to the value of from £80 to £100 were found. Howell was a wireman, and the property he was charged with stealing was said to be worth £5. It was said the robberies were systematic, and within the last two or three months the company had lost £2,000 worth of property. Burgess was sentenced to six months' hard labour and Howell to two months.

Camberwell (London).—On Wednesday the Finance committee reported that as the Board of Trade auditor refused to hear the Council with reference to the audit of the accounts of the County of London Electric Supply Co., they had, at the suggestion of London County Council requested the Board of Trade to make regulations, under sec. 8 of the company's order, to enable the Board to direct the auditor to take into account the circumstances of the company in allocating the capital expenditure between the areas of the various local authorities in which the company is operating in order that any party interested should be allowed to appear and to be heard before the auditor. The Board has now replied that after carefully considering the representations of the Council, they are not prepared to make the regulations suggested. The committee, however, advise (and the Council have approved) that the Board of Trade be asked to reconsider their decision.

Cleethorpes.—On Wednesday the Council decided to ascertain whether the railway company would take electrical energy for lighting and power, and also to ascertain the probable demand for current for private lighting before embarking upon a municipal scheme of electricity supply.

Companies Struck off Register.—The "London Gazette" of Jan. 13 contains a list of companies removed from the Register. These include the following:—

British United Tramways.
Clayton Engineering & Elec. Co.
Electric Traction Insurance Association.
Electrical Automatic Loom Synd.
Electrical Instruments Syndicate.
European Electric Railways & Public Works Construction Co.
Farrall Incandescent Electric Light Syndicate
London & N.-W. Elec. Tramways.
Metropolitan Electric Tubes Synd.
Nottinghamshire Elec. Tramways.
South-West Wireless Telegraph Ship Co.
Tramways Construction Co.

Coventry.—The salary of the borough electrical engineer (Mr. J. A. Jeckell) has been increased by the Electric Lighting committee from £400 to £500 per annum. The Council have, however, referred the matter back.

The Coventry Electric Tramways Bill, 1905, will be opposed by the City Council.

Croydon.—The proposal of the Council to promote a bill to extend the Corporation electric tramways to the borders of the district from South to Upper Norwood is meeting with some opposition (led by Sir William Treloar) from residents of the latter district, but the Council have decided, by a small majority, to proceed with the bill, and a town's meeting called on Wednesday last week supported this decision.

Dorchester.—Last week the Council decided to oppose the application of the Dorchester and District Electric Supply Co. for a provisional electric lighting order.

East Ham.—The Council have made arrangements whereby the services of an experienced attendant will always be available free of charge to examine and adjust private arc lamps when required.

Edinburgh.—Sanction to a further loan of £90,000 has been obtained for electric lighting extensions, making the total authorised capital £950,000.

Electrical Power Distribution in Cities.—At a meeting of the Aberdeen Association of Civil Engineers on the 10th inst. a Paper entitled "The Distribution of Electrical Power in Cities" was read by Mr. A. H. McKay, mains superintendent of Aberdeen Corporation electricity department. The chair was taken by Mr. George Mann.

Mr. McKay described the general principles involved in designing a continuous-current low-tension system of electrical distribution, explaining the applications of both the two-wire and three-wire systems and the necessity for a methodical use of feeders from the generating station to the distributing mains to ensure the pressure being kept constant throughout the system. Other points discussed were the success and economy attending the introduction of increased voltage, the different systems of laying mains and the use of subways. The Paper concluded with some practical remarks on the faults met with in an electrical system, their causes, location and elimination. The Paper throughout was illustrated by sheets of diagrams and a collection of electrical apparatus appertaining to the points introduced in the lecture.

Messrs. J. Alex. Bell, the city electrical engineer, Milne, Cook, Moncur, Conway and Simpson took part in the discussion, and a hearty vote of thanks was passed to Mr. McKay for his Paper.

Electricity in Mining.—The Nundydroog Company proposes to raise an additional £70,000 for providing (among other things) electrical machinery in connection with the additional 2,000 H.P. to be provided by the Mysore Government under the Cauvery Falls power system, of which the company is to take 275 H.P., and for the company's share of outlay on the Kolar Mines power station. It is expected that the mine, when equipped with electrical power, will be worked much more economically.

A contract has been arranged for the supply by the Sunderland District Electric Tramways (Ltd.) of electric current for lighting, coal-cutting, hauling, pumping, &c., to the Lambton Collieries, Co. Durham, from the tramway company's generating station at Philadelphia. In addition to the colliery's demand, current will be supplied to Houghton-le-Spring and Hetton-le-Hole, and in the Easington rural district, as well as motive power for the company's tramways.

Forthcoming Books.—"The Electrician" Printing & Publishing Co., London, have in the press an important work, entitled "Electricity Meters and their Management," by C. H. W. Gerhardi. This book will treat fully of the practical management of electricity meters, including their erection, testing, &c.

Messrs. Whittaker & Co. will shortly publish "The Insulation of Electric Machines," by H. W. Turner and H. M. Hobart.

Fulham (London).—The Council are recommended to lay mains for public and private lighting in 38 streets at a cost of £2,705. 17s. In these streets there are 193 gas lamps and standards, which are to be adapted for electric lighting at £1. 15s. per lamp. On Jan. 5 there were 1,403 customers, representing an equivalent of 70,193 8 c.p. lamps connected. During 1904 the new connections were equal to 30,000 8 c.p. lamps.

Glasgow Suburban Tramways.—A conference of representatives of the Town Councils of Partick, Govan, Pollokshaws, Rutherglen, Barrhead, Clydebank and Kirkintilloch was held last week to consider the Glasgow Corporation provisional orders.

The Councils object to the Tramways Consolidation Order as it will reduce the rateable value of the tramways in counties to one-fourth, and the deficiency will have to be met by the various burghs and the rural portions of the counties jointly. The representatives thought that Glasgow Corporation, having obtained a tramway monopoly in the districts, should not be permitted to escape with a reduced assessment. By the 78th clause of the General Order it is provided that telephones and electrical plant shall be assessed only on one-fourth of the annual value, and the conference agreed to insist that these be assessed on their full value. It was further agreed that the restricted assessment would be an injustice to the National Telephone Co., who pay on the full value, and also to any electric power companies who may be authorised to supply electricity in the burghs.

Gravesend.—The Council will proceed with their application for a provisional electric lighting order for Northfleet, notwithstanding the latter Council's opposition.

Harwich.—The Council have asked the Board of Trade to extend the period of the Harwich Electric Lighting Order (1902) until the Dock Bill is dealt with by Parliament.

Holyhead.—Sanction has been receiven to a further loan of £1,000 for extensions of the electric lighting mains.

Huddersfield.—The total receipts of the tramways department for the nine months ended Dec. 31 were £54,095, and after paying interest (£9,824) and allowing £7,991 for redemption of debt, the balance was £8,857, but no provision has been made for depreciation.

Inquest.—At Leeds on Monday the city coroner (Mr. J. C. Malcolm) resumed his inquiry into the circumstances attending the death of William Baskerville, a clock-winder, who died suddenly whilst attending to the clock in the new market hall on Jan. 6.

At the last hearing it was stated that deceased met his death as the result of an electric shock while engaged in the tower, one of the witnesses (Albert Brown) saying that on going to release Baskerville he received a shock.

ALBERT BROWN repeated his evidence and said that he did not think he was touching the ironwork of the clock with any part of his body when he received the shock whilst lifting the weight off the deceased man's arms. The switches controlling the electric current by which the clock going was worked were turned on at the time.

JOHN PRIESTLEY, a stall-holder in the market, who went to Baskerville's assistance, said that on putting his hand through the trap-door leading to the clock he touched something and felt a distinct shock.

Mr. T. HARDING CHURTON, electrical engineer, had made, at the request of the coroner, an examination of the clock, and now said that it would be almost impossible to attend to the clock without getting a shock if the electric current happened to be on. The voltage of the electric current was 200, and that could cause death if the victim was in continuous contact with a live part.

The medical evidence was to the effect that deceased had suffered from a weak heart, and current of such a voltage passing through his body might cause death.

SAMUEL CUTTRESS, called on behalf of Messrs. Potts and Sons, makers of the clock, thought there was no danger arising from the electrical parts, but in his opinion the clock tower was dangerously constructed.

The jury returned a verdict of Accidental Death, adding a rider that death was caused by electric shock whilst winding up the clock.

Isle of Wight.—In addition to obtaining a renewal of the street lighting contract for Shanklin for three years, the Isle of Wight Electric Light & Power Co. have secured a renewal of the Bonchurch lighting agreement for five years from last summer.

Islington (London).—The Lighting Committee have decided to lay conduits and mains along Holloway-road at an estimated cost of £2,800. Some further low-tension distributing mains are to be laid at an estimated cost of £132.

Kirkcaldy.—The Council have received sanction to a further loan of £30,000 for electric lighting, making the total £80,000.

Lewisham (London).—The South Metropolitan Electric Light & Power Co. have submitted terms for public arc lighting, but, as the Works and Highways committee is endeavouring to obtain a reduction in the price of gas from the local gas company, the matter has been adjourned for the present.

Liverpool.—On Monday the chairman of the Tramways committee (Sir Chas. Petrie) said the number of passengers carried last year was 116,642,663, the receipts being £540,916. The increase for 1904 over 1903 had been as follows: Mileage 3·68 per cent., passengers 3·17 per cent., receipts 3·13 per cent.

Newcastle-on-Tyne.—For the position of manager of the Corporation tramways at £700 per annum the following candidates have been selected:—

Mr. C. J. Spencer, manager of Bradford City Tramways; Mr. H. C. Bishop, borough electrical engineer and tramway manager, Newport; Mr. J. H. Cowell, traffic manager and superintendent Blackburn Corporation Tramways; Mr. G. Conaty, manager of City of Birmingham Tramways Co.; Mr. T. P. Easton, chief clerk and accountant Newcastle Tramways; Mr. Ernest Hatton, general manager Salford Corporation Tramways; Mr. C. W. Mallins, traffic superintendent and chief assistant to general manager of Liverpool Tramways; Mr. R. F. Rogers, general manager of Middlesbrough, Stockton and Thornaby Electric Tramways; Mr. W. Wyld, general manager Birkenhead Tramways, and Mr. H. E. Yerbury, chief engineer and deputy manager Sheffield Tramways. The selected candidates will be interviewed by the Tramways committee to-day (Friday) when a further selection will be made to go before the Council.

The Tramways committee suggest that the Lighting committee should erect 180 additional arc lamps, making a total of 389, for which the former committee offer to supply current at £12 per lamp per annum, compared with the present charge of £15. 10s. The Lighting committee have deferred consideration of the proposal.

Newcastle (Staffs.)—A flat rate of 3d. per unit has been adopted for the supply of electric current for power.

Newfoundland Telegraphs.—The arbitrators appointed to determine the sum to be paid to the Reid Syndicate by the Newfoundland Government, as compensation for the acquisition of the telegraph system, has delivered a sealed award, the contents of which will be made public on Feb. 3. The syndicate claimed $3,500,000.

Norwich.—The Corporation decided on Tuesday to apply for a loan of £80,000 to meet estimated capital expenditure to Sept. 30, 1907, for mains, services, meters, steam turbine generator, surface condensing plant, superheaters, boilers and piping.

Nottingham.—A ratepayers' meeting has approved the Corporation bill for the extension of the electric tramway system, &c., at an estimated cost of about £100,000.

Personal.—Mr. M. Farrer has resigned his position as chief assistant engineer to Twickenham & Teddington Electric Supply Co., to take up the position of resident engineer to the Ramsgate & District Electric Supply Co.

Radcliffe.—The Council have applied for sanction to a loan of £10,000 for the purchase of electric motors, arc lamps, &c., to be let on hire for wiring consumers' premises.

Rochdale.—An inquiry was held here on Wednesday into the application of the Council for permission to borrow £42,405 for additional generating plant for the electricity works, extension of the electric lighting mains, &c.

St. Andrews.—The Electric Lighting committee have been authorised to visit Edinburgh and Dalkeith to obtain information regarding electricity supply.

Shoreditch (London).—On Tuesday the Lighting committee reported that they had considered a report by the borough electrical engineer (Mr. C. Newton Russell) as to the growth of the demand on the generating stations, which has now reached nearly 2,000kw., and which would probably be exceeded this winter. At times of heavy load even the temporary stoppage of one of the large engines at Whiston-street would necessitate other plant being overloaded.

Mr Russell also pointed out that by generating electricity with modern plant at Whiston-street the saving in fuel cost alone would be sufficient to cover interest on and repayment of new capital expenditure. The committee were of opinion that it was necessary to instal such additional plant, and that in view of the period which must elapse between the time when the extensions were approved and the time when the plant was installed, specifications should be prepared and tenders invited for the following alternative schemes:—(a) Two steam turbo-generators, each of 1,000kw., with all necessary condensers, pumps, boilers, superheater, steam and water pipes, switch gear, balancer and underground mains, at an estimated cost of £37,000; (b) two steam turbo-generators, each of 1,500kw. capacity, with condensing plant, &c., at an estimated cost of £46,000.

The committee (with the view of obtaining the fullest information as to type of engine to adopt, especially as regards avoidance of vibration nuisance) suggested that they be authorised to visit three of the principal stations in the country where steam turbo-generators have been in use for some time, third-class rail fare being allowed, with expenses not exceeding 15s. per day per head.

Mr. Howell moved the adoption of the report, and said that as the power companies were now so active it was necessary, in order to meet this formidable competition, that municipalities should have the most modern machinery. With turbine plant they could double their output without having to spend one penny on land or buildings. At present their plant had a capacity of 3,000kw., which, roughly speaking, had cost £86 per kilowatt. It was now proposed to double the output at a cost for the additional plant of £15 per kw. That would not only make a good profit but would also tend to hasten the time when electricity would be brought within the reach of every ratepayer. The three places selected to visit would be possibly chosen from Manchester, Newcastle, Sheffield, Rugby and a couple of other towns. There were no stations in or near London where turbines had been running for a sufficiently long time for an inspection of them to be of value.

After a long discussion, during which it was stated that there was a profit of £3,000 on the undertaking last year, the report was adopted.

South Bank (Yorks.)—A special meeting of the Council will shortly be held to consider proposals of the Cargo Fleet Iron Co. for the supply of the electricity for public and private lighting in the district.

Stafford.—The Gas and Electricity committee recently recommended the Council to grant an increase of salary to the electrical engineer (Mr. R. E. Meade), but, in view of the lack of employment in the town, Mr. Meade has withdrawn for six months his application for an increase of salary, to which he considers he is fairly entitled.

Stepney (London).—On Wednesday the Council reversed its previous decision to use Nernst lamps for lighting a portion of White Horse-street. A portion of the street is already lighted by arc lamps, and it has now been decided to have a uniform system of lighting. A licence is to be obtained from the Crown at £3. 10s. per annum for the mains laid within the precincts of the Tower of London

Thornaby-on-Tees.—A committee has been appointed to consider an offer by the Cleveland & Durham County Electric Power Co. to take a transfer of the Council's electric lighting order, 1902.

Tokens on Tramways.—Celluloid counters representing home coin values will shortly be issued for use in payment of fares on London County Council's tramways.

Torquay.—The adjourned inquiry into the application of the Council for permission to borrow £42,200 for the erection of new electricity works was held last week.

The inspector (Mr. H. Ross Hooper, C.E.), stated that from the detailed information now supplied it was clear that thousands of pounds would practically have to be placed to a loss account, in superseding the existing station and the capital outlay on building, and, to a certain extent, on the plant. He had seen the plant, and ascertained what it was proposed to do. The electrical engineer (Mr. P. Storey) was making the most of what he had, and the question remained that there would probably be between £8,000 and £9,000 to be deducted from the present application and transferred to revenue account.

The town clerk (Mr. F. S. Hex) said it was impossible that £9,000 could be charged against revenue, especially against one year's revenue. The question was whether it would not involve the opening of a suspense account for a few years. He suggested, seeing that the success of the electric lighting undertaking had been demonstrated by the user of the present site for the generating station, that the amount of the loans contracted for that purpose should remain to be dealt with as now, that principal and interest should go on as though no alteration had taken place, and that the Corporation should also pay the principal and interest on the fixed charges necessary for the new loan. If neither of these two proposals could be adopted, there would remain another suggestion, that they should go on with the works, and in the meantime steps should be taken with a view to obtaining a provisional order for the amendment of the Torquay electric lighting order, 1891, and to get extraordinary borrowing powers with regard to a probable deficit. The demand on the present generating station had outgrown the supply, and it was absolutely necessary for a new station to be provided, apart from the question of supplying current for the tramways. The Corporation had a contract with the Dolter Electric Traction Co., to supply electric energy and under that arrangement the Corporation thought they had obtained a good customer.

Evidence of the financial position of the undertaking was also given by Mr. Hex and by the chairman of the Electric Lighting committee (Mr. Taylor). Technical details of the generating plant at the new station were supplied by Mr. P. Storey.

Trade Unions and Electricity Supply Works.—A deputation from the Amalgamated Society of Engineers recently complained of the non-employment of bona-fide engine fitters at Plymouth electricity works.

The report of the Electricity and Street Lighting committee submitted at last week's Council meeting included a minute which recommended that the society be informed that the existing arrangements were conducive to the efficient working of the undertaking, and the committee saw no reason to interfere therewith, but if in future the association desired to make any specific complaint, the committee would give it consideration.

The report was adopted.

Westhoughton (Lancs.)—The District Council has signed an agreement with the Lancashire Electric Power Co. for the supply of electric energy in bulk for all purposes. It is expected that supply will be available in about four months, and that a considerable demand will arise for energy for power in this important coal-mining and manufacturing district.

Willesden.—The Council have received sanction to borrow £2,801 to meet excess expenditure on the electricity undertaking and £15,000 for extensions of mains. The total amount now sanctioned is £157,441, and the Council has borrowed £125,600. On Tuesday it was resolved to borrow the balance (£31,841) from the Union Assurance Society at £3. 17s. 6d. per cent.

Workhouse Lighting.—Ashton-under-Lyne Guardians have decided to obtain a report from an electrical engineer as to the advisability of putting down independent generating plant at their workhouse.

Bedwellty Guardians are putting down electric lighting plant at the workhouse, and an advertisement inviting tenders appears in another column.

Dinners, &c.—Nottingham Corporation tramway employees, who number about 450, are entertained annually in three sections, and the first gathering took place on Tuesday.

Mr. J. Aldworth (general manager of the tramways) presided, and those present included the Mayor (Ald. J. Bright), Councillor J. Houston, Messrs. A. Brown (city engineer), H. Talbot (electrical engineer), and others.

The Mayor congratulated the drivers on the absence of accidents, and said there was no city of the same size in the kingdom where accidents had been so few. When the tramway undertaking was started the committee were under the impression it was going to be a great financial success, and that they were going to have profits without end. Time, the great sobering element, however, would prove that although the city had a fine property, and the undertaking would pay reasonable profits, it would not pay exaggerated profits.

Half of the Norwich Electric Tramways Co.'s employees were entertained at dinner by the directors on Wednesday evening. The chairman of the company (Baron E. B. d'Erlanger) presided, and said the tramways had carried 7,886,000 people during the past year, and there was a singular immunity from accidents.

The annual social gathering of the employées of Glasgow Corporation tramways department took place on Friday last:—

The Lord Provost (Sir John Ure Primrose, Bart.) referred to the severance of ex-Bailie Paton's long connection with the department and to the excellent work he accomplished as convener of the Tramways committee. After expressing regret at the departure of Mr. John Young for London, he gave some interesting details regarding the working of the tramway system. They were now operating 72½ miles of road. It was estimated that this year there would be an increase of about £30,000 in the revenue. The record weekly income had been reached last week, when the drawings amounted to over £17,000. The staff numbered 4,030, of whom 3,200 were members of the Friendly Society. The Corporation were applying for power to make further extensions, which would add 20 miles to the system. In the workshops they were putting top covers on 100 cars, and they were building 100 additional cars. The superannuation fund was growing steadily, the invested funds now amounting to £9,500. The present annual car mileage was 16,500,000, and the number of passengers carried was 200,000,000. The estimated revenue for this year was £750,000. The weekly wages bill was £5,400.

Electro-Harmonic Society.—A smoking concert will be given this (Friday) evening, at 8 p.m., in the King's Hall of the Holborn Restaurant, London, W.C.

Smoking Concert.—The staff of the St. Helens Cable Co. have inaugurated a series of annual "Smokers," and the first of these was held on the 13th inst., when 120 members participated in the evening revel. All the contributors to the programme, both instrumental and vocal, were members of the staff. Mr. Kenyon, who was to have presided, was, through indisposition, unable to be present. If the result of the smoker in any way approached the hilarity graphically depicted in the very original invitation card prepared by the committee and executed in the company's drawing office, then there was commotion Warrington way last Friday evening.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

West Ham Borough Council invite tenders for the supply of engine room stores, cable, integrating wattmeters, double-pole house cutout boxes, transformers, incandescent lamps and coal. Forms of tender after 26th inst. of the borough electrical engineer (Mr. W. J. Bullock), Central Electricity Station, Tucker-street, Canning Town. Tenders to the town clerk (Mr. Fred. E. Hilleary) by 4 p.m. Feb. 9. See also advertisement.

The Guardians of *Bedwellty* Union invite tenders for a complete electric lighting installation (steam dynamos, booster, battery, switchboard and motors), also cables and wiring at their workhouse, Tredegar. Firms desiring to submit tenders should apply by 25th inst. to the consulting engineers (Messrs. Herbert Lewis & Fletcher), Prudential-buildings, Cardiff. See also an advertisement.

Stockport Tramways committee invite tenders for the overhead equipment of about four miles of electric tramway, and also for copper rail bonds. Drawings may be seen and specification, &c., obtained from the borough electrical engineer (Mr. A. J. H. Carter), Millgate, Stockport. Tenders (addressed to the Chairman of the committee) to the town clerk's office, Stockport, by noon Feb. 6. See also an advertisement.

Stockport Gas and Electricity committee invite tenders, by Feb. 1, for 10 complete feeder pillar boxes with bases.

Stockport Corporation also require tenders by noon, Feb. 6, for the supply of ten double deck tramcars. Particulars from the borough surveyor.

Stockport Corporation further require tenders by noon, 30th inst., for supply of Welsh and Scotch granite setts for their tramway routes. Forms of tender, &c., from the borough surveyor.

Grimsby Corporation invite tenders for motors (from ½ H.P. to 10 H.P.) with starters (two years' contract); water-purifying plant for separating oil from condensed water; and 12 months' supply of oil, stores, arc lamp carbons and globes, incandescent and Nernst lamps, tools, rubber goods and cables, &c. Tenders to Mr. W. A. Vignoles, Electricity Works, Grimsby, for motors and purifier by Jan. 23, and for stores by Feb. 1.

London County Council require tenders by 24th inst. for road-work and plate-laying for their conduit system of Northern tramways in Rosebery-avenue, and a portion of the authorised tramway in St. John Street-road.

Handsworth Urban District Council invite tenders for power and lighting circuits and fittings in generating station, pipework, feed pumps, economiser, &c., and electricity meters. Tenders to the Council House, Handsworth, before noon Feb. 2.

Great Yarmouth Corporation invite tenders for supply and delivery of tramcars, complete with motors, controllers, trolleys, &c., steel poles, trolley wires, insulators, feeder and section pillars, &c. Tenders to the Town Hall, Great Yarmouth, by noon Feb. 2.

Ilford Council invite tenders for extensions to switchboard gallery and steel gangway from engine room to boiler house. Tenders by noon 24th inst.

Southend Corporation invite tenders until Feb. 10 for extension of boiler house.

Keighley Corporation invite tenders (until Jan. 30) for tramcars.

Tenders are invited by the *Norwegian* State Railway Department, Christiania, for the supply of galvanised iron wire 4mm. diameter (8,000kg.) and 3mm. diameter (5,000kg.); also for 4,000 insulators, 500 carbon plates for Leclanché elements and 4,000kg. of sal ammoniac for Leclanché elements. Tenders have to be in by 3 p.m. Feb. 8 to the managers, Statsbanerne, Christiania. It is to be observed that there is a preference of from 10 to 15 per cent. to Norwegian tenderers.

The Town Council of *Porto* (Portugal) notify a competition, which will close on March 15, at 3 p.m., for a concession for the exclusive right of working tramways in the town, on the terms of "Conditions" approved by the Council. Conditions of the competition can be obtained at the Portuguese Consulate, 6, South-street, Finsbury, London, E.C.

The Prussian State Railway authorities, *Cologne*, invite tenders until 31st inst. for 126,900 porcelain insulators, 94 tons of bronze wire, 449 tons of galvanised iron wire, &c. Tenders to Die Königliche Eisenbahn Direction, Cologne.

TENDERS RECEIVED AND ACCEPTED.

Fulham Council have received the following tenders for supply of a 1,000kw. alternator:—

Gen. Electric Co. (*accepted*)	£6,718	Dick, Kerr & Co.	7,090
Brush Co.	7,555	Brit. Thomson-Houston Co.	7,003
Vickers, Son & Maxim	7,545	International Electric Co.	6,995
Electrical Co.	7,535	John Fowler & Co.	6,936
British Westinghouse Co.	7,197	Bruce Peebles & Co.	6,935
British Westinghouse Co. (alternative)	7,357	Mather & Platt	6,910
Electric Construction Co.	7,135	Siemens Brothers & Co.	6,894
		Witting, Eborall & Co.	6,891

A clause was inserted in the specification stating that the Council would not consider any tender for material or work of foreign manufacture, or made abroad and re-erected in this country, unless with the engineer's permission.

Messrs. Mountain & Gibson, Elton Fold Works, Bury, Lancs., have secured the contract from Erith District Council (through the British Westinghouse Co.) for 14 of their M.G. 21 E.M. electric motor trucks for the Council's tramways, and for one sweeping and watering car mounted upon a M.G. 21 E.M. tramway truck, to be built to the specification of the consulting engineers, Messrs. Hawtayne & Zeden.

Erith District Council have accepted the tender of the British Westinghouse Co. for 14 Brush car bodies (Mountain & Gibson trucks and B.W. equipments) at £7,995. 10s., and also for seven Brush top-deck covers at £526. 15s. The same company have received an order for magnetic track slipper brakes at £700 and for track-sweeping and watering car at £626. 10s.

Perth Corporation have accepted the tender of the British Electric Plant Co. for a 500kw. compound traction generator, with engine for same, the combined set having an overload capacity of 600kw.; and the tender of Cowans Limited for traction switchboard. Altogether 44 tenders were received, and the amount of the accepted tenders is about £4,000.

The contract for the supply of electric tramcars to Leith Corporation has been divided between the Brush Co. and the British Thomson-Houston Co. The amount of the former company's tender for the whole of the cars was £19,228 and that of the latter £18,978. 10s. After discussion the contract was divided between the two companies.

Norwich Corporation have accepted the tender of C. A. Parsons & Co. for a 1,000kw. steam turbine generator at £6,400.

Burslem Council have accepted the tender of Babcock & Wilcox for boilers at £1,087 and that of the Electrical Power Storage Co. for storage battery at £780. 15s.

Bermondsey (London) Council have accepted the following tenders:—Chas. Franklin, Birchgrove coal, 20s. 9d. per ton; Hayward Bros. & Eckstein, shutters to boiler house, £34. 5s.; Sweet Bros., wiring clock tower, Rotherhithe Town Hall, £9. 5s.

Southwark (London) Council have placed an order with British Insulated & Helsby Cables (Ltd.) for 440yds. of low-tension triple concentric cable at £96. 5s.

City of London Guardians have accepted the tender of May & Calder to maintain the telephone installation at the offices in Bartholomew-close.

Walter Scott (Ltd.) have secured the contract for the rails of the Stockport Corporation tramways, and the rail joints are to be supplied by the Cooper Patent Anchor Joint Co.

Swinton and Pendlebury Council have accepted the tender of Davenport, Sparrow & Co. for putting the Council offices and the hospital into telephonic communication.

Halifax Council have accepted the tender of J. Sunderland & Co. for electrical work at £114. 10s.

Whitehaven Council have placed an order with J. Ellwood for distilling apparatus for the battery at the electricity works.

East Ham Town Council have accepted the tender of A. Gallenkamp & Co. for chemical apparatus for the new technical college and secondary day school at £348. 7s. 1d. F. E. Becker & Co. also tendered at £368. 13s. 10d., J. J. Griffin & Sons at £377, Baird & Tatlock (London) at £405. 12s. 6d., and Brewster, Smith & Co. at £453. 13s. 3d. The contract for physical apparatus was let to F. E. Becker & Co. at £421. 17s. 6d. J. J. Griffin & Sons tendered at £436. 9s., and Baird & Tatlock at £465. 15s. 5d. The contract for photographic apparatus was awarded to Perken, Son & Co. at £53. 8s. 4d., and that for carpentry, tools, &c., to Pfeil & Co. at £249. 8s. 3d.

Electric Lighting and Power Contracts.—Among the contracts recently placed with Messrs. Foote & Milne, 66, Victoria-street, S.W., are the following:—Pembroke Dockyard, Netley Hospital, King Edward VII's Sanatorium, and for the erection and complete equipment of electricity works at Saffron Walden and Newquay.

BUSINESS NOTICES.

The Union Electric Co., 151, Queen Victoria-street, London, E.C., announce that from Jan. 2 they have taken over the electrical department of Moul & Co., 76-8, York-street, Westminster. This includes Hartmann & Braun measuring instruments, automatic and hand switches, cut-outs, lightning arresters, &c. Mr. H. E. Moul has joined the staff of the company as its technical manager.

Messrs. B. Sherman, F. H. Rogers and D. H. Muston, electrical engineers, &c., 16 and 17, Devonshire-square, London, E.C., have dissolved partnership.

Messrs. W. H. R. Saunders and W. E. O. Williams (trading as J. B. Saunders & Co.) electric engineers, Palmer street, London, S.W., and Cardiff, have dissolved partnership. Mr. Saunders will pay debts relating to the telegraph, telephone and general electric business, and will continue business with new partners, J. H. P. Berthon and S. G. Leech (as J. B. Saunders & Co.) at Palmer-street, London, S.W., and James-street, Cardiff, while Mr. Williams will pay debts of the electric light and electrical engineering part of the business, and will trade as W. E. O. Williams & Co. at West Bute-street, Cardiff.

The Canadian Government has opened a London city office at 73, Basinghall street, E.C., where Canadian books of reference will be available, and where it is proposed in due course to display some of the leading Canadian products and resources.

BANKRUPTCIES, LIQUIDATIONS, &c.

The public examination of H. Coles, electrical engineer, 10, York-street, Swansea, will take place on Feb. 8 at Bankruptcy-buildings, London, W.C.

A first and final dividend of 1s. 5¼d. will be payable on 27th inst. at 24, Railway-approach, London Bridge, in the failure of W. Wenham, electrical engineer, 5, Century-buildings, Croydon.

A first dividend of 3s. will be payable on 30th inst. at 4, Castle-place, Nottingham, in the bankruptcy of A. Smith, lately trading as the Electric Motor Supply Co. at Houndsgate, Nottingham.

A first and final dividend of 11½d. is payable at 22, Park-row, Leeds, on 23rd inst., in the failure of P. J. Murley, formerly fire-alarm contractor, of Leeds and Bradford.

An application for the discharge of Robt. Foster, formerly trading with Walter Baker as Robt. Foster & Co. at Burnley, and as the Nelson Electrical Engineering Co. at Nelson, will be heard on Feb. 16 at the Court House, Burnley. The discharge of Walter Baker has been suspended for two years.

Claims against the Thames Valley Launch Co. (Ltd.) are to be sent by Feb. 14 to Mr. F. J. Saffery, 14, Old Jewry-chambers, London, E.C.

Claims against the British Columbia Telephones (Ltd.) must be sent by Feb. 20 to Mr. M. Brewer, 49, Queen Victoria-street, London, E.C.

Sale by Tender.—The liquidator of the Industrial Storage Battery Synd. (Ltd.) if prepared to sell by tender the whole of the assets and undertaking of the syndicate in one lot. The property consists of a substantially built long-leasehold factory at Reading, specially designed and adapted for the manufacture of storage batteries, with the plant, fixtures and fittings and the goodwill and patent rights for Great Britain in the Elieson storage battery and secret processes connected therewith. An advertisement contains further information, and full particulars and forms of tender may be obtained of Messrs. Ashurst, Morris, Crisp & Co., 17, Throgmorton-avenue, London, E.C., or from the liquidator (Mr. Wm. W. Futcher, C.A.), 103, Gresham House, Old Broad-street, London, E.C.

Plant for Sale.—A number of electric motors are advertised for sale in another column; also four electric drum hoists, complete with controllers. Applications to Messrs. Mayoh & Haley, America Wharf, Townmead-road, Fulham, London, S.W.

Messrs. Mottershead & Co., 7, Exchange-street, Manchester, advertise for sale an E.C.C. booster.

Two 55kw. steam dynamos and a horizontal steam engine are advertised for sale. Applications to the manager, Plaistow Wharf, Victoria Docks, London, E.

Plant Wanted.—Mr. W. Reynolds, 43, Alexandra-rd., Bedford, wishes to hire or purchase a second-hand or new dynamo, giving 45 to 60 amps at 550 volts; also two series-wound motors about 7½ H.P. each.

Premises for Sale, &c.—A freehold factory is to be sold, complying with L.C.C. requirements, and provided with up-to-date improvements, fireproof construction, electric lift, &c., space about 15,700ft. The floor area (five storeys) is about 68,000ft. super. Particulars from Messrs. Leage, auctioneers and surveyors, 10, City-road, Finsbury, London, E.C. See also advertisement.

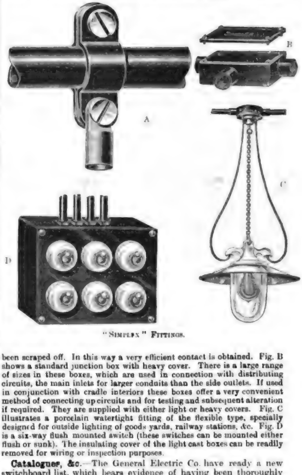
Messrs. Douglas Young & Co., 51, Coleman-street, London, E.C., advertise for sale (or letting on lease) a foundry and workshops, with total ground area of about 6,300ft.

A ground floor, area 2,700 super. ft., equipped with electric power, and suitable for general engineering, is to let. Applications to Messrs. Marshall & Co., Campbell Works, Stoke Newington, London, N. See advertisement.

Electrical Exhibition—*Postponement.*—The electrical exhibition which was to have been held at Islington (London) Baths, Hornsey-road, N., in February-March next has been postponed until October or November. The borough electrical engineer at Islington (Mr. Albert Gay) will, however, be glad to receive applications for space or for advertisements in the catalogue. It is proposed to include electric lighting and power machinery, heating and cooking apparatus, fittings, launches, fountains, illuminations, novelties of all kinds, &c. The space available for exhibitors will be about 4,000 sq. ft. A rental will be charged for space, but current will be supplied free. Particulars from Mr. Gay, 50, Eden-grove, Holloway, N. See also an advertisement.

Simplex Conduits and Fittings.—We referred last week to the issue of a new price list of "Simplex" conduits and fittings, and a companion publication is a Conduit Wiring Handbook, issued by the Simplex Steel Conduit Co. In this full particulars and tables relating to wiring work on the "Simplex" system are fully set out. We may refer again to the new price list in order to call attention to several items which deserve special note.

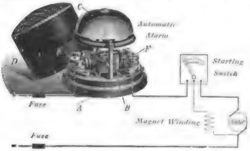
Fig. A shows the "Simplex" earthing grip made for all sizes of conduits from ⅝in. to 2in., and consisting of two stout metal bands screwed together over a part of the conduit from which the enamel covering has been scraped off. In this way a very efficient contact is obtained. Fig. B shows a standard junction box with heavy cover. There is a large range of sizes in these boxes, which are used in connection with distributing circuits, the main inlets for larger conduits than the side outlets. If used in conjunction with cradle interiors these boxes offer a very convenient method of connecting up circuits and for testing and subsequent alteration if required. They are supplied with either light or heavy covers. Fig. C illustrates a porcelain watertight fitting of the flexible type, specially designed for outside lighting of goods yards, railway stations, &c. Fig. D is a six-way flush mounted switch (these switches can be mounted either flush or sunk). The insulating cover of the light cast boxes can be readily removed for wiring or inspection purposes.



"SIMPLEX" FITTINGS.

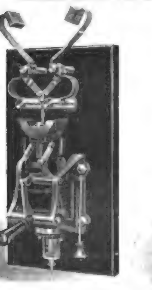
Catalogues, &c.—The General Electric Co. have ready a new switchboard list, which bears evidence of having been thoroughly overhauled, and every effort has been made to include within the 50 odd pages of which it consists all information likely to be required on the subjects of switchboards, traction panels, feeder pillars, excitation columns, motor and accumulator boards and switch gear. The illustrations show clearly a large variety of this apparatus, including some large switchboard installations put in by the company for a variety of special work. This particular section of the company's full catalogue has been rendered necessary by the demand for panels for traction and lighting systems necessitating a considerable addition to this department of the company's business.

The Adnil Electric Co., of 6, Victoria-avenue, Bishopsgate-street Without, London, E.C., have ready a catalogue and price list of **automatic overload alarms.** Full details of the design and use of this apparatus are given. This alarm does not stop the motor when the overload for which it is adjusted has been reached, but merely gives a warning by ringing a bell, so that the earliest convenient opportunity may be taken to relieve the motor of its overload. The interior of the alarm is shown in the accompanying illustration. It is placed in series with the main supply to the motor, and the essential part consists of a coil through which the drop of pressure varies from ½ to one volt. The moment the drop of pressure through the coil has reached the latter figure (due to the overload) a small current passes through the coils B, and attracts the armature of the relay, closes a local circuit through the coils of the electric bell, and causes it to ring. The instrument can also be employed to indicate overload on dynamos, excess current from accumulators and abnormal increase of current through arc lamps, &c.



ADNIL AUTOMATIC OVERLOAD ALARM.

A neat price list of **switches and switchboards, fuses, circuit breakers, &c., of standard** patterns up to 11,000 volts has been issued by **Messrs. Lionel Robinson & Co., of Ferry Works, Thames Ditton, Surrey**, and can be obtained by the trade from the firm direct or from their London offices and representatives, Messrs. Frampton & Paine, 29, Old Queen-street, Westminster, S.W. The illustrations herewith show an automatic circuit breaker fitted with a loose arm, and having laminated contacts and carbon break. The arm has an arrangement for making the final break with carbon, and the carbon pieces are so arranged that the arc flies upwards and disperses itself harmlessly. The circuit is closed by means of the loose arm, making it impossible to close the circuit on an overload, and doing away with the necessity for a single-pole switch in the circuit.



Messrs. Mather & Platt, Salford Iron Works, Manchester, have issued the fifth edition of their pocket catalogue and tables. In this catalogue the list of machines has been brought up to date, and several types not previously included have been added. There are also a number of additional tables in the second section of the catalogue, making the list, strongly bound in pocket form, a most useful pocket companion.

The Electrical Co., 121-125, Charing Cross-road, London, W.C., have ready seven illustrated sheets of polyphase motors and generators for belt driving and for belt driving or direct coupling.

The latest publications of the Electrical Co., 121-125, Charing Cross-road, London, W.C., include (1) a Nernst lamp card, (2) a price list of sections D and E of the company's main catalogue dealing with slow-speed continuous-current dynamos and motors. The Nernst lamp card claims that there are 3,000,000 of these lamps now in use.

A further list of Empire roller bearings has been issued by the Empire Roller Bearings Co., 15, Victoria street, Westminster, S.W. A list of the tramways and railways which are using these bearings includes a large number of electrical lines.

J. S. Fairfax & Co., Essex-street, London, W.C., have issued a list of new types of reduction gear, under the title of "Direct Driving from High-speed Shafts at Low Speeds." The list is illustrated, and some useful notes on the subject of direct driving are given.

Single-pole circuit-breakers for continuous-current circuits up to 550 volts are illustrated and described in a circular list issued by Ernest F. Moy (Ltd.), Camden Town, London, N.W.

The Brush Company have issued a neat pamphlet illustrating Brush canopies for tramcars.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Jan. 11 to 17, with the ports of destination :—

Africa—Alexandria, £198 (telegraph material); Beira, £12; Cape Town, £227 (including £115 telegraph material); Durban, £936 (including £484 telegraph material); Mombasa, £56 (including £35 telegraph material); Port Elizabeth, £75. *Argentina*—Buenos Ayres, £355; Rosario, £3,153. ***Australasia***—Adelaide, £968; Melbourne, £428; Perth, £518; Sydney, £130; Wellington, £887 (including £660 telegraph material). *Belgium*—Ostend, £58. *British Guiana*—Demerara, £7. *Canada*—Halifax, £18 (telegraph material); Toronto, £70. *Ceylon*—Colombo, £11. *China*—Canton, £105; Shanghai, £139. *Germany*—Hamburg, £18 (telegraph material). ***Holland***—Amsterdam, £738. *Hong Kong*, £544. *India*—Bombay, £211; Calcutta, £245; Madras, £41). *Japan*—Yokohama, £375. *North Atlantic*, £4,575 (submarine cable). *Russia*—St. Petersburg, £380 (telegraph apparatus). *Siam*—Bangkok, £2,610. *Spain*—Bilbao, £14. *Straits Settlements*—Penang, £22. Singapore, £18. *Sweden*—Stockholm, £11. *United States*—New York, £25. *West Indies*—Trinidad, £13. *Zanzibar*, £24,960 (telegraph cable). Total £43,151, against £26,064 in corresponding week last year (Jan. 13 to 19).

CITY NOTES.

MEMORANDA (Jan. 19).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 27[illegible]d. per oz. Consols 88$\frac{1}{4}$–88[illegible] for money, 88[illegible]–88[illegible] for account; 2$\frac{1}{2}$ per cent. annuities 87[illegible]–87[illegible]. Consols Pay Day, Feb. 1. Stocks and Shares Continuation Days, Jan. 25 and Feb. 7; Ticket Days, Jan. 26 and Feb. 3; Pay Days, Jan. 27 and Feb. 9; Mining Share Carry-over Days, Jan. 24 and Feb. 6.

CENTRAL LONDON RAILWAY CO.—The general meeting will be held on Feb. 8.

CITY & SOUTH LONDON RAILWAY CO.—The directors have declared a dividend on the ordinary stock for the past half-year at the rate of 1[illegible] per cent. per annum, £1,500 being placed to renewal fund and £1,149 carried forward. Last year the dividend was at the rate of 2 per cent. per annum, the same amount being placed to renewal fund and £746 carried forward.

DIRECT UNITED STATES CABLE CO. (LTD.)—The report of the directors for the six months to Dec. 31 last states that the half-year's revenue, after deducting out-payments, amounted to £51,029. 12s. 10d., compared with £47,814. 16s. 4d. for the corresponding period of 1903, an increase of £3,214. 16s. 6d. Working and other expenses (including income tax) amounted to £22,108. 6s. 1d., leaving £28,921. 6s. 9d. as net profit, or with £2,168. 1s. 1d. brought forward, £31,089. 7s. 10d. For the corresponding period of 1903 working expenses and other payments amounted to £21,816. 3s. Interim dividends of 3s. per share for the quarter ended Sept. 30, and of 3s. per share for the quarter ended Dec. 31 (requiring £18,213) have been declared, and after setting aside £10,000 to reserve, the balance of £2,876 7s. 10d. has been carried forward. Reserve has been debited with £8,477. 0s. 11d. for cost of cable repairs, and after being credited with interest on investments and amount now set aside amounts to £172,964. 12s. 1d., taking the investments at cost price. The establishment of a pension scheme for the company's staff, to take the place of the existing system of endowment assurances, is recommended by the directors, and particulars of the scheme will be submitted to the forthcoming shareholders' meeting.

DUBLIN UNITED TRAMWAYS CO. (1896) (LTD.)—For the half year ended Dec. 31 the amount available for division is £50,318, out of which

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Jan. 14	1,060	+ 9	88	46,719	+ 5,811
Airdrie	,, 6	288	...	48	9,457	...
Ayr Corporation	,, 14	169	+ 8	26	12,229	+ 580
Barnsley	,, 6	154	+ 21	1	154	+ 21
Barrow	,, 6	179	...	46	9,518	...
Bath Electric Trams, Ltd.	,, 11	56[illegible]	+ 102	2	1,116	+ 290
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 8	1,065	+ 36	2	2,089	- 18
	,, 15	964	- 69			
Birmingham Corporation	,, 14	884	...	54	16,540	...
Birmingham Tramways Co.	,, 13	5,590	+ 567	2	11,134	+ 1,061
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 15	830	+ 63	41	44,179	+ 6,085
Blackpool and Fleetwood	,, 14	168	- 8	2	318	- 61
Blackp'l, St. Anne's & Lytham	,, 12	121	- 14	¶11	1,364	- 241
Bolton Corporation	,, 15	1,591	- 57	42	77,158	+ 411
Bournemouth Corporation	,, 11	906	+ 19	‡41	45,091	+ 2,177
Bradford Corporation	,, 14	3,780	+ 410	39	164,906	+ 20,318
Brighton Corporation	,, 15	758	+ 12	41	44,004	+ 3,509
Brisbane Tramways	Nov. 23	2,311	+ 26	22	53,863	+ 362
	,, 30	2,338	- 231			
Bristol Trams & Carriage	Jan. 13	4,651	+ 114	23	178,467	+ 2,115
Buenos Ayres & Belgrano	Dec. 11	3,363	+ 91	9	29,412	- 297
	,, 18	3,078	+ 199			
Burnley Corporation	Jan. 14	994	+ 217	15	2,466	+ 3,067
Burton Corporation	...	...	...	...	...	...
Calcutta Tramways Co.	,, 14	R44,018	+ R6,272	2	R92,850	+ R16,018
Camborne-Redruth	,, 16	96	- 4	11	1,204	- 206
Cardiff Corporation	...	...	...	...	...	...
Carlisle Tramways Co.	,, 14	151	- 17	2	341	- 4
Central London Railway	,, 14	7,262	+ 305	2	14,377	+ 266
Chatham & Dist. Lt. Rys.	,, 13	603	+ 92	2	996	- 15
City & South London Rly.	,, 15	3,062	- 97	3	9,464	- 102
Colchester Corporation	,, 12	168	...	24	5,979	...
Cork Electric Trams Co.	,, 13	4 9	+ 13	2	812	- 96
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 6	498	+ 25	1	498	+ 25
Dover Corporation	,, 14	170	...	42	9,400	- 120
Dublin & Lucan Railway	,, 13	100	+ 18	2	183	+ 18
Dublin Southern District	,, 13	761	+ 52	2	8,438	+ 179
Dublin United	,, 13	3,798	+ 61			
Dudley—Stourbridge	,, 6	783	+ 36	1	783	+ 36
Dundee Corporation	,, 11	885	+ 54	¶38	29,018	+ 226
East Ham Council	,, 14	614	+ 27	41	29,533	+ 1,591
Gateshead & Dist. Trams	,, 6	977	+ 144	1	977	+ 144
Glasgow Corporation	,, 14	15,838	+ 674	†33	471,094	+ 23,130
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 6	183	- 19	1	183	- 19
Gt. Northern & City Rly.	,, 14	1,568	+ 13	2	3,163	...
Greenock & Port Glasgow	,, 6	688	+ 166	1	668	+ 166
**Halifax Corporation	,, 11	2,497	+ 324	41	61,812	+ 4,516
Hartlepool Tramways	,, 6	287	+ 44	1	287	+ 44
Huddersfield	,, 14	1,201	+ 66	41	56,616	+ 3,610
Hull Corporation	,, 14	2,166	+ 108	41	90,564	+ 10,871
Ilford District Council	,, 14	365	+ 31	¶41	15,765	+ 923
Ilkeston Corporation	,, 11	102	- 12	15	1,668	- 259
Ipswich Corporation	,, 14	834	+ 27	41	19,794	...
Isle of Thanet Co.	,, 14	233	+ 66	16	9,091	- 117
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	,, 6	93	+ 3	1	93	+ 3
Kirkcaldy Corporation	...	...	...	...	...	...
Lanarkshire Trams Co.	,, 13	569	+ 63	2	1,393	+ 23
Leeds Corporation	,, 14	5,217	+ 570	41	243,091	+ 13,748
Leicester Corporation	,, 14	1,707	...	2	3,450	...
Liverpool Corporation	,, 7	10,274	+ 630	1	10,274	+ 630
Liverpool Overhead Rly.	,, 15	1,480	- 39	3	4,414	- 312
London County Council	,, 7	12,089	+ 3,363	§40	513,921	+ 400,916
Lowestoft	,, 16	136	...	2	272	...
Maidstone Corporation	,, 12	97	...	26	2,687	...
Manchester Corporation	,, 14	11,558	+ 1,027	41	502,091	+ 22,091
Mersey Railway	,, 14	1,643	+ 149	2	3,307	+ 233
Merthyr	,, 6	171	+ 1	1	171	+ 1
Metropolitan Elec. Trams	Dec. 31	847	...	26	49,263	+ 15,285
Middleton	Jan. 6	269	+ 34	1	269	+ 34
Nelson Corporation	,, 14	103	+ 12	42	4,912	+ 1,825
Newcastle-on-Tyne Corp.	,, 14	3,893	- 85	2	7,137	+ 919
Newport (Mon.)	,, 7	530	+ 109	15	7,671	+ 1,101
	,, 14	521	+ 97			
Oldham, Ashton & Hyde	,, 6	490	+ 23	1	490	+ 23
Oldham Corporation	,, 15	1,964	+ 303	42	52,211	+ 2,870
Perth (W. A.) Elec. Trams	,, 15	1,467	+ 42	2	2,759	+ 104
Peterborough	,, 6	107	- 6	1	107	- 6
Poole and District	,, 6	229	+ 8	1	229	+ 8
Portsmouth Corporation	,, 14	1,465	+ 109	§40	80,417	+ 6,841
Potteries	,, 6	1,718	+ 253	1	1,718	+ 253
Reading Corporation	,, 14	575	+ 29	2	1,169	+ 105
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 6	66	+ 18	1	66	- 18
Salford Corporation	,, 16	3,736	+ 236	41	109,107	+ 8,429
Sheerness	,, 4	61	+ 12	1	61	+ 12
Sheffield Corporation	,, 15	4,350	+ 101	†43	193,543	+ 4,894
Southampton Corp'ation	,, 14	859	- 2	41	40,369	- 2,104
Southend Corporation	,, 11	524	+ 37	41	14,863	+ 1,494
Southport Tramways	,, 6	256	+ 24	1	256	+ 24
S. Staffordshire Trams.	,, 6	650	- 8	1	650	- 8
Stockport Corporation	,, 12	412	+ 63	41	22,984	+ 8,146
Sunderland Corporation	,, 15	1,055	+ 75	41	52,568	+ 1,397
Swansea Trams	,, 6	467	+ 17	1	467	+ 17
Taunton Trams	,, 6	42	- 5	1	42	- 5
Tynemouth and District	,, 6	190	- 10	1	190	- 10
Tyneside Trams Co.	,, 11	316	+ 68	2	625	+ 74
Wallasey District Council	,, 14	653	+ 59	§41	31,110	+ 2,116
Walsall	,, 14	436	...	8	874	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 13	1,110	...	46	44,236	...
Weston-super-Mare	,, 4	27	+ 9	1	27	+ 9
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 6	860	+ 59	1	860	+ 59
Worcester	,, 6	271	+ 167	48	14,748	+ 7,500
Wrexham	,, 6	91	+ 2	1	91	+ 2
Yorkshire Woollen District	,, 6	532	+ 65	1	532	+ 65

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. ** Fortnight. ‖ One day.

the preference dividend and a dividend at the rate of 6 per cent. per annum, tax free, on the ordinary shares will be paid. It is proposed to write off £3,365. 7s. 3d. balance of cost of electric welding of the Dalkey line, to place £4,000 to reserve and £1,000 to the accident insurance fund, leaving £6,847. 13s. 6d. to be carried forward.

EASTERN TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended Sept. 30 last states that the revenue amounted to £589,386. 6s. 2d., from which are deducted £178,269. 13s. 7d. for ordinary expenses and £41,847. 17s. 7d. for expenditure relating to maintenance of cables, depreciation of spare cable, sundry differences in exchange and income tax payable abroad, leaving a balance of £369,268. 15s., to which is added £1,233. 13s. 10d. brought forward, leaving an available balance of £370,502. 8s. 10d. After providing for income tax payable in England, interest on loan from Eastern & South African Telegraph Co., debenture interest and for two quarterly preference dividends, absorbing in all £97,870. 9s. 11d., there remains £272,631. 18s. 11d., out of which the directors have placed £12,000 to reserve for maintenance ships, £125,000 to general reserve and allocated £100,000 to meet the two interim dividends of 1¼ per cent. each on the ordinary stock, the balance of £35,631. 18s. 11d. being carried forward.

KERNST ELECTRIC LIGHT CO. (LTD.)—For year ended Sept. 30 last the profit was £4,840. 1s. 6d., subject to depreciation. The directors have carried through the scheme for the reduction of capital. The suspense account having been written off, the profits made are available for distribution, and the directors propose that a dividend be paid at the rate of 3½ per cent., that £1,250 be allocated to patent depreciation reserve, £100 to further depreciation of investments, and that £349. 3s. 6d. be carried forward.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—Resolutions have been passed by the several classes of shareholders of this company whereby the rights of the shareholders have been so far modified as to extinguish the special privileges attaching to the "first issue" ordinary shares, and also converting the 6 per cent. preference into 5 per cent. preference shares.

PORTSMOUTH STREET TRAMWAYS CO.—At the meeting last week the Gosport and Alverstoke Tramways Bill was approved.

SOUTH LONDON ELECTRIC SUPPLY CORPN. (LTD.)—During the quarter ended Christmas, the company sold 2,546,868 units, realising £21,760, compared with 2,009,230 units, realising £18,230 in the corresponding quarter of 1903.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have been asked to appoint a special settling day in and grant a quotation to a further issue of 11,222 £1 fully-paid shares of the *Cape Electric Tramways (Ltd.)*, and also to allow a further issue of £29,000 sterling 500-year 4 per cent. redeemable debenture stock of the *Commercial Cable Co.* to be quoted.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., Jan. 18.	Rate per cent. yielded.	Dividend due.	Highest.	Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	2/0	Anglo-Argentine Ord. Shares	5½-5¾	5 9 10	Ap, Oc	5¾	5⅜
5	2/6	Do. 5% Cum. Pref.	6¼-6¾	4 7 0	—	6⅝	6⅜
St.	6%	Do. Permanent 6% Deb. Stock	140-143	4 3 11	—	105	104½
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104-106	4 15 3	—	..	..
10	6%	Barcelona Tramways Ord.	12-12½	5 8 0	—	12¼	12⅛
10	5/0	Do. 5% Cum. Pref.	9¾-10	5 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	96-100	4 10 0	—	..	..
100	5%	Do. 5 per Cent. Debs.	99-102	4 19 8	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1¾-2	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾-4¼	4 17 8	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	94-96	4 11 10	..	94	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	100-106	5 16 8	—	..	..
St.	5%	Do. Pref. Ord. Stock	100-103	4 17 2	—	..	..
10	5/0	† Do. 5% Cum. Perp. Pref.	10-10½	4 10 11	—	..	..
[illegible]	4½%	Do. 4½ per Cent. 1st Mort. Dbs	103%-104%	4 6 9	—	..	..
100	4½%	† Do. Vancouver Power Debs.	97-100	4 10 0	..	..	..
5	1/6	Buenos Ayres and Belgrano Ord.	4½-4¾	6 2 10	—	4⅞	4½
5	3/0	Do. 6 per Cent. "A" Cm. Pref	6¼-6½	4 18 1	—	6	6⅛
5	3/0	Do. "B"	5¾-6¼	5 6 8	—	6⅛	5⅞
St.	5%	Do. 5 per Cent. Debs.	105-107	4 13 6	—	..	..
St.	6%	Do. 6% 2nd Deb. Stock Prov. Certs.	101-104	4 16 2	—	103½	..
St.	6%	Buenos Ayres Elec. Trams (1901) Ltd.	94-97	6 3 1	..	..	..
5	3/0	Calcutta Tramways	8¼-8¾	3 7 6	—	8⅝	8⅛
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106-108	4 3 4	—	..	..
1	0/6	† Cape Electric Tram Shares	1⅝-1¾	3 14 0	..	1⅝	1⁹⁄₁₆
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	102-104	4 18 1	..	102½	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	101-103	4 17 8	Ja, Jul	..	..
100	5%	Montreal St. Ry. St'g 5% Mort Debs. (1908)	100-103	4 17 8	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103-105	4 5 9	..	..	..
St.	6%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	101-104	4 16 2	..	..	..
		ELECTRICITY SUPPLY.					
5	3/0	Calcutta Electric Supply Ord.	8¼-8¾	3 14 6	..	8⁹⁄₁₆	..
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	86-91	5 9 11	—	..	..
10	..	Havana Electricity Co. Shares	9¾-10¼	—	—	10⅛	10¼
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	⅝-⅞	..	—	½	..
1	..	Rand Electric	1-1⅛	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	100-102	4 8 9	Ap, Oc	..	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share.	Last Dividend.	Name.	Price Wed. Jan. 18.	Rate per Cent. Yield. £ s. d.	Dividend Due.	Business Week to Jan. 18. Highest.	Lowest.
1	6%	Bath Elec. Trams Pref. Ord.	1½—1¾	..	..	..	..
1	11·4d	Do. 5% Cum. Pref.	¾—1	5 0 0	..	1	..
10	4%	Bristol Tramways and Carriage Ord.	19—20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10—10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106—108	3 14 0	Feb, Aug	..	..
10	8/0	British Electric Traction Ord.	9½—10½	5 14 4	..	10½	9½
10	6/0	Do. 6 per Cent. Cum. Pref.	11—11¼	5 6 8	Feb, Aug	11⅛	11⅛
St.	5%	Do. 5 per Cent. Perpetual Debs	118—120	4 3 4	..	119½	119
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	97—99	4 10 11	..	98½	97¾
St.	4%	Central London Ordinary Stock	91—93	4 6 0	June, Dec	93	92¼
St.	4%	Do. 4 per Cent. Pref. Stock	101—103	3 17 9	..	102½	101½
St.	4%	Do. Deferred Stock	85—87	4 12 0	..	85¾	..
100	4%	† Do. 4 per Cent. Debs.	107—109	3 13 5	..	108½	108½
5	2/6	City of Birmingham Trams 5% Cm. Prf.	4¾—5¼	4 17 6	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100—103	3 16 5	..	..	..
St.	2¼%	City and South London Rly. Con. Ord.	45½—46½	4 16 10	Feb, Aug	46¼	46
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122—125	4 0 3	Feb, Aug	..	..
St.	5%	Do. (1896)	118—121	4 2 8	..	120	..
St.	5%	Do. (1901)	117—120	4 3 4	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104—107	3 14 9	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13¾—14¼	4 2 9	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15¾—16¼	3 12 9	..	..	..
10	3 0¼	Gt. Northern & City Rly. Prf. Ord. (4%)	6½—6¾	4 8 10	..	6¾	6¾
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8½—9½	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19—20	5 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	15—15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	110—112	4 0 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90—93	4 6 0	..	..	..
10	1½%	Liverpool Overhead Railway Ord	3¼—3½	5 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10—10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10—10½	4 18 0	..	10¼	10¼
St.	4%	Do. 4% 1st Mort. Deb. Stock	103—106	3 18 2	..	104¼	..
St.	..	Mersey Con. Ord. Stock	6—9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10—13	..	..	..	..
1	..	Metropolitan Electric Trams Def	½—¾	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	1⅛—1¼	4 17 0	..	..	..
St.	4½	Do. 4½% Deb. Stock	103—106	4 5 9	..	104½	103½
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—1½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	8—9	5 11 2	..	8½	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99—102	4 8 3	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London	97½—98½	5 1 6	..	98½	97½
St.	3%	Waterloo and City Ord.	90—92	3 5 3	June, Dec	..	..

TELEGRAPHS.

Share.	Last Dividend.	Name.	Price Wed. Jan. 18.	Rate per Cent. Yield. £ s. d.	Dividend Due.	Business Week to Jan. 18. Highest.	Lowest.
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	99—102	4 0 0	Jan, July	..	..
20	..	Amazon Telegraph	¾—1¼	..	Jn, Dec	..	..
St.	12/6	Anglo-American	57—58	4 10 8	F,My,Ag,N	57½	..
St.	25/0	Do. Preferred	103—104	5 1 0	F,My,Ag,N	104	103½
St.	2/0	Do. Deferred	12¾—13¼	0 14 6	F,My,Ag,N	13⅛	12¾
100	£2	Commercial Cable Capital Stock	170—180	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95—97	4 2 6	Jn,Ap,Jy,O	96½	96½
10	5/0	Cuba Submarine Ord.	8¾—9¼	5 8 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16½—17½	5 14 3	Feb, Aug	..	..
5	2/0	Direct Spanish Ord	3½—3¾	5 11 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7¾—8¼	6 1 3	April, Oct	..	..
60	4½%	Do. 4½ per Cent. Deb.	100%—102%	4 10 0	Jan, July	..	..
20	8/0	† Direct United States Cable	10¼—10¾	5 10 4	Ja,Ap,Jy,O	10½	10½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99—101	4 9 1	Jn, Dec	100	..
St.	25/0	† Eastern Ordinary	134—137	5 2 2	Ja,Ap,Jy,O	137½	134½
St.	17/6	† Do. 3½ per Cent. Pref. Stock	87—89	3 18 8	Ja,Ap,Jy,O	89½	88
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105—107	3 14 9	May, Nov	106	106½
10	2/6	† Eastern Extension	13½—14	5 0 0	Ja,Ap,Jy,O	13¾	13¾
St.	4%	Do. 4 per Cent. Deb. Stock	106—108	3 14 3	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	101—103	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 5	May, Nov	101½	101½
10	5/0	Great Northern (of Copenhagen)	29½—29¾	5 1 2	Jan, July	..	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	99—101	4 9 1	June, Dec	..	..
25	12/6	Indo-European	45—47	5 6 5	May, Nov	46¾	46½
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	86—89	4 10 11	June, Dec	..	—
10	4/0	West African Telegraph Shares	7½—7¾	5 9 2	—	..	..
2½	..	West Coast of America	[illegible]	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	98—100	4 0 0	Jan, July	..	..
10	..	West India and Panama	½—¾	..	May, Nov	..	..
10	7/0	Do. 6 1st Pref. ex 7 - on act. of arrears	7½—7¾	7 17 6	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	6¾—7¼	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101—103	4 17 1	Jan, July	101½	..
10	3/0	Western Telegraph	13½—14	5 0 0	Mr,Jn,O,D	13⅞	13¾
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101—103	4 17 1	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	100—102	3 18 6	—	..	..

TELEPHONES.

Share.	Last Dividend.	Name.	Price Wed. Jan. 18.	Rate per Cent. Yield. £ s. d.	Dividend Due.	Business Week to Jan. 18. Highest.	Lowest.
5	3/0	* Chili Telephone (fully paid)	6—6½	5 14 3	August	6½	6½
1	0/7½	Monte Video Telephone Ord.	1⅛—1¼	2 11 9	..	..	..
St.	6%	National Co. Pref. Stock	105½—107½	5 9 7	..	106½	105½
St.	6%	Do. Def. Stock	103—105	4 12 6	..	104	100½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	15—15½	4 0 0	Feb, Aug	14	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12—13	4 12 4	Feb, Aug	12¾	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5¾	4 10 11	Feb, Aug	5½	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	96—98	3 11 6	June, Dec	97½	97¼
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101—103	3 17 8	..	102½	101½
..	24/0	Do. Do. Prov. Certs, all paid	101—103	3 17 8	..	..	..
1	0/7½	Oriental	1—1¼	5 18 6	April, Oct	..	—
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼—1½	4 16 0	..	..	..
St.	20/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	100—103	..	..	..	..
5	3/0	United River Plate	6½—6¾	6 18 6	July	6½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5¼	4 17 9	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104—106	4 14 4	June, Dec	105	..

FINANCIAL, INVESTMENT, &c.

Share.	Last Dividend.	Name.	Price Wed. Jan. 18.	Rate per Cent. Yield. £ s. d.	Dividend Due.	Business Week to Jan. 18. Highest.	Lowest.
5	3/0	Elec. & Gen. Investment 5% Cum. Pref.	4¾—5¼	4 17 1	—	..	—
10	2/0	Globe Telegraph and Trust	10½—10¾	5 6 8	Ja,Ap,Jy,O	10¾	10⅝
10	3/0	Do. 6 per Cent. Pref.	14—14½	4 3 9	Ja,Ap,Jy,O	14⅜	14¼
100	6%	Submarine Cables Trust (Cert.)	120—125	4 18 4	April, Oct	121½	..

ELECTRICITY SUPPLY.

Share.	Last Dividend.	Name.	Price Wed. Jan. 18.	Rate per Cent. Yield. £ s. d.	Dividend Due.	Business Week to Jan. 18. Highest.	Lowest.
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12—12½	6 8 0	..		
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10	4 10 0	..		
10	6/0	Do. 6% Cum. Second Pref.	11—12	5 0 0	—		
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103—105	4 5 9	—		
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5¼—5¾	3 9 7	..		
St.	4½%	Do. Do. 1st Debs	101—104	4 7 0	—		
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..		
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 6 1	Mar, Sept		
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105—108	3 14 1	..		
5	4/0	Charing Cross & Strand Electric Sup.	8½—8¾	4 11 6	Feb, Aug		
5	2/3	Do. 4½ per Cent. Pref.	5¾—6¼	3 16 8	Feb, Aug		
St.	4%	Do. 4% Deb. Stock (red.)	101—103	3 17 8	..		
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	—		
5	2/3	Do. Do. (1903)	4¾—5	4 10 0	..		
5	2/3	Chelsea Electric Supply Ord.	6¾—7	4 2 2	March		
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108—110	4 1 10	Jn, Dec		
10	5/0	City of London Electric Lighting Ord.	11—11½	4 7 9	Feb, Aug		
10	6/0	Do. 6 per Cent. Cum. Pref.	13½—14	4 5 9	Jan, July		
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123—125	4 0 0	Jn, Dec		
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101—103	4 7 3	..		
10	4/0	County of London Elec. Supply Ord.	9—9½	4 4 2	..		
10	6/0	Do. 6 per Cent. Cum. Pref.	12—12½	4 16 0	Mar, Sept		
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107—110	4 1 10	..		
St.	4½	Do. Second Deb. Stock Prov. Certs.	101—103	4 7 5	..		
5	2/0	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 9	—		
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	102—105	4 7 0	—		
5	3/6	Hove Electric Lighting Ord.	7½—8	5 6 3	..		
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	100—102	4 8 9	..		
5	5/0	Kensington & Knightsbridge Ord	12½—13	4 12 4	..		
5	6%	Do. 6 per Cent. 1st Pref.	6¾—7	4 5 9	Jan, July		
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102—104	3 17 3	—		
5	..	London Electric Supply Ord.	2½—3	..	—		
5	3/0	Do. 6 per Cent. Pref.	5⅞—6⅛	5 3 3	..		
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96—98	4 1 8	Mr,Jn,S,D		
10	9/0	Metropolitan Electric Sup. Ord.	18—18½	5 0 0	April, Oct		
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½—5¾	4 0 0	Jan, July		
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110—116	3 18 3	Jn, Dec		
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96—99	3 11 3	..		
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	92—95	4 18 0	..		
10	[illegible]	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	13½—13¾	6 7 1	Feb, Aug		
5	8%	Newcastle Elec. Supply Ord.	8—8½	4 18 5	Feb, Aug		
5	5%	Do. 5 per Cent. Non. Cum. Pref.	6½—6¾	4 0 0	Feb, Aug		
1	..	Northern Counties Elec. Sup. 17/- paid	15/3—16/9	3 6 8	Mar, Sep		
10	6/0	Notting Hill Electric Ord.	14½—15	4 0 0	March		
100	4%	Do. 4 per Cent. 1st Mt. Debs.	102—104	3 17 0	..		
5	2/6	Oxford Electric Ord.	6¼—6¾	5 2 2	March		
St.	4%	† Do. 4% Deb. Stock	95—100	4 0 0	..		
5	6/0	St. James' & Pall Mall Elec. Ord.	13½—14½	5 0 0	Feb, Aug		
5	3/6	Do. 7 per Cent. Pref.	8½—9	3 17 9	Feb, Aug		
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	95—100	3 10 0	..		
5	4/0	Smithfield Markets Electric Sup. Ord.	2¾—3¼	6 3 1	—		
St.	4%	Do. 4 per Cent. Deb. Stock	85—87	4 12 6	..		
5	2/0	South London Electric Supply Ord.	4½—4¾	3 8 8	—		
1	..	South Metrop'n Elec. Lt. & Power Ord.	⅞—1⅛	..	—		
1	0/8½	Do. 7% Cum. Pref.	1⅛—1⅜	4 18 9	—		
St.	4½	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & com.)	107—110	4 2 3	—		
5	3/0	Urban Electric Supply Ord.	6—6½	4 17 6	..		
5	2/6	Do. 6% Cum. Pref.	5⅛—5⅜	4 15 6	..		
St.	..	Do. 4½% 1st Mort. Deb.	105—107	—	..		
5	6/6	Westminster Electric Supply Ord.	13—13½	5 0 0	Mar, Sept		
5	2/6	Do. 5 per Cent. Cum. Pref.	6½—6¾	3 14 0	—		

ELECTRIC MANUFACTURING, &c.

Share.	Last Dividend.	Name.	Price Wed. Jan. 18.	Rate per Cent. Yield. £ s. d.	Dividend Due.	Business Week to Jan. 18. Highest.	Lowest.
1	6d.	Alliance Elec. Co. 6% Cum. Pref.	⅜—½	6 14 2	..		
1	6d.	Aron Elec. Meter 6% Cum. Pref.	½—⅝	..	..		
5	6/0	British Insulated & Helsby Cables Ord.	5—5½	6 19 2	July, Feb		
5	3/0	Do. 6 per Cent. Pref.	5¾—6¼	5 4 4	Jan, July		
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101—104	4 6 6	—		
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101—103	4 8 9	—		
5	3/0	British Westinghouse 6% Pref.	2½—3	..	—		
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	[illegible]—88	4 11 0	..		
2	..	Brush Electrical Engineering	¼—½	..	March		
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼—1⅜	7 12 2	Mar, Sept		
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96—98	4 16 6	Mar, Sept		
St.	4½%	Do. Perpetual 2nd Deb. Stock	74—77	5 17 0	Jan, July		
5	5/0	Callender's Cable Con. Ord.	9½—10	5 5 0	Jan, July		
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4 15 3	Jan, July		
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104—106	4 4 11	Nov, May		
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1¼—1½	4 5 4	..		
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	95—98	4 13 6	..		
1	0/3½	Chadburn's (Ship) Telegraph Ord.	¾—1¼	8 17 6	..		
2	1/6	Crompton and Co. (Nos. 1 to 54,000)	2—2¼	3 6 10	Jan, July		
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96—98	5 2 0	Jan, July		
5	10/0	Dick, Kerr & Co. Ord.	8—8½	5 17 8	Sept		
5	3/0	Do. 6% Cum. Pref.	5¾—6	5 0 0	Sept		
St.	4½%	Do. 4½% Deb. Stock	106—107	4 4 0	..		
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	¼—½	..	Feb, Aug		
5	..	Do. (£5 paid)	1—1¼	..	Feb, Aug		
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77—82	4 17 3	June, Dec		
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79—84	6 0 6	..		
5	2/6	† Edmundson's Elec. Corp. Ord.	6½—6¾	5 [illegible] 0	H'lf-yearly		
5	3/0	Do. 6 per Cent. Cum. Pref.	6—6½	4 [illegible] 0	—		
St.	4½%	† Do. 4½ per Cent. 1st Mort. Deb. (red.)	103—106	4 3 3	..		
2	1/7½	Electric Construction Co.	1½—1¾	6 8 0	July		
2	2/9½	Do. 7 per Cent. Cum. Pref.	2¼—2½	5 17 0	July		
St.	4%	† Do. 4 per Cent. 1st Mort. Deb. (red.)	97—99	4 0 10	Jan, July		
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90—95	5 5 3	—		
10	6/0	General Electric (1900) 6% Cum. Pref.	9½—10	5 0 0	—		
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91—96	4 3 6	..		
5	5/0	Henley's Telegraph Works Ord.	10½—10¾	6 10 [illegible]	Feb, Aug		
5	2/3	Do. 4½ per Cent. Pref.	6½—6¾	4 3 9	Feb, Aug		
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	110—112	4 0 10	Feb, Aug		
10	[illegible]	India Rubber, Gutta Percha, &c., Wrks.	15—16	6 5 0	Feb, Aug		
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99—102	3 18 5	Mar, Sept		
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11—11½	4 7 0	Mar, Sept		
12	12/0	Telegraph Construction & Mainten'ce.	38—40	5 13 6	Mar, July		
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101½—103½	3 17 3	Jan, July		
5	—	Willans and Robinson Ord.	1—2	..	Apr, Oct		
5	—	Do. 5 per Cent. Cum. Pref.	2—3	—	Apr, Oct		
..	4%	Do. 4 per Cent. 1st Mort. Debs.	74—79	5 1 3	May, Nov		

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to

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NOTES.

As a Supplement to this issue of *The Electrician*, we present our readers with our annual sheet table relating to the electric power companies of the United Kingdom. One of the features of this summary, which strikes the casual observer with some surprise, is the large number of temporary stations and provisional arrangements which have been arrived at, and the slow rate of progress which is being made in many cases between commencement and completion of the permanent generating plant. The reason is not far to seek, however. A study of the financial history of the older electricity supply undertakings, whether run by companies or municipalities, will reveal the fact that but a small proportion of them during the first year or two of their existence could earn a proportionate return on the large capital invested in them. Many of the power companies are therefore proceeding with two principles very much in view. They are endeavouring, on the one hand, to supply consumers as early as possible without waiting for the completion of the permanent generating stations, so as to earn a revenue as soon as possible, while, on the other hand, they are not over-anxious to spend too much capital in advance of the load. The result is the erection of temporary stations and the use of small units of plant pending the permanent equipment of the generating works. If we may be pardoned for uttering a word of warning, we would point out that there is a danger of following out this second principle too closely, and of missing the largest and most profitable consumers by not being ready to supply them. It is the buyer's privilege to take months to make up his mind with regard to a purchase, but, having done so, to make immediate delivery a condition of the bargain. One, at least, of the pioneer power companies has missed its opportunity by too great delay during the constructional stage.

◆

Messrs. Siemens & Halske's new incandescent lamp may prove to be a departure of very great importance. People have always been dissatisfied with carbon, as it is brittle and difficult to handle. After years of work, lamp makers have succeeded in making carbon filaments uniform and reasonably hard. In early days Edison hovered to and fro between platinum and carbon, but Swan turned the scale in favour of carbon. There have been various attempts to use carbides, borides, silicides, and coatings of boron and silicon have been proposed and worked at; but so far it is doubtful if any success has been attained in those directions. The Nernst was quite a new departure, as it consists of an electrolytic conductor which gives a high efficiency, does not work in vacuo, and needs preliminary heating.

◆

Several inventors have been working at infusible metals, but the subject is very difficult. The advantages of a metal, if it is more refractory than carbon, are that it is more easy to work and to make uniform; and its temperature coefficient is likely to be high enough to help the lamp on excessive pressures. On the other hand, some forms of carbon have positive temperature coefficients—or are said to have them—at lamp temperatures. The drawback to metal wire is its low specific resistance. This means that a wire must be so long and thin as to involve great practical difficulties in making lamps for 200 volts or so. This is seen strongly emphasised in the new lamps described. When it is remembered that the pressure of our distribution system is limited almost entirely by the difficulties of the lamp maker, it will be realised how important the question of specific resistance really is. We rather wonder that Messrs. Siemens and Halske do not turn their attention more towards large lamps to compete with the arc. The specific resistance difficulty is less, and the arc is behind the incandescent and Nernst in capability of working on high pressure.

THE patience and industry of the inventors of the Siemens lamp is beyond praise. Making lamp filaments of rare refractory metals is an exceedingly difficult problem. The first difficulty is to obtain the metals in anything approaching a pure state, and next is to make a refractory metal, generally obtainable impure and as a powder only, into fine homogeneous wire. At present the lamp does not seem ready to compete with others, but a metal that will work at 1·5 watts per candle may have a great future before it.

◆

MR. J. S. HIGHFIELD's short article, which appears on p. 573 of this issue, will be read with some concern both by dynamo designers and the engineers who are responsible for the maintenance of extra high-tension generating plant. It appears that, under certain conditions, materially assisted by London fog, there may be a formation of nitric acid on the armature conductors of machines which are charged at high potentials, and that the quantity thus produced has in some instances sufficed to destroy the insulation of these conductors. The remedy is to be sought in the exclusion of moisture from the conductors and the avoidance of rough surfaces, and therefore does not present any new problem in dynamo design. Mr. HIGHFIELD suggests that all free space in the slots should be filled up with compound in the style of the "solid" system of mains, but we fear that this would be rather "messy," especially on overloads and after long runs. The remedy should rather be sought in an impervious insulating material for the windings themselves.

◆

A SITUATION, which at first sight appears rather serious, has arisen at Brighton. It will be remembered that the Corporation of that town are building a large generating station at Southwick, at an expenditure of something like £277,000, and that Mr. ARTHUR WRIGHT is responsible for the design of this station. For some reason, which is by no means clear, certain insinuations and aspersions have been cast upon their consulting engineer by the Council, and he, very naturally, resents this. There is an arrangement existing by which Mr. WRIGHT can terminate his agreement with the Council, and he has given notice to do this on April 19th next. Thus, the Council will find themselves in the unenviable position of being without the services of the engineer who has designed the huge works at Southwick, when those works are no more than half completed. Fortunately, however, Mr. WRIGHT is willing to come to some fresh arrangement provided the insinuations and aspersions cease forthwith, and it is to be hoped that the Council will have sufficient foresight to give an undertaking to this effect. Municipal authorities who employ professional men of high repute must understand that such men will not tolerate treatment other than that to which their position entitles them, and Mr. WRIGHT cannot be blamed for the course he has taken.

◆

A SOMEWHAT drastic method of curing the depredatory habits of a dog was employed recently by a Sheffield butcher, and his ingenuity resulted in his appearance as defendant in the County Court. According to the evidence, the plaintiff was working near the butcher's shop, and his dog, somewhat anticipating the dinner hour, fetched a rabbit and two pieces of meat without attending to the usual formality of paying for them. The butcher was apparently well acquainted with the dog's rapacious appetite, and, foreseeing that the animal would return, disconnected a wire from his electric fan and fastened it to a piece of meat. Presently the dog returned, took the bait, and expired. The cure had been more effective than the butcher desired, for he disclaimed any murderous intentions, intimating that he had only wished to punish the animal by giving it a shock. However, the judge held that the defendant was liable for the consequences, and gave judgment for the plaintiff for £3 and costs. We do not desire to discuss the legal aspects of the case, but must express our satisfaction that the butcher, as a representative of the consumer class, has been taught the inadvisability of utilising his electric supply for purposes for which it is not intended.

◆

"Electrification" of the District Railway.—It is announced that a trial trip was made with an electrically-propelled train from Mill Hill Park to Whitechapel on Friday last. Everything was satisfactory with the exception that the coping of certain of the platforms projects too far over the rails.

Engineering Standards Committee.—Mr. James C. Inglis, general manager of the Great Western Railway, has been nominated by the Council of the Institution of Civil Engineers as one of their representatives on the Engineering Standards committee, in the place of the late Mr. John Allen McDonald, engineer-in-chief of the Midland Railway.

Cable Interruptions.	Date of Interruption.
Cayenne—Pinheiros	Aug. 18, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Tarifa—Tangier	Jan. 18, 1904
Cayenne—Paramaribo	July 13, 1904
Sitka—Valdez (Alaska)	Nov. 11, 1904
Cap Haytien—Puerto Plata	Dec. 27, 1904

Royal Meteorological Society.—The Council of the Royal Meteorological Society have arranged to hold an exhibition of meteorological instruments from March 14th to 17th next, at the Institution of Civil Engineers (by permission of the President and Council). The exhibition will be chiefly devoted to recording instruments; but it will also include new meteorological apparatus invented or first constructed since the Society's last exhibition, as well as photographs, drawings and other objects possessing meteorological interest.

Northampton Institute.—Mr. H. M. Hobart has consented to give lectures on "Electrical Engineering Design" for two evenings a week, until the end of the term, in place of Mr. E. Kilburn Scott, who has been appointed lecturer in electrical engineering in the University of Sydney. Mr. M. Holroyd Smith has been appointed chief assistant in the mechanical engineering department in succession to Mr. W. E. Curnock, who has been appointed head of the mechanical engineering department of the Technical College, Huddersfield.

Electric Lifts.—In describing the electric lifts made by Messrs. A. Smith & Stevens in our issue of January 13th, p. 515, it was stated that the lift attendant started the lift by inserting a definite resistance in series with the motor, the further cutting out of resistances being done automatically by the movement of the lift. We are now informed by the makers, however, that this starting resistance is automatically inserted at the last moment before stopping, so that the attendant has simply to actuate the motor reversing switch and the main switch by the pull of the rope in order to set the lift going.

Royal Society.—Among the Papers down for reading yesterday were the following:—"On the Comparison of the Platinum Scale of Temperature with the Normal Scale at Temperatures between 444 C. and −190 C., with Notes on Constant Temperatures below the Melting Point of Ice," by Prof. M. W. Travers, F.R.S., and A. S. C. Gwyer; "On the Drift produced in Ions by Electromagnetic Disturbances, and a Theory

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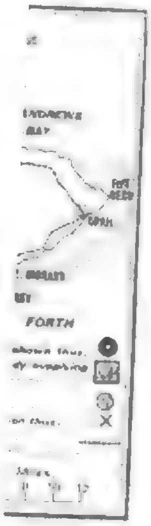

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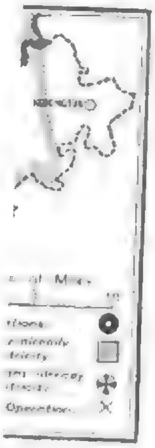

Accident at Burnley.—A regrettable accident, by which Mr. Robert Birkett, the electrical and tramway engineer, received rather severe injuries, occurred at the Burnley Borough Council electricity works on Friday last. The sub-committee had met at the works to see a Reavell air compressor, which was borrowed from the tramways department, tried on an armature. The starting switch and terminals had been mounted on the machine locally, and from there wires were run to the traction switchboard, the positive connection being made through a feeder switch. After about 20 minutes' run for observing the temperature rise of the compressor it was decided to operate on

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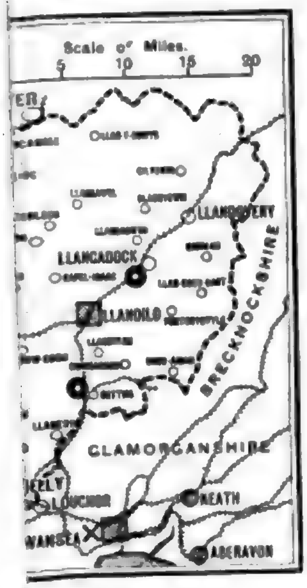
KENT ELECTRIC POWER CO.

TRIC POWER CO.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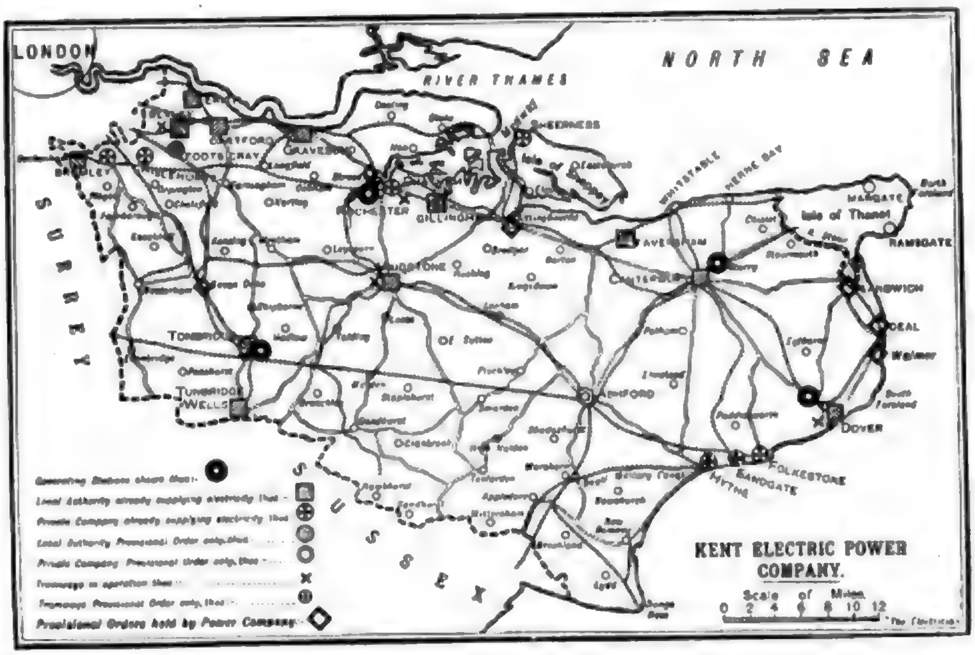
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FOOTS CRAY
DARTFORD
ROCHESTER
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Isle of Sheppey
WHITSTABLE
HERNE BAY
MARGATE
Isle of Thanet
RAMSGATE
SANDWICH
DEAL
Walmer
DOVER
FOLKESTONE
SANDGATE
HYTHE
CANTERBURY
FAVERSHAM
MAIDSTONE
TONBRIDGE
TUNBRIDGE WELLS
ASHFORD
Generating Stations shown thus:
Local Authority already supplying electricity thus
Private Company already supplying electricity thus
Local Authority Provisional Order only, thus
Private Company Provisional Order only, thus
Tramways in operation thus
Tramways Provisional Order only, thus
Provisional Orders held by Power Company
KENT ELECTRIC POWER COMPANY.
Scale of Miles.
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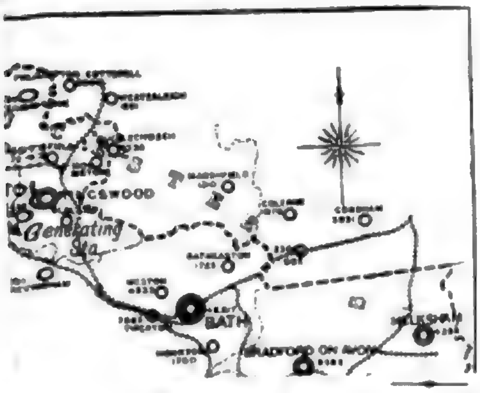
The Electrician

ECTRIC POWER CO.

SHROPSHIRE AND WORCESTERSHIRE ELECTRIC POWER CO.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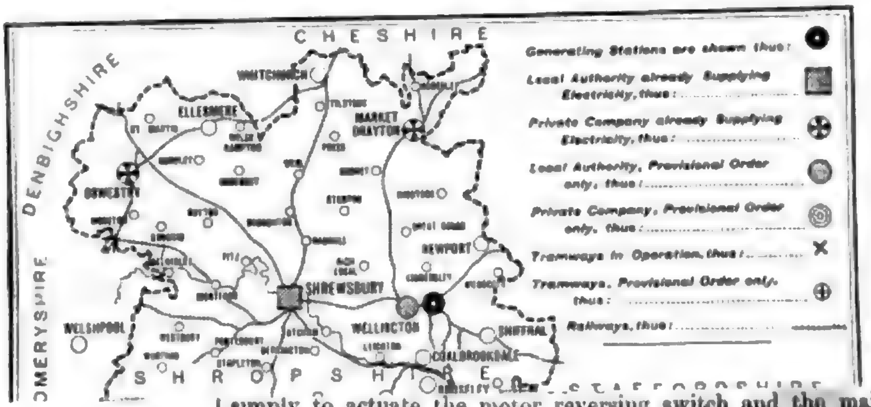
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STAFFORDSHIRE
WHITCHURCH
ELLESMERE
MARKET DRAYTON
OSWESTRY
NEWPORT
SHREWSBURY
WELLINGTON
SHIFNAL
WELSHPOOL
COALBROOKDALE
Generating Stations are shown thus:
Local Authority already Supplying Electricity, thus:
Private Company already Supplying Electricity, thus:
Local Authority, Provisional Order only, thus:
Private Company, Provisional Order only, thus:
Tramways in Operation, thus:
Tramways, Provisional Order only, thus:
Railways, thus:

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Tramways and Light Railways Association.—Under the Articles of Association the following are about to retire from the Council of the Tramways and Light Railways Association. Messrs. Atherley-Jones, C. E. Baker, E. R. Calthrop, Philip Dawson, C. H. Gadsby and C. E. Waite. It is announced in the official circular of the association for January that the following have been nominated to fill the vacancies:—The Hon. Arthur Stanley, who has been selected as President, H. England, J. B. Hamilton, J. H. Rider, S. Sellon, and Lord Vaux of Harrowden. The members continuing to serve are Messrs. C. R. Bellamy (Vice-President), Alfred Baker, W. Worby Beaumont, A. N. Connett, Jas. W. Courtenay, James Devonshire, A. L. C. Fell, J. Barber Glenn, Thomas W. How, E. F. Vesey Knox, Roland le Strange, W. M. Murphy, A. M. Willcox and Sir C. Rivers Wilson.

A Diesel Electric Boat.—According to the *Zeitschrift fur Elektrotechnik*, a boat has recently been put into service on the Lake of Geneva which is driven ordinarily by a 45 H.P. Diesel engine (running at 260 revs. per min), but electric power is made use of at starting and for reversing. The Diesel engine is directly coupled to a dynamo and a small exciter on the one side, while there is a magnetic coupling on the other side through which it can be connected directly to the propeller shaft. An electric motor is also provided, the motor armature being keyed on to the propeller shaft. At starting the Diesel engine is disconnected from the propeller shaft, and drives only the generator and the exciter. The motor is now switched on and its torque and speed are adjusted by regulating the excitation. When full speed has been attained in this way, the motor is switched off, and the Diesel engine is directly coupled to the propeller shaft.

Scientific Study of Engineering.—At the Battersea Polytechnic on Saturday evening, Sir William White, who has accepted the Presidency of the Battersea Polytechnic Engineering Society for the coming year, delivered his Presidential Address on "The Scientific Study of Engineering." The main part of the lecture consisted of sound advice to engineering students at evening classes, but several interesting opinions were expressed which are capable of much wider application. One of the most serious drawbacks to methodical study was the excessive popularisation of science in text books, many writers having an imperfect knowledge of the subject of which they treated. The result was that the student received but a smattering of knowledge, and learned nothing of the principles. In the past the results of evening classes were unsatisfactory, but more organised classes were now being introduced, and better results could be looked for. He welcomed the greater attention which was nowadays paid to practical mathematics and applied mechanics, because a thorough knowledge of these subjects was undoubtedly the basis of any engineer's training. Too early specialisation was to be deprecated, and a good secondary education should not be overlooked. The curriculum for this should be the same, no matter the branch of engineering which it was desired that the student should ultimately adopt. The foremost subjects in this period of education were practical mathematics, applied mechanics and chemistry. Systematic courses of evening instruction in the various branches of engineering extending over three or four years were very desirable, and he was pleased to say that this had been adopted on a small scale with very satisfactory results. An extension of this system could not fail to be beneficial.

Accident at Burnley.—A regrettable accident, in which Mr. Robert Birkett, the electrical and tramway engineer, received rather severe injuries, occurred at the Burnley Borough Council electricity works on Friday last. The sub-committee had met at the works to see a Reavell air compressor, which was borrowed from the tramways department, tried on an armature. The starting switch and terminals had been mounted on the machine locally, and from there wires were run to the traction switchboard, the positive connection being made through a feeder switch. After about 20 minutes' run for observing the temperature rise of the compressor it was decided to operate on a dynamo. To do this it was necessary to wheel the machine from the wood floor across a trench covered with cast-iron floor plates. The engine driver who was pulling the machine, on stepping on to the plates was thrown down with considerable violence, his head coming in contact with the floor plate. At first it was thought he had slipped, but later it was seen that he was in pain. In trying to get to him Mr. Birkett took hold of the drawbar of the compressor with the intention of pushing it back, but as soon as he stood on the floor plate he was thrown down with such force that the pattern of the plate was engraved on his knees, his trousers were pierced, the blunt heads of the plates, which are intended to prevent slipping, cut one of his knees, and he was held there in an unconscious condition for some seconds. The switchboard attendant was prevented from attempting to rescue him, but the chief assistant, Mr. Nutter, realising that something was alive, rushed to the switchboard and broke the circuit. It was afterwards seen that the armouring of the indiarubber hose had come in contact with the exposed terminal and the whole machine was alive. Nobody but Mr. Birkett was seriously hurt, and we are glad to say that, with the exception of his knee, he is now nearly well again and hopes to resume duty in a couple of weeks.

The Abolition of Telegraph Posts.—A deputation organised by the Commons and Footpaths Preservation Society, and introduced by Mr. Shaw Lefevre, waited upon the Postmaster-General yesterday afternoon, the object being to urge that steps should be taken to prevent the disfigurement of commons and places of natural beauty by the erection of lines of unsightly telegraph posts and wires. Mr. Shaw Lefevre referred to the Hog's Back, Surrey, and other places where the natural beauty of the district had been entirely destroyed by the erection of telegraph poles, and pointed to the fact that the London County Council invariably refused consent for the erection of poles or wires upon any of the parks or commons coming within their jurisdiction. It was also mentioned that at Grassmere the view had been entirely spoiled, and that in the case of Harpenden Common disfigurement had occurred merely for the sake of saving 15s. per mile. The Postmaster-General pointed out that this was per mile per wire, and that there might possibly be 24 wires. In his reply, Lord Stanley said his sympathies were all with the objects of the deputation, but he was between those who objected to the spoiling of the scenery and the demands of the general public, who asked for telegraphic and telephonic facilities and wanted them cheaply. They therefore had to find the cheapest way. Although telegraph wires could be, and were being, put underground, it was impossible to put the long trunk telephone wires underground, because their efficiency would be impaired. One way which would partly remove the nuisance complained of by the deputation would be an enlargement of the powers of the Postmaster-General with regard to wayleaves on private property at the sides of roads. Until this was done he could only promise to give careful consideration to all representations made to him concerning threatened landscapes.

Low Temperature Phenomena.—A most interesting discourse on "New Low Temperature Phenomena" was delivered by Prof. Sir James Dewar, F.R.S., at the Royal Institution last Friday evening. After giving a brief but concise history of the researches dealing with the absorptive properties of charcoal, he showed some striking experiments demonstrating this property, and subsequently explained that the power of absorption is enormously increased by lowering the temperature. By connecting a small bulb containing charcoal to the top of a barometric tube, he showed that a small decrease in the volume of the air took place, but when the bulb was immersed in liquid air, the barometric column rose at a great rate, thus proving the enormously enhanced absorptive power of the charcoal at a low temperature. Additional proof was advanced by means of a tube connected to a spark coil. A small quantity of charcoal was situated at one end of the tube, but the latter did not show a high degree of exhaustion until the charcoal was cooled by liquid air. Another interesting experiment was that in which a tube was connected to a coil in parallel with a spark gap. There was charcoal in one end of the tube but not in the other, and when the latter was cooled by liquid air the discharge continued to pass through the tube in the ordinary way. On cooling the end containing the charcoal, however, a high vacuum was obtained and the discharge took place across the spark gap. The lecturer next showed that charcoal is highly selective in its absorptive properties, having practically no effect upon helium but great power to condense nitrogen and oxygen of atmospheric air. Thus a considerable quantity of helium was obtained in a tube in a few minutes and the characteristic spectrum of the gas was clearly visible by means of the spectroscope. The last experiment was perhaps the most interesting of all and evoked considerable applause from a crowded and distinguished audience. A radiometer had been specially made and filled with hydrogen by Sir Wm. Crookes and at the end of a long thin tube sealed into its base was a quantity of charcoal. On cooling with liquid air no condensation of the hydrogen took place and consequently the radiometer vanes remained stationary. On substituting liquid hydrogen for liquid air, however, rapid condensation took place and the vanes flew round at a great speed. Thus it was proved that hydrogen can be condensed by charcoal at its own boiling point (about 25 deg. absolute) but not by liquid air (about −185°C.). Among other exhibits in the library was an Orling-Armstrong electro-capillary recorder, arranged to work under conditions representing those of a long submarine cable.

Royal Commission on Coal Supplies.—Part I. of the Final Report of the Royal Commission on Coal Supplies has just been issued as a Parliamentary paper, and five other similar publications have yet to be issued to complete it, the present pamphlet being styled "General Report." The Commission was appointed in December, 1901 :

> "To inquire into the extent and available resources of the coalfields of the United Kingdom ; the rate of exhaustion which may be anticipated, having regard to possible economies in use by the substitution of other fuel or the adoption of other kinds of power ; the effect of our exports of coal on the home supply and the time for which that supply, especially of the more valuable kinds of coal, will probably be available to British consumers, including the Royal Navy, at a cost which would not be detrimental to the general welfare ; the possibilility of a reduction in that cost, by cheaper transport, or by the avoidance of unnecessary waste in working through the adoption of better methods and improved appliances, or through a change in the customary term and provisions of mineral leases ; and whether the mining industry of this country, under existing conditions, is maintaining its competitive power with the coalfields of other countries."

It will thus be seen that the proceedings of the Commission have not a large electrical interest, but there are passages in the report to which attention may be usefully directed. Among the witnesses who gave evidence were Mr. A. S. E. Ackermann, who dealt with American mining methods and coal-cutting machines ; Prof. F. W. Burstall upon the manufacture and transmission of producer gas ; Mr. W. J. Crossley upon economies in the production of power by gas engines ; Prof. George Forbes, F.R.S., upon water-power installations ; Mr. W. E. Garforth on coal-cutting machines (electrical and others); Mr. Michael Longridge on economies in the use of coal, particularly as to improvements in engines and boilers ; Hon. C. A. Parsons, F.R.S., on steam turbines ; G. E. Stringer on coal-cutting machines ; and Mr. B. H. Thwaite on the utilisation of blast furnace gas. Altogether 47 meetings for taking evidence were held and 120 witnesses examined. The report, after discussing the resources of our coal fields and the probable duration of our coal supply (in connection with which several tables are given), deals with "Possible Economies." From the evidence of the witnesses, it appears that in 1902 there were 149 electrical coal-cutting machines at work in the United Kingdom and 231 in 1903. The use of electricity in mines since the introduction of coal-cutting machines, both from the point of view of economy and efficiency, is regarded by colliery owners and managers as invaluable. The general opinion at present, however, is against its use for winding engines, although some are being used on the Continent. It is estimated that about 52 million tons of coal per annum are converted into steam at mines and factories in the United Kingdom, and that the average consumption per indicated horse-power per hour was about 5lb. This should not be more than 2lb., and one of the chief sources of this wastefulness was attributed to small consumers whose engines were scattered over factories and workshops with long ranges of pipes and small ineffective boilers. Although the use of oil and gas engines was increasing, the installation of central power stations must be resorted to in order to secure greater economy. Amongst the suggestions made by witnesses were a more extended use of economisers, automatic stokers and mechanical draught, as well as systematic analyses of chimney gases and the ashes from the furnace. Superheating, an extended use of exhaust steam for heating purposes and the purification of boiler water were also advocated. The advantages of the steam turbine, as set forth in evidence by the Hon. C. A. Parsons, F.R.S., are also given. The report is a résumé of the evidence given by witnesses, and no opinions are expressed by the Commissioners on the matters referred to above.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-Day) FRIDAY, January 27th.

Physical Society.

5 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda :—(1) "Action of a Magnetic Field on the Discharge through a Gas," by Dr. R. S. Willows. (2) "Action of Radium on the Electric Spark," by Dr. R. S. Willows and J. Peck. (3) "The Slow Stretch in Indiarubber, Glass and Metal Wires when subjected to a Constant Pull," by P. Phillips. (4) "Determination of Young's Modulus for Glass," by C. A. Bell. (5) "Some Methods for Studying the Viscosity of Solids," by Dr. Boris Weinberg.

SATURDAY, January 28th.

Institution of Electrical Engineers : Students' Section.

3 p.m. Visit to the General Post Office Central Telephone Exchange. Meet at the Addle Hill entrance.

MONDAY, January 30th.

Faraday Society.

8 p.m. Meeting at the Institution of Electrical Engineers, 92, Victoria-street, Westminster. The following Papers are down for reading : (1) "Mass Analyses of Muntz's Metal by Electrolysis and Some Notes on the Electrolytic Properties of this Alloy," by J. G. A. Rhodin ; (2) "On the Equilibrium between Sodium and Magnesium Sulphates," by R. Beckett Denison ; (3) "Refractory Materials," by E. K. Scott.

TUESDAY, January 31st.

Institution of Electrical Engineers : Manchester Local Section.

7:30 p.m. Meeting in the University. Paper to be read : "Some Points on the Selection of Electric Cables," by Ll. B. Atkinson and C. J. Beaver.

WEDNESDAY, February 1st.

Institution of Civil Engineers : Students' Section.

2:30 p.m. Visit to the National Physical Laboratory, Bushy House, Teddington. Train from Waterloo (South Station) to Teddington at 1:40 p.m.

Institution of Electrical Engineers : Students' Section.

7:30 p.m. Meeting at 92, Victoria-street, Westminster, S.W. Paper to be read : "The Present Electrical Equipment of the London County Council Tramways," by J. W. Anson. Mr. J. H. Rider will take the chair.

Society of Arts.

8 p.m. Ordinary Meeting. Paper to be read : "The Navigation of the Nile," by Sir William H. Preece, K.C.B., F.R.S.

THURSDAY, February 2nd.

Rugby Engineering Society.

8 p.m. Meeting in the Benn Building, High-street. Paper to be read : "The Application of Electric Power to Collieries," by G. M. Brown.

Rontgen Society.

8.15 p.m. Ordinary General Meeting at 20, Hanover-square, London, W. Paper to be read : "Some Points in the Construction of a High Frequency Machine," by Dr. Clarence A. Wright. An X-Ray Diaphragm Compressor by Dr. Thurston Holland will be exhibited by Messrs. Newton & Son.

FRIDAY, February 3rd.

Institution of Electrical Engineers : Manchester Students' Section.

7:30 p.m. Meeting in the Municipal School of Technology. Paper to be read : "The Electric Equipment of Automobiles," by V. H. Mahler.

Junior Institution of Engineers.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read : "Recent Developments in Electric Lighting," by Prof. H. T. Davidge.

SATURDAY, February 4th.

Glasgow Technical College Scientific Society.

7:30 p.m. Meeting at 38, Bath-street. Paper to be read : "Cathode Rays and Allied Phenomena," by Prof. Blyth.

Institution of Electrical Engineers : Glasgow Local Section.

7:30 p.m. Smoking Concert at Grosvenor Restaurant, Gordon-street, Glasgow.

THE INSULATION OF ARMATURE OR OTHER COILS FOR HIGH-TENSION APPARATUS.

BY J. S. HIGHFIELD.

Some trouble has been experienced from time to time by the breakdown of the insulation of armature coils in alternators built for 6,000 volts and upwards. The writer has had particular trouble in this way with a 10,000-volt alternator, which broke down on one or two occasions. In this machine—in fact, in the case of most machines—the copper is insulated from the core plates by means of a solid mica or micanite tube, having a dielectric strength capable of resisting at least four times the working pressure; and the ends of the tubes in this particular case, as they are generally, are carried out quite clear of the frame, so that there can be practically no chance of sparking taking place from the ends of the coils to the frame.

There was evidently something unusual about the cause of the breakdowns, and careful experiments were therefore made to determine the exact cause of the trouble. The coils in question are insulated between turns with varnished cotton braiding, and without by the micanite tubes above mentioned, the micanite being of the best possible quality, and the tubes being exceedingly well built. The coils are formed by winding the ribbon, of which the conductors consist, through two tubes. The ends of the coils, where they emerge from the tubes, are protected by slips of mica and wrappings of the well-known ordinary Empire cloth with prespahn, and finally black-taped to give some mechanical protection, the workmanship being all that could be desired. Upon examining a coil, by splitting open the tube, it was at once apparent that serious corrosion had been taking place, the braiding being practically destroyed, and the copper covered with a green deposit. An inspection of the ends of the coils showed that the Empire cloth near the tubes was completely rotted, being quite damp and having a strong acid reaction, but the braiding was in fairly good order, although also damp and having acid reaction. Upon opening some of the tubes, it was discovered that, in some of the coils, the whole of the braiding was rotted away, the copper being covered with a green deposit, which, upon analysis, was found to be nitrate of copper; there also appeared to be a certain amount of free nitric acid present. In the Empire cloth, at the ends of the coils, sulphuric acid was found. As the materials were all of the best, it was immediately suspected that the nitric acid was formed by brush discharge causing ozonisation of the air, and in order to make quite sure of this fact, one of the tubes was carefully cleaned, and a strip of bright copper gauze covered with pure filter paper was placed inside the tube, the outside of the tube being covered with tin-foil connected to earth, the copper being connected to the supply of 10,000 volts—the paper was not specially dried.

Ozone was produced in considerable quantities at once, and in about one week a considerable amount of green deposit of nitrate of copper was formed on the copper gauze, and free nitric acid on the filter paper. The cause of the breakdown of the coils was therefore quite clear. Brush discharge took place on the inside of the coils from the copper to the mica, and, with the nitrogen from the atmosphere and moisture from the air, produced nitric acid. The acid worked itself out of the tube, and, combining with the gypsum in the Empire cloth or braid, formed sulphuric acid at the ends of the coils. It was found that the coils at the end of the machine were in a worse condition than the ones lower down, and the degree of corrosion was somewhat variable, pointing to the fact that some of the coils were dryer than others, there being no doubt that the rate of corrosive action was enormously increased by the presence of free moisture.

Prof. Ernest Wilson some time ago carried out some researches on the formation of ozone, and found that ozonisation set in at a pressure in the neighbourhood of 2,000 volts, and that the rate of production increased at a greater rate than the increase in pressure, the amount being very considerable at 5,000 volts, and very much more than twice the quantity at 10,000 volts. It would appear, therefore, that in any machines, even down to as low a pressure as 2,000 volts, trouble from the above-mentioned cause might be experienced. Careful vacuum drying of the coils during the process of insulation would undoubtedly serve to delay the breakdown of the machine, but it certainly seems that no method of insulation admitting air between the copper, iron and insulation can produce a machine that will last for all time. The only proper method is to fill in the whole of the space from copper to iron with insulating material, so as to entirely exclude air. The mere sealing of the ends is not likely to be a remedy, as considerable heat is generated in the armature; this expands the air in the coils, and on cooling a slight vacuum is formed which encourages the entrance of fresh air bringing with it some quantity of moisture.

This investigation also showed the necessity of carefully insulating the last two or three coils at the end of the armature where the pressure is greatest. It was found that, on the last coil particularly, the copper was pitted in places, and opposite each little lump the braiding was punctured.

On all alternating-current systems surgings will arise, causing rises in potential at frequencies greatly exceeding the working frequency. The result appears to be as though the whole pressure of the machine is thrown on the first coil, and sometimes the first two or three coils. The ordinary braiding is not nearly sufficient to resist these rises. The end coils need therefore to be insulated in a much more secure way than the remaining coils of the armature.

The writer has to acknowledge the great help given by Prof. Ernest Wilson in carrying out the investigation.

ELECTRICITY METERS.*

BY C. H. W. GERHARDI.

(Continued from page 534.)

Brush-Gutmann Meter.—The Brush-Gutmann meter is another example of the induction-motor type of integrating wattmeter. It is made in America, and its design and workmanship are good. Its case is composed of an iron box with an aluminium cover containing the necessary windows for reading the dials and inspecting the disc. The case fits on to the rim of the cast-iron box and is cemented round, forming a dust-and-damp-tight joint. Fig. 13 illustrates the meter with its cover off,

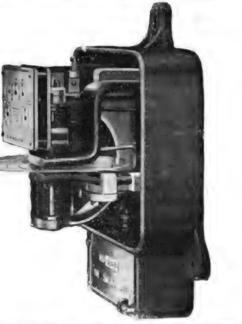

FIG. 13.—SHOWING PERMANENT MAGNET OF BRUSH-GUTMANN METER.

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* From a forthcoming book to be published by "The Electrician" Printing and Publishing Co. All rights are reserved.

and shows the permanent magnet of the brake which, as will be seen, is of a very good form for remaining permanent. The bracket on which this magnet is clamped is provided with slots for the clamping screws, which enable the magnet to be shifted towards the edge of the disc, or in the other direction, for calibrating at high loads. In all meters where the magnet is shifted to alter the speed, it will be easily seen that whenever the discs extend beyond the air-gap, the speed is reduced by bringing the magnet towards the edge of the disc, causing the brake to work at a greater leverage. Where, however, the air-gap extends beyond the edge of the disc, moving the magnet outwards reduces the lines through the disc and thus increases the speed.

The rotor is different to those of other meters in that it is slotted in spiral lines (see Fig. 13). It is claimed that by so slotting the disc a higher torque is obtained. The stationary portion of the motor is shown in Fig. 14. The core is composed of two parts, the main portion and the "bridge," which is the portion below the disc. The magnetic circuit, therefore, has two air-gaps, one in which the disc rotates and another at the back which prevents the bridge being in actual magnetic contact with the main portion. The shunt coil is placed on the back leg of the core, being supported by projections on the aluminium strips, which hold the two portions of the core in place. There are two main coils, one above and the other below the disc, carried on the main bracket.

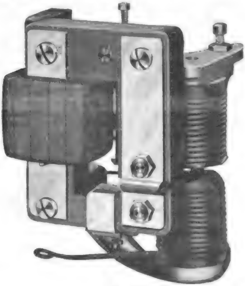


Fig. 14.

On the inner side of the main core is the friction-compensating piece by which the meter is adjusted at light loads. This is moved up or down by means of a screw which works against a small lug on the bracket which carries the motive part and is seen in Fig. 13.

The adjusting device for obtaining the quadrature relation between the shunt and field fluxes is seen in Fig. 14. It is a band of copper placed round the bridge; this band is provided with terminals at its two ends, and the electrical circuit is completed through a short piece of wire which enables the current generated to be adjusted to the amount required. The reaction of this current on the field which generates it causes the flux of the shunt circuit to be in quadrature with that of the main when the adjustment is correct, and the meter is capable of measuring the true energy transmitted when the load is inductive. The loop of wire provided to close the circuit of the compensating band is long enough to give a wide range of adjustment, so that the meter may be quickly compensated to work on other periodicities than that for which it is intended.

The meter is easily installed, being provided with a centre lug at the top containing a double hole for letting the screw head pass through. The terminal box is below and is provided with a hinged lid. The dials are direct reading in watt hours instead of B.T. units, and it would be better if they were made for the latter for use in Great Britain.

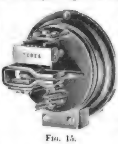


Fig. 15.

The shunt watt loss is very small, and varies from $\frac{1}{2}$ to 3 watts, depending on the pressure and periodicity. In a 100-volt 10-ampere meter it was found to be 0·638 watt, with a shunt current of 0·0375 amperes on 60 ~ supply.

Two-wire meters above 100-amperes capacity are provided with series transformers, the meter always being of 5-amperes capacity. For pressures above 250 volts potential transformers are employed. In three-wire meters, both outers are taken into the meter in the usual way in meters up to 50-amperes capacity; those of higher amperage are used in conjunction with series transformers having two primary and one secondary coil, an ordinary two-wire meter being used with this transformer. The testing constant given for these meters is the watt hours per revolution.

Eclipse Meters.—The Eclipse integrating induction watt-meters are made by the Lux'sche Industrie werke A.G. (for whom Mr. G. Braulik is the agent in Great Britain). They are made in two types (1) for non inductive (F.E.G.) and (2) for inductive loads (F.E.M.). The two types are similar in size and external appearance, the difference being in the motor. The F.E.M. is shown in Fig. 15 with cover off, and the disc, brake magnet, cyclometer train, and compensating resistance for inductive loads can all be seen. The motor is not visible, it being fixed behind the false back plate which has a long slot through which the disc passes. The terminal

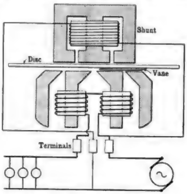


Fig. 16.—Eclipse F.E.G. Meter.

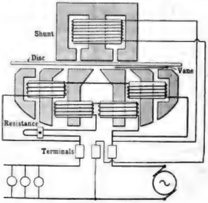


Fig. 17.—Eclipse F.E.M. Meter.

box, which is rather too small, is shown with its cover on. The mains are inserted upwards and are clamped by screws, the heads of which are just under the cover. The appearance of the F.E.G. meter with its cover off is very similar to the F.E.M. but the regulating resistance is absent.

The motive part of the F.E.G. meter is shown diagrammatically in Fig. 16 and that of the F.E.M. in Fig. 17. By comparing these it will be seen that the compensated meter is somewhat more complicated, having two more main coils. Of the two, however, it is to be recommended, as the F.E.G. was found to have a constant 50 per cent. too high (meaning that the meter under-registered) on a load the power-factor of which was as high as 0·8. It would thus be very risky to send out such a meter, for the consumer might add inductive apparatus to his non-inductive load at any time. The F.E.M. meter, from tests made by the author, has been found to differ only by about 3 per cent. on a power-factor of 0·5. Short-circuiting through a fuse of double the ampere capacity seems to have no effect on the constant. The torque of these meters is rather low, being about 1gr.-cm. at full load. The moving part is extremely light, but if additional friction appears in the registering train the constant is greatly affected.

The meters can now be had with the ordinary dial trains. These are a great improvement on the cyclometer trains, in which it is very difficult to detect faults. Some trouble has been caused in this direction.

The low-load adjustment may be effected by moving the vane (see Figs. 16 and 17) to the right or left. The speed is increased by moving the vane nearer the spindle, and, consequently, the reverse effect is produced by moving it the other way. Alteration of the vane may affect the high-load speed if much adjustment is necessary, but in a much smaller degree. The action of the flux on the vane produces a torque which may cause the meter to run on its shunt if made too strong. To prevent this, a very small piece of iron is let into the disc, so that when the iron gets between the poles of the brake magnet it is held there magnetically, and thus prevents creeping

The meters are made in various sizes up to 50 amperes. Their starting currents are good, being about one-hundredth of full load. The full-load drop varies from 1 volt on a 2½-ampere meter to 0·1 volt on a 50-ampere meter. The shunt current of 200-volt meters is about 0·018 ampere, the true watts being 2 watts, cos ϕ for the shunt circuit is 0·556, which makes the lag angle 56 deg.

(*To be continued.*)

THE LONDON COLISEUM.

This enormous place of amusement, situated in St. Martin's-lane, possesses many features which are undoubtedly unique, and not the least among them is its electrical equipment. Apart from lighting, the extent of which will be indicated later in this article, there is no similar arrangement of stage mechanism in the world, and the details have had to be worked out entirely without a guide or any similar apparatus or mechanism as a basis, as, from the magnitude of the tables, no experiments were possible before placing contracts. Owing to the fact that the supply for the stage lighting and power is far greater and more important than that to the front of the house, we propose to deal with it first.

The main services to the stage are all from the Charing Cross & Strand Electricity Supply Co.'s network, and enter the building in an underground chamber built specially to receive them. All the service work has been carried out by the Supply Company themselves, and the result is a very excellent piece of workmanship. The cables are all carried in sheet-iron casing filled with sand, until they reach the main switches, after which they are cleated to the wall, and after passing through the main distribution boards are carried in steel conduit. There are four three-wire services, for the lighting and power, taken from the ordinary network, but in the event of failure of this source, the entire supply can be derived from special theatre mains which are run from one of the Charing Cross Company's sub-stations and supply theatres only from separate generating plant. For changing over from one supply to the other change-over switches by Ernest F. Moy (Ltd.) have been fixed, and the operation is, of course, the work of a moment. It is interesting to observe (Fig. 1) that a special telephone is provided direct from the change-over switches to the company's sub-station, so that immediate warning may be given of any intention to take current from the theatre mains should it be necessary. From each main change-over switch the cables are taken to separate cast-iron fuse boxes and there divided up into circuits of suitable carrying capacity for the lamps which they have to supply. When fully lighted, the stage requires about 2,000 amperes. This is made up of 3,000 32 c.p. lamps, 24 arcs, one 80 ampere arc for a biograph, nine 50 ampere arcs for special stage effects, and three arcs in the front of the house. All the incandescent lighting is at 200 volts and the arc at 100 volts. The entry of the power service is quite distinct from that of the lighting, although they are both in the same room but separated by several feet.

Situated next to the main intake room is an arc intake room supplied by a three-wire service also from the Charing Cross Company. Here again the ordinary service is duplicated by one taken off the special theatre mains and a three-pole change-over switch is provided. Normally, the arcs are all worked off the theatre mains and the ordinary network is kept as a stand by. There are also a few lamps in the intake, dimmer and controller rooms which derive their supply from the same source, but connection is made to the cables on the live side of the change-over switch. Thus, whether the lighting or power, or both, for the stage is being supplied either by the ordinary network or by the special theatre mains, there is always light to enable an attendant to get at the change-over switches. The theatre mains inside the building are run in Doulton conduit, embedded in concrete, painted a distinctive colour, so as to be easily distinguishable from any other cables. Indeed, the conduits throughout the building have been painted with different colours, so that one may see in a moment whether the cables inside are for lighting, power or arcs. For the smaller wiring Bathurst tubing has been used, but for all heavy work, and that on the stage, screwed steel conduit has been employed. Where it has been necessary to carry the wires in wood casing, nothing but solid oak has been put up.

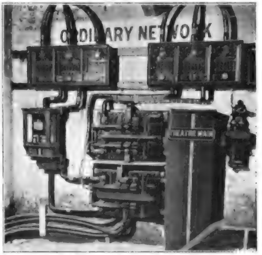


FIG. 1.—ORDINARY NETWORK INTAKE, SHOWING MAIN CHANGE-OVER SWITCHES.

The main stage switchboard (Fig. 2) is fixed on a lighting gallery, specially constructed, about 12ft. from the stage level. On this gallery is also a regulator, and both it and the switchboard are mounted on steel frames. These boards control the whole of the stage lighting, and the different coloured lamps being fed from coloured enamel slate panels, upon which the switches are fixed, the colour of the lamps controlled by any switch can be seen at a glance. There are four different colours employed—viz., red, blue, amber and white, and there are 17 circuit switches on each panel of the board. On this board there are no negative wires whatever; these are all divided up in the intake rooms in the basement and connected to a fuse-board to which negative wires only are attached, so that there is no possibility of a short-circuit either on this fuse-board or on the main switchboard itself. The regulator is of a type now met with very frequently in new theatres; the gear is of Messrs. Moy's standard type (*The Electrician*, Vol. LII., p. 642), and permits of the lowering of the circuits individually or collectively by means of an ingenious locking device. It is fitted with short-circuiting switches and steel rope tracker gear. This tracker gear, after passing over pulleys, passes down into the dimmer room, wherein about 50 Lyons liquid resistance jars are situated. Great credit is due to Messrs. Blackburn, Starling & Co. for the way in which they have carried out this portion of the work, and the arrangement of the tracker gear is probably superior to that of any other theatre in this country.

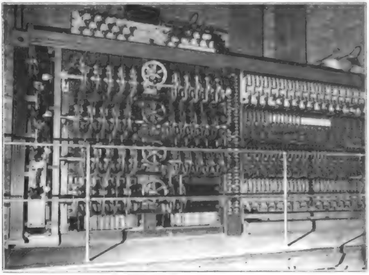


FIG. 2.—STAGE SWITCHBOARD AND REGULATOR.

At one end of the switchboard gallery is the arc lighting switchboard and regulator (Fig. 3). All the arc resistances are situated in a room in the basement, adjacent to the main intake rooms. The footlights, known technically as the "float," contain 250 32 c.p. lamps of all four colours. On each side of the proscenium there is one length carrying 150 32 c.p. lamps also of all four colours. For head lights there are eight battens, seven of which have from 160 to 200 and the other 100 32 c.p. red, white and blue lamps. In addition to these, there are also 12 portable hanging lengths, each fitted with 12 32 c.p. lamps, which can be carried about the stage for special lighting. On different parts of the stage are some 110 plugs varying in size from 10 to 40 amperes, and these may be used either for the arcs, reduced from 100 volts to the requisite voltage, or for incandescent lamps at 200 volts. Another interesting feature of the stage lighting is the system of eight special four-colour plugs, which can be used in conjunction with a pair of trolleys. The latter can be run about the stage as required and connected to any of these plugs, so that a supply may be had at almost any point. Each trolley is fitted with 16 four-colour 10 ampere 2-pin plugs. Although not strictly on the stage, the boxes occupied by the auditorium choristers are lighted from the stage supply. In these boxes there are two bunch lights, each provided with 54 32 c.p. lamps of three colours, and in the arched ceilings of the boxes there are 30 32 c.p. lamps also of three colours. All the plug and batten fittings mentioned above are of Mr. E. Wingfield Bowles' patent, as are also the 50 orchestra stands which have been supplied.

On each side of the proscenium is a number box for indicating to the audience the number of the turn on the programme. The numerals are formed by a series of small incandescent lamps operated by a rotary switch fixed in the prompt corner. It is interesting to note that the length of wire required for these number boxes is no less than 3 miles. An important part of the work is the signal system, the main board of which is also fixed in the prompt corner, so that the prompter or stage manager has at his command a system which permits him to control any portion of the machinery or effects by the mere pressing of a button. This main board comprises 32 ways connected to the same number of outlying stations, each station being provided with a red and green lamp, which, by means of a prearranged code, convey instructions noiselessly and instantaneously to the operatives. Thus the old system of bells and the still older system of shouting are entirely eliminated.

In order that there may be a minimum waste of time a complete installation of telephones, for the heads of the various stage departments, has been provided. The exchange is in the basement under the stage and there is an operator always in attendance to look after the 21 stations. From the prompt corner to the dressing rooms, orchestra, flies, green room, band room, &c., there is a very complete system of electric bells.

The whole of the above work, such as refers to lighting and signalling, has been carried out by Messrs. Blackburn, Starling & Co., the Coliseum being the thirty-third theatre which they have equipped with electric light, and all the materials, with a few exceptions, have been manufactured at their Nottingham works.

Naturally, the feature of greatest interest at the Coliseum is the revolving stage, which consists of three concentric rings or stages, the outer one and the intermediate being each 12ft. across, and the middle circle 25ft. 7in. The entire diameter across the three is 75ft., and so accurate has been the building up, that only 1in. of clearance is necessary; this permits of

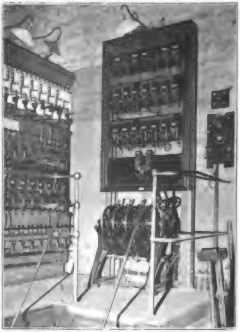


FIG. 3.—ARC SWITCHBOARD AND REGULATOR.

the tables running separately, without rubbing or touching. Rolled-steel under-frames, 9ft. high, support the tables, and instead of the motors and wheels being on the carriages, as in a tramway, a run-way has been fixed to the under-frames, and this runs on the motor pulleys, thereby reversing the usual order of things and securing considerable lightness, absence of moving contacts for the current and a very great reduction in noise. The rings or stages can run in either direction as separate pieces, or can be locked together for combined effects, and though each has its own set of motors, the latter may be run in parallel when necessary. Screwed to the underframe, with a layer of compressed felt between the surfaces, is the stage flooring, which is composed of 2½in. teak planks. An excellent idea of the appearance of the tables during their construction is given by Figs. 4 and 5, which show the method of supporting and driving. When it is known that some 130 H.P. of electric motors are provided for driving this stage it will be recognised that the electrical work in connection with it is of no little importance. Situated in the main intake room are the double-pole main switches and fuses which control the supply to the motors (Fig. 6). After leaving the change-over switch, the service is divided up, and three branches are taken straight to three separate cast-iron boxes as shown. The largest of these is for the outer table, and the other two for the intermediate and inner tables respectively. Immediately above the switches are fuse boxes, one for each pole, and from this point the cables run to a main switchboard (Fig. 7) in the controller room.

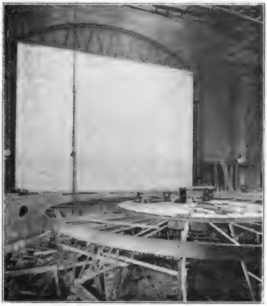


Fig. 4.—Stage During Construction.

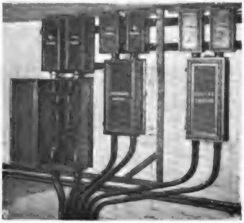


Fig. 6.—Main Switches and Fuses in Table Mains.

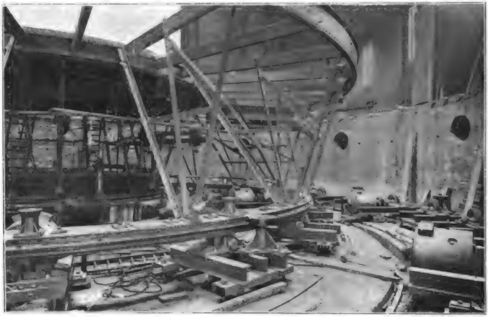


Fig. 5—Inner and Intermediate Tables in Position.

All the cables are Messrs. W. T. Glover's fireproof, and are drawn into steel tubes treated with Angus Smith's compound. The switchboard consists of panels of enamelled slate mounted on steel frame, and has the following instruments fixed upon it: four circuit breakers, one for the centre table, one for the intermediate and two for the outer; four ammeters, one in series with each circuit breaker; and four switch fuses for each motor. The automatic circuit breakers are of Messrs. J. E. Spagnoletti & Co.'s patent edgewise type (Fig. 11), fitted with toggle joints so arranged as to prevent any possibility of the switch being closed when there is a short-circuit on the line. There are 14 motors in all, and as there is a fuse in each pole of both field and armature, there are altogether 56 switch fuses. As the motors are reversible, both armature and field leads come back to this board.

For regulating the speed of the motors some exceedingly large controllers have been installed by the Sturtevant Engineering Co. There are four of these controllers (Fig. 8), three of which control four motors each, and the fourth two motors Owing to the fact that the largest table requires such a considerable amount of power it was not thought advisable to control all its motors with one controller, and therefore they have been divided into two groups of four, each of which is controlled by a separate controller. Under normal conditions, however, the two controller drums are worked simultaneously by means of gearing

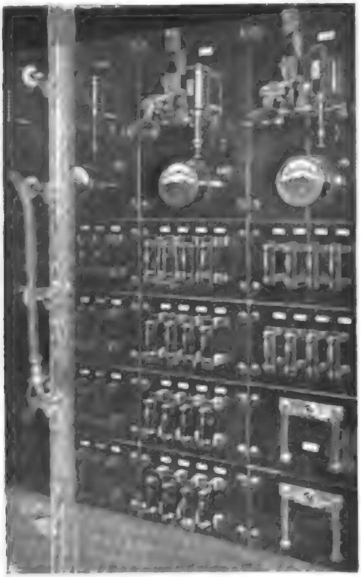


Fig. 7.—Motor Switchboard.

They are of the drum or tramway type, and the method of control is not only by series parallel combinations of the various groups of motors, but intermediate speeds are also secured by inserting resistance in series with the motors and by other means. By a novel arrangement the making and breaking of the circuit on contacts inside the controller is avoided, and, instead, the circuit is always made and broken by solenoid-controlled main switches, all of which are equipped with carbon making and breaking contacts and magnetic blow-outs. The controllers are operated through worm gear from rotary handles situated on a gallery above the stage level, and at the other end of the switchboard described above, so that the operators always have a full view of the stages when they are revolving. In addition, each rotary handle is fitted with a large disc which shows the operator precisely which step of the controller he is using at any time. Turning the controller handle backward from the "off" position has the effect of short-circuiting the motor armature through a variable resistance for the purpose of quickly stopping the motors, the motor fields being fully excited during this operation. Emergency switches are fixed on the gallery within reach of the operator's hand, whereby in case of accident, the motor circuit can be instantly opened. By opening an emergency switch, the operator breaks the circuit of one of the solenoid-controlled main switches, and this, of course, opens the main circuit. The minimum speed of the large table obtainable with these controllers is 2 miles per hour, and the maximum 20, and the intermediate speeds increase by two miles per hour each. From the controllers about 40 cables, varying in size from 61/15 to 19/16, go to the resistance room, and are run in a specially constructed trench. A similar plan is adopted for the cables to the motors, and draw-in boxes are provided underneath the stage for each table. At the draw-in box a hollow cast-iron pillar is erected, and the cables pass up this into steel tube, which is carried round to all the motors at a height of about 4ft. from the ground. The outer table is equipped with eight 10 H.P. motors running at 216 revs. per min., the intermediate table with four similar motors, and the inner table with two 4½ H.P. motors running at 450 revs. per min. and driving through worm gear. All the motors were built and supplied by Messrs. J. P. Hall & Co. When the largest table revolves at 7½ revs. per min. its outer peripheral speed is 20 miles per hour. The outer, intermediate and inner tables have respectively 32, 16 and 8 bearing pulleys, and 16, 8 and 4 thrust pulleys, in addition to the driving pulleys attached to the motor shafts.

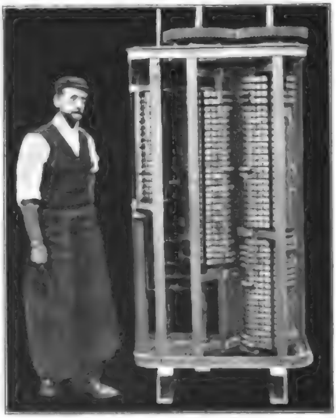


Fig. 8.—Sturtevant Controller.

As has already been mentioned, it is possible to employ the motors themselves for braking purposes, but hydraulic brakes are also provided and are held off when the pressure is on. By means of the latter it is possible to bring the tables from full speed to a dead stop in 26 seconds. Hydraulic pressure indicators are provided on the stage switchboard gallery, as are also indicating ammeters to show what current is being used by the different tables. The hydraulic brakes are operated by foot plungers fixed in front of the controller handles. Underneath the centre table is fixed a metallic brush, which makes contact with a series of contacts connected to a special lamp indicator board on the controller platform. The voltage of this indicator is 12 volts, and it serves the purpose of indicating the position of the centre table when the other tables are covered with scenery.

From the prompt corner to the controller platform a Chadburn ship telegraph has been fixed to enable the stage manager to communicate instructions regarding the movements of the tables to the attendant in charge. The arrangement of this apparatus is similar to that usually supplied by the

Chadburn's (Ship) Telegraph Co. for the engine-room telegraphs of merchant steamers, generating stations, &c., with the exception that the bell movement in the indicator is replaced by an ingenious tappet device (Fig. 9). It was thought that a bell would make too loud a sound for stage purposes, and the tappet motion, which gives a sharp metallic click, was thus arranged. The wheels in the transmitting instrument are connected to the wheels on the indicator by wire and chain, and at each order one of the tapping rods is raised and caused to strike the case of the instrument a sharp blow, by which the attention of the attendant is attracted.

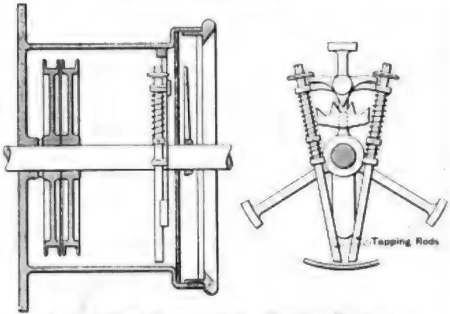


Fig. 9.—Tappet Arrangement of Chadburn Telegraph.

In addition to the tables, there are also five large panorama rolls driven by 5 H.P. motors supplied by the Lancashire Dynamo and Motor Co. Each panorama motor has in connection with it a special motor panel (Fig. 10) enclosed in a cast iron case, and containing an ammeter, double-pole switch and enclosed fuse, and a maximum and no-voltage circuit-breaker.

There are also two motors for hoisting and lowering scenery. Each of these drives a long shaft by means of worm reduction gear, and this shaft is geared on to three or four hoisting barrels, which can be thrown in or out of gear as required by a clutch. Other electrically-driven appliances in connection with the stage are :—two lifts to the dressing rooms, an Otis elevator to the flies, a pump driven by a 3 H.P. Electromotors Limited motor, and a travelling crane driven by a B.T.-H. motor.

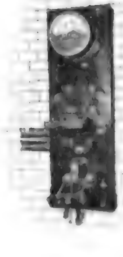


Fig. 10.
Panorama Motor Panel.

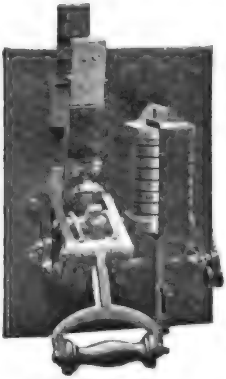


Fig. 11.—Circuit-Breaker.

All the wiring for the motors on the stage has been carried out by Messrs. J. E. Spagnoletti & Co., who also made the motor switchboard situated in the controller room, the circuit-breakers, the special lamp indicator, &c. The contract, as may be gathered from the above, was a very large one, and it has been carried out in an excellent manner.

Coming now to the front of the house, one three-wire service from the Charing Cross Company's mains is brought in, and another from the Metropolitan Electric Supply Co. Only the outers are, however, made use of in the case of the latter service. All incandescent lighting and power is taken from the outers at 200 volts, and arcs from the middle wire of the Charing Cross service at 100 volts. The two supply companies each have a separate room for their intakes, where the usual main switches and fuses are provided. Each company's service is taken to a main house distribution switch and fuse board, the two boards being duplicates, and from here the whole of the auditorium lighting, including staircases, passages, lavatories, vestibules, &c., is controlled. From these boards, circuits are taken to upwards of 30 sub-distribution fuse-boards placed in different parts of the house for controlling various local lights. Also in the main house switch room there is a main arc distribution double-pole switch and fuse board for controlling the numerous arc and projector lamps fixed in different parts of the auditorium in special ventilated and fireproof chambers. Finally, in the same room is a main double-pole switch and fuse board for the motors which work the talking and revolving signs, hoists, fans, &c.

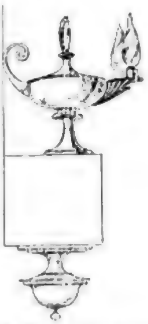


Fig. 12.—Roman Lamps Round Grand Circle Fronts.

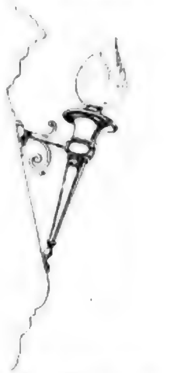


Fig. 13.—Roman Torches Round Upper Tier Fronts.

The whole of the auditorium lighting and that of the public parts of the house is wired on the duplex system, so that any one light on the Metropolitan Supply is followed by a light from the Charing Cross supply; thus, in the event of the total failure of one company's supply, the other company will give sufficient light in every part of the building. All the cables are run in screwed steel barrel, and all the fittings are fixed directly on to the cast-iron box into which the pipe is screwed, so that the whole tubular system is metallic throughout. Messrs. Blackburn, Starling & Co. have been responsible for this part of the work, the magnitude of which may be gauged from the fact that there are no fewer than 1,552 16 c.p. lamps, in addition to a biograph arc, two projectors, several arcs and about 52kw. for power.

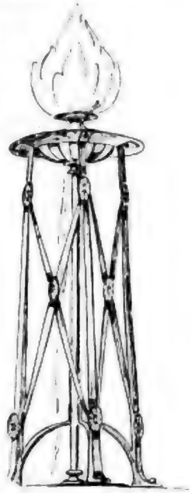


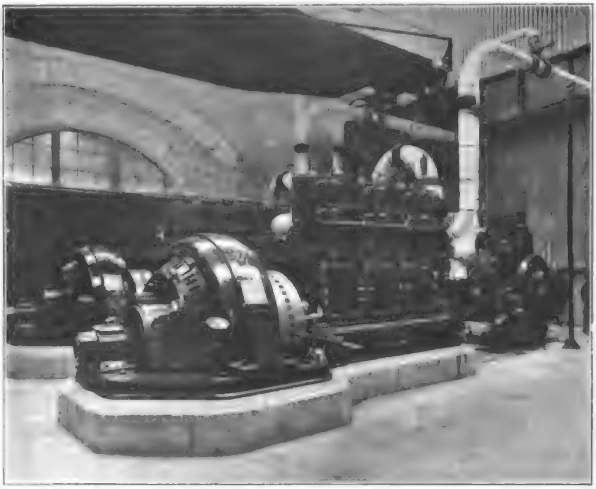
Fig. 14.—Roman Brazier on Top of Tower.

No pains have been spared to make the installation ornamental as well as of high quality and great utility. This is evidenced by the style of the fittings and the electroliers which have been employed. These are of Messrs. F. & C. Osler's make, and those on the grand tier fronts are reproductions of antique Roman lamps (Fig. 12). On the upper tier fronts are metal torches with flambeaux shades to represent a flame (Fig. 13). The fittings in the corridors, staircases, and entrance are the result of a study of antique Roman metal work, and while the suitability for the requirements of electric lighting has been carefully considered, the leading characteristics of the Roman metal design have been preserved. Fittings in the tea rooms are in the style of the modern English School and a novel arrangement of coloured beads has been introduced in the centre fitting.

The revolving sign, which makes an excellent landmark at the top of the building, is built up of steel sections, and measures 14ft. in diameter. It is bolted at every intersection, and on the steel work the word "Coliseum" is fixed, in letters 5ft. 6in. high, composed of hard wood, gilded with English gold and fitted with 500 incandescent lamps. This ball is supported on a hollow steel shaft, running some 67ft. down, inside the tower, where the necessary gearing for driving it is fixed; this comprises an electric motor, worm gear and revolving fuse boxes for controlling each individual letter.

Before concluding this article we have to congratulate Mr. Oswald Stoll on his remarkable enterprise and Mr. E. Wingfield Bowles, the consulting engineer, on the success which has attended his labours. We also have to thank these gentlemen and the various contractors concerned for enabling us to collect the information given above.

ELECTRICAL PLANT AT GIBRALTAR DOCKYARD.



ALLEN-E.C.C. SETS AT GIBRALTAR DOCKYARD.

The new scheme which the Admiralty have in hand for the equipment of the naval dockyards with electrical power has been fittingly inaugurated by the establishment of such a plant at Gibraltar. The contract for this included the building and erection on site of steam dynamos and electrical gear, air and circulating pumps and condensers, all of which, with the exception of the electrical gear, was undertaken by Messrs. W. H. Allen, Son & Co. For the electrical generators, motors and balancing sets the Electric Construction Company were contractors.

Comprising the generating plant are four three-crank compound high-speed forced-lubrication engines of Messrs. Allen's standard type, directly coupled to E.C.C. generators and each capable of developing 200kw. Each engine will develop 300 I.H.P. at 380 revs. per minute, when supplied with steam at 110lb. per square inch at the stop valve, and exhausting either into the atmosphere or a condenser. The high-pressure cylinder is 15in. in diameter and the two low-pressure cylinders are each 16in. diameter, the stroke in each case being 9in. The cylinder volumes and the successive points of cut-off have been so adjusted as to produce as nearly as possible an equal distribution of power on all three cranks, with a view to reducing the irregularities in turning moment to a minimum.

Cast steel has been employed in the construction of the low-pressure pistons, which are conical in form and are fitted with Rowan's patent rings. The high-pressure piston is of the solid-block type and of cast iron, and is fitted with a solid packing ring of rectangular section. All three pistons are of equal weight, and the connecting rods and piston rods are all identical, thus ensuring a good balance. For the cylinders a special mixture of hard and tough close-grained cast iron has been made, having an ultimate tensile strength of 12 to 15 tons per square inch. They are provided with all the usual accessories in the way of drains, relief valves and provision for indicating, the hand-levers for opening and closing the drain cocks being placed in close proximity to the engine stop valve.

All valves are of the solid piston type, and take steam on the inside edges, thereby reducing the pressure on the glands as compared with valves taking steam on the outer edges. Each valve is driven independently from an eccentric on the crankshaft, the two low-pressure eccentrics being forged solid with the shaft, and the high-pressure eccentric being of forged steel and keyed on. The three cylinders are completely isolated from each other, in order that the correct distances between their centres may be preserved at all temperatures. They stand upon a massive and neatly designed cast-iron trunk, which completely encloses the working parts of the engine, the walls of which also carry the slides for the main crossheads. Between the top of this trunk and the cylinders are cast-iron distance pieces, which are cast in one piece with the cylinder bodies and are provided with openings which permit of easy access to the piston and valve rod stuffing boxes, for inspection and adjustment. The apertures through which the piston and valve rods pass into the trunk are fitted with a special form of bush, which effectively prevents oil from passing up into the cylinders, and also prevents water from entering the crank chamber. The whole trunk and cylinders complete stand upon a massive cast-iron bed-plate, which forms a reservoir into which the oil drains, and from which the oil is supplied at a pressure of about 15lb. per square inch to all the working parts by means of a small valveless force pump driven from one of the eccentrics of the engine.

Piston rods, valve rods, connecting rods, eccentric rods and crankshaft are all of Siemens-Martin steel, having a tensile strength of 28 to 32 tons per square inch and giving under test an elongation of 30 per cent. in a length of 2in. With the exception of the cross-head bearings, which are of gun-metal, the whole of the bearings throughout are lined with white metal and all are supplied with oil under pressure, from the force-pump described above. The governor is of Messrs. Allen's standard crankshaft type, and operates a double-beat throttle valve of special design, placed between the stop valve and the engine, the spindle entering the valve-box through a practically frictionless bush. A solid disc pattern flywheel is forced on to the end of the crankshaft and securely keyed; the dynamo side of the wheel is accurately faced up to form the coupling face for the armature.

All cylinders, stop valve, governor valve and steam separator are properly lagged with asbestos, laid on under steam and are covered with blue sheet steel, the whole thus presenting a very neat appearance. The following test results from the official trials of one of these sets, made at Messrs. Allen's works at Bedford, may be of interest:—

	Condensing.	Non-condensing.
Output in kw.	200	200
Revs. per min.	380	380
Steam per kw. per hour in lbs.	26·5	32·6
Steam pressure in main pipe	120lb. per sq. in.	120lb. per sq. in.
Throttled steam pressure	86lb. " " "	107lb. " " "
Vacuum in inches of mercury	27·0in.	0

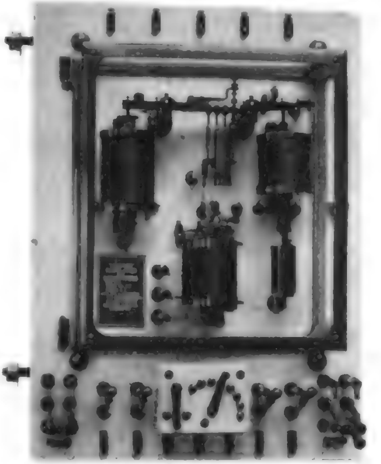
The governor trials show a variation in speed from no load to full load of 2·9 per cent., the specified limit being 3 per cent.

There are four independent surface condensers, each capable of dealing with 6,600lb. of steam per hour and maintaining a vacuum within 4in. of the barometric pressure, when supplied with circulating water at a temperature not exceeding 60° F. Each condenser casing is of cast iron and cylindrical in form, and fitted with tube plates of 1¼in. thickness of the best rolled brass. These tubes are all of the best solid drawn brass of ⅝in. external diameter, and are fixed in the tube plates by means of screwed ferrules and tape packing, the ferrules having lips to prevent the tubes from slipping out of place. One of the waterheads of the condenser is provided with a horizontal diaphragm, by which the water is made to circulate twice through the length of the condenser, traversing first the lower tubes and then the upper ones. Each has a total cooling surface of 660 sq. ft., and is fitted with the usual accessories, including vacuum gauge, drain cocks, &c. The air-pumps are of the vertical single-acting Edwards type, the barrel having a diameter of 14in. by 6in. stroke. They make from 120 to 130 revs. per min. Each is driven directly by a single cylinder double-acting steam engine by means of side rods from the engine crosshead, the steam cylinder, having a diameter of 6in. and a stroke of the same length, being placed in line with the air pump barrel. The valve seatings, guards, bucket and air pump barrel are of gunmetal, and the bucket rod is of forged bronze, the valves being of the "Kinghorn" pattern. All the engine working parts are of the best Siemens Martin steel. Each circulating pump is of Messrs. Allen's well-known "Conqueror" pattern, having suction and discharge branches 5in. diameter, and is capable of delivering 450 gallons of water per minute when running at 700 revs. per min., against a maximum lift of 10ft. including pipe friction. The pump body is of cast iron, the disc of gunmetal and the spindle of forged naval bronze, the disc having a diameter of 10in. It is coupled directly to a continuous-current motor by the Electrical Construction Co., both pump and motor being mounted on the same baseplate. These circulating pumps are each fitted with a steam air ejector for starting. The general appearance and arrangement of this plant is well shown in the accompanying photograph, taken after erection at Gibraltar.

AUTOMATIC VOLTAGE REGULATORS.

The British Thomson-Houston Co., realising the fact that the voltage regulation of generators, more especially of the alternating-current type, has long been recognised as of great importance, have developed and placed upon the market regulators for automatically accomplishing this result independently of speed changes and variations in load. These voltage regulators are designed for switchboard use and are mounted on a marble or slate base. The metal parts are all highly polished and have a black oxide finish, while the magnets are wound with specially treated silk-covered wire. The whole device is enclosed in a glass case which can be readily opened for inspection. There are two types, TA regulators for alternating-current generators; and TD regulators for continuous-current generators.

With type TA regulator the voltage of the alternating-current generator is automatically maintained at any desired value by varying the exciter voltage by means of the regulator. This is accomplished by rapidly opening and closing a shunt circuit across the exciter field rheostat The moving parts of the regulator are all very light and move only a short distance; thus they can operate at a high rate of speed without any pumping or hunting effects. This instrument was fully described by Mr. H. S. Meyer in the third part of a Paper entitled "Voltage Regulation in Alternating-Current Systems," read before the Liverpool Engineering Society and published in *The Electrician*, Vol. LII., p. 772. The rheostat shunt circuit is opened and closed by a differentially-wound relay, and the current for operating this relay is taken from the exciter 'bus bars and is controlled by floating main contacts. Current for operating the continuous-current control magnet is also taken from the exciter 'bus bars. The relay and the continuous-current control magnet constitute the continuous-current portion of the regulator, and maintain not a constant but a steady exciter voltage. A magnet having a potential winding connected, by means of a potential transformer, to the 'bus bars or the circuit to be regulated, constitutes the alternating-current portion of the regulator. This magnet also has an adjustable compensating winding which is connected in series with the secondary of a current transformer usually inserted in the principal lighting circuit. Its core is attached to a pivoted lever carrying a counterweight which is balanced by the attraction of the magnet. If a load is thrown on the generator the voltage will tend to drop, the alternating-current magnet will weaken and destroy the balance of the core and lever and cause the main contacts to close; this in turn will close the relay contacts and entirely short-circuit the exciter field rheostat, thus increasing the exciter voltage until the original balance of the alternating-current magnet core and lever is restored and the alternating-current voltage maintained at the required value. A diagram of connections is given in *The Electrician*, Vol. LII., p. 773.



B.T-H. Voltage Regulator (Type TA).

In some cases the exciter voltage may vary from 70 to 125 volts from no-load to full-load. This is especially true if the load is partly inductive and the regulator is adjusted to compensate for the line loss. In order to get the full range of regulation within the scope of the regulator in such cases, the alternating field rheostat should be turned entirely out and the exciter field rheostat adjusted to lower the alternating-current voltage about 65 per cent. below normal. When the regulator is switched in, it will close the rheostat shunt circuit and instantly build the voltage up to normal, and maintain normal voltage by rapidly opening and closing the rheostat shunt circuit. The regulator may be thrown in and out of service without varying the voltage. Once the regulator is adjusted to maintain a constant voltage at the centre of distribution with the use of the compensating winding, it requires no further adjustment, and the station voltage will be automatically raised and lowered to maintain the desired voltage at the centre of distribution. The regulator is practically independent of speed, power-factor and temperature changes, and is mounted on a base 15in. by 20¼in. by 1¼in. It is preferable to fix it on the switchboard, allowing about 4ft. from the floor to the bottom of the regulator, and as near the exciter panel as practicable.

The type TD regulator for continuous-current generators works on the same principle as the TA regulator, but is simplified by the fact that the exciting voltage is the same as the voltage to be regulated. It is therefore possible to dispense with one operating coil.

It may be mounted on the front of the switchboard panels or on rigid iron brackets at either end of the switchboard. These regulators are applicable to shunt or compound-wound generators, but in regulating compound-wound generators they should only be arranged to regulate one generator at a time. All the generators operating in parallel should be connected to the regulator, so that regulation may be obtained from any one of the generators operating in parallel, or when only one is operating at a time. With shunt-wound generators each generator should be provided with a regulator, as shunt-wound generators will not trail, due to the absence of the series-winding of the generator. TD regulators are at present designed to regulate machines up to 125kw. capacity, and are adapted for the commercial voltages of 100 to 125 and 210 to 250. If it is desired to regulate generators of a greater capacity than 125kw. they should be provided with exciters for the excitation of the fields, and the type TA regulator should then be used instead of the type TD.

SOME APPLICATIONS OF ELECTRICITY IN GERMAN MINES.

The Electrical Co., of 121-125, Charing Cross-road have equipped quite a number of mines with electrical winding plant, and they have sent us a description and technical particulars of a number of German installations of this character.

For some of the largest installations carried out by the Company the "Koepe" pulley has been very successfully employed in conjunction with electric working. It consists of a grooved pulley of large diameter mounted on the shaft coupled to the winding motor; the winding rope passes round this pulley and over the pit-head gear outside the winding shed, and is thence attached to the cages, the weight of the rope being balanced by the tail rope on the cages. It forms thus an endless system. The arc of contact of the rope on the Koepe pulley is so chosen that the maximum loads occurring are lifted by the friction alone between the rope and pulley, an ample safety factor being allowed for. It has been found possible, working this system electrically, to reduce the weight of the winding pulley to about one-half the weight of the drums usually required for steam winding plant. Other systems of winding drums are, however, likewise applicable to electrical working.

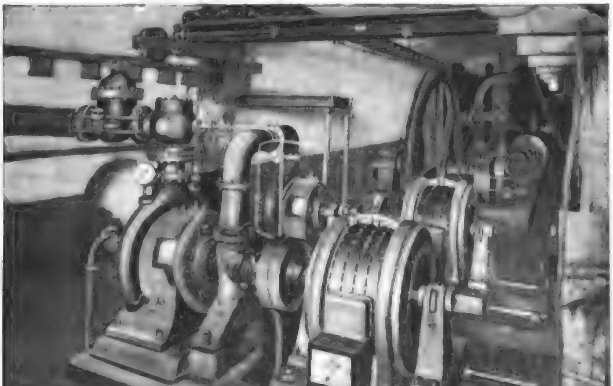


Fig. 1.—Pumping Plant in the "Victor Rauxel" Pit.
Two 600 H.P. three-phase motors, 5,000 volts, 960 revs. per min. Delivery, 1,540 gals. per min to height of 1,650ft.

The winding plant at "Preussen II." pit deals with an output of 100 tons of coal per hour, mined from a depth of 2,310ft. The installation (see Figs. 2 and 3) was designed on the three-phase system with liquid resistance control for the winding motor.

The generators consist of three three-phase revolving-field machines, each of 550 K.V.A. output, working at 2,100 volts with a frequency of 25~ per sec. at a speed of 94 revs. per min., the armature frames being of the A.E.G. patented type, with tie rods. The engines consist of three twin compound engines of 800 H.P. per set. The winding plant includes a Koepe pulley of 20ft. diameter, the winding rope being 1¾in. diameter. During normal running the speed of the motor and Koepe pulley is 50 revs. per min.

Details of the winding are as follows: Coal lifted per journey, 2 tons 8cwt.; speed (for coal), 52½ft. per second; speed (for miners), 16ft. per second.

The winding cycle for coal is: Starting, 16 seconds; normal full speed, 27 seconds; slowing down, 18 seconds; changing, 17 seconds.

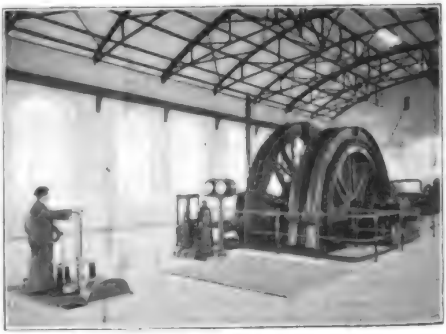


Fig. 2.—Winding Plant at "Preussen II." Pit.
Three-phase motor, 650 H.P., 2,000 volts, 50 revs. per min. Useful load 2 tons 3 cwt. Speed 52½ft. per sec.

Each winding cycle occupies, therefore, 78 seconds. At starting the power required amounts up to 1,880 H.P., but during running the demand falls to 650 H.P.

The weight of cage is 3 tons 16 cwt.; tubs (4), 1 ton 8 cwt.; coal, 2 tons 4 cwt.; rope, 4 tons 18 cwt. Total weight, therefore, 12 tons 6 cwt. For inspection of the shaft and rope, &c., any desired speed ranging down to about 20in. per second can be easily obtained.

The winding drum is direct-coupled to an A.E.G. three phase induction motor with slip-rings. The 2,000-volt current is brought to the motor through insulated cables. From the diagram (Fig. 3), it will be seen that the current from the supply station goes through high-tension fuses to an emergency switch. Beyond the latter is arranged the reversing switch for altering the direction of rotation of the winding motor. This switch is actuated directly from the controlling lever, and the lever is set up for the driver in precisely the same way as in the case of a steam-winding engine. In the mid-position of the lever the current is switched off and the motor is electrically disconnected. By moving the lever to left or right the current is sent through the stator of the motor for one or the other direction of rotation. The actual starting of the motor, as also its speed regulation, is controlled by inserting liquid resistance in series with the rotor windings. Each of the three phases of the rotor is led to this end to the resistance plates, which are insulated and suspended in the containing tank shown, with which is combined a reservoir below. Through both of the latter there is kept up a constant circulation of soda solution, and as soon as the regulating valves at the bottom of the upper vessel are shut the liquid begins to rise and allows a passage of current between the resistance plates, thus speeding up the motor. The higher the liquid rises and the greater the surface of the plates covered, the smaller becomes the resistance in the rotor circuit, and therewith the speed of the motor advances towards its full value which occurs when the liquid has reached the overflow point. The regulating valves are actuated by the same hand lever referred to above, which controls the direction of rotation of the motor. After the lever has set the stator switch in the back or forward position for one or the other direction of running, it can be moved through a certain arc without the reversing switch being affected. This intermediate path allows of the adjustment of the regulating valves to bring the liquid resistance to the correct height, so as to run the motor at the required speed. Only when the lever reaches a point near the mid-position is the stator reversing switch again actuated and the current interrupted. A special point of the arrangement is that the rise in speed of the motor by decrease of the resistance is also controlled by the water supply of the pump feeding the resistance, so that the driver cannot possibly start faster than the arrangement of the water supply—made with due regard to the friction of the rope on the Koepe pulley, or the overload capacity of the plant—will allow. By this compulsorily-graded rise of the liquid and the progressive speed which it ensures, all shock or unsteady movements at starting are entirely avoided.

In order to obtain an immediate start of the motor when the hand lever is set out to its limit, the resistance plates are so arranged that they are always immersed to a certain depth in the liquid traversed by the current, so that on switching in the stator the necessary current to enable the motor to start traverses the rotor windings. The braking arrangements are laid out on a plan similar to than obtaining with steam winding engines but are still safer.

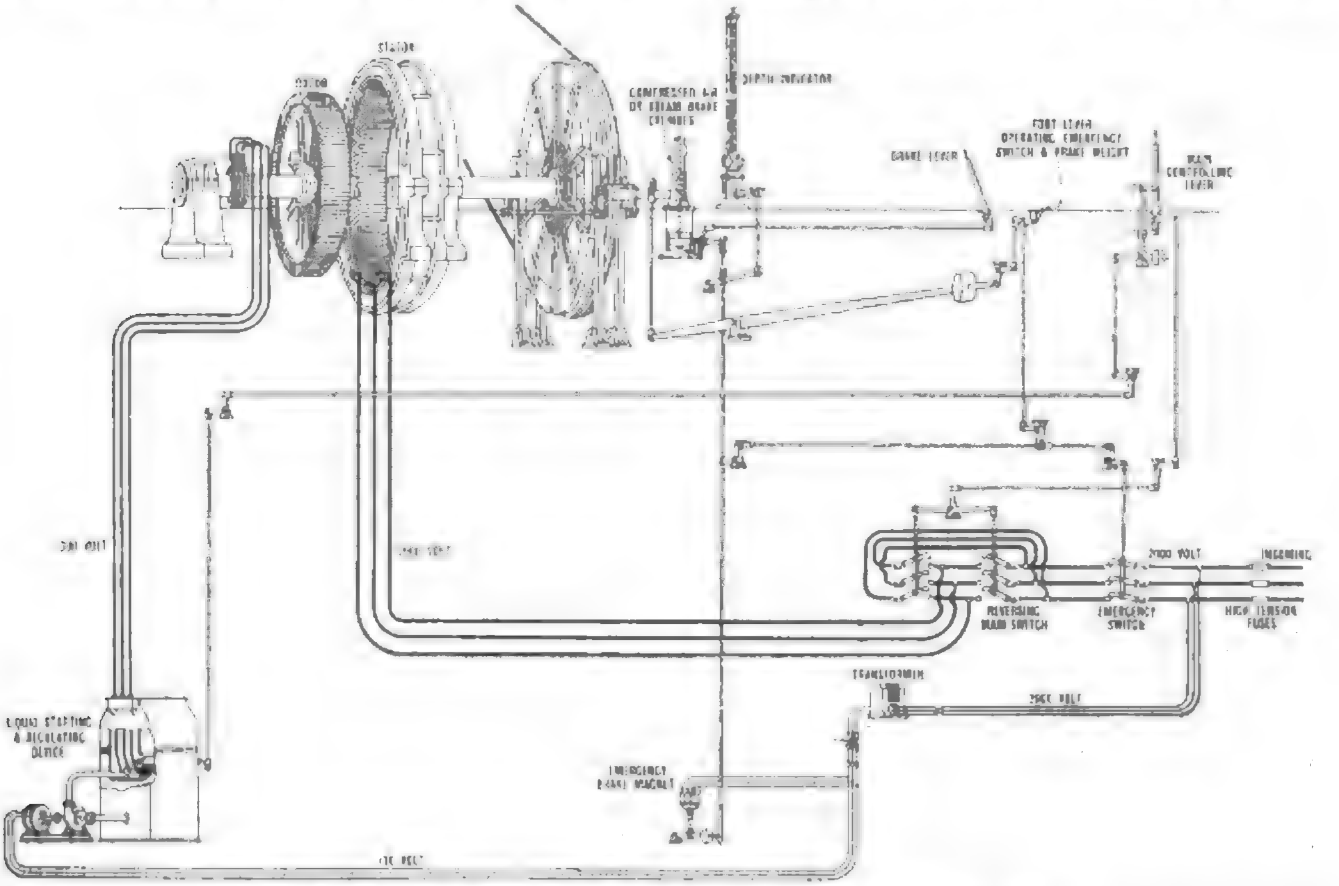


Fig. 3.—Diagram of Connections of the Winding Plant at "Preussen II." Pit.

The Koepe pulley carries on either side a brake rim of some 20ft. diameter, on which four brake blocks work. These can be thrown in through compressed-air gear by a hand lever. The same brake is also applied in case of over winding by the action of the depth-indicating gear shown in the diagram and at the same moment the emergency switch opens, so that all current is cut off from the plant.

In case of accidental interruption of the current, as for instance due to the melting of a fuse in the main leads, an electromagnetic braking device is fitted which releases a weight and so actuates the connecting rod of the compressed-air brake and opens the emergency switch. For the further contingency that the air-pressure brake might refuse to work, a reserve braking device is provided in the form of a foot-lever, by depression of which the driver can also open the emergency switch.

An example of a winding plant operated by a combination of three-phase and continuous currents is in use at the "Donnersmarckhütte." Two 892kw. three-phase machines in the power house generate current at 1,500 volt pressure, the speed of the machines being 94 revs. per min. These generators are directly driven by Körting gas engines operated by furnace gas. A third set is used as a reserve. On account of the speed variations inseparable from gas-engine working, the generators have damping coils, in order to obtain perfect parallel working. They are excited with current at 220 volts. The frequency of the supply is 50 ∿ per second.

The weight of coal lifted per journey is 1 ton 5 cwt. from a depth of 1,650ft. and with a maximum speed of 16½ft. per second. The drums are each 12ft. 6in. in diameter and 8ft. 7in. overall width. The load is divided between two tubs, each weighing 7½ cwt. empty, and the weight of the cage, &c., empty is 5 tons, it being designed to eventually take much heavier loads, according as the mine is deepened. A 1in. circular winding rope is used.

The continuous-current shunt-wound winding motor (Fig. 4) is separately excited at constant voltage from the exciter E, as shown in the drawing, and runs at 150 revs. per min. with a normal output of 280 H.P. during winding and an output up to 400 H.P. during starting. It drives the winding drum in this plant by means of toothed-wheel gear with a reduction ratio of 1 to 6. The drum is fitted with brake blocks. Under normal working conditions the brake is actuated through compressed air by means of a hand lever, but a drop weight serves as a safety brake, and is actuated through the depth-indicating gear or, in the case of the current being interrupted, by a magnetic brake, B. The drop weight is kept balanced by a compressed-air cylinder, but can also be released by hand.

The Ilgner converter plant includes a three-phase induction motor connected to the supply mains, giving at a theoretical speed of 500 revs. per min. an output of 125 H.P. It will be noticed at once, therefore, that while the winding motor must work up to 400 H.P., the three-phase induction motor in this case is only of about one-third this output. The induction motor is coupled by means of a flexible coupling to a shaft carrying a cast-steel flywheel weighing 15 tons, with a diameter of 11ft. (maximum peripheral speed about 280ft. per second), and mounted on the same shaft is a compensated continuous-current generator Déri system for an output of 72kw. Beyond the left-hand outer bearing is an exciter set consisting of an 8kw. 220-volt compound-wound machine, which excites the fields of the continuous-current generator and the winding motor.

The starting and speed control of the winding motor is effected by means of the Leonard system by alteration of the excitation through the reversing and controlling switch R.S., shown in the diagram. One of the special features of the switching arrangements in this system is that the controlling lever of the rheostat R.S. is so designed that for each position to which it can be put by the driver there is a definite fixed speed for the winding motor, no matter what the load may be which is being lifted or lowered. Also the driver can electrically brake the winding motor, either quickly or slowly, by suitably adjusting the lever so as to make the winding motor run as generator and so help to speed the flywheel.

The Ilgner converter works in the manner described below. The energy in the form of three-phase current from the network is brought to the induction motor coupled to the flywheel and the continuous-current generator. The latter, especially when the winding motor first begins to run, must commutate a current many times greater than the normal full-load current, with almost no volts pressure and with the brushes in neutral position. For this reason a so-called "compensated" continuous-current generator on the Déri system is used and in this machine, by means of the special winding, any cross-magnetic action of the armature is completely negatived, and perfectly sparkless working is obtained for all loads and voltages.

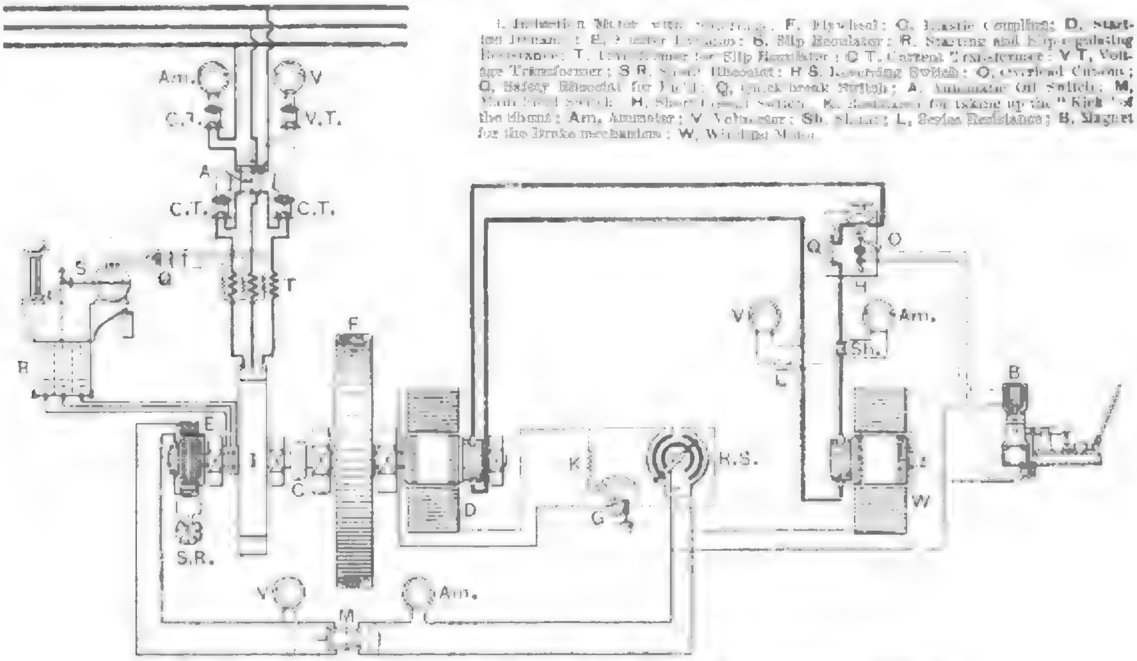
The converter serves two purposes. Firstly, it converts the high-tension three-phase current to continuous current, and secondly, its still more important function is to secure an almost complete avoidance of the otherwise heavy "peaks" of current on the supply mains, brought about through the starting of the winding plant. This is effected by the arrangement that at the starting of the winding motor and during its acceleration period, the extra demands of the winding motor are supplemented by the energy stored up in the flywheel which drives the generator and assists the induction motor. During the changing intervals and periods of light load the supply from the power station is used in order to again accelerate the flywheel, which has meanwhile been slowed down due to its having given off some of its energy. The flywheel has the further advantage that it safeguards the plant against any breakdown due to a fuse in the station or circuits giving out, as it alone has sufficient energy stored in it to drive the generator for a considerable time. The speed variations of the converter in this installation lie between 490 and 432 revs. per min.

In order to produce these flywheel effects over the necessary range, that is, in order to secure that the energy taken up by the three-phase motor from the network will not exceed a certain figure—carefully calculated in each case with regard to the working conditions of the winding—the liquid starting resistance R used for the induction motor is provided with an automatic "slip" regulation depending in action on the amount of current taken from the mains. This works in such a manner that at the moment of starting of the winding machine, that is, at the moment when the tendency of the motor is to take a higher current than its normal current, resistance is automatically inserted in the rotor and vice versa when the load diminishes, during the slowing down and changing periods of the winding, that is, when the current tends to decrease, the resistance is automatically diminished. As a result of this insertion of resistance, not only is the "slip" increased (up to about 12 per cent.), in other words, not only is the flywheel slowed down and forced to give up a considerable store of its energy, so helping to drive the generator, but also as the resistance of the rotor circuit is increased in proportion as the speed falls, the rise in current in the induction motor is impeded.

At the speeding up of the flywheel when the load on the winding motor is reduced the reverse action takes place, when by the gradual switching out of the resistance, a sudden sinking of the current in the induction motor below its normal value is prevented, and it is gradually sent up again to its correct speed. In order to bring the converter set to a stop quickly, when required, a brake-block is arranged below the flywheel-rim, and this can be applied by means of a hand-wheel and spindle and is fitted with water cooling, conveniently controlled by a tap near the brake spindle. The converter set is kept continually running during the hours of winding.

All necessary precautions such as maximum cut-outs, fuses, emergency switches, &c., in addition to the brakes already mentioned, are provided. The switch G has for object the immediate cutting out of the field excitation of the generator D in order to be able, if necessary, to stop the winding motor at once by this means. Near to the driver is also erected a cast-iron column carrying the ammeter and voltmeter, &c., which guide him when starting up, together with the pressure gauge to indicate whether the correct air pressure is available for the brake.

As in all other services in mining, the application of electricity for pumping leads to a far more satisfactory and economical solution than that offered by other methods hitherto employed, such as steam pumping. The advantages of electric pumps over steam-driven pumps have been often discussed in these columns, and need not be repeated here. Fig. 1 shows the pumping plant erected by the company in the "Victor Rauxel" pit. Each of the two sets consists of one 600 H.P. three-phase motor, running at 960 revs. per min. and driving directly a Sulzer centrifugal pump. The supply pressure to the motors is 5,000 volts. These centrifugal pumps are interconnected, and the first one delivers to the second at a pressure corresponding to 825ft. The total height to which the water (1,540 gallons per minute) is raised is 1,650ft.



I, Induction Motor with [illegible]; F, Flywheel; C, Elastic Coupling; D, Starting Dynamo; E, [illegible]; S, Slip Regulator; R, Starting and Slip-regulating Resistance; T, Transformer for Slip Regulator; C T, Current Transformer; V T, Voltage Transformer; S R, Speed Rheostat; R S, Reversing Switch; O, Overload Cut-out; G, Safety Rheostat for Field; Q, Quick-break Switch; A, Automatic Oil Switch; M, Main Field Switch; H, Short-circuit Switch; K, Resistance for taking up the "Kick" of the Shunt; Am, Ammeter; V, Voltmeter; Sh, Shunt; L, Series Resistance; B, Magnet for the Brake mechanism; W, Winding Motor.

FIG. 3.—DIAGRAM OF CONNECTIONS OF WINDING PLANT AT THE "DONNERSMARCKHÜTTE."

FUEL ECONOMY IN STEAM POWER PLANTS.*

BY WILLIAM H. BOOTH AND JOHN B. C. KERSHAW, F.I.C.

INTRODUCTION.

In presenting this Paper the authors are aware that economy in most or all electrical power plants, as usually understood, is at present unattainable. The lighting station, the load of which at every moment of its working hours can, with care, be arranged to suit the economical load of the running plant, is nevertheless seriously handicapped by the very short length of time during which the total plant is at work. The possession of a really durable and efficient storage battery would raise the load-factor of the plant probably eightfold. The traction power house, the load-factor of which, for tramway work, varies approximately with the cube root of the number of cars run, cannot be worked economically, because, though all the power in the station must be run all the working hours, excepting, of course, necessary spares or stand-by plant, yet the load on the running plant varies from a maximum to a minimum

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[*] Paper read before the Institution of Electrical Engineers, Jan. 12th.

every few minutes, and the mean load of the plant, except in the case of systems of several hundred cars, is but a small proportion of the total maximum load, and the steam engines at least must be wasteful. Here again economy in its fullest sense is a question of accumulators.

The authors assume that the fullest economy of first cost and more especially of running cost, are recognised by all station engineers as only obtainable, in the present state of knowledge, by means of a battery. But they are also aware that the battery is so far from perfect that its adoption in any case must still be a matter of grave and careful deliberation, and that the greatest economy ideally possible is too controversial to enter into in this Paper, save incidentally. But there are numerous economies possible in every power plant, and an endeavour will be made to point these out in the hope of stimulating the search after possible and practicable economy, to suggest thoughts on which all station engineers may work—thoughts many of them suggested to the authors by engineers who have directed their own energies in certain directions more than in others. Economy, commercially considered, is not identical with economy of first cost, nor yet with economy in fuel or wages. Nor can commercial economy be defined even as that compromise which makes the best return on the outlay, for there are other considerations which are sometimes paramount.

It is, for example, justifiable to economise plant in a traction station down to such a point that, at occasional special loads, the cars shall run a small percentage slow. But the parallel happening in a lighting station is altogether undesirable and defeats its own ends, because the public who use current are not yet trained to switch off some lamps when current fails. In all which follows, therefore, it must be understood that every means to economy that is put forward must be considered afresh for each particular case, for its adoption may be good or otherwise, according to the company in which it finds itself, and, though the authors are particularly concerned in fuel economy pure and simple, they are not unmindful of the discounts to be made on account of commercial considerations.

Steam-power economy is to be secured by attention to fuel and its combustion, feed-water and its treatment and heating, furnace design and arrangement, steam treatment and its use in suitable engines.

The subject divides itself into the several heads as follows:—(1) Feed-water; (2) Fuel; (3) Boilers and Furnaces; (4) Steam; (5) Waste Gases; (6) Draught. In such a Paper statistics would only lead to controversies that might obscure the intention of the Paper, which is rather to emphasise principles than to indicate beaten paths.

FEED-WATER.

Most electrical engineers are now ready to admit the importance of attention to the physical and chemical characteristics of their feed-water supply, and they recognise the impossibility of obtaining the highest efficiency from their boilers if the water is passed into them without preliminary heating, carrying all the original suspended dirt and dissolved impurities. Only very few natural waters are fit for use in steam boilers without some preliminary treatment; chemical examination can alone reveal whether this treatment is required and what must be its character. It is not the authors' purpose to go at length into the theory and practice of water-softening for steam-raising purposes, and they will only deal very briefly with a few of the more important points arising in a consideration of the subject. The practical side of the subject was dealt with very adequately by Messrs. Stromeyer and Baron in a Paper read before the Institution of Mechanical Engineers last session.

Analysis.—The examination of a water intended for steam-raising purposes should cover its acidity or alkalinity, presence of oily or fatty matter, total solids, temporary and permanent hardness. A trained chemist is required for this work. The examination of the water supply should be repeated at monthly intervals, since changes occur in the composition of all natural waters, according to the period of the year and the rainfall. Water taken from rivers or streams near the coast is subject to contamination by sea-water at the periods of flood-tide in the spring and autumn, and this danger must be recognised and guarded against.

When softening apparatus is installed, whether of the automatic or intermittent type, daily tests should be made of the water leaving the apparatus, since there is grave risk in many cases of excessive amounts of chemicals being used for softening. This excess produces priming and other evils in the boilers. The authors have seen at a north country works an ingenious automatic arrangement of 24 vessels for retaining this number of separate samples of the water during the day's work, each one filling in succession and requiring one hour for this purpose. The chemist at these works spends half an hour each morning in this sampling place (which is kept locked), and tests in this time selected samples of the previous 24 hours for alkalinity and hardness. Some check of this kind is imperative, since even the most reliable types of automatic softening apparatus are apt at times to get out of order, and variations in the composition of the water supply, as already noted, occur during the spring and autumn months of the year.

Softening Apparatus.—All waters containing more than 15 English degrees of total hardness (*i.e.*, an equivalent of 15 grains of calcium carbonate per gallon) should be subjected to treatment with chemicals before use in the boilers; and in large steam-generating plants it would probably pay to put in a softening apparatus when the water employed tests above 10 degrees of hardness.

The addition of "boiler compositions" to the feed-water as it enters the boilers is unscientific and bad. A boiler is designed for making steam, and not for carrying out half a dozen other operations, which sellers of "secret" compositions and unwise engineers sometimes attempt in it. External treatment of the water in an apparatus, which permits removal of the deposit before the water enters the boiler, is therefore an essential condition of scientific steam-boiler management. The authors do not propose to discuss the relative advantages of automatic and intermittent softening apparatus. Each type has its advantages and disadvantages, but scientific control is required with one, as with the other, to obtain the best results; and, in the absence of this, boiler troubles are certain sooner or later to ensue.

Scale and Grease Troubles.—A thin coating of scale upon the boiler plates is advantageous, since it protects the iron from pitting and corrosion. When this coating has increased to $\frac{1}{16}$in. in thickness no further advantage is gained, and the rate of heat transfer through the plates is diminished enormously as the scale increases in thickness. The heat-conducting power of scale is stated by various authorities to be between one-thirtieth and one-hundredth that of boiler plate, and should the scale contain oil, its conductivity for heat is still further reduced. The presence of oily matters in scale can be easily detected by heating a small portion of the scale upon a platinum spatula in a Bunsen flame; the scale, if it contains oil, chars and gives off a disagreeable odour under such conditions. Oil in the water supply, and oily scales are a cause of pitting and corrosion, since animal and vegetable oils yield decomposition products of an acid character, at temperatures which may easily occur within the boiler. The examination of the water supply must, therefore, include tests for oily and fatty matters, when water from the exhaust is employed. When mineral oils are used for lubrication this danger of course is not so great, since these oils do not yield fatty acids on decomposition; but even in this case it is the better plan to keep the oily matters out of the boilers by efficient filtration. The addition of caustic soda to the feed-water as it enters the boilers, in order to saponify the fatty matter, is not to be recommended, since soapy water leads to priming and other troubles only a little less serious than those caused by oils. Although the complete separation of oil and grease from feed-water is not a simple matter, it can be effected with well-designed apparatus intelligently worked. As a guard against pitting and corrosion, the authors recommend the use of zinc slabs and rods, bolted in suitable positions to the stays and angle plates of the boiler. The action of this metal is too well known to require comment; and even if its electrochemical action does not come into play, these metal projections into the body of boiling water will help to promote regular steaming in the boiler.

Preheating and Thermal Storage.—The advantage of feeding the boilers with water approaching as nearly as possible to the boiling temperature is now fully recognised. Not only does this promote more regular steam generation and, therefore, the efficiency of the boiler plant, but it also accelerates the softening process, since the chemical reactions upon which this is based take place much more rapidly in hot solutions than in cold or warm ones, and the precipitates obtained are more easily settled out in the former case.

The only question regarding the value of preheating upon which engineers are now disposed to differ, relates to the use of live steam for this purpose. It is admitted that all the waste heat of a boiler plant, whether of the exit chimney gases or of the exhaust and condensing water, should be utilised, if possible, in the feed-water supply, and that the heat obtained in this way is clear gain. But, the advantages of using live steam, in addition, for heating the feed-water up to 212° F., or above that limit, as in the *Thermal Storage* system, is not by any means fully recognised, and there is still a disposition to regard this method of using live steam as uneconomical and wasteful. The authors do not agree with this view. The heat of the live steam is retained in the feed-water heater, and the advantages to be gained by having all the water heated to a temperature of 212°F. or higher, far exceed the slight loss of heat which occurs by condensation and radiation from the connecting pipes between the pre-heater and the boilers. Of course this loss must be minimised by placing the feed-water heaters close to the boilers.

The real cause of the increased efficiency which independent authorities (as, for instance, Mr. Miller and Col. Crompton) assert has been obtained from boilers fed with water at or above 212° F., is not yet settled. If water containing solid matter in suspension be heated in a glass vessel, it can be observed that convection currents are set up which continue until the boiling temperature is attained. These currents must necessarily absorb some portion of the heat energy of the fuel, and convert it into mechanical work. A possible explanation of part of the gain observed when feeding boilers with water at or above 212° F. is, therefore, that the loss of heat due to the performance of merely mechanical work is avoided, and the whole of the heat energy of the fuel is devoted in the boiler to the conversion of the water into steam. In the feed-water heater as usually designed, convection heating does not take place to any great extent, the water being heated by falling through the steam in the form of mist or spray.

This explanation finds some support in a Paper read by Mr. Hamilton before the Belfast Mechanical and Engineering Association in 1902, and quoted in a leading article in the *Engineer* of August 19, 1904. In this Paper Mr. Hamilton pointed out that the hotter the water inside the boiler the greater is the amount of heat which passes through the boiler plate per unit of superficial area, the measure of relative efficiency being the gain in temperature when not steaming and the water evaporated when steaming. The increased heating power when steaming represented a gain of about 100 per cent. in the normal heat-transmitting power of the boiler plates.

The subject is well worth more study than it has yet received, for the facts relating to the gain in boiler efficiencies when fed with water at or above 212° F. seem indisputable, and when a satisfactory explanation of the cause has been given engineers will no doubt be ready to adopt pre-heating and thermal-storage plant to a much greater extent than is now the case. The steam boiler of the future is likely, in fact, to be specially designed for this double duty of preheating its feed water and providing steam; and it is interesting to note that one or two boilers of this type have already been designed and patented.

Fuel Supply.

The importance of the fact that fuel represents 50 per cent. of the total works cost in the generation of electricity, and that from 10 to 20 per cent. of this outlay can be saved, is often ignored by engineers when contemplating the low price at which they have placed their fuel contracts. It is held that, because fuel is cheap, therefore it may be wasted with impunity; and much of the inefficiency to be found in the boiler houses of electricity works is to be traced to this fallacy.

But a 10 per cent. saving on the total works costs is worth effecting even when these costs are exceptionally low; and systematic sampling and testing of the fuel would in many cases be found to save money. The supplies of fuel, whether cheap or dear, ought therefore to be subjected to regular sampling and testing. A check upon the colliery firm or coal merchant supplying the fuel is afforded by the laboratory examination, and this is useful not only in maintaining regularity in the quality of fuel supplied, but also in affording a basis for the new contracts which are from time to time made. The recent letter of Mr. C. E. C. Shawfield, of Wolverhampton, which appeared in *The Electrician* of October 7, 1904, is proof that at last the truth of these statements is being recognised; and the only criticism the authors have to make on this letter is, that Mr. Shawfield does not appear to recognise the need of employing specially trained men for sampling and testing work.

Sampling.—The sampling of fuel requires care if the sample is to be representative of the bulk supplies, and much of the distrust in engineers' minds relative to the value of laboratory examination of fuels, has been due to lack of expert control of the sampling operation. A copy of sampling rules is therefore included in the Appendix of this Paper, and it is recommended strictly to adhere to these when sampling fuel for analysis. It may be considered a striking fact, but it is none the less true, that a sample of only 1lb. in weight, when properly taken, can be truly representative of 50 or 100 tons of coal; and from such a one-pound sample a trained chemist can, by further grinding and reductions, obtain a sample of 2 grammes or less which shall be equally representative of the original bulk of fuel.

Whole shiploads of copper and iron pyrites containing several hundreds of tons are regularly sold on the results of the analyst's tests made with only ½ gramme of ore, without any disputes occurring between buyer and seller, and it is certainly not impossible to obtain equally accurate sampling and testing in the case of fuel. But, as already said, scientific knowledge and control are required in the sampling operation, and lacking this no fuel test is worth the paper upon which it is written. The idea should therefore be given up that a few shovels of coal taken from any part of the fuel heap and placed in a box constitute a "*sample*," and some personal time and attention should be devoted to the rudimentary principles of sampling and to the training of men specially for this work.

A regular and constant check upon the fuel supplies can then be obtained by having daily samples of the fuel taken. These samples can either be tested separately, or an average can be obtained at weekly intervals, by mixing all the daily samples and reducing these to smaller bulk in the manner described in the sampling rules. When a coal-conveying plant is installed, an automatic sampling arrangement should be added to it.

Testing.—The testing of fuel for technical purposes should cover moisture, ash, coke, volatile matter and calorific value; the last being calculated from the approximate analysis and also ascertained by burning from ½ gramme to 2 grammes of the fuel in one of the various forms of fuel calorimeters. Men without training in chemical analysis should not undertake this kind of work. Fuel calorimetry is difficult, and even trained chemists require practice and experience in it before trustworthy results can be obtained.

Placing Fuel Contracts.—It is often found that the fuel which yields the best laboratory test results is not that which produces the most steam per pound of fuel when burnt under the boilers; and a tendency is manifest to make use of this fact as an argument for dispensing altogether with fuel analysis and calorimetric tests, when placing fuel contracts. This view is a superficial one, and is wanting in a true appreciation of the factors which govern the combustion of fuel under the boilers.

Every type of boiler-surface is naturally best fitted for burning a specific kind of fuel, and by empirical trials this fuel may, of course, be found. When fresh contracts are to be made two courses are open: either to obtain a fuel as nearly as possible equal in physical and thermal properties to that last contracted for—or, to obtain a different fuel and adapt furnaces and draught to the new fuel. Now the chemical and calorimetric examination is of the greatest value in either case. It simplifies the search for a fuel similar in all characteristics to that last used, since if the percentage of ash, volatile matter, coke and fixed carbon be determined, the desired fuel can be selected without recourse to the troublesome and expensive steam-raising trials under the boilers. If, on the other hand, another type of fuel be selected owing to its much lower price, the laboratory examination will be a guide to the changes required in furnace construction, methods of firing and draught, in order to get smokeless combustion and high efficiencies, when this fuel is burned under the boilers.

Too little attention has certainly been given in the past to this question of adapting the furnace construction and methods of firing to the fuel, and whatever boiler makers chose to recommend has been much too readily accepted. Most of the electricity works where high-priced fuel is now being used, because it is asserted that steam cannot be kept up or that smoke is produced when burning cheaper fuel, are simply playing into the hands of the South Wales Colliery companies.

The authors assert that with suitable furnace construction and scientific control, bituminous fuels can be burnt without causing smoke troubles and with high efficiency under every type of boiler, and that great savings in fuel costs could be effected in this direction. But the furnace construction must be adapted to the fuel, and it is absurd to suppose that furnaces designed for burning anthracite or semi-anthracite fuel, will satisfactorily burn fuels containing 30 per cent. or more of volatile matter. The percentage of volatile matter which a fuel gives off when heated is in fact a measure of the size of the chamber required for its complete combustion, and it is here that the laboratory examination of fuel yields results of the greatest value. That such an examination is still regarded as unnecessary and of no help in the placing of fuel contracts, is clear proof of how much has still to be learned in the scientific control of steam plant.

(*To be continued.*)

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Mechanism." By S. Dunkerley. (London: Longmans, Green & Co.) 9s.

"Second Stage Magnetism and Electricity." By R. Wallace Stewart. 2nd edition. (London: W. B. Clive.) 3s. 6d.

"Avogadro and Dalton: the Standing in Chemistry of their Hypotheses." By Andrew N. Meldrum. With a preface by F. R. Japp. (Edinburgh: W. F. Clay.) 3s.

"Motors and Motoring." By Prof. H. J. Spooner. (London: T. C. & E. C. Jack.) 1s.

"British Standard Specification for Portland Cement." Report of the Engineering Standards Committee. (London: Crosby Lockwood & Co.) 2s. 6d.

"How to Read a Workshop Drawing." By W. Longland (London: Dawbarn & Ward.) 6d.

"Die Abstimmung funken-telegraphischer Sender." By A. Slaby. Reprinted from *Elektrotechnische Zeitschrift*.

"Annual Report of the Board of Regents of the Smithsonian Institution" for the year ending June 30, 1903. (Washington: Government Printing Office.)

"Bulletin of the Massachusetts Institute of Technology." December, 1904. No. 1. Vol. XL. (Massachusetts: The Institute.)

"Einrichtung und Betrieb Elektrotechnischer Fabriken." By Dr. F. Niethammer. (Stuttgart: Ferdinand Enke.)

"L'année Électrique Électrothérapique et Radiographique" for 1904. 5th edition. (Paris: Ch. Béringer.) fr.3.50.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Tangential Force of Light.—The existence of pressure on a surface due to the incidence of a normal beam of light, first deduced as a consequence of the electromagnetic theory by Maxwell, was recently fully confirmed by the experiments of Lebedew, and quite independently by the exact work of Nichols and Hull. These experiments show that the pressure exists and that it is equal to the energy density in the incident beam. If the beam is inclined to the normal of the surface on which it falls, and is not absorbed by the surface, there is a reduced normal pressure on the surface. But when the light is absorbed, there is, in addition, a tangential pressure on the surface, which urges it to motion in its own plane. This stress has been experimentally proved to exist by J. H. Poynting. The tangential stress is much more easily detected than the normal pressure. For the action of the gas surrounding the surface is normal to it, and is with difficulty disentangled from the normal light pressure. But the gas action is at right angles to the tangential stress, and it is merely necessary to arrange a surface free to move in its own plane to eliminate the action of the normal forces and to reveal the tangential stress. The author has realised these conditions by fixing two small circular glass discs at the ends of a horizontal light glass rod with their planes perpendicular to it. One of the discs was lampblacked and the other silvered. The rod was placed in a light wire cradle and suspended by a light quartz fibre about 25cm. long in a brass case with glazed sides. On the cradle was a mirror by which deflections could be observed with a telescope on a millimetre scale 1·8 metre distant. A deflection of one scale division corresponded to a tangential force on the disc of about one two-millionth of a dyne. The air was pumped from the case till the pressure was less than 1cm. of mercury. A parallel beam from a Nernst lamp was then directed so as to be incident obliquely on the lamp blacked disc. In all cases the disc moved away from the source of light. This is a brilliant proof of the existence of the tangential force. A quantitative determination showed an agreement to within 12 per cent., and a maximum at an incidence of 45deg., as required by the theory.

[J. S. Poynting, *Philosophical Magazine*, January, 1905.]

Kerr Effect at Low Potentials—G. W. Elmén has discovered a variation from Kerr's law of the double refraction of carbon bisulphide under electric stress when that stress becomes very small. When light polarised at an angle of 45deg. to the lines of force is passed through certain dielectrics, between two parallel electrodes, they become doubly refracting. The difference of phase, δ, between two components of light at right angles and parallel to the lines of force, as represented by Kerr, and verified by later observers, is

$$\delta = \pm \frac{BP^2 l}{a^2},$$

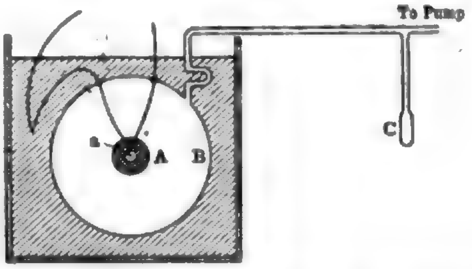
where B is the electro optic constant, depending on the dielectric, l the length of the beam, a the distance between the plate electrodes, and P the difference of potential between the electrodes. From the author's data, there seems to be a decided deviation from the above law for low potentials. As the potential was decreased from about 200 volts per millimetre between the electrodes, the decrease of δ was observed to be in smaller ratio than the decrease of P^2. The author used an elliptic half-shade polarising system. The potential was supplied by a storage battery of about 1,400 volts, and was measured by means of a voltmeter which had been calibrated so that the possible errors for potentials under 200 were less than 1 per cent. On plotting the electro-optic constants as ordinates and the potential gradients as abscissæ, the curve for carbon bisulphide is approximately a straight line until about 200 volts per millimetre of distance, when it turns and seems to become almost asymptotic to the ordinates. The author points out the great similarity between the Kerr electro-optic constant and the permeability of iron as determined by magnetic induction, and suggests that possibly the double refraction in liquids under electric strain is due to a state of polarisation analogous to that which takes place in a magnetic substance when magnetised.

[G. W. Elmén, *Physical Review*, January, 1905.]

Electric Combination of Hydrogen and Oxygen.—P. J. Kirkby has obtained some interesting results in the course of his work on the union of hydrogen and oxygen at low pressures through the passage of electricity. He prepared the gases simultaneously by the electrolysis of pure barium hydrate contained in a small sealed glass vessel. By this method the gases were generated free from hydrocarbons, ozone and peroxide of hydrogen. The mixed gases were dried and admitted to a glass bell jar containing the parallel plates between which the current was to be passed. The parallel plates were connected to the poles of a battery of small lead cells, ranging up to 1,080 volts, through a high resistance and a sensitive ammeter. In this way the quantity of electricity passed through was known, while the pressures before and after its passage were determined by McLeod gauges. The results showed that in spite of great variations in the pressure and in the distance between the electrodes, the lowering of pressure in millimetres of mercury bore to the quantity of electricity in coulombs passed through the hydrogen and oxygen a nearly constant ratio amounting to about 2, and ranging from 1·6 to 2·4. The distances experimented with ranged from 0·25cm. to 1·5cm., and the pressures from 1·1mm. to 9·3mm. of mercury. Within these limits, at all events, from six to nine times as many molecules of water vapour are formed as pairs of ions. This result is independent of the capacity of the apparatus and of the nature of the electrodes.

[Rev. P. J. Kirkby, *Philosophical Magazine*, January, 1905.]

Law of Radiation at Low Temperatures.—E. Bose proposes a novel method for testing whether the Stefan-Boltzmann law of radiation holds good at very low temperatures. A quantity of radium bromide is enclosed in a thick-walled platinum ball a surrounded by a glass vessel b, which can be evacuated and kept at a constant temperature. The platinum ball is suspended by a thermocouple, which serves as a thermometer as well as a suspension (see diagram). Now, when a state of equilibrium has been attained, the platinum ball will always be a few degrees above the temperature of the surrounding vessel, and the difference will be the greater the more the temperature of the glass vessels approaches the absolute zero. The heat given out by a certain quantity of radium being known, the radiation constants are quite determined. The "black body" conditions may be realised by platinising the ball by means of Lummer and Kurlbaum's platinising liquid. The radiation of the radium is most likely independent of the temperature, but its variation, if any, could be allowed for. The author proposes to choose the masses of radium in such a manner that in an envelope kept at freezing point the temperatures maintained by three different preparations should be 0·1deg., 1deg. and 7deg. respectively. A quarter gramme of radium bromide would be the maximum quantity required. He shows that if the fourth-power law of radiation holds good down to the lowest temperatures, the absolute temperature assumed in an envelope kept at the absolute zero would be 53·42deg. absolute in the case of the first preparation, 95·11deg. in the case of the second and 155·99deg. in the case of the third. All intermediate temperatures would be easily deduced.



[E. Bose, *Physikalische Zeitschrift*, January 1, 1905.]

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THE APPLICATIONS OF ELECTRICITY TO THEATRES.

It has been said that if some of our progenitors could return to mortal existence they would altogether fail to recognise the world of their time and would probably be scared out of reason at some of the extraordinary results of scientific progress. The same might equally well be said of the early school of actors, except that the great changes have occurred more recently and many older members of the theatrical profession have been actual witnesses of them. Not very many years ago, it was the exception to find electric light in a theatre, whereas now it is, of course, quite the rule. Indeed, it is by no means impossible that many who read this article will remember the old paraffin foot-lights, which are still used by some of the "penny gaffs" touring the provinces and performing plays of a most lurid order. It is even conceivable that some will also recall the farthing dip or the rush-light by whose aid some of the most famous actors who have ever lived played many parts. Following these primitive forms of illumination came gas, and a large number of theatres, both in and out of London, are still provided with the older method of lighting. It is, however, used chiefly as a stand-by in the more modern theatres, and is being gradually eliminated even for this purpose. The old-fashioned "sun burner," situated in the roof far above the heads of the audience, and consisting of innumerable small jets, is slowly but surely disappearing, and it is perfectly safe to say that it is gone for ever as far as new theatres are concerned. Its disadvantages, as well as its advantages, were numerous and obvious. Probably it was adopted in the first instance owing to the ease with which it could be lighted and extinguished, as compared with its equivalent in individual jets located in various parts of the building. Pilot jets had to be provided in any case, and it was easier and cheaper to provide two or three for the sun burner than one for each individual isolated jet. As to the effect produced, there still remains a diversity of opinion, and certain managers are loth to dispense with the principle of the sun burner; consequently they insist on a large electrolier replacing the sun burner when gas is ousted by electricity.

Lighting of the auditorium is comparatively easy, however; when once the intensity of illumination has been decided upon, it remains simply to exercise a wise discretion in the patterns of the fittings, so that these may harmonise with the general scheme of decoration. The actual wiring is, of course, a most important point, but does not differ greatly from that of other large buildings except that the individual lamps are not controlled by ordinary tumbler switches, but are wired in groups, each group being controlled by a switch either contained in a lock-up case or situated on a large board in charge of a regular attendant. Some auditorium lighting is also controlled from the stage switchboard, and a certain number of lamps, such as those which indicate exits, &c., are, under a regulation of the London County Council, always left on. In no circumstances may these be extinguished during a performance, and they are termed "police lights." Another interesting regulation imposed by the London County Council makes it imperative for a theatre to be provided with two separate and distinct means of lighting. Formerly, compliance with this regulation was effected by installing both electric light and gas, but now the practice is to dispense with gas and substitute for it an electric service by another supply company. But this is not all: the very newest theatres in London have really three sources of supply, two being from separate companies, and the third from a set of special theatre mains laid by one of the companies and fed by entirely separate generating plant. Normally, current is taken from both companies, while in some cases the special theatre mains are also used and in others kept purely as a stand-by. It may be mentioned, in passing, that the London County Council, by virtue of powers accorded to it under the Metropolis Management and Building Acts Amendment Act 1878, and the Local Government Act 1888, specifically states that all stage lighting should be carried out by means of electric light. There are, however, many stage managers and others who maintain that lime lights as distinct from arc projectors are absolutely essential for good effects and the result is that there are still far more of the former than the latter in use at the present day. But this can hardly be looked upon as lighting proper, and provided the requisite precautions are observed, no exception is taken to it by the Council.

Perhaps no class of wiring work presents so many difficulties as that on the stage of a theatre. In the early days very feeble attempts were made to render it free from danger and liability to breakdown, and an inspection of some old work, especially in the provinces, could only inspire the thought that there must have been some beneficent Providence whose sole duty was to protect the lives and property of actors and stage employees from disaster. Such things as casing held up by the wires which it was supposed to protect, switches which closed again automatically after being opened, and many other instances of either bad workmanship or rough, untrained treatment, were only too numerous. But those times and the evils they bore have disappeared. The lighting of a theatre is now a science in itself, and consulting engineers have arisen who have made a special study of it. These, working in conjunction with the London County Council or other authorities controlling the lighting of theatres, have evolved a system which is as near perfection as could be desired. An excellent example of this is to be found at the new London Coliseum, an article on which appears on another page. Here, although the lighting load alone is far greater than that of many small towns, yet there is, in addition, a power load which many borough electrical engineers would view with envy if it were not for the exceedingly low load factor which is secured. As a matter of fact the peak is not of more than a few minutes' duration—*viz.*, the length of time required for the great Derby scene. This takes place four times a day, and for the rest of the time there is very little power required at all, except for turning the stage slowly in order to bring fresh scenes before the proscenium. Without doubt the work at the Coliseum represents one of the finest examples of theatre illumination and equipment extant, and those whose duty it has been to design and carry it out are entitled to the warmest praise.

It would be useless, on this occasion, to assert the superiority of electricity over any other form of illuminant for stage purposes, since it has been proved, by its universal adoption, to be most eminently suitable. Its chief recommendation is its absolute immunity from danger when properly installed and maintained. Efficient maintenance and constant inspection are most important, owing to the rough treatment which all stage appliances invariably receive. By means of frequent tests and constant supervision, however, all fear of evil results may be eliminated, and the public may rest assured that the risk of fire from electrical causes is practically non-existent.

THE TANTALUM LAMP.*

BY DR. W. VON BOLTON AND DR. O. FEUERLEIN.

PART I.—BY DR. W. VON BOLTON.

Whilst the carbon filament incandescent lamp remained for nearly two decades the sole representative of glow lamp manufacture, progress was being quietly made in this art. The firm of Messrs. Siemens & Halske has for many years been working at a solution of the problem of an economical incandescent lamp, and arrived, some time ago,† at the fundamental principle that the visible part of the radiation of an incandescent body increases progressively with its temperature. This warrants the postulate that the most economical lamp will be that whose incandescent material will withstand the highest temperature.

Messrs. Siemens & Halske had arrived at this conclusion and charged me several years ago with the task of discovering a material which should have a melting point considerably above the temperature at which incandescent lighting becomes highly economical, so that filaments made of such a material would not melt or disintegrate at that temperature. Whilst our laboratory work, founded upon this idea, was going on, the first two advances in incandescent lighting were made public, one being the "Nernst" and the other the "Osmium" lamp.

There are certain metals the melting points of which are known to be considerably above 2,000°C., and the task resolved itself into finding one which, while fulfilling the above requirement, could be easily worked to form a filament, and not be very rare or difficult to procure. It was early observed that brown vanadium pentoxide, which, according to Berzelius does not conduct electricity, is, as a matter of fact, a conductor even when cold. This observation induced me to try whether vanadic acid could not be electrolytically decomposed. In this I succeeded, but the melting point of the vanadium obtained proved too low for the purpose in view. Since the metals niobium and tantalum are members of the vanadium group, niobium having an atomic weight double that of vanadium while the atomic weight of tantalum is double that of niobum, it was thought that one or both of these metals might prove to have the desired qualities. On experimenting with niobium on the lines adopted for vanadium, it appeared that this metal has a considerably higher melting point than that of vanadium, but not, however, sufficiently high; moreover, some of the niobium filaments which I made had a very strong tendency to break up when heated by the electric current.

Tantalum was tried next. I reduced potassium tantalo-fluoride in the manner prescribed by Berzelius and Rose and found that the finely divided tantalum so produced became fairly coherent on rolling, so that by this treatment metallic strips of it could be made. It was also attempted to work tantalum oxide into the shape of a filament by mixing it with paraffin and to reduce it directly into the form of a metallic thread. In these experiments there was observed for the first time a minute globule of molten tantalum, and this globule was of sufficient toughness to permit hammering and drawing into wire. Following out this observation, tantalum powder was melted in a vacuum, and then it was found that the highly-heated metal parted with the gases it contained. In this manner I produced my first filaments of pure metallic tantalum, which were, however, very small. When these had been used in lamps with promise of good results, an attempt was made to devise a definite process of purification. The potassium tantalo-fluoride was reduced to metallic powder; this powder contains a small proportion of oxide and of hydrogen which is absorbed during the reduction. When the powder was melted in a vacuum the oxide and absorbed gas disappeared, and a reguline metal remained; on carefully re-melting this it became so pure that no appreciable impurities could be detected in it.

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* Translation (through the courtesy of Mr. Alexander Siemens) of a Paper read before the Elektrotechnischer Verein of Berlin on January 17th.

† *Cf.* W. Siemens in *Elektrotechnische Zeitschrift*, Vol. IV., p. 107, 1883.

The chemical properties of this pure tantalum are very remarkable, and some of them are of such a nature as to lead me to suppose that nobody other than myself has ever had metallic tantalum in his hands. When cold, the material strongly resists chemical reagente; it is not attacked by boiling hydrochloric acid, aqua regia, nitric acid or sulphuric acid, and it is also indifferent to alkaline solutions; it is attacked solely by hydrofluoric acid. Following the behaviour of steel, when heated in the air it assumes a yellow tint at about 400° C., and the tint changes to dark blue when the tantalum is exposed for some time to 500° C., or for a shorter time to 600° C. Thin wires of the substance burn with low intensity and without any noticeable flame when ignited. It absorbs hydrogen as well as nitrogen with great avidity, even at a low red heat, and forms with them combinations of a metallic appearance, but rather brittle. It combines with carbon very easily, forming several carbides which, as far as they are at present known, are all of metallic appearance, but also very hard and brittle. The product which Moissan thought to be tantalum was clearly a carbide of this nature or an alloy of a carbide with pure tantalum, for Moissan himself stated that his metal still contained ½ per cent. of carbon. Considering the high atomic weight of tantalum (183) it is obvious that a very small quantity of carbon suffices to carburize a relatively large quantity of tantalum. This view of the constitution of Moissan's product is confirmed by the properties he ascribed to the metal—namely, specific gravity 12·8, great hardness and brittleness. These are not properties of pure tantalum. When in the form of powder, still containing, as previously stated, oxide and hydrogen, the specific gravity of my material is about 14; when purified by fusion and drawn into wire it has a specific gravity of 16·8. It is somewhat darker than platinum, and has a hardness about equal to that of mild steel, but shows greater tensile strength than steel does. It is malleable, although the effect of hammering is relatively small, so that the operation must be rather long and severe to beat the metal into a sheet. It can be rolled, as well as drawn, into very fine wire. Its tensile strength as a wire is remarkably high, and amounts to 95kg. per square millimetre, while the corresponding figure for good steel is 70kg. to 80kg., according to Kohlrausch.

The electrical resistance of the material at indoor temperature is 0·165 ohms for a length of 1 metre and a section of 1 sq. mm. (specific conductivity as compared with mercury 6·06). The temperature coefficient is positive, and has a value of 0·30 between 0°C. and 100°C. At the temperature assumed by the incandescent filament in the lamp at 1·5 watts per candle-power, the resistance rises to 0·830 ohms for a length of 1 metre and a section of 1 sq. mm. The coefficient of linear thermal expansion between 0° C. and 60° C. is 0·0000079, according to experiments made by the Imperial Normal-Aichungs commission. Fusion is preceded by a gradual softening, which appears to extend over a range of temperature of several hundred degrees. The specific heat is 0·0365, so that the atomic heat is 6·64, which is in accord with the law established by Dulong and Petit.

Part II.—By Dr. O. Feuerlein.

The results of the work carried out in our chemical laboratory, as described by Dr. von Bolton in the first part of this Paper, were, of course, of the utmost interest to our incandescent lamp manufacturing department. As soon as Dr. Bolton's experiments showed that the originally brittle tantalum could be made ductile enough to draw into wire by the usual methods, and that this wire could be bent and coiled like a thin steel wire, it became possible to test it thoroughly as to its usefulness for incandescent lamps. The first trials with wires of about 0·3mm. diameter gave most promising results. They confirmed the fact that tantalum has a very high melting point, and that it is but slightly subject to disintegration in a vacuum, even when subjected to a heavy current.

The first tantalum lamp that proved moderately satisfactory in that it admitted of an exact measurement of the electric and photometric conditions and stood a burning test for some time, was completed just over two years ago—viz., on December 28, 1902. This lamp had a loop shaped filament made of the first tantalum wire ever drawn. The diameter of the wire was 0·28mm., its effective lighting length 54mm. and its electrical resistance when cold 0·29 ohm. This corresponds to a specific resistance (1 metre length, 1 sq. mm. section) of 0·331. The photometric measurements made at efficiencies of 2, 1½ and 1 watt per Hefner candle-power showed potential differences of 4·9, 4·95 and 5·9 volts, currents of 5, 5·46 and 6·2 amperes, and illuminating values of 11, 18 and 37 Hefner candle-power respectively. On being burnt at 1 watt per candle-power the lamp had a life of 20 hours, during which it blackened considerably.

As the chemical and mechanical manufacturing processes developed and the material became purer and the wires more uniform, the results obtained also improved. The lamps lasted longer and blackened less; at the same time the specific resistance decreased until it had dropped to the present figure of 0·165 for the pure metal. It is clear that the material used for the first lamps still contained a considerable quantity of impurities, probably niobium and carbides, which caused the great disintegration and the nearly double specific resistance. During these first trials we looked very carefully into the question as to what dimensions the filament of a tantalum lamp ought to have for ordinary voltages and illuminating values. From the dimensions of the filament used in the first lamp we calculated that, with this rather impure material, we should require a filament about 520mm. long and 0·06mm. diameter for a lamp for 110 volts, 32 Hefner candle-power and 1·5 watts per candle-power. These unusual figures increased when the specific resistance of the material had diminished to the present value of 0·165, at which for a 32 Hefner candle-power lamp, a filament of about 700mm. in length by 0·055mm. in diameter was required; for a 25 Hefner candle-power lamp, a filament of about 650mm. by 0·05mm. diameter was required. Thus, in order to construct a practical and useful lamp for standard voltages and illuminating values, we had to solve the problem of drawing the tantalum wire in sufficient length down to a diameter of 0·05mm. to 0·06mm.; this we succeeded in doing after long and laborious trials.

In July, 1903, we possessed the first tantalum lamp with a filament of about 0·05mm. diameter. It had a loop-shaped filament 54mm. long and it took 0·58 amperes at 9 volts and gave 8·5 Hefner candle-power at 1·5 watts per candle-power. On the basis of these figures a lamp having the same quality and diameter of wire and working at the same efficiency on a 110-volt circuit would have a filament 650mm. long and would give 43 Hefner candle-power. The experiments thus far had proved that the task of producing lamps for 110 volts and a maximum of 25-32 Hefner candle-power was not an easy one in several respects. We had to solve the problem of suitably and reliably fixing a filament rather more than 2ft. long within a glass globe which should not exceed to any great extent the dimensions of the usual incandescent lamps. The first and most obvious attempt was made, of course, by adhering to the loop shape and accommodating the required length of wire by connecting several such bows in series within the lamp. However, lamps made according to this plan with two to four tantalum loops gave results which were anything but satisfactory.

It appeared that, like all other metallic filaments which have hitherto been used for incandescent lamps, tantalum wire softens sensibly at the temperature attained when worked at 1·5 watts per candle-power. To use loop-shaped or spiral filaments similar to the carbon filaments of the common incandescent lamps, was, therefore, out of the question. There was no difficulty in suspending the loops, but in that case the lamps would have to be used exclusively in a vertical position, a limitation which we wished to avoid in all circumstances. Besides, such a construction would necessitate staying the loops firmly to prevent them from becoming entangled with each other during transport of the lamps. Nor did lamps made with loops of corrugated wire (Fig. 1), or of plain or corrugated metal ribbon give satisfaction; for although the loops were certainly shortened in this way, there were other drawbacks which caused us to abandon this construction. It soon became apparent that the one road to success lay in the direction of dividing the filament into a number of short straight lengths supported at their ends by insulated holders. In this manner we succeeded at last, in September, 1903, in producing the first really serviceable lamps for about 110 volts. This lamp is illustrated in Fig. 2, and it will be seen that it contains two glass discs cast to a central wire holder; each disc carries laterally 12 arms having small hooks at their ends and insulated from each other. Through these 24 hooks the thin tantalum wire is drawn up and down between the two discs. This is believed to be the first metallic incandescent lamp for nearly 110 volts which, like the common carbon glow lamp, can burn in any position whatsoever. This lamp supplied about 30 Hefner candle-power on a 94-volt circuit at 1·5 watts per candle-power. It lasted for 260 hours and lost during that time 9·5 per cent. of its illuminating power.

After this first practical success we redoubled our efforts to improve the lamp further. As far back as about the middle of October, 1903, we succeeded in making the first 200-volt tantalum lamp, which was of a design similar to the lamp just described, but with 18 arms on each disc and with a greater distance between the two discs. I may add at once that it is of interest only as a curiosity, for it has served no practical purpose. The length of its filament was 1,350mm. and the illuminating value about 60 Hefner candle-power. In the course of further development the form of the frame of wire filament for the 110-volt lamp went through different stages, the principle of subdivision being always followed. Among other constructions we tried some in which, instead of one long filament, a number of short pieces of wire were fixed on a supporting frame; these pieces, connected in series, made up the total length required.

Fig. 3 represents a lamp thus constructed, the wire being fixed obliquely in 16 straight pieces between two insulated supporting stars. Such lamps offer the advantage that short pieces of filament can be used in the manufacture. But they are only reliable if the wires used in the same lamp are absolutely uniform in diameter and quality. In the end we arrived at the shape represented in Fig. 4, which is for 110 volts, 25 c.p. and 1·5 watts per Hefner candle-power. In this form, differing from most of the previous constructions, the central support consists of a short glass rod carrying two discs, into which the arms, bent upward and downward in the shape of an umbrella, are cast. The upper star has 11, the lower 12 arms, each upper arm being in a vertical plane midway between the vertical planes in which two adjacent lower arms lie. Between these 11 and 12 arms, which are bent into hooks at their ends, the entire length of the filament is drawn in a zigzag fashion. Its extremities, held by two of the lower arms, are connected with the foot of the lamp by means of platinum strips.

The standard type for 110 volts 25 Hefner candle-power and 1·5 watts per candle-power has a filament 650mm. long and 0·05mm. in diameter. The weight of this filament is 0·022 grammes, so that about 45,000 lamps contain together 1kg. of tantalum. The shape of the glass globe is adapted to the frame described above. Care has been taken to make it of a size not exceeding the usual maximum dimensions of common incandescent lamps of the same candle-power (25 Hefner candle-power 110 volts). This shape offers a number of noticeable advantages. In the first instance it is very stable and will stand strong shocks without damage to the lamp. A considerable number of such lamps sent across the sea to test their ability to withstand the hardships of transport came back unhurt, although they had been packed just like common glow-lamps, and no special care in any respect had been taken in their handling. The lamp burns, of course, in any position, and can therefore be held in any kind of fitting. The light is rather white and agreeable, and its effect is particularly uniform if the lamp is provided with a ground-glass globe.

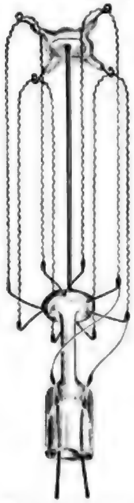

FIG 1.—LAMP WITH CORRUGATED FILAMENT.

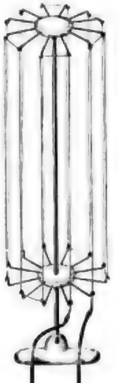

FIG. 2.—EARLY TYPE OF TANTALUM LAMP.

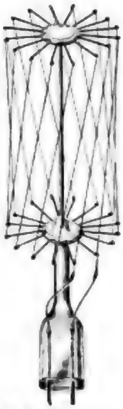

FIG. 3.—TANTALUM LAMP WITH FILAMENTS FIXED OBLIQUELY.

We shall now proceed to describe the electric and photometric properties of the lamp and its behaviour in actual use. Numerous trials for lengthy periods of time at 1 to 3 watts per candle-power have proved the vast superiority of the tantalum lamp over the carbon filament lamp under equal electric and photometric conditions. Expressing this fact in figures, we can state that the tantalum lamp consumes about 50 per cent. less current at the same voltage, with the same intensity of light and the same useful life; or that, at the same economy, its life is several times that of the carbon type. Moreover, at an initial efficiency of 1·5 volts per Hefner candle-power the tantalum lamp has an average life quite sufficient for all practical requirements, so that this rating has been standardised for the 110-volt lamp. Trials have also proved that the lamps have a life of several hundred hours at 1 watt per Hefner candle-power, but in that case they were very sensitive to variations of pressure and often showed an early decrease of illuminating power. The useful life of the tantalum lamp—*i.e.*, the time within which it loses 20 per cent. of its initial illuminating power—averages between 400 and 600 hours at 1·5 watts per Hefner candle-power. Some specimens have proved to have a useful life of as much as 1,200 hours. The absolute life, in general, amounts to 800–1,000 hours under normal working conditions. Further, we have to remark that the tantalum lamp blackens but little unless it has been strongly overheated during work in consequence of partial short-circuiting of the filament.

It is very interesting to observe the behaviour of the tantalum lamp during the whole course of its life. The first fact worthy of note is that, like some carbon lamps, the illuminating value increases at the beginning, generally after a few hours, by 15 to 20 per cent. In the same way the consumption of current rises by about 3 to 6 per cent., while the consumption of energy drops to 1·3 to 1·4 watts per candle-power. After that, the illuminating value gradually decreases, while a corrresponding increase of the consumption of energy occurs. The average behaviour of the 25 c.p. lamp at 110 volts with reference to its various periods of life is shown in the following table :—

Life in hours.	Intensity of light in Hefner c.p.	Consumption of current in amperes.	Watts per Hefner c.p.
0	25-27	0·36–0·38	1·5-1·7
5	28-31	0·37-0 39	1·3–1·5
150	25-27	0·36-0·38	1·5–1·6
300	22-24	0·36–0 38	1·6–1·7
500	20-22	0·36–0·38	1·9–2·0
1,000	18-20	0·35–0·37	2·1–2·2

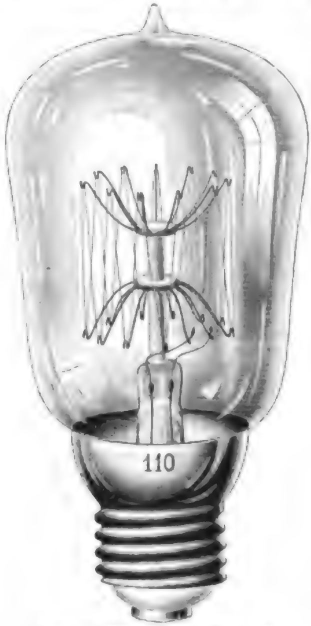

FIG. 4.—COMPLETE LAMP. FULL SIZE.

The initial increase of illuminating value and of current consumed is doubtless caused by a change in the structure of the tantalum wire, this change being accompanied by a reduction of resistance and, consequently, of the phenomena resulting therefrom. We may say at once that after a certain amount of use the filament presents a radical change in appearance when viewed with the naked eye. While the fresh filament has a perfectly smooth and cylindrical surface, it acquires a peculiarly glistening aspect as it grows old, so that a lamp having served for some time can be readily distinguished from a new lamp. When looked at under the microscope, the filament that has burned for a length of time shows a clear tendency towards contraction and formation of drops or beads. Fig. 5 is an illustration of a piece of filament in its fresh state and of the same piece after 1,000 hours of service, the specimen in each case being magnified 100 times. This gradual shortening of the filament can also be observed in the lamps themselves, and offers a further indication of the age of a lamp.

Fig. 6 represents the filament frame of a new lamp. It will be noticed that the tantalum wire is led up and down and hangs loose on the supporting frame in easy wide arches, without sharp bends. But after being used for some time the aspect of the lamp is quite different. As shown in Fig. 7, the wire has contracted, the wide arches have disappeared and sharp-pointed angles have taken their place.

The behaviour of these lamps is most peculiar when the filament has burnt through. While with all other incandescent lamps the burning through of the filament is tantamount to the economical death of the lamp, it may happen with tantalum lamps that they burn through several times without being rendered useless; on the contrary, each burning through is followed by an increase, often considerable, of the illuminating power. This peculiar result is due to the fact that in many cases a broken wire comes in contact with its neighbour, so that the circuit is again established. A part of the filament is thus cut out of the circuit, and the lamp consequently burns more intensely, and sometimes even too intensely, in which case, of course, only a short span of life is left to it. Yet we have had more than one lamp under observation, the filament of which broke for a first time after a short period of service and then broke repeatedly, but notwithstanding this the lamp lived more than 1,000 hours. We have often succeeded in rendering a lamp with a broken filament serviceable again by tapping it to bring the broken piece into contact with its neighbour. Fig. 8 represents the frame of a lamp in which the filament was burnt through in three places, and yet continued to do service. For the sake of clearness, the back spans of the filament have been omitted in the drawing, while the front spans which were carrying the current are drawn in specially heavy lines.

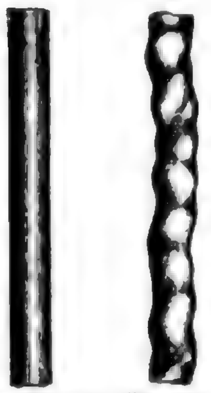

Fig. 5.—Tantalum Filament, Before and After 1,000 hours' Use.

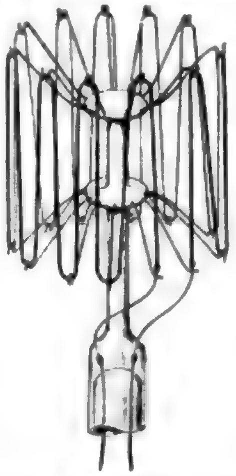

Fig. 6.—Filament Frame of a New Lamp.

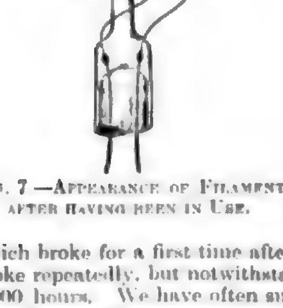

Fig. 7.—Appearance of Filament after having been in Use.

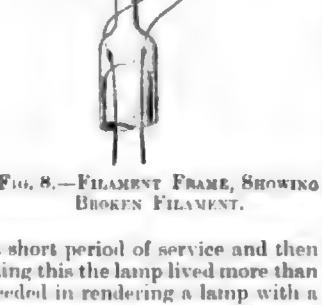

Fig. 8.—Filament Frame, Showing Broken Filament.

It must further be mentioned that after serving for some time, say 200 to 300 hours, the tantalum filament loses a great deal of its mechanical resistance; while, as has been stated by Dr. v. Bolton, tantalum wire, when new, has a greater tensile strength than steel; it becomes brittle, and will break easily in the course of its life as a filament. It is therefore advisable when lamps have served for some time not to remove them from their old fittings and put them into new ones, as that might easily cause the filament to break. New lamps are not very sensitive to strong shocks, even while burning, but when this alteration in the filament has occurred it is well to preserve them from shocks.

The behaviour of the tantalum lamp under a very great increase of voltage is of special interest to the incandescent lamp maker. As was to be expected, the trials made in this respect have also shown the superiority of this lamp over the carbon lamp. It has been ascertained that tantalum lamps for 110 volts, 25 Hefner candle-power and 1·5 watts per candle-power only burn through at 260 to 300 volts if the pressure is increased slowly and gradually, while with carbon lamps designed to work under the same conditions nothing like that figure can be obtained. The superiority of the tantalum lamp over the carbon lamp with regard to blackening of the glass globe can also be proved in a few hours by means of comparative burning tests at about 30 per cent. overload.

Another advantage of the tantalum lamp over the carbon lamp is that the resistance of tantalum, like that of all other metals, strongly increases with the rise of temperature, while carbon is known to diminish in resistance when it is hot. In Fig. 9 the variation of the resistance of tantalum and of carbon as a function of the voltage is graphically represented, the pressure being assumed as 100 volts and the resistance at 100 arbitrary units when the efficiency is 1·5 watts per Heffner candle-power, so that for each per cent. of variation of voltage the respective percentage of variation of resistance is shown. It will be seen in the first instance that the resistance of the tantalum increases to more than five times its original value from the cold state to 1·5 watts per Hefner candle-power, while the resistance of the carbon decreases to about one-half of its initial value. It will further be noticed that even afterwards the resistance of tantalum goes on rising, while the resistance of carbon keeps dropping. Therefore the increase or decrease of pressure causes the strength of current, and with it the illuminating value, to rise or fall at a quicker rate in the carbon lamp than in the tantalum lamp, and, consequently, the latter is less sensitive to variations of pressure than the former.

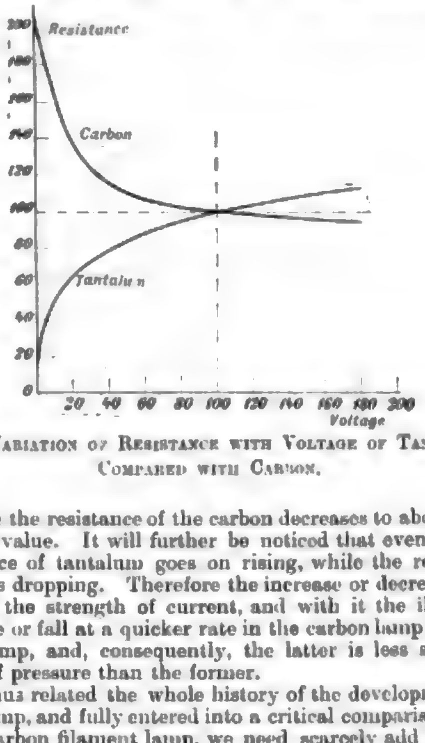

Fig. 9.—Variation of Resistance with Voltage of Tantalum as Compared with Carbon.

Having thus related the whole history of the development of the tantalum lamp, and fully entered into a critical comparison between it and the carbon filament lamp, we need scarcely add that we do not intend, of course, to be satisfied with what we have already obtained. For the time being, however, and until a larger building has been erected for the production of tantalum, our firm has resolved to keep to the type for which there is an immediate practical demand. That is the lamp for 100 to 120 volts, which supplies 25 Hefner candle-power at 110 volts, or will have a higher or lower illuminating value if worked at correspondingly higher or lower voltages. In conclusion I would recapitulate the properties which we claim as peculiar characteristics of our invention as follows:—

1. The tantalum lamp has a filament made of a metallic conductor and burns at once on being connected without any previous heating.

2. The light-giving wire is prepared by melting in a vacuum and drawing; it is tough even in the cold state, and can therefore be coiled and fixed in the lamp when cold.

3. A relatively great length of wire can be placed in a simple manner within a bulb of ordinary dimensions.

4. Tantalum ore exists in considerable quantities and can be easily procured.

5. Similar principles of treatment can be adhibited to other metals of a very high melting point.

TRAMWAY OVERHEAD EQUIPMENT MATERIALS.*

BY H. M. SAYERS.

(Concluded from page 554.)

Bracket arms are often much too long for safety. A 2in. tube 12ft. 6in. long, fixed as a cantilever, and loaded with the weight of a span of trolley wire and the suspension fittings, is very near its breaking point. The longer the arm the less efficient the tie rod, owing to the more acute angle between the two members. As generally made, tie rods are pulled up by a nut, so that their effective strength is the resistance of the threads to shear. Bracket arms 18ft. and 20ft. in length are therefore extremely unsafe, having practically no margin of safety. It is better to use eye-ended tie-rods and dispense with nuts, and no real difficulty arises in erection if the clamps are fixed at measured distances, so that the brakets and tie-rods make the correct calculated angle; but if adjustment is necessary it is best provided by a long, solid, right-and-left thread sleeve fitting the two parts of the rod like a rigging screw. Struts are usually inapplicable, but if the scrollwork can be made to give some support so much the better. Bracket-arm pole clamps should be of substantial length, and a good fit on the pole by internal fitting rings at top and bottom. The bolts should fit through long bored sockets in the planes of the fitting rings, and be kept close into the poles. The socket receiving the arm should be of ample length and well thickened out to the body of the clamp. In fact, in designing bracket arms and fittings the stresses and strains should be calculated out as for a loaded cantilever, ignoring the tie-rod, but adding 50 per cent. to the dead weight to allow for the rolling load and its hammering effects. Then the tie-rod and its fastenings should be designed to carry the same load safely. Malleable cast iron is the best material for pole and bracket-arm clamps and bowstring brackets. Porcelain shackles should be used as the secondary insulation of bowstrings.

On straight work the "straight line" hanger is the best insulated fitting, but on curves, and wherever there is a probability of lateral pressure on the wire the pull-off pattern must be used. The caps of these should be provided with some form of locking device, and a soft leather washer should be placed between the head of the insulated bolt and the cap. The insulating material on the bolts is far from perfect. The compounds are trade "secrets," but very slight investigation shows that shellac is the insulating and consolidating element in nearly all. Mica, asbestos, and other mineral substances add some toughness to the mass, but its mechanical qualities are generally poor. Whilst new the insulating qualities are very good, but in a short time the atmosphere deposits dirt on the exposed surface, and sooner or later in damp weather a trifling leakage of current chars the surface and breakdown speedily follows. This should not happen if the secondary insulation remains good and, if porcelain is used, such breakdowns are very rare, because a porcelain surface does not char with a small creeping leak, it dries up and the leakage ceases. A somewhat tough vulcanite has been introduced. Vulcanite has had extensive trials in telegraph practice and obtained a bad reputation. Tramway conditions are less favourable to its permanence. The usual practice of keeping the two trolley wires for up and down directions separately insulated and separately fed is highly advantageous. But at junctions this becomes very difficult. Insulated crossings are a variety best avoided, and, as above stated, the best course is to feed junction work separately; the next best thing is to feed it through one wire only of one of the junctioning lines, and to insulate the junction from all the other wires. In bowstring suspensions care should be taken to provide ample clearance above the cap of the hanger. Sometimes only a small fraction of an inch is left between the cap and the bracket-arm tube, with the result that at every passage of a trolley wheel the hanger strikes the arm, damage soon resulting

The soldered ear is the best form of attachment for the trolley wire. The use of wire of figure 8, or grooved section, makes the mechanical ear satisfactory, but such wire is at once more expensive and more troublesome to erect, so that the balance of advantage remains with the soldered ear. The metal used for ears should be a tough bronze or gun-metal, and careful inspection after machining is necessary to eliminate defective pieces, as the castings are somewhat apt to show blowholes and other weak places. The groove to receive the trolley wire should be milled to [illegible]in. larger diameter than the wire, and should come to a sharp edge. It is doubtful whether the small lugs, which it is usual to provide at the ends of the ears for hammering over the wire, serve any useful purpose. They sometimes hold up a wire that has not been properly soldered until traffic commences. 15in. is the minimum length of ear for straight work, the tendency is to increase the length up to as much as 24in., but the advantage seems doubtful. On curves longer ears are necessary, and by bending them to a proper radius the change of direction of the trolley wheel is much smoothed. Unfortunately, curved ears tend to pull into angular shape with use. There seems no good reason why they should not be cast curved with lateral webs to impart stiffness. It would not be necessary to use many different radii, as the varying radii of the track curves should be met by the use of a larger or smaller number of pull-offs, with a standard deviation at each. Splicing ears should not be needed in building a new line, but are necessary for repair work. They are rarely well designed, the wire ends having to be bent too sharply, and some patterns are provided with foolish little steel set screws, that invariably set fast and break off. Anchor ears should be provided with stout eyes of rounded section, to which the anchor wire can be secured without bending to a dangerously small radius.

In section insulators the pull of the wires has necessarily to be transmitted through insulating material, and it ought to be so transmitted as a straight pull without any binding or twisting component. This is inconsistent with the necessity for allowing a straight level path for the trolley wheel. Hence the best designs are but compromises. The terminating arrangements for the wire ends need the same easy curvature as in splicing ears. It is better to dispense with set screws for securing either the feeder cable or the trolley wires, and to have tinned sockets or grooves into which they can be soldered. The air-gap pattern is probably better than that with a gap stick, but there should be two distinct air gaps, and an insulated running piece between them, to prevent an arc being drawn in the event of an earth on one wire. Gap sticks of lignum vitæ have been found to wear smoothly and give a regular life. Mr. Sayers then exhibited a "Hewer" section insulator, made by Messrs. T. Noakes & Sons. This insulator is shown on p. 594. Mr. Sayers thought it one of the best yet made, although not perfect. Its construction is clearly shown in the drawing, and its weight is about 21½lb. We understand from the makers that the insulating material has been improved lately, so that it is now less liable to crack than formerly.] Junction special work fittings also require careful selection. For central wires and rigid trolley heads the frog makes a satisfactory facing point, provided that it is properly set, with reference to the track points and the length of the cars and trolley booms. Even with swivelling trolley heads, frogs will work fairly well if the wire is approximately central, but for side wires swithes with movable tongues should always be used in the facing direction. Frogs will work on side wires in the trailing direction, but must have deep checks and grooves to take the wheel flanges, as there is a considerable centrifugal force tending to de-wiring, and automatic or spring switches are preferable. Crossings are apt to give more trouble than frogs or switches. The greatest care should be taken to get them of the correct angle to suit the track crossing, but as the angle is also affected by the lengths of car and trolley boom, the junction should be drawn to scale, a template of the car and trolley boom fitted to it in successive positions to ascertain the best angle and position for the crossing. Even with a central wire there must be a lateral pressure on the trolley wheel taking the junction curve, so that guidance by the flanges across the gap is necessary. A swivelling trolley head adds largely to trouble at crossing by its liability to turn while crossing the gap, and this liability is aggravated by any considerable side reach. At junctions on single lines it is best to use only a single trolley wire and thus avoid the use of crossings, especially if swivelling heads and side wires are used. It involves the use of three automatic switches, but these give much less trouble than one crossing. All these fittings should be so designed that the trolley wires need not be cut when fixing them, and so that they can be securely held by pull-off and span wires to their positions.

As regards the feeder pillars, the best advice is to make them as big as will be tolerated. The cylindrical pattern gives the largest amount of useful space for the area covered and for the weight of the casting, and has the practical advantage that when opened the panel is somewhat more accessible. On the other hand, the fitting of the curved doors is not so good a job as with the flat-sided pillar, and when the doors are closed there is less clearance between them and the live parts. Provision should be made for ventilating the pillars without permitting the entrance of rain or snow; the bottoms should be filled in over the concrete with a thick layer of pitch or bitumen, and all leading in pipes stoppered. The safest kind of panel is a cast-iron frame into which are cemented porcelain insulators carrying the live metal work, the frame being itself carried from the sides of the pillar by oil insulators. It should be easily removed for replacement by a new panel. All the cable connections should be made on one side of the panel, the switch fittings being on the other. Plain quick break switches are frequently used and answer most purposes, but where a number of feeder pillars are fed by one cable feeder the use of switch fuses, such as the Bates' pattern, will sometimes isolate a faulty length of trolley wire and avoid the stoppage of all the sections served by the feeder. As these switch fuses are not dearer than quick break knife switches and have no troubles of their own they should be chosen, although in most cases the feeder circuit breaker will outstrip the fuse.

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* Paper read before the Tramways and Light Railways Association on Jan. 13, slightly abridged.

All cable ends should be terminated with corrugated porcelain stoppers suitably sealing the dielectric. A kicking coil and lightning arrester are necessary to protect the underground cables. Three or four kinds of arresters are in use, and there is not much to choose between them. I think the Garton is perhaps the best. They all get blown to pieces occasionally, either by a lightning discharge or the short set up by it. Telephone fittings are generally included in feeder pillars. They should not be fixed on the switch panel, but quite separately, and surrounded by an earthed metallic frame to protect them from leakage. The same treatment is best for the pilot wire terminals that may be provided. Telephones do not thrive in feeder pillars, and there is rarely any room for them. The provision of a socket box into which the cords of a portable set may be plugged is therefore the best arrangement. If fixed telephones are thought essential they should be placed in separate pillars, or in boxes secured to the poles. In many cases small holes are drilled through the pole underground and above the span wire or bracket attachments, and the cables threaded through these holes with the slight protection of a wooden or fibre bush. Experience shows that they are frequently damaged and have in consequence but a short life. Their replacement, in case of need, is a particularly tedious and exasperating job. The following has been found a good method of dealing with this matter (Fig. 2). An oval hole about 3in. by 5in. is cut in one side of the pole about a foot below the ground level, and a special quarter bend of 3in. pipe passed into the pole and bolted through a flange which fits its periphery. This 3in. pipe finishes in the base of the feeder pillar with a bell mouth providing a duct of ample diameter and easy curvature for the passage of the four cables. The pole is fitted with a special finial made in two parts. The lower part fits easily into the top of the pole supported by a narrow flange resting on the pole end and expanding upwards and outwards to form the ornamental base collar of the finial. The portion inside the pole carries four screwed glands provided with rubber gaskets, and bored to pass the cable. Screwing up the glands secures the cables by compressing the rubber packing rings. Four holes are cored out in two opposite pairs, through the bottom of the flared out part, through which the cables descend outside the pole. This fitting is wired by passing the four cable lengths through the glands and then, by an easy and regular curve, through the holes in the wide part. A hauling wire having been threaded down the pole and into the section pillar, the long ends are drawn through the pole and the fitting rests on its place. The upper part of the finial is merely a cover shaped to match the other pole finials, and secured by two tap bolts. The outside cables are secured to the pole by a suitable clamp, and then taken by an easy curve to the span wire or bracket. This arrangement is safe for the cables and, in case of need, their replacement is a very simple and speedy operation. It is almost essential to use indiarubber insulated cable, as the dielectric must be waterproof and flexible. Flexible metallic tubing has been found very suitable. It adds little to the diameter and weight; it is very flexible up to a certain point, and then refuses to bend further, which is a safeguard to the cable. The metal sheathing of the cable should not touch the trolley span or bowstring wire, and should, therefore, be cut well back. On span-wire work it is best to carry the feeder cables on a separate span wire above the trolley wires. This should be insulated in the usual way, and the sheathing cut back from it. The cable ends then dip down very conveniently to the section insulators, and there is a long surface of cable covering free in air, over which very little leakage can occur. The cable terminals here should be made with corrugated porcelain stoppers as a further precaution. On bracket arms the cables should be secured by special collars fitted with ebonite bushes, and arranged to give the longest possible leakage path.

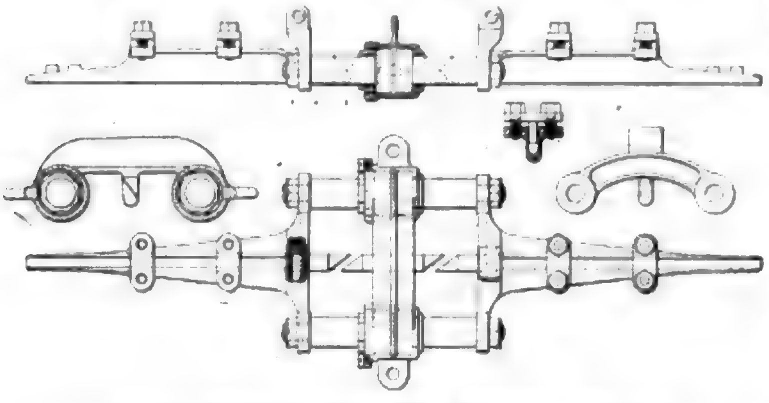
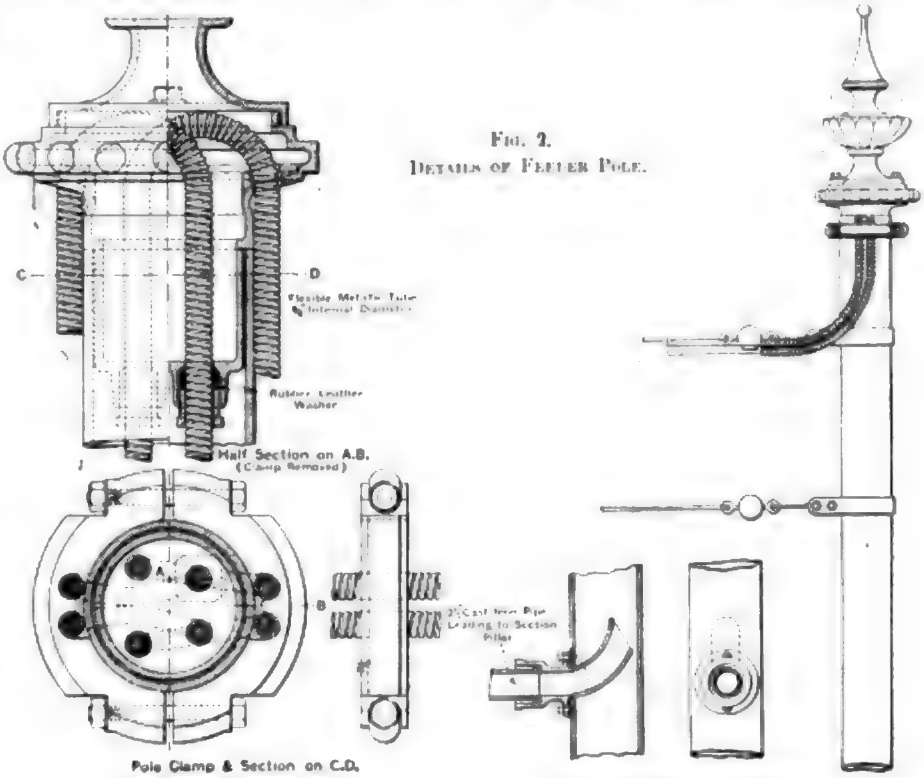


FIG. 1.—"HEWER" AIR GAP SECTION INSULATOR. Scale—1:8.

For guard-wiring galvanised steel wire, No. 8 standard gauge, is found suitable. Solid wire is better than stranded, having a longer life. The same wire may be used for guard-wire spans. Guard wires should be run over the span wires and secured to them by binding wire sweated at the ends of the lappings. In some atmospheres it is necessary to use bronze instead of steel wire. On bracket arm work, a span wire from the pole to a standard clamped to the end of the bracket makes the best job, but a neat and good-looking arrangement is hard to find. Secure erection is often neglected for the sake of light or ornamental appearance, with sad results. Telephone and pilot wires are sometimes run on tramway poles; hard-drawn copper is the best material. Good telegraph practice should be followed in the design and attachment of the insulators, but a somewhat freer use of shackles is sometimes desirable. These wires are sometimes carried on the trolley or guard wire span wires, but it is difficult to make a good job of this. No. 12 wire is usually large enough, smaller sizes are too weak. They should be carried at such levels and positions that they cannot be blown across the trolley wires if broken in a gale. The speaking on these telephone lines would be improved if they were rotated after the manner of the Post Office trunk lines. They generally suffer much from trolley-wire induction. Overhead feeders have sometimes to be provided for. They have to be carried from suspender wires and to be covered, best done by hard cotton or hemp braiding saturated with waterproof preservative compound. These conductors should be shackled off at every pole. If they are large, it will be necessary to increase the size and stiffness of the poles used.

FIG. 2.
DETAILS OF FEEDER POLE.



Top of Pole. Scale—1:8.

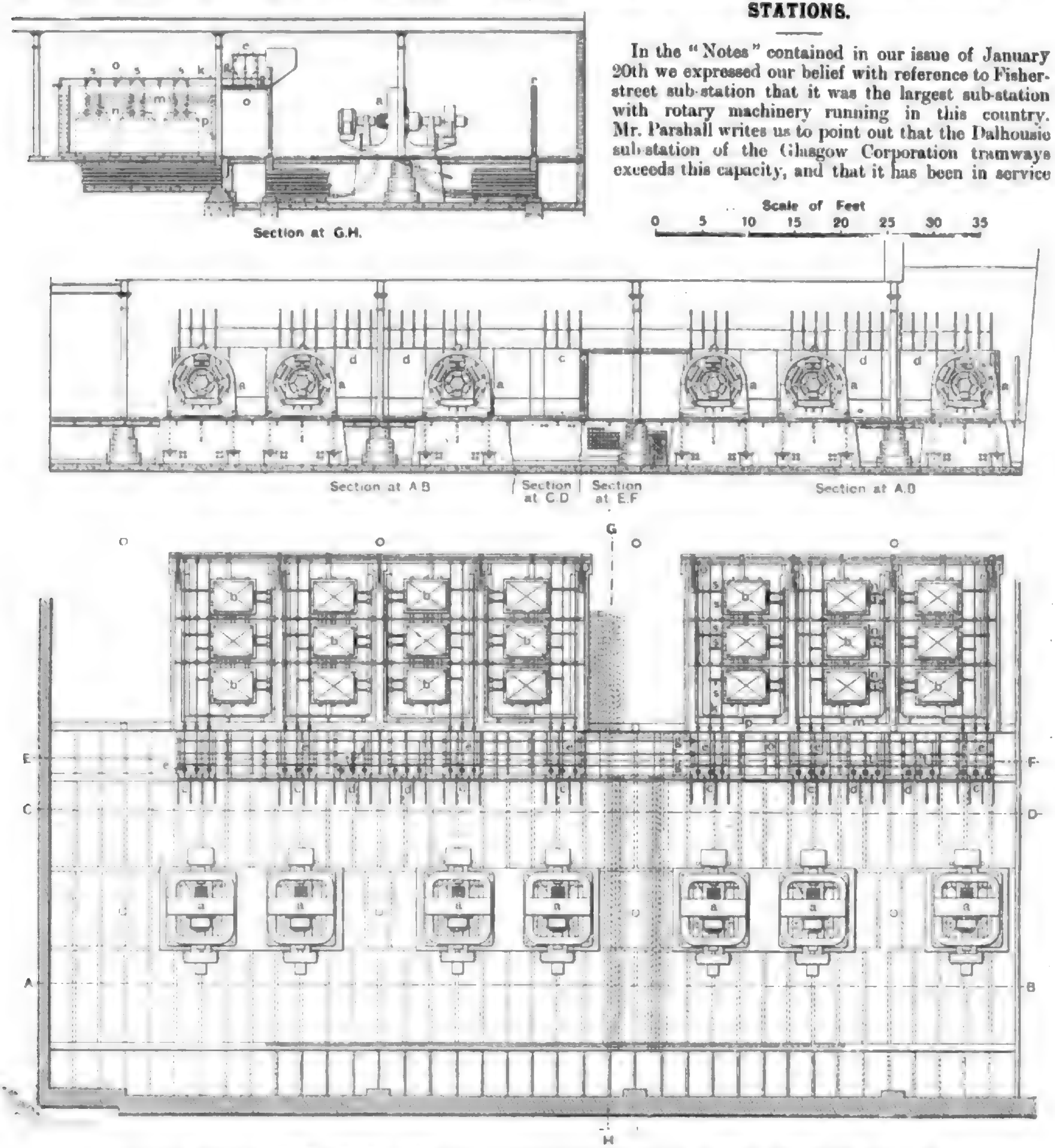
Leading-in Band. Scale—1:24.

There must be now a good deal of information available as to the normal life of various items of overhead equipment under various conditions of traffic and atmosphere, and also as to the nature and frequency of breakdowns. Mr. McElroy last year made a laudable attempt to collect some of this information, and I am considerably indebted to the Paper which he prepared for the last Conference of the Municipal Tramways Association. This, however, is only a beginning, and only partial because, for some reason not easy to understand, no information was given to Mr. McElroy by any tramway company's officials. It is by the collation and discussion of information from all sources that advance may be expected, and every little helps, so the continuation of Mr. McElroy's good start is highly desirable.

The cost of overhead work seems to vary a good deal more than it should. Some authorities put it at £1,500 to £2,000 per mile of route, but I don't know how so much can be properly spent. Thoroughly good span-wire work for either double or single lines can be erected for £1,200 per route-mile, with a fair profit to the contractor. Bracket-arm work, for single lines, where a single line of poles is generally sufficient, can be done for £1,000 per route mile, or even less under specially favourable conditions. *These* rates include average amounts of guard wiring and proportion of junctions, but very heavy and complex junctions, car-shed, fan-work and similar special requirements will involve some additional expense. A great deal of money can be spent on elaborate scroll-work and fancy painting, especially if a little goldleaf is thought necessary to harmonise with the surroundings; but these are matters of taste rather than engineering, and those who like to pay for them will doubtless continue to do so.

GLASGOW CORPORATION TRAMWAYS SUB-STATIONS.

In the "Notes" contained in our issue of January 20th we expressed our belief with reference to Fisher-street sub-station that it was the largest sub-station with rotary machinery running in this country. Mr. Parshall writes us to point out that the Dalhousie sub-station of the Glasgow Corporation tramways exceeds this capacity, and that it has been in service since 1901. We are enabled by Mr. Parshall's courtesy to describe this sub-station, which is one of five similar sub-stations supplying the Glasgow Corporation tramways.



PLAN AND SECTIONS SHOWING GENERAL ARRANGEMENT OF DALHOUSIE SUB-STATION (GLASGOW CORPORATION TRAMWAYS).

a a a.—500kw. Rotary Converters.
b b b.—200kw. Transformers.
c c c.—Panels for Transformers and Converters.
d d d.—Panels for H.T. Feeders.
e e e.—Connections to Transformer Switches.
g g g.—H.T. 'Bus-bars.
k k k.—H.T. Transformer-bars.
m m.—L.T. Transformer Bars.
n n n.—Flexible Connections to L.T. Side.
o o o.—Insulating Supports for H.T. Bars.
p p p.—Insulating Supports for L.T. Bars.
r.—L.T. Switchboard.
s s s.—Flexible Connections to H.T. Side.
t t t.—Connections to Feeder Switches.

The plant is arranged as shown in the accompanying illustration, and consists of static transformers and rotary converters, there being in all 7 units, and each unit comprising three single-phase 200kw. transformers and one rotary converter of 550kw. rated output. The sub-station is supplied by three-phase currents at a pressure of 6,500 volts between phases, and having a frequency of 25 cycles per second. Each static transformer transforms from 6,500 to 330 volts, which is the pressure at the collector rings of the rotary converter corresponding to 525 volts on the D.C. side of the converter.

Referring to the illustration, it will be seen that each group of three transformers is contained in a brick cell with an iron door in the front and set with the centre line at right angles to the line of converters.

The high-tension 'bus bars consist of round copper tubes carried overhead on insulators, and comprise a main set of 'bus bars carried by angle irons behind the switchboard and transformer 'bus bars carried on angle irons above the switch cells. The transformer sets are connected to their respective 'bus bars in delta by means of rubber-covered cables. The transformer 'bus bars are connected to the main 'bus bars by means of a three-phase air-break switch, as at the time these sub-stations were designed oil-break switches had not been developed to the present extent. The 'bus bars for the transformer secondaries are carried on insulators fixed to the walls of the transformer cells and are of bare copper; these 'bus bars are connected to the collector rings of the rotary converters by lead-covered cables and contain a switch in the circuit which is mounted on the switch panel immediately in front of each transformer cell. This constitutes an economical and safe system of high and low-tension A.C. 'bus bars, with fire risk entirely eliminated, and is simple and easy to manipulate. The D.C. board is set parallel to the A.C. board on the opposite side of the sub-station, and needs no description, as it is of the usual type of traction switchboard.

The connections between the A.C. board and rotary converters, and between the latter and the D.C. board, are carried in pipes laid in the foundations of the rotary converters. It will be seen that the connections are arranged so that there is no crossing of cables anywhere. The connecting cables are paper insulated and lead covered, those on the A.C. side of the converter being three core cables.

The rotary converters, transformers and switchboards were supplied by the Westinghouse Company. Each rotary converter carries a track booster on one end of the shaft and an induction motor on the other end. The transformers are of the oil-cooled type.

All the sub-stations have been laid out on similar lines, the plant in each case being accommodated in tramway depot buildings belonging to the Tramway Department.

GERMAN REGULATIONS FOR HIGH-TENSION OVERHEAD WIRES.

The regulations of the Verband Deutscher Elektrotechniker as amended last year include a number of rules for high-tension overhead wires and cables, the chief points in which we give briefly below:—

All installations come within the range of the high-tension regulations, if the effective pressure between any conductor and earth is (or may be through an earth) more than 250 volts.

Overhead wires must be bare, but where they are exposed to detrimental chemical action they may be provided with a coating of protective paint.

The insulation of overhead wires in damp weather must not be less than 80 ohms per volt and kilometre (128 ohms per volt and mile) but need not exceed 1,500,000 ohms. Generating plants are to be provided with means for measuring the insulation resistance during actual service.

Overhead wires must have a cross-section of not less than 10 sq. mm. (0·0155 sq. in.).

The insulators must be of porcelain, glass or an equivalent material, and, when used for voltages above 2,000 volts, they are to be tested at the factory to at least double the working voltage. The insulators are to be used in an upright position only.

Earth connections are to be soldered, the only exception being when earthing switches are used, in which case the connections may be screwed to the switch and the object to be earthed. Wire netting, perforated or unperforated metal sheets, or similar materials are to be used as earth plates, and pipework may form part of the earth connection, but must be supplemented by such earth plates.

Supports and guarding devices of overhead conductors, the voltage of which to earth exceeds 500 volts, must be marked by a red zig-zag.

Overhead wires must be at least 6 metres (20ft.) above the ground in ordinary positions and at least 7 metres (23ft.) when crossing highways. The span and sag of overhead wires are to be such that the factor of safety against breaking is 10 in the case of wooden poles, and 5 in the case of iron structures. At −20°C. (−4°F.) the tensile stress in the overhead conductors must not be more than one-fifth (or one-third in the case of hard-drawn metal) of the breaking stress.

Overhead wires and apparatus must be inaccessible without special means.

In inhabited places the overhead wires must be provided with section switches which may be operated during actual service.

In inhabited places and grounds and in the proximity of roads, where falling wires might endanger life, the wires are either to be placed so high that, upon breakage, the wire ends hang not less than 3 metres (10ft.) above the ground, or the falling of the wires must be prevented by guards, or means must be provided for causing the fallen parts to become "dead." Provision is to be made at corners of the transmission line for preventing the wires from dropping should the insulators break.

Where the pressure exceeds 1,000 volts, the anchor wires are to be fixed to the poles with the interposition of an insulator, and the point of attachment to the pole must not be less than 3 metres (10ft.) above ground.

If iron poles are used which cannot be well earthed, the pole is to be surrounded (but not touched) by wood or a material having similar insulating properties, to a height of 2 metres (6½ft.) The earth conductor of the lightning rod must be treated in a similar way.

Where the wires run along the outside of buildings, the distance per 1,000 volts between wall and wire must not be less than 1cm. (0·4in.). The total distance must be at least 10cm. (4in.).

THE ELECTRICAL OPERATION OF TEXTILE FACTORIES.

The following is an abstract of the discussion on Mr. H. W. Wilson's Paper on the above subject, which took place at the Manchester Local Section of the Institution of Electrical Engineers on December 15th. An abstract of the Paper appeared in our issue of last week.

Mr. SEATON said he had recently had experience in cotton mills with rope driving, and found the efficiency of two mills recently tested to be 59 and 69 per cent. respectively He quoted Booth's figure of 0·36d. as being what he thought a fair equivalent cost at a cotton mill, and unless supply companies could supply at less than this figure he considered they were out of the field. The author's figures were 0·3d. and 0·35d. per unit, and he was therefore in agreement with him. Under present conditions, if supply companies supplied at less than 0·5d. or 0·75d. it constituted dumping, and this could only be done by making other consumers pay heavily. He thought 5 per cent. interest and 10 per cent. depreciation a fair allowance in calculations of this kind. Some mill owners worked out costs per I.H.P. per annum, but when they gave figures like 15s. 6d. per I.H.P. he thought one could reasonably doubt the accuracy of their methods.

Mr. W. B. WOODHOUSE thought mill owners were very slack in their tests, and accused them of taking indicator diagrams twice a year at full load and multiplying the horse-power by the number of hours in the year and calculating the cost. He had figures given to him from £2. 10s. to £5. 10s. per I.H.P. as total costs for Yorkshire mills of small size. The advantages of electric driving were increase of output and less variation in speed. The speed variations in the Yorkshire mills amounted to 10 per cent., and there was greater loss in power by belt driving, pulleys being often found quite bright through belts slipping. Electric driving enabled the mill owner to use the site of the engine room for extending the productive machinery. The power costs given by the author he thought could hardly be correct. The average efficiency of nine Yorkshire cotton mills which he had intimate knowledge of was 50 per cent. He thought power costs should be about 1d. per unit—at the very lowest ½d.—and he thought ¾d. perhaps nearer the correct estimate. The load-factor of Yorkshire mills he estimated to be 25 per cent. He hoped to see single-phase variable-speed motors on the market shortly.

Mr. SHAW said that the author had mentioned water-driven mills in the United States. He might say that the people who six years ago advocated electric driving only for water-driven mills and direct driving where steam power was used, were now the advocates of electric driving in both cases. He thought the estimate of 0·3d. and 0·35d. per unit both on the low side, and thought 0·4d. and 0·45d. nearer correct. He was met by the argument, when proposing to fit up cotton mills, that it was all right where mills were old, but when large new mills were erected it was cheaper to drive direct From his experience he did not believe th[illegible] be the case. In a mill of 75,000 spindles the first cost [illegible] it will [illegible] tricity, and he had also seen one operative lo[illegible]les used. [illegible] 300 spindles long, which was a very great recomm[illegible] available [illegible] driving The man was able to do this owing t[illegible] thread troubles, consequent upon a steadier d[illegible] efficiency of Lancashire mills to be 50 per cent.[illegible] with rope driving direct from the line shaft [illegible] 75 per cent. The question of the durability [illegible] bility of old-style mills might be taken at [illegible] with electric driving where no motor h[illegible] was still in first-class condition.

Mr. WHITEHEAD (a mill owner) took special exception to the remarks of Mr. Woodhouse about the slack methods of mill owners, and could assure him that they took very great care to know everything about the working of their mills. He could show records of indicator diagrams taken at least once a week for the last nine years. He was, however, going to have electric driving.

Mr. B. L. GAMLEN thought ¼d. per unit would mean dumping. He called attention to the author's figure of £10,000 as the cost of generating plant, and thought that it was low; £13,000 was nearer the mark.

Dr. BOWMAN expressed the opinion that the difference between the efficiency of a Yorkshire worsted mill and a Lancashire cotton mill was accounted for by the variations in the counts. In a Yorkshire mill there was 10 times more variation in the number of counts used than in a Lancashire cotton mill. He also took exception to the remarks of Mr. Woodhouse, and said that he knew where indicator diagrams had been taken three times a day for six months. In a rope-driven mill working regularly with five counts, which he had himself tested, he found the load-factor to be 90 per cent. He would call attention to the great difference which the weather made to the power taken by a cotton mill. The bands were always tight on a Monday morning after the mill had stopped, and in wet weather moisture in the atmosphere always made a heavy load. He thought the author's figures of 0·3d. and 0·35d. per unit were, according to his experience, amply justified. He had personally tested mills whose total costs were 0·22d. per I.H.P. per hour; under 0·33d. was easy, with an upkeep of under 2½ per cent. He was the first person to fit up a 1,000 H.P. mill with rope driving from a line shaft, and he was told that he had better hang himself with the first rope, because it was sure to be a failure, but he was glad to say that it was a success, and that it was proved to be best modern practice to-day. In this particular mill the difference of cost between belts and ropes was £1,100. He estimated the cost of mill equipment at £10 per I.H.P., and thought that electric driving would cost nearly £10 per I.H.P. for motors alone. He might say that there was no ballooning with rope driving such as Mr. Shaw mentioned, and that a rope drive gave quite as steady a torque as electric driving. Rope driven cotton mills ran up to their speed limit, and electric driving could not effect any further economy in this direction, as a higher speed caused the threads to become hairy, and this feature limited them to a particular speed. In the author's Paper he would have been glad to have had more information with regard to the counts on the machines, whether 8, 10, or 15, and whether a hard twist or a slack twist, all these things having a very great deal to do with the power required.

Mr. C. C. ATCHISON (Rochdale) had also noticed the effect of weather on cotton machinery. He thought that it was a question for the power supply companies to tackle. Corporation supply departments at present prices—at any rate those indicated by the author—were out of the question. He thought ¼d. to ⅜d. per unit on the low side as an estimate. The reason why power companies could not compete with mill owners was because they had to pay carriage on the current, that is to say, they were obliged by the Board of Trade to put down very expensive cables and lay them underground. He thought that if the Board of Trade would allow power companies to run overhead cables, as was done in America, it would help power companies to compete with cotton mill owners. He did not think Lancashire mill owners would be willing to shut down while the power station got over the peak, as they did at the mills in Montreal, just in order to get current at cheaper rates, and he thought it useless to propose anything of that kind to them.

CORRESPONDENCE.

CABLE LAYING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: When writing my letter of December 24th, which you were good enough to publish, it was my desire to avoid unprofitable polemics. The burden of my letter was the fact that 15 years ago I had laid indiarubber insulated lead-covered services surrounded with sand wetted with common coal tar, and that there had been no failure of such services. I also said that I had laid mains on the solid system in wood troughing, and that these had given trouble. These two points are not controvertible. I should now say that having been asked by a correspondent for a sample of the "bitumen" used by me, and having sent this sample to him, he informs me that it is not bitumen. In my letter I called it bitumen, meaning the substance supplied for such work by firms of good standing.

Some correspondents praise *refined Trinidad* bitumen. I shall be glad to get some specific instance of mains having been laid in pure refined bitumen, because from quotations I have had for this substance I feel that the expense of using it is too great for its being generally adopted. I have been unable to discover any case of main laying in *refined* bitumen.

Some correspondents ask me for details of the quantities . . . The services quoted by me as having been laid 15 years . . . were laid without any particular care; the sand was not dried before being mixed with the tar, and no troughing was used. Mains laid by me within the last year and half are placed in good roomy troughing, surrounded with sand which was carefully air-dried and tossed with coal tar in the manner of mixing concrete or cement mortar by hand. Some additional tar is added when the casing is being filled, and the material is well packed round the cable by the workmen, who use small-sized trowels for the purpose. I also use tarred sand in the trench, so that the casing is surrounded with it. This, I think, besides being an additional protection to the mains, will also preserve the wood of the casing from damp and decay. Some correspondents say that coal tar acts chemically upon insulation to destroy it. I should be glad to get some specific account of this. What kind of insulation is attacked by coal tar? A year ago a feeder, consisting of three separate cables laid in wooden troughings filled solid, failed (the length of feeder concerned is about 50yds.); the immediate repair of this feeder was necessary. We had no cable in stock of the kind needed. We spliced the damaged parts, mended the insulation with Blackley tape (after cleaning off the original filling material: this was easily accomplished, because it did not adhere to the lead), and re-laid in tarred sand in new and more roomy troughing, and this feeder has given no trouble since—they are diatrine cables. In many parts the lead of these cables had been much electrolysed, and the tarred sand is now in immediate contact with the Blackley tape.

Your correspondent has somehow taken me as confessing that in one case the lead sheathing was defective when the cable was laid; this is not so. I described very fine annular cracks as showing in parts where no electrolytic action had yet begun to show, but I have never seen such cracks in new cable. I can imagine such cracks being produced by unequal expansion between the cable and the filling material if from any cause a cable is overloaded so that it perceptibly heats the fight between the lead and the filling might produce the cracks observed; these fine cracks appeared to be fine true lines going completely round, forming complete circles in planes at right angles to the axis of the cable. I did not examine them microscopically.

I have experimented with tarred sand by exposing it to the sun and air in a thin layer, an inch or so, and, as was to be expected, the tar evaporates, leaving the sand not coherent. Underground the conditions are different, but I am of opinion that it is advisable to treat the tar to some boiling, so as to drive off the more volatile constituents, but the heating should not be carried so far as to make the tar behave like pitch when cooled. I am of opinion that it should be kept a long way from having a tendency to fracture from sudden shock as pitch does.

The correspondent who condemns lead sheathing does not convince me. I think that lead sheathing surrounded with the viscous, adhering, self-compressed filling which results when tarred sand is used is a necessary separating material between the insulation and the filling, whose function is purely to protect the cable from the moisture of the ground.

Some of my correspondents have perhaps not studied with sufficient care what happens when electrolysis takes place in moist earth. We may suppose that at the first instant of electrolytic action it is sensibly uniform over a considerable area of, say, lead sheathing, but in a very short time the action concentrates to definite points from which the resulting salt spreads through the ground in tree-like formations: it is for this reason that water pipes are sometimes perforated in definite holes and do not suffer a uniform wasting over their surface. In every case of cable failure there is, of course, electrolysis, the result of leakage between cables at different potential in the same boring. This leakage is made possible by moisture, which penetrates the lead and insulation; it is no doubt infinitesimal to begin with, but electrolysis grows and develops along definite lines at definite points on the conductors. In time the leakage becomes noticeable, and then very soon current ceases to pass in any useful way beyond the defective region.

In my country the "white-haired boy" designates excellence or supposed excellence of the boy. Another correspondent, who imagines that he designates ages of time by saying that a certain kind of mains will last to be seen by my white-haired great-grandchildren, fails, because a man of my age might already have white-haired great-grandchildren. In these matters prophecy and vagueness of estimate should be avoided.

The correspondent asks if the ground is excessively wet at the points of failure. The soil of small towns and the outlying parts of large towns is necessarily wetter than where the roads are surfaced with wood paving, closely-flagged sidewalks and having basements on both sides. There are also exceptional places where salt brine is thrown out on the pavement and macadamised roadway and discharged into badly-constructed drains. In such circumstances it is very difficult to protect any kind of mains. Some of our mains are in such places. They are no doubt exceptionally tried. In parts they are laid along quays where the tide rises frequently higher than the mains.—Yours, &c. JAMES PERRY.

PARLIAMENTARY INTELLIGENCE.

The following bills have been passed by the examiners, since our last issue, as having complied with Standing Orders :—

Birmingham Corporation, Nottingham Corporation, Hythe Corporation, University College, London (Transfer), Halifax Corporation, Swansea Corporation, Metropolitan Railway, South Wales Electrical Power Distribution Co., Croydon Corporation, Ealing Corporation, Central Electric Supply Co., Loughborough Corporation, West Cumberland Tramways, Metropolitan and Great Central Railway Cos., Central London Railway, Ulster & Connaught Light Railways, Blackpool, St. Anne's & Lytham Tramways, Mexborough & Swinton Tramways, Shepton Mallet Gas Co. (Electric Lighting), Tyneside Tramways & Tramroads, North-East London Railway, Colne Corporation, Mansfield Corporation, Shropshire & Worcestershire Electric Power, Metropolitan District Railway, Accrington Corporation, Stockport Corporation, Abertillery Corporation, Oldham & Saddleworth Tramways, Metropolitan Electric Tramways, North Metropolitan Electric Power, Channel Ferry & Quay (Dover), Weybridge & Walton-on-Thames Electric Supply, Chelsea Electric Supply, London Southern Tramways, Sheffield University, Great Central Railway, Whitechapel and Bow Railway, Metropolitan Electric Supply Co. (Acton), Baker-street and Waterloo Railway, Charing Cross, Euston and Hampstead Railway, Edgware and Hampstead Railway, Great Northern, Piccadilly and Brompton Railway (No. 1), City of London Electric Lighting Co.

When the Liverpool Corporation (Tramways) Bill and the Bury Corporation Bill were called, no appearance was made, and consequently the measures will be dropped.

The Wellingborough & District Tramroads & Electricity Supply Bill, the Wigan Corporation Bill, the Hastings Tramways Bill and the Buenos Ayres and Grand National Tramways Bill have been postponed until Thursday, Feb. 16.

The Coventry Electric Tramways Bill has been reported as not having complied with Standing Orders, and will, therefore, go before the Standing Orders Committee.

The Metropolitan Electric Supply Bill (various powers) has been postponed until Wednesday, Feb. 1.

The Great Northern, Piccadilly and Brompton Railway (No. 2) Bill has been postponed until Thursday, Feb. 2.

Refuse Destructor in Zurich.—One of the few refuse destructor plants on the Continent is that erected by Messrs. Brown, Boveri & Co. in Zurich. It is situated on the boundary of this Swiss town and contains, according to the *Elektrotechnische Zeitschrift*, 12 destructor cells capable of burning 120 tons of refuse every 24 hours, the destructors being supplied by the Horsfall Destructor Co. of Leeds. The carts bringing the refuse are raised by an electric crane, and then tipped, and the refuse falls on to the grate. Forced draught is produced by an electric fan, and the air is heated before it reaches the furnace by being passed around it. The hot gases from all the destructors are led through a common flue to two water-tube boilers, which supply steam at 115lb. per square inch and a temperature of 480 F. to a 150kw. 220-volt 50 ~ three-phase turbo-generator of the Brown-Boveri-Parsons type. It is stated that each pound of refuse evaporates on the average 0·75lb. of water, and that the clinker amounts in weight to from 30 to 40 per cent. of the refuse. Part of the electrical energy generated is employed to supplement the town supply.

LEGAL INTELLIGENCE.

Catchpole v. Champion Baby Arc Lamp Co.

In the Lord Mayor's Court (London) last week, before Sir F. Fulton, K.C., and a common jury, plaintiff (a commercial traveller) sought to recover damages for wrongful dismissal and breach of contract. Plaintiff said he was employed by defendants temporarily to sell a patent electric lamp until the return of a Mr. Moffatt from the United States. He started work in October. He was successful in placing some trial orders. Then he was told by a partner (Mr. Bowyer) that his services would no longer be required owing to their discontinuing the sale of the lamp. He considered he was entitled to be compensated for loss of commission, as if he had been allowed to continue he would have earned £8 a week.

For the defence, Mr. Bowyer said that after entering into the arrangement with plaintiff, he discovered that there was a defect in the lamp. He explained to plaintiff that the lamp must be withdrawn until this defect was remedied, and that the arrangement with him would be continued when the lamp was perfected. Plaintiff had not sold any lamps, but had received £3 on account of commission.

The jury found for plaintiff for £10, leave to appeal being given and execution stayed for 14 days.

Mica Insulator Co. (Ltd.) v. Bruce Peebles & Co. (Ltd.)

In the Outer House of the Court of Session, Edinburgh, last week, Lord Stormonth Darling closed the record in this action for £500 damages for alleged breach of contract, and also for interdict. Pursuers are owners of letters patent dated 1892 and 1895. Under the former the company manufacture a substance which is sold by them and known in the trade as Micanite, and under the latter manufacture and sell a substance known as extra flexible micanite cloth or paper. In December, 1903, defenders are said to have contracted to purchase from pursuers their whole supply of mica segments, micanite segments and cut rectangular mica for 1904. For some months prior to the commencement of the action pursuers stated that defendants ceased to order any micanite from them, and pursuers aver that defenders are now manufacturing micanite, and in doing so that they are infringing the letters patent referred to. Defenders deny alleged breach of contract with pursuers, and dispute the validity of the patents.

Bruce Peebles & Co. v. Hester.

The Court of Appeal (the Master of the Rolls and Lord Justice Cozens Hardy) on Monday heard an appeal of defendant from an order by Mr. Justice Jelf in chambers. Plaintiff sought to recover £3,630 on bills of exchange accepted by defendant and dishonoured on presentation. Defendant owned an estate on Canvey Island upon which he wished to have a tramway built, and he entered into a contract with plaintiffs to carry out the work. The tramway was to have been completed by June last year, but was not, and it was agreed that a penalty of £1,000 should be paid. Afterwards an arrangement was entered into under which the bills were given in respect of moneys admittedly due from defendant to plaintiffs in respect of the work, but defendant contended that it was a condition precedent to the bills being presented that plaintiffs' contract should be completed by Sept. 3, 1904. Defendant alleged that the contract had not been completed up to the present, and that he had therefore a good defence. Mr. Justice Jelf gave defendant leave to defend on bringing £1,600 into court. Defendant thought he ought to have unconditional leave.

The appeal was allowed, costs of the appeal to be costs in the cause.

Holdern and Another v. Anti-Vibrator (Ltd.)

Mr. Justice Warrington on Wednesday had before him this action in which the plaintiffs, trading as the Max Electric Accumulator Co., originally claimed £210 for three batteries with cases. A receiver had been appointed of the defendant company and they did not appear and plaintiffs only proceeded in respect of one battery which had been actually supplied.

Judgment for plaintiffs for £66 and costs.

Electric Tramways Construction & Maintenance Co. (Ltd.)

In the Chancery Division on Tuesday the petition of Mr. A. J. Paine to compulsorily wind up this company was ordered by Mr. Justice Buckley to stand over until February.

Edey v. Smith.

In the City of London Court on Friday, before Judge Rentoul, K.C., the last stage in this case (reported in our issue of Nov. 18) was reached. The action was for £76, for work done and materials supplied for electric lighting and bell fitting at flats in Chelsea. Plaintiff's case was that he had done the work satisfactorily, although he had been prevented from completing it. Defendant pleaded that plaintiff had refused to complete his contract and that the work was done so badly that defendant could not ask the Chelsea Electricity Supply Co. to give a supply of current, and the electric bells would not ring. When the case was last before the Court Judge Rentoul, K.C., gave judgment for plaintiff for £20 on one item and said that as to the rest plaintiff was to complete the work. It was now stated that defendant would not allow [illegible] plaintiff to do so, and judgment was given for plaintiff for £46. 5s. in addition, and costs.

City of London Electric Lighting Co. v. Hunt.

In the Lord Mayor's Court, London, on Monday, before the Recorder (Sir F. Fulton, K.C.) and a jury, plaintiffs sought to recover £18. 1s. 10d. for electric current supplied for lighting and heating for three quarters. Defendant had been a customer of plaintiffs since 1900, and no dispute arose until the end of 1903, when he complained of the meter readings. Eventually the meter was tested by the City Corporation electrical inspector, and it was found to be in error. Plaintiffs contended that they were entitled to charge for all current registered up to the time the meter was found to be incorrect, but they made an allowance for the March, June and September quarters.

For the defence, it was urged that, as the meter was found to be inaccurate, defendant was entitled under his original contract to pay a sum based upon the former or the subsequent reading. He had been in the habit of paying from £1 17s. to £3 per quarter, and suddenly, in March, 1904, he was presented with an account for £8.

The Recorder held that, under the company's Act of Parliament, defendant could not question the accounts until October, when the meter was tested. The evidence of the inspector must then be taken as conclusive. In his view the claim was undefended and the jury found for plaintiffs, with costs.

Overhead v. Underground Telephone Wires.

The Railway and Canal Commissioners (Mr. Justice Bigham, president, Sir F. Peel and Viscount Cobham) heard yesterday (Thursday) the applications of the Postmaster-General *v.* the Rural District Council of Croydon and Brentford Urban District Council.

The ATTORNEY-GENERAL, on behalf of the Postmaster-General, said the difference which had arisen was whether certain lines of telephonic and telegraphic communication which the Postmaster-General was willing to put up at a reasonable cost should be laid underground or from poles above ground. The difference in the cost was very serious, and in one case it would be a matter of consideration whether the Postmaster-General could provide the communication required if the wires had to be placed underground. By the Act of 1863 the Postmaster-General had power to put up and maintain posts along any street or public road, but he could not open up the streets or erect posts without the consent of the local body in control of the road. The difficulty which had arisen in the present case was that the local public body had refused their consent to the posts. Where such a difficulty arose the Act said that it should be referred to a police or stipendiary magistrate, or to the judge of a county court. With regard to the three cases in dispute at Croydon, Judge Russell decided that the wires should be laid underground, and the Postmaster-General now brought the matter before the court as he was entitled to do under the Act, not as an appeal but for re-hearing, if necessary. With regard to the proposed new telegraph communication to a station called South Beddington, a very extensively signed petition had been presented by the inhabitants of that district, asking that a post office which existed in Stafford-road should be utilised for telegraphic purposes. The District Council said the extension wires should be placed underground, but the Postmaster-General said that the income would be so small that the cost would be out of all proportion. He was ready and willing to give the communication if he could use posts. It was a country road, and he submitted that it was absolutely unnecessary to incur the expense of putting the wires underground. The overhead wires would be no obstruction to traffic. He put in photographs, plans and measurements of the roads.

Mr. MACMORRAN, K.C. (for Croydon Council) said the district was rapidly being built over, and there were from 1,000 to 1,500 houses nearly finished. It was not at all a country district, but had a distinctly urban character. The roads were mostly narrow with narrow footpaths and poles 30ft. high and 2ft. at the base would be an obstruction.

The ATTORNEY-GENERAL said he was willing, and it should be a condition, that the posts should be iron posts, which were much thinner than wood.

Mr. MACMORRAN said the cost of maintaining underground wires was less than that of overhead wires with posts.

The PRESIDENT suggested that the parties should come to a settlement, and, after a conference,

The ATTORNEY-GENERAL said they had arranged terms with regard to Croydon. The Postmaster-General, as to one line, would be at liberty to erect poles, either creosoted or painted. As to another route, there was no reason why the wires should not be underground, the Postmaster-General laying the tubes and wires and the District Council filling up the channels.

In the case of Brentford, it was agreed that on part of the route the lines should be partly under ground and partly iron posts, the other part in the outskirts to be overhead with painted or creosoted poles. Orders of consent were drawn up accordingly.

Damages for Electrocution of a Dog.

At Sheffield County Court on Thursday last Judge Mansel-Jones gave judgment in an action brought by Joseph Rodgers against the Zeala Meat Co. and A. F. Johnston, their manager, for £5 damages for having killed plaintiff's dog on Nov. 2 by electrocution.

His HONOUR said on Nov. 2 plaintiff's dog went to defendants' shop and stole a rabbit and two pieces of meat. Johnston determined that if it came in again he would give it an electric shock, and accordingly he detached the electric wires from the fan used for circulating air in the shop, and embedded them in a piece of meat, which he laid on the floor about the middle of the shop. In the evening plaintiff passed the shop, and having gone a few paces beyond it he missed his dog. Looking back he found it lying inside the shop door with a piece of meat in its mouth, and the wires attached to it, though the wires were drawn out from the attachment in the wall. The dog's jaw was fixed on the meat, and it was practically dead. It appeared that the dog had seized the meat and was making off with it when the shock practically killed it on the spot. There was no evidence against defendant company and there must be judgment for them. If Johnston had killed the dog with a cleaver he would have been liable for damages. Though the dog was a trespasser it was not necessary, for the protection of his employers' property, to destroy it. He had no right to kill it by an overt act, and that being so, as it was illegal to kill it directly, it was equally illegal to kill it by strategem or trick. He gave judgment against Johnston for £3 with costs, and for the company without costs.

Mr. MUIR WILSON (for defendants) said he would take time to consider the question of appeal.

Workmen's Compensation Act.

His Honour, Judge Lush Wilson, K.C., recently delivered his reserved award at Exeter in the arbitration between Back and Dick, Kerr & Co. Back claimed under the Workmen's Compensation Act, for 11s. 6d. per week, being applicant's half wages during incapacity caused by an accident while in the employment of defendants. On Aug. 17 last Back was at the L. & S. W. R. goods yard, Queen-street station, unloading a truck of tramway rails, one of which fell, fracturing plaintiff's right arm. He was an out-patient of the local hospital for three months. His wages at the time of the accident were 23s. a week, and he was still incapacitated. The point to be decided was as to whether plaintiff was engaged in, on or about engineering works within the meaning of the Act.

Judge WILSON held that the station yard, used as a depot for stacking the rails, came within the definition "in, on or about engineering works." But having regard to the medical evidence, he had doubts as to the degree of incapacity of applicant. For the present, he awarded him 11s. 6d. per week.

The case of Hartley and Quick came before the Court of Appeal (the Master of the Rolls and Lords Justices Mathew and Cozens-Hardy) last Friday on the appeal of defendant from the award of the Portsmouth County Court Judge under the Workmen's Compensation Act 1897.

Applicant, a workman in the employ of defendant (a builder and contractor), was engaged in erecting for Portsmouth Corporation a building adjoining the Corporation's electricity generating works, the new building forming an extension of that station. The existing station exceeds 30ft. in height. Plaintiff was working on this new building, and was injured by falling off the scaffold while carrying up materials. Defendant's case was that applicant's employment was not one to which the act applied, as he was not at the time of the accident employed on, in or about a building exceeding 30ft. in height. The County Court Judge held, however, that the employment came within the act, as he held that the two buildings were intended ultimately to form one complete whole, and he gave applicant an award of 12s. 6d. per week. Against this decision defendant now appealed.

Their lordships held that, the new building being merely an extension of the old one, it could not be said the two were separate, and therefore applicant was employed upon the extension of a building exceeding 30ft in height and was entitled to compensation under the act.

The appeal was dismissed with costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Newcastle-upon-Tyne Electric Supply Co. invite applications for the position of engineer-in-charge of shift at their Carville power station. Applications to the technical manager (Mr. J. S. Watson). See an advertisement.

West Bromwich Council require an assistant electrical engineer. Commencing salary £120. Applications by noon of Feb. 4 to the borough electrical engineer (Mr. John H. Wray), electricity works, Black Lake, West Bromwich. See also advertisement.

Battersea (London) Borough Council require an electrical engineer, to take entire charge of their electricity department. Commencing salary £400 per annum. Applications by Jan. 31.

The Admiralty announce that there will be on April 1 several vacancies for assistant masters in H.M. dockyard schools. Salary £150, rising by £10 per annum to £250, with pension and chance of selection for promotion to senior masterships. Applications to Secretary (C.), Admiralty, Whitehall, London, S.W., by Feb. 6.

Wakefield Electric Lighting committee recommend the appointment of Mr. H. A. Neville, at present chief assistant electrical engineer, as borough electrical engineer, in succession to Mr. C. M. Shaw. The commencing salary is £300 per annum, rising by annual increments of £25 to £400.

A. K. Taylor, late of the British Electric Traction Co., has been appointed electrical inspector for the Presidency of Bengal, Calcutta.

Arbroath.—The Board of Trade have granted three months' extension of time for carrying out the terms of the Council's electric lighting order, 1899. The Council recently agreed to transfer their powers to the Empire Electric Light & Power Co.

Australasia.—The New South Wales Government tramways revenue was £290,926 in the last quarter of 1904, compared with £207,667 in the corresponding quarter of 1903. Expenditure increased from £179,642 to £190,113.

Battersea (London).—On Wednesday the Borough Council had under consideration a report of the electrical engineer (Mr. W. A. Kemm) recommending certain extensions of the electricity works at an estimated cost of £16,000. The Lighting committee endorsed Mr. Kemm's recommendations, and these were adopted by the Council without dissent or discussion. The proposed extensions are as follows:—

One 750kw. turbo generator, estimated cost, £4,700; condenser with valves, £225; three water-tube boilers with fittings, automatic stokers, including brickwork, £3,850; pipework in connection with turbo, boilers and condenser, £1,400; two switchboard panels for feeders and generators, instruments, &c., £300; meter for generator, £25; cables for generator, £86; one motor-driven pump for condensing water, including pipes, starting switch, &c., £1,300; one boiler feed pump, £150; valves for main steam line, £200; foundations for turbo and pump, and chequer plating, £400; one Green economiser with brickwork, £650; contingencies, £472; alteration to pipes in river, £1,500; office charges, £742—total, £16,000.

Belfast.—Messrs. Combe Barbour are building at their Belfast works three vertical triple high-speed engines of the enclosed type for Belfast tramway power station, for direct coupling to Westinghouse generators. Each engine will develop 1,550 B.H.P. at 180 revs. Steam is admitted by piston valves to all cylinders, and forced lubrication is fitted throughout.

Bradford.—The position of the electricity undertaking was discussed at the meeting of the Electricity committee on Friday, and it was agreed, in view of the fact that in the opinion of the borough electrical engineer (Mr. J. A. Blackman), further serious expenditure not yet estimated will be necessary for alterations and additions to the distributing system and otherwise, to recommend that Mr. H. R. J. Burstall (of Burstall & Monkhouse) be called in as consulting electrical engineer to report to the Council as soon as possible upon—

(*a*) The condition of the whole of the plant of the department as it was in November, 1903.

(*b*) Whether the alterations and additions since sanctioned by the Council were and are requisite and necessary.

(*c*) If generally, having regard to the whole of the circumstances, the engineer has adopted correct means of surmounting any difficulties with which he may have had to contend.

(*d*) Whether the re-arrangement made by the engineer in the organisation of the department is an improvement, and likely to facilitate future working, taking into consideration the qualifications of the individuals concerned.

Brazil.—The Rio de Janeiro Tramway, Light and Power Co. have obtained the transfer of a concession granted by Rio municipality to a local firm for the supply of electrical energy generated by water power to the city. The company is composed of a group of American and Canadian capitalists and electrical engineers, and is said to have a nominal capital of £5,000,000.

Bridlington.—A supply of electricity for private lighting will be available in a few days, and it has been decided to give notice to the local gas company to terminate their contract for the supply of gas for public lighting on Feb. 28.

Brighton.—On the presentation of the Lighting committee's report last week it was announced that a communication had been received from the consulting electrical engineer (Mr. Arthur Wright) terminating his agreement with the Corporation as from April next.

The Mayor (Ald. F. Blaker) said he proposed to let Ald. Sendall make a report on the matter, and Ald. Marx supported the idea, remarking that Mr. Wright was morally responsible for the Southwick generating station project, and while it was half uncompleted, they received intimation from him that he was going to leave them.

Ald. Sendall said he had now heard for the first time that Mr. Wright was retiring from their service. He gave details of the scheme and stated that while they were pledged to a large expenditure, the position was not so bad as he had feared. His object in rising was to ask Mr. Wright, ere he left, to give them a complete report on their position and on their future prospects, for their guidance.

Ald. Carden said the outside figure the Council were committed to spend at Southwick was £277,000. The resignation of Mr. Wright was put forward as an alarming fact. The fact was, however, that his agreement terminated on April 19, and he had merely given due notice. Mr. Wright would probably be willing to enter into some other arrangement with them, but he would not continue to be subject to the insinuations and aspersions thrown upon him by members of the Council.

Councillor Sone moved that the report be referred back to the Lighting committee, but this was defeated by 36 votes to 10.

The Lighting committee's report, which recommended that the agreement with Hove Corporation for the supply of electric current to Aldrington be sealed, was then adopted.

Canary Islands.—Señor G. L. y Castillo has applied for a concession for a service of electric tramways to run from Las Palmas to the port of La Luz.

Chambers of Commerce.—From Feb. 28 to March 2 the annual meeting of the Association of Chambers of Commerce of the United Kingdom will be held in London, and amongst the subjects down for discussion are the following:—"Telegraphic Communication with the Continent," "General Telegraphic Communication," "Telegraphic Facilities," "The Anglo-French Telephone Service," "Municipal Trading Finance," "Patent Law Amendment," &c.

Cheltenham.—Mr. E. Pearse Burd held a Local Government Board inquiry on Tuesday into the application of the Corporation for a provisional order to enable them to pay off, by a special rate, the accumulated deficit of £17,000 on the electricity supply undertaking.

The Town Clerk (Mr. R. O. Seacome) said the expectation that the electricity works would have earned a net profit by now had not been realised, and the Council, having put their house in order, asked to be allowed to pay off the accumulated deficit by a loan on such terms that the repayment of capital and interest would not involve a greater burden than a 2d. rate, or, in any case, that the repayment should be spread over a period of 10 years.

Gen. Babbage (a ratepayer) objected to the ratepayers being saddled with the deficit, which, he contended, had accrued owing to the continued disregard by the Electric Lighting committee of sec. 52 of the Electric Lighting Order of 1890, which stipulated that any deficiency of income in any year should be charged on and payable out of the local rate. He questioned the authority of the Local Government Board to legalise what, in his opinion, had been from its inception irregular and illegal.

The inspector will report in due course.

Chile.—The Chilian Electric Tramway and Light Co. have supplied current to Santiago since 1900, and the station had at Dec. 15 last the equivalent of over 60,000 8 c.p. lamps, including 256 H.P. for motors. There are 572 consumers on the company's books. The population of Santiago is 320,000.

Cost of Lighting.—The cost of lighting the North St. Pancras (London) Infirmary by electricity last quarter showed a reduction of £22. 16s. on the amount of the corresponding period in 1903 when the lighting was almost entirely by gas.

Croydon.—A poll of the ratepayers is to be taken on the tramway clauses of the Corporation's bill on 31st. inst.

Sanction has been received to a loan of £20,765 for electric lighting extensions, to be repaid within 25 years.

Dartford.—The solicitors to the late resident electrical engineer (Mr. A. J. Waterland) have intimated to the Council their intention to bring an action to recover money claimed by their client for work done as a consulting engineer during the time he held his appointment. The Council will defend the action.

Dover.—A suggestion was made at Tuesday's Council meeting that the Council's electricity meter readers should leave cards with consumers showing the quantities of energy consumed. The question will be brought forward again at the next meeting.

Durham.—In a lengthy report presented to the County Council on Wednesday the Electricity committee stated that existing electric lighting and traction companies covered one-fifth only of the county and catered for only one-third of the population (representing nearly one-third of the ratable value of the county).

The committee recommended that the Council promote a bill for establishing an electric service for the county, and that an expert be engaged to draw up a scheme and report as to the practicability of utilising the High Force, Cauldron Snout and other waterfalls for generating electricity.

The clerk (Mr. Simey) expressed the opinion that the Council had not power to promote such a bill, and after a brief discussion the report was referred back.

Edinburgh District Tramways.—Edinburgh Tramways subcommittee have deferred consideration of a letter from the National Electric Construction Co. asking for consent to the construction of electric tramways from Fountainbridge to Slateford.

A syndicate offer to construct an electric tramway 7 miles in length connecting Dalkeith, Edinburgh, Bonnyrigg and Lasswade. The offer meets with general approval in the districts affected, and other towns have asked to be included in the scheme.

Electric Traction on Railways.—In the half-yearly report of the London, Brighton & South Coast Railway Co. it is stated that the Board has decided, on the recommendation of its consulting electrical engineer, made after a long and exhaustive inquiry, to carry out a scheme of electrification on the South London section of the railway from Battersea Park to Peckham Rye, upon a system presenting many novel features, the working of which will be watched with great care. The initial cost will, it is said, not be large, and the results may have an important bearing upon the future working of the company's traffic.

Exhibitions.—The County of London Electric Supply Company announce that an electrical exhibition will be held at 118-122, Holborn, E.C. (adjoining Messrs. Gamage's premises), from March 20 to April 5 inclusive. The exhibition will be divided into two sections, *(a)* light and heating and *(b)* power, and in view of the fact that the district is largely a manufacturing one special attention will be given to the latter section. A nominal charge will be made for floor space, but all current will be supplied free of charge. Intending exhibitors can obtain full particulars from the secretary (Mr. H. B. Renwick), Moorgate court, Moorgate place, London, E.C.

Hamilton (Scotland) Town Council have agreed to place the town hall at the disposal of the Urban Electric Supply Co. for holding an electrical exhibition from Sept. 25 to 30.

An exhibition of electric light fittings, cooking and heating apparatus, &c., is being held this week at the Runnacleave Hall, Ilfracombe. The surplus profits will be devoted to the local hospital fund.

An international exhibition will be held in Brussels in 1908.

Goole.—The Corporation have decided to put into force their electric lighting order.

Java.—An extensive, if somewhat piecemeal, network of telephonic communication is established throughout Java. Batavia, the centre of the extensive trading operations of the Dutch East Indies, appears to be especially well served telephonically, and altogether there are 88 exchanges at work on the island. In the majority of cases the area served by each separate exchange is a comparatively restricted one, there being 21 separate owners of the exchanges. The lines are of overhead construction throughout. The city of Batavia has been in the possession of a telephone service since 1882.

Batavia, Medan and Soerakarta are each provided with electricity works, the companies supplying Batavia and Medan having headquarters at Amsterdam, the Soerakarta supply being owned by a Batavia company. Batavia has a population of 115,000, Medan 30,000 and Soerakarta 100,000. Supply in all cases is on the alternate-current system.

At Batavia there is a service of electric tramways which has been working since 1898. The line is 15km. in length.

The telegraphs of the island of Java are owned by the State, which has 8,338·64km. of aerial and 3,352·64km. of underground lines and cables in operation under the charge of Mr. H. Rudolph, Inspector-General and Chief of Posts and Telegraphs.

Halifax.—At the statutory meeting of ratepayers last week the clauses of the Corporation's omnibus bill relating to the construction of tramways outside the borough were disapproved. The clause authorising the Corporation to supply gas fittings, &c., on hire was also defeated, though the Corporation already possess similar powers in regard to electric light fittings, &c.

Hammersmith (London).—Extensions of the electric lighting mains, estimated to cost nearly £1,200, were authorised on Wednesday by the Borough Council.

A claim has been received from Mr. Mulholland, of the King's Theatre, for £123. 2s. 6d. as loss sustained owing to current not being continuously available at the opening of the theatre at Christmas, 1902. The Council decided to disclaim all responsibility.

Hampstead (London).—Last week the Council authorised the laying of feeder and distributor cables in various roads and the purchase of seven transformers at a total cost of £1,348. There are now 4,038 consumers, representing the equivalent of 282,385 8 c.p. lamps connected to the mains.

Hanley.—68 applications have been received for the position of borough electrical engineer, vacant by the resignation of Mr. C. A. Cowell. These have been reduced to eight, which have been referred to a committee of the whole Council for final decision.

It was reported at Tuesday's Council meeting that 300,000 units were generated at the Corporation's electricity works in 1904 more than in 1903, while 1,853 tons less fuel were consumed.

The Potteries Electric Traction Co. intend to apply for permission to abandon certain railways authorised by the Potteries Light Railways (Extension) Order, 1902, and to extend the time for completing the others until February, 1907.

Hornsey (Middlesex).—Last week the Electricity Supply committee recommended that

After the meter reading for the March quarter a sliding scale of charges for electric current be adopted for each succeeding quarter's account as follows:—

For the first 100 units consumed, 5d. per unit: for each succeeding 100 or part of 100 a reduction of ¼d. per unit until 3½d. per unit is reached; all units between 600 and 2,000 to be charged at 3½d., and above 2,000 at 3d. If the consumer occupies more premises than one he may have the consumption at each shop or house added together. The demand indicator system of charging (7d. per unit for 100 hours' use of the maximum demand per quarter and 2d. beyond) will still be available.

The Council decided to defer consideration of the report for two months to enable the Finance committee to investigate the figures given.

At Dec. 31 there were 600 consumers, representing the equivalent of 33,761 8 c.p. lamps connected.

Horsham.—The electrical engineer (Mr. J. B. Morgan) reports that the demand for current is increasing and a scheme of extensions is under consideration.

Italy.—Signor L. M. Ciurolo, C.E., of Genoa, has applied for powers to utilise the Laccio Waterfall, Torriglia, for electric power for industrial purposes and for tramways. Signor Ciurolo's scheme is estimated to cost over £28,000.

Another application has been received by the Government from Signori Curletti & Erba, of Milan, for a concession for utilising the waters of the Val Baghera and Val Pabbolli waterfalls (Brescia) to the extent of 7,840 H.P. The cost of these works is estimated at £32,000.

There is stated to be an excellent opportunity for the introduction into Venice of a well-made and cheap line of motor launches, as many Venetian families are beginning to introduce private motor boats. Others are likely to follow if a suitable article is placed on the market.

In May last the Italian Government assumed the control of the telephone service in Venice, complaints having been made by subscribers of the indifferent character of the service when provided privately. A reduction from £8 to £6. 10s. per annum has been made, and a proposal to connect Venice with Trieste by telephone is under consideration.

The River Cellina water power scheme is near completion. This will provide 7,000 H.P. for immediate use, and later on this will be increased to 10,000 H.P., to be increased still further when the scheme is completed.

London County Council.—At Tuesday's meeting (the first after the recess) it was agreed to loan St. Pancras £5,370 and Stepney £10,000 for electric lighting.

Tramways.—The Highways committee reported on the contract of Messrs. Reid Bros. for the laying of the ducts for the cables for the New Cross and Greenwich, &c., sections of tramways. The work had been completed at a cost of £29,168, which was nearly £5,000 above the original tender. The extra cost had been necessitated by various unforeseen circumstances, and it was recommended that the account be paid.—Agreed.

Theatre Lighting.—In a report the Theatres committee pointed out that the Council's regulations require that in places of public entertainment two systems of lighting shall be provided, the two systems to be taken from two separate companies. The Charing Cross and Strand Company had asked that the two systems of electric lighting which they have made arrangements to supply to places of amusement within their district may be regarded as complying with the regulation, one source of supply being from Lambeth and the other from West Ham. The committee were satisfied that the two supplies will be sufficiently independent, and recommend that the Council's consent be given for a limited period of three years.—Agreed.

Lighting of Schools.—Mr. Lewin Sharp called attention to a proposal in the Education committee's report to equip certain schools with incandescent gas burners, and asked if the committee would consider the question of electric lighting, especially in districts where the local authority were the lighting undertakers.

Sir W. Collins replied that where there were gas fittings in schools, the committee would adhere to gas, but where a new school was built they would consider the question of electric lighting.

Ludlow.—Last week the Council approved the draft agreement with Mr. W. Norton for the erection of electricity works. Mr. Norton is applying for a provisional electric lighting order.

Lytham.—The Council have entered into an agreement with Foote & Milne (Ltd.) for the erection of electricity works. The Lytham order was allowed to lapse last year, but favourable terms have been secured from the company, the Council reserving the right to purchase at the end of 10 or 20 years.

Mansfield.—The Council have retained Messrs. R. Hammond & Son as consulting electrical engineers for 12 months at a fee of 50 guineas and out-of-pocket expenses.

Negotiations are proceeding between the Council and Mansfield Woodhouse Urban Council for the supply of electricity in the district.

Mexico.—Señors Quijero and Rivero have obtained a concession to employ the waters of the River Atoyac (Puebla) for the purpose of supplying electric power. A further concession grants them the right to construct canals and bridges and to erect telegraph and telephone wires for the use of the works. Machinery, apparatus, instruments and materials for these works are allowed to be imported free of duty provided the whole of the goods are imported at one and the same time.

The "Diario Oficial" of Dec. 30 contains particulars of a number of applications to the Mexican Government for concessions for water power in Mexico. Particulars of these applications are set out in the "Diario," which may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

Mica.—It is stated that important mica seams have been found at Coquimbo, Chile, and samples of this mica may be seen at the Commercial Intelligence Department of the Board of Trade, 17, Basinghall-street, London, E.C.

Mr. Edison.—It is announced that Mr. T. A. Edison has undergone a dangerous operation for mastoiditis. It appears that a growth developed about 12 months ago, and on the advice of his physicians the operation has been made. Mr. Edison is now doing well.

Municipal Telephony.—Brighton Corporation Telephone Department, to celebrate its first year's working, held a conversazione on Jan. 13. The telephone was brought into requisition in adding to the attractions of the evening, and by permission of the proprietor of the Theatre Royal (Mr. Councillor Beryl, a member of the Telephone committee), the music of "The Girl from Kay's" was given on the electrophone. Mr. D. J. Barnes, the popular manager of the telephone undertaking, and Mrs. Barnes, did the honours of the evening in receiving the guests, &c.

A sub-committee of the Estates and Finance committee of Coventry Corporation has been appointed to consider the question of establishing a municipal telephone service.

At the meeting of Hull Telephone committee on Monday the engineer (Mr. Holme) submitted a report as to the estimated cost of extensions. It is proposed to add 1,000 additional lines at a total cost of £20,873, and it was decided to apply for sanction to borrow this sum.

Natal.—Applications have been made by the Natal Government for permission to introduce bills into the legislative assembly authorising the construction and working of tramways (worked either by electricity or other power) to connect up Durban Corporation tramways and other lines.

Newcastle-on-Tyne.—For the position of manager of the Corporation tramways the Council have to make a final choice from the following, selected by the Tramways committee: Messrs. H. E. Yerbury (Sheffield), C. J. Spencer (Bradford), C. W. Mallins, (Liverpool), Ernest Hatton (Salford) and G. Conaty (Birmingham.)

Nice.—The Nice Chamber of Commerce have received authority to erect electric cranes and other machinery necessary for the improvement of the working conditions at the port of Nice, France. The "Journal Officiale" of Jan. 16 contains further particulars.

Ploughing by Electricity.—The Societa Elettrotecnica Italiana (Turin) have invented and constructed devices for the application of electric power to ploughs and other farm machinery. An experiment in electric ploughing was recently made near Turin in the presence of representative agriculturists from different parts of Italy, and with satisfactory success. The device consists of two power cars stationed at each side of the field between which are stretched cables attached to the plough. Electric current of about 500 volts is taken from a trolley line. Each car is said to give 25 H.P., which can be increased to 40 H.P. The plough is pulled by the cables from one side of the field to the other, and when it reaches the end of the furrow it stops automatically, current being cut off. It can be run backward or forward with ease. One man manages the plough, and each car is operated by one man, so that three men do all the work. Much depends on the condition of the soil, but it is said that from 7 to 15 acres can be ploughed in 12 hours. The power cars are said to be as easily managed as traction engines, and power can be applied to thrashing machines, cornshellers, pumps, grain drills, &c.

Plymouth.—The Tramways committee estimate that they will have to expend during next year £12,958 on capital account, including cost of constructing one new line.

Poplar (London).—On Wednesday the Finance committee notified the receipt from the electrical engineer (Mr. Bowden) of his reasons why no money should be transferred to general fund account from the present credit balance of the electricity undertaking. Mr. Bowden said if the repayments had not been deferred for 1901, 1902 and 1903 they would now have a deficiency on revenue account of £2,455. 8s. 7d., instead of a surplus of £6,892. 13s. 5d.

The Finance committee concur with the Electricity committee in approving Mr. Bowden's reasons and his suggestion with regard to establishing a reserve fund.

Mr. Bowden has also reported to the Electricity committee on certain extension required before next winter, and his recommendations have been adopted by the committee.

Tests in public lighting by Nernst lamps are being carried out at present, and two streets are to be lighted with ¼-ampere lamps for comparison with the ½ ampere lamps in an adjoining street. Some extensions of the arc lighting has also been approved at an estimated cost of £375.

Presentation.—Mr. H. Garnett, for many years superintendent of P.O. telegraphs at Manchester, has been presented by his colleagues with a testimonial on his retirement. Mr. Garnett entered the service of the Magnetic Telegraph Co. in 1858, and after the transfer of the telegraphs to the State in 1870, was for several years employed at the Stock Exchange branch office. He was promoted to the rank of superintendent in 1900, and retired in December last after 46 years' service.

Provisional Order Transfer.—Runcorn Urban District Council intend to transfer to the Mersey Electric Supply Co. (Ltd.) the undertaking authorised by the Council's provisional order of 1899. The Council reserve the right to purchase at the end of 14, 21, 28 or 35 years or any subsequent seven years. The company are to pay the Council the cost of obtaining the order (£274).

Rubber.—It is stated that a Mexican plant has been discovered which emits a sap that, when dried, closely resembles rubber. According to the discoverer's account of the find there are immense quantities of the plant in Mexico. The sap is greenish colour, and has a slight smell of rubber.

Southampton.—The borough electrical engineer (Mr. H. F. Street) has presented his annual report to the Electricity committee on the expenditure on the new electricity works on the Western Shore. The total cost is £21,954. 10s. 4d., which exceeds the loan by £4,869. 10s. 4d. The committee recommend the Council to apply for sanction to borrow £6,300 to cover excess expenditure.

Southern Nigeria Telegraphs.—Capt. J. P. Moir, D.S.O., R.E., who has been appointed by the Colonial Office to take charge of telegraph construction in Southern Nigeria, left London on Saturday for Lagos. He will be followed in a week by a party of non-commissioned officers, who will superintend the working parties on the line of construction. The actual work of construction will begin in March with the lines on the delta of the Niger, so that this portion of the work in the swampy country can be got well in hand before the rains commence. About 400 miles of telegraph will be erected and the work will occupy a year. Calabar and Lagos will be put into direct land communication, and from a point on the line between Calabar and Bonny the line will be carried to Onitsha, on the Niger, thence to Benin, Warri and Lagos, where it will effect a junction with the telegraph to Kano and Sokoto.

Spain.—The Bidasoa Iron & Steel Co. has received authorisation to appropriate 5,000 litres of the waters of the River Bidasoa (Yanci) for the generation of electric power.

Swansea.—From April 1 the charges for current for lighting will be 6d. and 2d., and for power 2d. and 1½d.

Tariff Changes.—The duty on imported incandescent electric lamps, mounted or unmounted, imported into the Philippines is to be 20 per cent. ad val. in place of the existing rate of $2 per 100 lamps. On plain porcelain insulators a duty of 20 per cent. is under consideration, compared with $4 per 100kg. at present.

A duty of 2½ per cent. has been fixed upon electric batteries and electric cables and wires by the South African Customs Union.

A duty of 85 per cent. ad val. has been fixed by the United States Customs Department upon thin discs of carbon used for electrical purposes other than electric lighting.

Taunton.—The Council have entered into an agreement with the Langdon-Davies Motor Co. for the supply of motors for hiring out and for sale on the easy payment system.

Telephonic Communication in Japan.—Since its introduction into Japan some 15 years ago telephonic communication, like all other scientific industries, has made rapid strides, and the service, although not yet as complete as in the United Kingdom and other parts of the world, is well on the way to completeness. The following details show how the Government telephone has progressed since they acquired the telephone in 1890:—

In December, 1890, there were only two exchanges and 16 call offices, but in 1895 these had increased to 4 and 24, and at Dec., 1902, there were 27 exchanges and 151 call offices. Subscribers in 1890 numbered 343 (equal to two persons in every 10,000 of the population), in 1895, 2,853 (14 in 10,000), and in 1902 29,941 (1 in every 133). At Dec. 31, 1902, there were 23,300 applicants awaiting connection.

The length of telephone lines in 1890 was 50ri (122 miles), with the working lines extending to 331ri (807·64 miles); in 1895 178ri. (433·22 miles), and 2,156ri. (5261·64 miles); and in 1902 1,039ri. (2,535 miles) and 43,345ri. (105,761·80 miles).

The financial side was equally progressive and satisfactory. In 1890 there was a balance of 2,300yen (£230) on the wrong side, but this was wiped out the next year, and the figures since are shown below:—

	Receipts. Yen.	Expenses. Yen.	Profit. Yen.
1892	48,069	32,722	15,347
1893	94,959	52,849	42,110
1894	132,967	75,229	57,738
1895	142,431	91,549	50,882
1896	150,444	113,605	36,839
1897	228,505	179,612	48,893
1898	574,332	324,038	250,294
1899	1,039,957	630,471	405,483
1900	1,513,912	964,900	549,012
1901	1,810,411	1,175,982	634,429
1902	2,263,626	1,278,991	984,634

(1.000 yen equals nearly £100.)

Thermit Welding.—It is stated by the "Railway Review" of New York that the Union Pacific road has successfully welded a broken engine frame by the alumino-thermit process. This is one of a few attempts recorded of the use of thermit to weld a broken locomotive frame.

Transvaal Imports.—Tramway material to the value of £147,000 was imported into the Transvaal during the 10 months ended Oct. 31 last compared with £69,000 in the corresponding period of 1903. The value of electric cables, wires and fittings for the same period was £58,000 in both years.

Valparaiso (Chili).—It is announced that the Municipality has sequestrated the property of the Chilian Electric Tramway & Light Co. for an alleged debt of $20,000 owed by the old tramway company. Although both companies settled their accounts in November, a receiver has been placed in possession.

Wakefield.—The City Council will on Tuesday be recommended by the Electric Lighting committee to apply for sanction to a further loan of £18,000 for electric lighting extensions.

Walsall.—The accounts of the first year's working of the Corporation tramways show a net profit of £2,269. 3s. 9d. after payment of interest and sinking fund charges. The total revenue was £25,080. 18s., an average of 9·52d. per car-mile, and the working expenses, including power cost, 6·51d. per mile. 632,368 car-miles were run and 451,471 passengers carried.

The capital outlay to Dec. 31 was £149,774, against the estimate of £138,669. The Tramways committee recommend that the net profit be carried to reserve, as the cost of maintenance of the newly-constructed lines and repairs to cars and equipment had been very small and a considerable increase of expense under these headings must be expected. At an early date it will be necessary to reconstruct the permanent way of the portion of the lines purchased from the South Staffordshire Tramways Co., and a partial substitution of double for single track will probably be found advisable.

Watford.—The electrical engineer (Mr. W. H. F. Colebrook) is to report on the advisability of introducing prepayment meters.

West Ham.—The Board of Trade have sanctioned the borrowing of £29,850 for tramway permanent way, £10,100 for electrical equipment and £18,550 for cars.

Whitwell.—The subject of electricity supply has been discussed, and will form the subject of debate at the annual parish meeting in March.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

West Ham Borough Council invite tenders for the supply of engine room stores, cable, integrating wattmeters, double-pole house cutout boxes, transformers, incandescent lamps and coal. Forms of tender after 26th inst. of the borough electrical engineer (Mr. W. J. Bullock), Central Electricity Station, Tucker-street, Canning Town. Tenders to the town clerk (Mr. Fred. E. Hilleary) by 4 p.m. Feb. 9. See also advertisement.

The Council of the Metropolitan Borough of *Bermondsey* invites tenders for the supply of stores and articles for one year from March 31, 1905, including arc-lamp carbons, conduits, electricity meters, demand indicators and main fuses, engine oils, indiarubber cables and jointing material, lead-covered cables and meter boards. Samples may be seen at the electricity works upon application to the borough electrical engineer, Mr. W. H. Vincent. Forms of tender from the town clerk (Mr. Fredk. Ryall), to whom tenders by 4 p.m., Feb. 6. See also an advertisement.

The Council of the borough of *Hammersmith* (London) invites tenders for the supply of stores for the 12 months ending March 31, 1906, including arc-lamp accessories, globes, &c., brooms and brushes, carbons, commutator brushes, electrical goods, files, fire bricks, gauge glasses, incandescent lamps, insulated wires, lubricating oil, metals, meters, oilmen's goods, packing and jointing materials, screws, tools and Welsh smokeless and other steam coal. Forms of tender from the borough electrical engineer (Mr. G. Gilbert Bell), electricity works, 85, Fulham Palace-road, London, W. Tenders to the town clerk (Mr. Thompson) by 4 p.m. Feb. 8. See advertisement.

Bury (*Lancs.*) Electricity committee invite tenders for the supply and erection of a 500kw. direct-current high-speed generating set. Specifications, &c., from the engineer and manager (Mr. S. J. Watson). Tenders to the Municipal Offices, Bank-street, Bury, by noon Feb. 14. See also an advertisement.

Ilford District Council invite tenders for about 2,400yds. of 0·4in. concentric armoured cable. Specifications from the borough electrical engineer (Mr. Arthur H. Shaw), Electricity Works, Ley-street, Ilford. Tenders to chairman of Council by 4 p.m., Feb. 7. See also advertisement.

Grimsby Corporation invite tenders for motors (from ½ H.P. to 10 H.P.) with starters (two years' contract); water-purifying plant for separating oil from condensed water; and 12 months' supply of oil, stores, arc lamp carbons and globes, incandescent and Nernst lamps, tools, rubber goods and cables, &c. Tenders to Mr. W. A. Vignoles, Electricity Works, Grimsby, for motors and purifier by Jan. 28, and for stores by Feb. 1.

Handsworth Urban District Council invite tenders for power and lighting circuits and fittings in generating station, pipework, feed pumps, economiser, &c., and electricity meters. Tenders to the Council House, Handsworth, before noon Feb. 2.

Great Yarmouth Corporation invite tenders for supply and delivery of tramcars, complete with motors, controllers, trolleys, &c., steel poles, trolley wires, insulators, feeder and section pillars, &c. Tenders to the Town Hall, Great Yarmouth, by noon Feb. 2.

Stockport Tramways committee invite tenders for the overhead equipment of about four miles of electric tramway, and also for copper rail bonds. Tenders to Chairman by noon Feb. 6.

Stockport Corporation also require tenders by noon, Feb. 6, for the supply of ten double deck tramcars. Particulars from the borough surveyor.

Stockport Gas and Electricity committee invite tenders, by Feb. 1, for 10 complete feeder pillar boxes with bases.

Stockton-on-Tees Electricity committee invite tenders until Feb. 10 for one year's supply of stores.

Leith Corporation invite tenders by 6 p.m., Feb. 15, for a 600kw. steam dynamo, a water-tube boiler and a traction switchboard.

Oulton Broad Council invite suggestions for public lighting. Communications by Feb. 4 to the clerk, Waveney-chambers, Lowestoft.

Saventhem (Belgium) municipal authorities invite tenders (until Feb. 18) for establishing electricity works. Particulars (4fr.) from and tenders to Le College des Bourgmestre et Echevins, Saventhem.

TENDERS RECEIVED AND ACCEPTED.

The Metropolitan Asylums Board have received the following tenders:—

For installing electric light, telephones and fire alarms in Belmont Asylum.

Bromley & Batstone (accepted), £2,214 (electric lighting £1,905, telephones £250 and fire-alarms £891.)

F. A. Glover & Co. tendered at £2,483. 10s., Belshaw & Co. at £2,660, Buchanan & Curwen at £2,675, Wenham & Waters at £2,806, Bergtheil & Young at £3,176. 10s. The estimate of the Board's engineer was £2,450.

For extending the internal telephones at the North-Western Hospital, J. W. Gray & Son (accepted) at £126. Also tendered: Private Wire & Telephone Installation Co. £140, New System Private Telephone Co. £160. 13s. 4d., A. V. Gifkins & Co. £162, Buchanan & Curwen £169, J. Richmond & Co. £258. 10s.

For the Fremantle (W.A.) electric tramways the following contracts have been placed by the consulting engineers, Messrs. Noyes Bros:—

Belliss & Morcom, four engines; J. G. Brill & Co., 14 cars; J. G. White & Co., cables, trolley wire and bonds; British Westinghouse Co., generator, motors, meters, lamps, transformers, switchboards. The order for the rails has been placed with the United States Steel Products Export Co.

Dover Town Council have accepted the tender of the British Electric Equipment Co. for the construction of the permanent way, the overhead equipment and laying of cables in connection with the construction of the Dover and River Light Railway.

Erith Council have accepted the tender of the British Westinghouse Co. for tramcar brakes at £700, and that of John Hitchen & Sons for mechanically-operated gates at the West-street tramway crossing at £290. 10s.

Islington Guardians have placed an order with the General Electric Co. for materials for installing fire-alarms at Cornwallis-road Workhouse.

For end screen at the Greenwich generating station the London County Council have accepted the tender of W. Harbrow at £1,437. Four tenders, varying from that of the accepted to £2,441. 2s. 5d., were received.

The Worthington Pump Co. have recently secured orders for condensing machinery for the Tientsin Electrical Co., the Walsall Electrical Co., &c.

BUSINESS NOTICES.

The Union Electric Co., 151, Queen Victoria-street, London, E.C., notify that, owing to the increasing demand for their dynamos, motors, arc lamps, meters and switch gear in the Tyne, Wear and Tees districts, they have opened an office at 43, Grainger-street, Newcastle-on-Tyne, under the direction of Mr. James Gilman.

Messrs. E. P. Allam & Co., electrical engineers, notify their removal from 11, Hatton-garden, to 11, Red Lion-street, Clerkenwell road, London, E.C., where they have opened more commodious offices, show rooms, factory and stores. The telephone No. (1280 Holborn) is unaltered.

BANKRUPTCIES, LIQUIDATIONS, &c.

The public examination took place on Thursday last of Wm. & Ed. Sumner, electrical engineers, &c., formerly carrying on business in partnership at 65, Victoria-street, and 108, St. Mary's-road, Garston, Liverpool, and 9, Grange-road, West Kirby, Cheshire, under the style of W. & E. Sumner. Liabilities £844, assets (book debts) valued at £12. 17s. 8d.

William Sumner said the partnership with his brother continued from 1900 until the business was transferred to a limited company in February, 1903, the purchase price being £4,206. They received £4,000 in fully-paid up £1 shares and £206 in cash. The book debts (£1,203) were not transferred, and the company was to pay to the vendors 7½ per cent. interest on £4,000 from Nov. 30, 1902, to the completion in March following. He and his brother were managing directors at £3 10s. and £3 a week respectively, besides £1 a week each against anticipated dividends on shares held by them. The company went into voluntary liquidation in September, and he believed the debenture holders' receiver did not expect to realise sufficient to pay the debenture holders 10s. in the £. No shares were offered to the public.

The examination was adjourned for an account to be filed.

Samuel Guest, electrical engineer, &c. (trading with F. C. Guest as Guest & Son, at 63, Otley-road, Headingley, Leeds), has been adjudicated bankrupt. First meeting of creditors Feb. 2, at 22, Park-row, Leeds, and public examination Feb. 14, at the County Court House, Leeds.

A first and final dividend of 8½d. will be payable 30th inst. at 8, Staple-inn, London, W.C., in the bankruptcy of C. M. Downie, electrical engineer, 4, Bloomsbury-street, W.C., and 28, Heathville-road, Crouch Hill, N., London.

An application for the discharge of Max Margowski, formerly managing director of the Automatic Telephone Co. (Ltd.), was heard at London Bankruptcy Court on Tuesday. Liabilities £8,800, assets £1.

Debtor attributed failure to losses in connection with the Automatic Telephone and other companies and to general stagnation of financial business. The trustee alleged that bankrupt had been guilty of fraud in relation to the transfer of shares to his wife, but the Registrar held that the charge had not been sufficiently proved. On other grounds he suspended the discharge for four years from August last.

On Wednesday application was made by Dr. F. H. Bowman, consulting engineer, &c., for his discharge. Liabilities £10,218. 8s. 6d., assets realised £25. Discharge suspended for three years.

A meeting will be held on Feb. 27 at 64, Gresham-street, London, E.C., to receive an account of the winding up of Hodges & Todd (Ltd.).

The Engineering Contract Corpn. (Ltd.) is to be wound up voluntarily. Mr. G. F. Story, 4, Southampton-row, London, W.C., is liquidator.

Plant for Sale.—Messrs. Beanland, Perkin & Co., Leeds, have for sale two 50 H.P. Sentinel engines, direct coupled to 30kw. dynamos; also a 35 H.P. gas engine, a 26kw. Taunton dynamo, two 33 H.P. Westinghouse engines with 18kw. Hartnell dynamos. See advertisement.

A Scott-Mountain compound-wound generator and a Crompton single-phase alternator are advertised for sale in another column.

Business for Sale.—A well-established mechanical and electrical engineering business is for sale by private treaty by Messrs. C. Baker & Co., 89, Bennett's-hill, Birmingham. See advertisement.

Premises for Sale, &c.—A freehold factory is to be sold, complying with L.C.C. requirements, and provided with up to-date improvements, fireproof construction, electric lift, &c., space about 15,700ft. The floor area (five storeys) is about 68,000ft. super. Particulars from Messrs. Leage, auctioneers and surveyors, 10, City-road, Finsbury, London, E.C. See also advertisement.

A ground floor, area 2,700 super. ft., equipped with electric power, and suitable for general engineering, is to let. Applications to Messrs. Marshall & Co., Campbell Works, Stoke Newington, London, N. See advertisement.

"**Kornit.**"—Messrs. Wallis Cox & Co., 23, Leadenhall-street, London, E.C., are introducing "Kornit," a composition invented in Russia, and for which they have acquired the exclusive rights for the United Kingdom and the Colonies for manufacture and sale. A report by Prof. V. B. Lewes on some tests made with this substance awards it a high place amongst electrical insulators, and as a competitor with ebonite and vulcanite. For electrical purposes a special make of "Kornit" is prepared for use in making fittings such as switches, key handles, cutouts, fuse boxes, ceiling roses, &c.

"**Steam.**"—This is the title given to an elaborately illustrated and interesting volume treating of Babcock & Wilcox plants. The book is now in its 5th edition, and has been revised and enlarged by the addition of further information upon refuse destructors, superheating, boiler installations in large power houses, additional tables, a number of new illustrations, &c. All, or nearly all, that has to be told concerning the Babcock-Wilcox steam generating plant is here set out in a tasteful and very readable form. Some of the largest installations for which the company has been responsible in this country, on the Continent, in South America and elsewhere, are described, and as a large number of these plants are at work in electricity stations, "Steam" is of particular interest to our readers. There are numerous sectional drawings given, and chapters on such practical subjects as Incrustation and Scale, Classes of Fuel, Chimney Construction, Superheated Steam, Prevention of Oil getting into Boilers, Covering for Boilers, Steam Pipes, &c. A number of scale drawings and a copious index render the volume of additional service to the busy engineer. The company claim to have nearly 5,000,000 H.P. of Babcock-Wilcox plant in actual use, the figures for electric lighting, electric railways, and general electrical engineering and supply reaching over 1,560,000 H.P. The volume of Babcock-Wilcox plant employed in electrical engineering work is many times larger than that for any other individual industry.

Turbines.—Mr. A. Steiger, 28, Victoria-street, London, S.W., representative in this country of Messrs. Escher, Wyss & Co., forwards a copy of a very fully illustrated description of turbines built by his firm from 1845 up to the present day. Some of the largest turbine work on the Continent has been carried out by this firm, who make machines for a varied range of work. The purposes to which high-pressure impulse wheels and various classes of pumping machinery have been put is shown in a series of excellent illustrations.

"**Colliery Managers' Pocket Book, 1905.**"—The "Colliery Guardian" Co., 30 and 31, Furnival-street, London, W.C., have published the 36th annual issue of the "Colliery Managers' Pocket Book, Almanack and Diary," which is edited by Mr. R. A. S. Redmaine, M.Sc., &c., professor of mining in Birmingham University. All the old features of the book have been carefully preserved and brought up-to date, and the contents of the book comprise a mass of information of interest to all who have to do with mining work, including an electrical section.

Catalogues, &c.—A new price list of moving coil ammeters and voltmeters (P.M., Oct., 1904) is being sent out by Messrs. Johnson & Phillips, in which several types of these well-known instruments are illustrated and described, including some good examples of the portable type of instrument.

The Rhodes Electrical Mfg. Co., 70 and 71, Bishopsgate-street Within, London, E.C., in a circular letter which can now be obtained by the trade, give particulars relating to the R. F. type of single-phase alternating-current motors. The company point out that experiments have been proceeding for the past year with this machine in order that the difficulty of the single-phase alternating-current problem may be solved, and that supply station engineers may have the opportunity of recommending a satisfactory motor with a view of increasing the day-load of their stations. The machine is claimed to have a very powerful starting torque, and operates at starting very much like a direct-current series-wound machine. The motor is said to be specially applicable to lifts, travelling cranes, pumps, or any other type of apparatus of which the constant load is directly coupled to the motor. The latest type of this machine is a combination of a repulsion and induction motor, having constant speed when the induction side of the machine is cut in, and being reversible by means of changing two connections, the latter operation effected by an ordinary chopper switch. The company also manufacture the R. X. type of motor. This motor starts at 2½ times its full-load running torque, with a starting current not exceeding about double full-load value. The external appearance of both machines is similar. By specialising these motors the company inform us that they are in a position to give quick delivery. The motors are made throughout at the works at Bradford.

Messrs. Siemens Brothers & Co. are sending out a further batch of leaflets, which include the standard specification of the firm's continuous-current generators and motors of the H-type; diagrams of connections between continuous-current motors (shunt wound, series wound and compound wound), particulars of Siemens starting rheostats, and a series of very clear diagrams showing how shunt, series and compound generators and motors have to be connected up for clockwise and counter-clockwise rotation.

Messrs. Siemens Brothers & Co. have issued an interesting circular of the Telpher line at the Blackburn Corporation gasworks. The illustrations show the Telpher line at work and the simplicity of handling coal, &c., ensured by the adoption of this apparatus.

A new injector list (No. 70), giving particulars of these machines and advice in their selection, is issued by Holden & Brooke, West Gorton, Manchester.

A price list (No. 3) of Kramos resistances is issued by Kramos (Ltd.), Bath.

Messrs. Marsh, Son & Co., 15, Gerrard-street, London, W., are placing on the market a new universal bracket designed for shop windows, &c. The same firm have a revised list of prices for cut-outs, lampholders, &c.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Jan. 18 to 24, with the ports of destination:—

Aden—£48. ***Africa***—Alexandria, £800; Cape Town, £555 (including £203 telegraph material); Delagoa Bay, £70; Durban, £1,114 (including £709 telegraph material); East London, £97 (including £44 telegraph material). *Argentina*—Buenos Ayres, £2,126 (including £496 telegraph material). ***Australasia***—Auckland, £10,782; Fremantle, £160; Lyttelton, £31; Melbourne, £481; Otago, £226; Perth, £70; Sydney, £892 (including £240 telegraph material). *Belgium*—Ostend, £14. *Brazil*—Santos, £128. *Ceylon*—Colombo, £534. *China*—Shanghai, £400. *France*—

Dunkirk, £10; Le Treport, £342; Rouen, £45. *Germany*—Hamburg, £195 (telegraph material). *Gibraltar*—£38. *Holland*—Amsterdam, £76; Rotterdam, £100 (telegraph material). *Hong Kong*, £339. *India*—Bombay, £898; Calcutta, £3,351; Karachi, £45; Madras, £498. *Japan*—Tokyo, £20,378. *Russia*—St. Petersburg, £32. *Siam*—Bangkok, £1,600. *Straits Settlements*—Singapore, £265 (including £50 telegraph material). *Sweden*—Stockholm, £76 (telegraph material). Total £46,314, against £4,541 in the corresponding week last year (Jan. 20 to 26).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

24,220 Gergacsevics. Lighting gas lamps by electricity.
25,765 Cervera. Electricity meters.
25,841 Berndt. Electrical skin exciter.
25,886 Dick. Coin-operated or controlled electricity meters.
26,124 Stewart, Turner and Dixon. Controlling and operating the points of electric railways and tramways.
26,513 De Macedo. Canopy trolley standard.
27,893 B.T.-H. Co. (G.E. Co., U.S.) Controllers for electric motors.
18,854 Armstrong and Orling. Telegraphic recording and perforating apparatus.
18,960 Tunstall. Electrical signalling.
19,063 Armstrong and Orling. Electro-capillary detectors, relays and recording apparatus.
26,465 B.T.-H. Co. (G.E. Co., U.S.). Systems of electric motor control.
27,038 Liddle. Sanding apparatus.
27,171 Chitty. Insulating electrical conductors and the like.
27,173 Kelsey. Connector for electric circuits.
27,298 Dawes. Magnetic separators for ores.
27,522 Tarnow. Electric ignition for explosion motors.
27,060 Cotia. Arc lamps.
27,199 Lewis. Arc lamps.
27,316 Warden-Stevens. Prepayment or automatic supply of electricity.
27,330 Fairweather (Stromberg Carlson Telephone Mfg. Co.). Telephone systems.
27,399 Leitner. Separating and supporting accumulator plates.
27,783 Romanoff (London) Synd. (Ltd.) (De Romanoff). Storage batteries.
28,003 Fairweather (Kellogg Switchboard & Supply Co.) Telephone transmitters.
28,059 B.T.-H. Co. and Cubitt. Earth-indicating apparatus for trolley standards.
28,183 Dickson. Electrically-actuated musical instruments.
27,956 Munro & Lumsden. Automatic temperature alarm.

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86 Kirkup and Alderson. Shot-firing batteries.
456 Leetham and Bousfield. Manufacture of chlorine by electrolysing sodium chloride solution and apparatus therefor.
821 B.T.-H. Co. (G.E. Co., U.S.). Electric motor control and apparatus therefor.
869 Johnston. Relays for recording, re-transmitting and controlling electricity.
964 Sturges. Electrical alarms for clocks.
1,624 Mudie. Preventing accidents from broken trolley wires.
1,968 B.T.-H. Co. (G.E. Co., U.S.). Motor control systems.
2,243 Thomson. Trolleys.
2,315 MacIver and Guy. Electrical terminal.
2,397 Carnegie and Beevers. Trolley wheels.
2,449 B.T.-H. Co. (G.E. Co., U.S.). Emergency brakes for electric vehicles.
2,452 and 2,453 B.T.-H. Co. (G.E. Co., U.S.). Controlling alternating-current motors.
2,456 B.T.-H. Co. (G.E. Co., U.S.). Control of alternating-current motors.
2,495 von Recklinghausen. Electric or vapour lamps.
2,558 Payne and Poupart. Automatically switching off current in a trolley wire when broken.
2,581 B.T.-H. Co. (G.E. Co., U.S.). Machines for making stems for incandescent lamps.
2,614 Prested. Terminals for batteries.
2,707 Wilson. Electrostatic wattmeters.
2,715 B.T.-H. Co. and Murphy. Arc lamps.
2,930 Lewis. Electromotors of the induction type.
2,948 Duddell. Wattmeters.
3,010 Ross and Matthews. Road contact system of electric traction.
3,087 Johnson. Electrically amalgamating and coating metals.
3,205 Fisher. Electrical measuring instruments and apparatus.
3,216 W. T. Henley's Telegraph Works Co. and Nichols. Fuse box for cables.
3,236 Wilson & Wilson & Pilcher. Tremblers.
3,243 Mensing. Arc lamps.
3,431 Kingsbury (Western Electric Co.). Telephones.
3,492 Tucker. Fixing covers of switches, &c.
3,547 Kingsland. Switches.
3,588 B.T.-H. Co. (G.E. Co., U.S.). Controlling alternating-current motors.
3,589 B.T.-H. Co. (G.E. Co., U.S.). Alternating-current motors
3,590 B.T.-H. Co. (G.E. Co., U.S.). Controlling electric motors.
3,603 Leitner and Lucas. Controlling apparatus for electric circuits.
3,643 Scott. Electric light baths.
3,657 Le Tall (Cooper-Hewitt Electric Co.) Gas or vapour electric lamps.
3,665 B.T.-H. Co. (G.E. Co., U.S.). Electric motor controllers.
3,666 B.T.-H. Co. (G. E. Co., U.S.). Switches.
3,840 Klinkenberg. Controlling apparatus for electric motors.
3,884 B.T.-H. Co. (G.E. Co., U.S.). Alternating current motors.
3,891 Lake (Arnot). Electrical energy meters.
3,896 Merz and Price. Protecting apparatus on alternating-current systems.
3,935 Seacombe Pressed Brick and Tile Works, Wilson & Jones. Cable troughs or conduits.
3,995 B.T.-H. Co. and Cubitt. Electric couplers.
4,059 Simm, Simm, Storey and Sellers. Electric furnaces.
4,134 Levis (G.E. Co., U.S.). Arc lamp electrodes.
4,396 Ferguson. Controlling incandescence lamps.
6,218 Imray (Deutsche Waffen and Munitions Fabriken). Automatic suspension device for arc lamps.
7,775 Glew. Instruments for rendering visible luminous effects produced by radio-active substances.
8,657 White. Printing telegraph receivers.
8,819 Loti and Latzko. Incandescent electric lamp fittings.
8,989 Martin. Service box or manhole covers. (Date applied for, April 20, 1903.)
10,691 Roussell and King. Electric typewriters and telegraphs.
14,105 Wiechmann. Connecting electrodes of galvanic batteries with their leads.
15,155 Dworzynski. Automatic electric balance.
15,343 Anderson and Dunne. Overhead electric railways and tramways.
16,479 Kretzinger. Telephone repeaters.
17,365 Boult (Eastern Fire Protection Co.). Alarm-operating mechanisms.
17,528 Siemens Brothers & Co. (Siemens & Halske A.G.) Automatically indicating and registering electrically the course of several physical processes.
17,532 Hinkson and Hey. Electric filters.
18,252 Henn. Automatic telegraphic transmitters.
18,403 Townsend. Electrolytic process and apparatus therefor.
18,628 Stern and Greene. Holder for incandescent lamps.
18,910 Pemberton. Electric heaters. (Date applied for, Jan. 4, 1904.)
18,987 Thomas. Gas or vapour electric devices. (Date applied for, Sept. 4, 1903.)
19,234 Webber. Rail joints and electrical rail bond. (Date applied for, Sept. 16, 1903).
19,266 Ziegenberg. Galvanic cell.
19,341 Haynes. Bearings for motors, dynamos, &c.
19,422 Haddan (Allgemeine Beleuchtungs und Heizindustrie Act. Ges.). Regulating mechanism for arc lamps.
19,997 Stuart. Apparatus for regulating voltage of electrical circuits. (Date applied for, Sept. 26, 1903.)
20,129 Smith. Utilising Hertzian waves.
21,402 Jungner. Electrodes for accumulators with invariable electrolyte. (Date applied for, Oct. 7, 1903.)
21,819 Bullard. Automatic telephonic exchanges.
22,003 Devonshire. Conduits for cables.
22,258 Rigola. Application of electricity to the human body.
22,355 Deutsche Telephonwerke R. Stock & Co. G.m.b.H. Telephone installations. (Date applied for, Aug. 25, 1904.)
22,368 Howorth (Ryder). Generating intermittent electric currents.
22,652 and 22,665 McFeathers and Christmas. Circuit-breakers.
22,964 Baker. Gas or vapour electric apparatus. (Date applied for, Nov. 6, 1903.)
23,009 Birnbaum and White. Intercommunication telephone systems.
23,050 Gill. Electric railways.
23,096 Howorth (Haskell). Thermo-electric generators.
23,279 Aron. Resistances.
23,377 Deutsch. Regulating dynamo-electric generators.
23,380 Soc. Electro-Metallurgique Francaise. Process for smelting nickel ores in an electric furnace, and crucible therefor. (Date applied for, Oct. 30, 1903.)
23,452 Moore. Insulation of coils of electrical apparatus. (Date applied for, Nov. 21, 1903.)
23,604 Riethof and Basch. Incandescent lamps.
23,622 Mollmann. Galvanic batteries.
23,677 Aron (Langumier). Electric tremblers or switches.
23,769 Barnes. Telephone systems.
23,867 Calahan. Trolley restorers. (Date applied for, Nov. 6, 1903.)
23,820 Carson. Electrical choke coils. (Date applied for, March 30, 1904.)
23,828 Prested. Terminal for electrical apparatus.
23,834 Hunt and Sandycroft Foundry Co. Alternating-current induction motors.
23,932 Paton. Trolley wire supports.
23,972 Siemens Brothers & Co. (Siemens & Halske A.G.). Electrical indicating or measuring instruments having springs to convey the current to a movable system.
24,102 Phoenix Dynamo Mfg. Co., Oelschlager and Haddock. Mountings and connections for conductors.
24,142 Johnson. Interrupters or spark-gap apparatus for high frequency currents.
24,165 Griffin. Automatic fire-alarms.
24,343 Heinemann. Electric signs.
24,369 Brandt. Electric emergency lamps.
24,951 Cooke and Cooke. Medical electric and magnetic appliances.

24,078 Soc. Industrielle des Telephones. Manufacture of electric conductors. (Date applied for, March 11, 1904.)
24,394 Corveschel. Connecting electric circuits especially applicable for the lamps of motor cars. (Date applied, Dec. 19, 1903.)
24,560 Frankel. Electric testing clip. (Date applied for, Dec. 2, 1903.)
24,572 De Dion and Bouton. Electric igniters for internal combustion engines. (Date applied, Aug. 16, 1904.)
24,663 Watermann. Electrical valve controlling systems.
24,715 Lea and Perrins. Electric globe lamps.
24,722 Whittaker. Electric tramcars and life guards.
24,770 Imray (Payne). Electric signalling devices.
25,078 Abon. (Boulez). Electric ignition for internal combustion engines.
25,106 Prestrd. Regulating the current through an electric lighting circuit.
25,114 De La Croix and Joel. Accumulators.
25,128 Marga. Fireproof, acid proof and electrically insulating material.
25,129 Thompson. (Stamm and Lewis). Electric braking apparatus.
25,218 Perret. Enclosed electromagnet. (Date applied for, March 12, 1904).

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Co. (Ltd.)

The sixty-fifth half-yearly general meeting was held on Wednesday under the presidency of Sir John Wolfe Barry, K.C.B.

The SECRETARY (Mr. A. R. Hardie) read the notice convening meeting, and some formal business having been disposed of,

The CHAIRMAN said: Gentlemen, before moving the adoption of the report and accounts I will, as usual, offer a few remarks. The accounts before the meeting to-day show the result of the half-year's working to Sept. 30 last, a result which I think may be described as satisfactory. My remarks to-day will be somewhat brief, as nothing of special interest has transpired incidental to the business since I had the pleasure of meeting you in July last. The accounts are presented in such a detailed form that they require few supplemental remarks. As a variant on the old proverb "Good Wine needs no Bush" I may say that "Good results require no explanation," more especially as, in the present instance, they speak to a large extent for themselves.

The gross revenue for the half-year under review amounted to £589,386, against £565,703 for the corresponding half-year to Sept. 30, 1903, or an increase of about £24,000. Various branches of the traffic, notably that with India, show a satisfactory increase. The South African traffic however, shows a considerable decrease compared with the corresponding half year of 1903, and in consequence of the cessation of the Somaliland disturbances the traffic with Aden has also decreased. In comparing the message receipts of the two half-years it must be borne in mind that considerable reductions in the rates came into force on July 1, 1903, the reductions affecting the revenue for the whole of this half-year, while the corresponding period was only partially influenced by these alterations in the tariffs. The dividends received on our holdings in other telegraph companies were rather more this half-year, so that our gross revenue shows, as I have already said, a gratifying increase of some £24,000.

The total expenses for the half-year, exclusive of income tax payable in England, show a small increase of about £4,000 when compared with the corresponding period of 1903. The expenses in London are practically the same as in the corresponding half-year. At the stations the net increase is about £8,500, the bulk of which is under the heading of "Salaries and Wages," and is due to the usual annual promotions and an increase of 56 in the number of the staff at our stations in England and abroad. As stated on former occasions the policy adopted by your Directors of reducing rates whenever the circumstances warrant such an alteration in the tariff must naturally have the effect of increasing the working charges, because, in order to deal efficiently with the greater volume of traffic which usually follows a reduction in the rates, the staff must be somewhat increased. It should not be forgotten that, whereas on a reduction of tariff it is necessary to increase the staff at once, it may take a long time to develop the same amount of revenue as that which existed prior to the reduction in the rates. During the last three years there has been a very considerable increase in the number of words carried, the number of "paying words" alone dealt with during 1904 being over four millions in excess of those of 1901, but, owing to the reductions in the rates, the receipts from messages are actually less than they were in 1901. The only other important increase is under the heading of "Maintenance of instruments" and is due to the adoption of improved methods and apparatus to improve the speed and accuracy of the service. It is our constant endeavour to eliminate errors by substituting electrical and mechanical devices for the old form of manipulation in sending and receiving messages. It was at one time hoped that these new methods would check the increase in the number of the staff, but so far it has not been so. The ever-increasing number of messages to be handled necessitates the adoption of improved methods of working and a larger percentage of trained electricians and mechanicians than formerly to keep the apparatus in a high state of efficiency. For the reasons which I have given we must be prepared as our system is extended and as tariffs are lowered for further increase of staff from time to time. Expenses under Abstract "C" show a decrease of about £4,000. We have had to carry out extensive repairs in connection with our own cables, but as our ships have been employed to effect considerable repairs for other companies the expenditure chargeable to our own revenue account is substantially reduced. The other items of ordinary expenses in the revenue account do not show much variation, the only notable difference being that of £904 under the heading of Staff Pension Fund. This apparent increased expenditure is due to a slight alteration in the method of charging the amounts paid to other companies in respect of contributions to the fund by the staff at the joint stations. In the half year to Sept. 30, 1903, these were included in the item "Contribution to other Companies" under Abstract "B," whereas this half-year they have been charged in the revenue account direct. The large increase in the charge for income tax is owing to the authorities having reconsidered the question of the allowance to be made for depreciation in respect of cables and other plant. A very large, and as we think an improper, reduction has been made in the allowance, but the commissioners have agreed to state a case in order to get the ruling of a Court of Justice as to what is a fair allowance for depreciation; meanwhile we have, of course, had to pay the increased charge for income tax pending the decision. As the other items of expenditure for the two half-years show such unimportant variations, I think, perhaps, it is unnecessary for me to trouble you further with regard to our expenses. The net result of the half-year's working is, that we are able to transfer the satisfactory amounts of £125,000 to our general reserve fund and £12,000 to the maintenance ships reserve fund, and to carry a balance forward slightly in excess of the corresponding half-year of 1903.

There is one item in the accounts which may require some little explanation, and that is a charge of £1,619 against the general reserve fund in respect of "premium on cancelled debenture stock." As you are doubtless aware, the Company has, for some years, held among its reserve fund investments, a small amount of our 4 per cent. mortgage debenture stock, and although it is, I believe, common practice for companies to invest surplus monies in their own debenture stock, it appears from a recent decision of Mr. Justice Buckley, that the effect of such investment is to cancel the stock. We have, therefore, eliminated this from the investments, and the figure appearing in the general reserve fund is the difference between the amount paid for the stock and the nominal value. We have charged against general reserve fund £113,100 in respect of new cables, and have repaid a further £100,000 to the Eastern & South African Telegraph Co. on account of the loan made to us in connection with the cables forming the new route to South Africa and Australia. This is a continuation of operations which have been fully explained at previous meetings. You will notice that we have made some changes in the constitution of our repairing fleet during the half-year. We were in need of a steamer of larger carrying capacity and have been able to acquire the ss. "Britannia." This vessel has already done some very useful work. We have disposed of the ss. "Mirror" to the Western Telegraph Co., this vessel being specially adapted to their requirements. The difference between the cost and the amount realised by the sale of ss. "Mirror" has been charged against the maintenance ships fund, in accordance with our usual practice.

I think these remarks deal with all the matters contained in the report and accounts, which I think require to be noted, but before sitting down I should like to refer to the retirement, on a well-earned pension, of Mr. H. A. C. Saunders, who has been the electrician-in-chief of the Eastern and Associated Companies since their formation. Mr. Saunders' association with submarine telegraphy dates back for 50 years, he having been actively employed in laying the earliest successful Atlantic cable. The regret which the Board and his colleagues feel at his retirement from active service is tempered by the fact that he has consented, at our request, to accept the position of consulting electrician; his wide knowledge and experience of electrical matters may thus be available as necessity arises. A complimentary dinner to Mr. Saunders was given on the 18th inst., the chair being taken by Sir John Denison-Pender, when several of the Directors of the Companies and I had the pleasure of being present. The opportunity was taken to make a presentation of plate to the guest of the evening, which had been subscribed for by his colleagues and old friends. Mr. Saunders is succeeded as electrician-in-chief by Mr. Walter Judd, who has been connected for many years with the Associated Companies, and has had much experience of his new duties, as he held the position of chief assistant to Mr. Saunders for some time. I now move the adoption of the report and accounts.

The VICE-CHAIRMAN AND MANAGING DIRECTOR (Sir J. Denison-Pender, K.C.M.G.), seconded the motion.

Mr. C. I. THORNTON said that, although the reserve funds investments, amounting to over £1,139,000, were taken at cost price, that did not represent their present value. For instance, he took about 10 of the investments, amounting together to £300,000, on which he found that there was a depreciation of about £50,000, or 15 per cent. Of course he knew the income from these investments was perfectly safe, just as if their price stood at what the Company originally paid for them, but he thought it was somewhat misleading to show an amount of £1,130,000 in this way.

The CHAIRMAN, in reply, said that it was perfectly true—as stated, in fact, in the balance-sheet—that the investments in respect of the reserve funds were taken at cost price, and fluctuations occurred in them. Depreciation had affected every investment, but the depreciation in the investments in question was considerably less than it was six months ago, and he believed that the total depreciation in them now amounted to about 15 per cent., which would be about £179,000. On the other hand, they sold some of their investments in former times, and realised a profit on them of £62,000, which had been credited to the reserve fund. It would be very difficult indeed to value them from time to time, and a misleading mode of valuation might be adopted, which would be most undesirable. They did not show any alteration in the values of the investments when they appreciated or when they depreciated; and he really did not know of any better way of showing the value of their investments except at cost price. With regard to Mr. Thornton's further question as to the allowance for ships' depreciation, this depreciation was dealt with in the item of "maintenance ships fund," £238,963.

Mr. JOHN NEWTON said he thought that the question of the provision made by the Company for the reserve funds was abundantly satisfied. The reserves, moreover, amounted to £1,500,000, and surely the shareholders could view with complacency temporary movements up and down in the investments. He felt sure that the shareholders would be unanimous in supporting the Directors' policy of continuing to add to the reserve funds and of investing in gilt-edged securities, with the substantial character of which they might rest assured, although the investments might go up or down in any given year. In regard to the question of depreciation, there was no parallel in the case of the Company and in the case of a bank, for whereas a banker might be called upon at any time to realise securities, the Company were not.

The CHAIRMAN said that he was very glad to hear what had fallen from Mr. Newton, whose remarks were very satisfactory to the Directors as coming from the body of the hall. It must be obvious to anyone that any attempt to value the Company's investments on account of reserve funds amounting to £1,140,000, as if they were going on to the Stock Exchange to try and sell them, would be quite illusory. The market value of such securities, as a rule, was no criterion of what might be obtained for them on the following day. The only course for the Company to take was to see that they invested in solid securities, which were available from time to time for the purposes of the Company, either in laying new cables or in restoring cables which became worn out. They certainly need not deal with them as a banker, who might be called upon at any moment to realise. He then put the resolution, which was carried unanimously.

The retiring Directors (the Right Hon. Lord Allerton and Sir Henry Charles Fischer, C.M.G.) were then re-elected, as were the auditors (Messrs. Deloitte, Dever. Griffiths & Co. and Messrs. Welton, Jones & Co.), and a cordial vote of thanks to the Chairman, Directors and staff terminated the proceedings.

Direct United States Cable Co. (Ltd.)

The fifty-fifth ordinary general meeting was held on Tuesday, under the presidency of Mr. E. M. Underdown, K.C.

The GENERAL MANAGER and SECRETARY (Mr. T. Finnis) read the notice calling the meeting and the auditors' report.

The CHAIRMAN then said: Gentlemen, it now becomes my duty to move that the report and accounts and the pension scheme be adopted. The revenue for the six months to Dec. 31 last, after deducting outpayments, amounted to £51,029, and the working and other expenses, including income tax, but exclusive of cost of cable repairs, absorbed £22,108, leaving a balance of £28,921 as net profit, making, with £2,168 brought forward from the previous half-year, a total of £31,089. This has been appropriated as follows:—Interim dividend of 3s. per share to Sept. 30, £9,106. 10s., interim dividend of 3s. per share to Dec. 31, the same amount, set aside to reserve fund account, £10.000, and carried forward to current half-year, £2,876, making the total, as above, £31,089. The revenue, as compared with that in the corresponding period of 1903—which, you will remember, was not as satisfactory as we could have wished, in common with the revenues of other telegraphic enterprises and business generally—shows an increase of £3,215, wholly resulting from a marked improvement in the business during the last few months of the year. The working expenses in London remain practically the same as in the corresponding period, but at the stations it is somewhat higher, owing to an increase in the wages and to the cost of repairs and renewals, considerable renovations having had to be carried out at the cable stations in Ireland and at Rye Beach, in the United States. In the aggregate the expenditure is £292 greater, while the revenue has increased, as I have already stated, by about £3,000. The reserve fund has been charged—following our usual practice—with the cost of cable repairs, and, as you are also aware, it is credited with the interest which arises from the investments. The reserve account has been charged with £8,477 for the cost of cable repairs in the half-year, and it has been credited with £7,469 from interest on the reserve investments and £10,000, as I have already told you, from the revenue account, increasing the balance of the account to £472,964. You are also aware that in the accounts the investments stand at cost price, and it may be cheering to you to know that although—as in the case of a great many other things—the actual market price of our securities some time ago showed a diminution, at the present time they stand approximately at their cost price, the difference being insignificant. I have so far dealt with the general business of the Company, which does not require any further remark from me; but you are also asked to-day to give your assent to the establishment of a pension fund. We have not originated this, but we find that it has been adopted by the Anglo Co., practically on the same basis, and by the Government departments; and you must know that the staff we have employed in this business is of a very particular kind, and it is most important that we should not lose the services of any member of our staff, if possible. In order to ensure this, we must cement the relations between ourselves and the staff. Hitherto we have adopted, to a certain extent, the policy of endowment assurance. We do not intend to do away with that as far as it has gone, but we do not intend to increase that form of assurance, but for the future to substitute a system of pensions, of which I will give you a few details, in order that you may have an idea of what is proposed. The pension will be payable at the age of 60 after a minimum period of 10 years' service, and it will be equal to one-sixtieth for each year of service on the average salary of the last three years, but no pension is to exceed two-thirds of such average salary, no pension is to exceed £500 a year, and no pension is to be paid except out of the profits of the company. Should an employé be obliged, for no personal fault, to leave the company's service, he will be entitled to a gratuity of one month's salary for each year of completed service on the basis of the salary he was in receipt of at the time of such retirement. Of course, if he were dismissed for dishonesty or misconduct, he would forfeit all right to any gratuity or pension. Provision is made for the case of employés who are compelled to retire before 60 in consequence of physical breakdown, but no pension would accrue on voluntary retirement of an employé without the consent of the Directors before he had completed 40 years of service. No contribution will be required from the employé himself. The Company will hold the moneys of the fund, and allow interest at 4 per cent. Now, this will require an annuity of £2,500, but as you have already authorised the expenditure of £1,000 under the endowment scheme, it will be only necessary to increase this amount by £1,500. The matter has been fully discussed elsewhere, and I strongly recommend the adoption of the scheme to you entirely in the interests of the Company, to say nothing of the duty we owe to our staff, who serve us well and faithfully. I now move the adoption of the report and accounts.

Sir JAMES PENDER, Bart., briefly expressed his pleasure in seconding the motion.

The CHAIRMAN, in answer to Mr. P. F. Wood, stated that if an employé on reaching the age of 60 were found to be capable of yielding reasonable service to the Company—and he sincerely trusted from experience that that might be the case even after the age of 60—he would not be forced to retire and accept a pension. Indeed, they would be very glad to keep him in the service. He desired to refer to one important point which he had forgotten to mention previously. They were enabled to state that the whole of the company's cables were in proper and good working order (cheers). He then put the resolution, and declared it carried unanimously.

A vote of thanks was afterwards passed to the Chairman, Directors and staff, and the proceedings terminated.

Nernst Electric Light (Ltd.)

The fifth annual meeting was held on Monday, Mr. Bertrand Drake, M.I.E.E., presiding.

In moving the adoption of the report, the CHAIRMAN said it was a source of satisfaction to the board, especially those of them who had helped to steer the ship through so many rocks, to be able to meet the shareholders at last with a clean balance-sheet, and with a proposal to pay a dividend. The capital had been reduced from £320,000 to £90,000. The profit for the year amounted to £4,840 compared with £3,926 for the previous year and a loss of £1,643 two years ago. The profit on sales of lamps and British royalties showed an increase of £1,401, and in view of the disturbed state of some of the company's territory—such as China, Japan and Asia generally—this must be deemed satisfactory. Although for the moment their lamps, or, at any rate, the vital portions of them, were being made by the Allgemeine Elektricitat Gesellschaft, yet the company's staff had to assemble the parts, test, when necessary, and pack the lamps here before they were despatched to their territories, and this represented a good deal of technical and other work in the warehouse. The present agreement with the Allgemeine was purposely made for only a limited period, and they would be unwise if they did not keep their technical branch sufficiently in touch with the different alterations to enable them to resume manufacture themselves in their territories, or elsewhere, should this be found desirable. With these facts in mind, he felt sure that those who had the necessary trade knowledge would bear him out that there had been no extravagance in the administration expenses. He was convinced that better results could be obtained by varying the proportions of the component parts of the lamp somewhat from the standard, according to the technical data which they were able to ascertain concerning the variation of voltage which was likely to occur. Experiments had already been made in this direction from which he anticipated, after discussion with the Allgemeine Co., some valuable results. The number of lamps sold during the year in their territories showed a steady increase, and from some of the districts, particularly where the voltage was regular, excellent results had been achieved. With regard to their patents, as they ran out the goodwill of a business took their place. In addition to the fundamental patents belonging to this company, they had others taken out at a later date covering the mechanical construction of the lamp in very much its present form. The lamps as now made by the Allgemeine Company contained many features covered by the patents taken out by himself and other members of their technical staff, which patents were given to the company without consideration, and were most useful in making the present agreement with the Allgemeine Company. Only recently they had made and shipped to the Allgemeine Company a big consignment of lamp cases of the company's registered design for their own use, and these were also supplied by this company in considerable quantities in England. He then dealt at length with the differences which had arisen with Mr. A. M. Oppenheimer, a director, on certain matters, including the question of directors' fees, and said that the board placed themselves unreservedly in the shareholders' hands.

Mr. J. G. DALZELL seconded the motion.

Mr. HENLE observed that the company were doing a commission business only, and he thought, therefore, that the administration expenses were too heavy. They might get a cheaper office and stop the expenses involved in making a lot of experiments.

Mr. ZUSMANN hoped the dissensions on the board would cease.

The CHAIRMAN hoped that the percentage of standing charges to the turnover would be reduced in future. He did not think that they would be wise in abandoning their present offices. He and his partner had 6,000 shares, and so there was every inducement for him to try and make the company a success.

The report, which recommended the payment of 3 per cent., was agreed to, and it was decided that the directors' fees for the current year should be £500.

Mr. OPPENHEIMER moved the election of Sir H. Seton-Karr, M.P., in the place of Mr. R. J. Wallis-Jones, who retired by rotation.

Mr. RUSHDEN seconded the proposition.

Mr. G. KITCHEN did not think that Sir Henry Seton-Karr had the technical qualifications for a director of the company.

Sir HENRY MANCE said there were two solicitors on the board, and Sir Henry Seton-Karr was a barrister. If they left the management of the business to the legal profession their shares would not be worth 1s. a piece.

The CHAIRMAN said that if Mr. Wallis-Jones were not re-elected, he and Mr. Dalzell would retire.

Eventually the meeting was adjourned for a month.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The report of the directors states that the total receipts from July 1 to Dec. 31, 1904 (including £2,535. 12s. 5d. from last account) amounted to £188,500. 7s. The traffic receipts show an increase of £8,720 compared with half-year ended Dec. 31, 1903. The working expenses of the half-year, including expenses of the s.s. "Minia," pensions account, &c., amounted to £70,306. 5s. 1d., an increase of £2,561. 7s. 9d. over the corresponding period. The directors have, before declaring net profits, set apart £10,000 to renewal fund, leaving £108,194. 1s. 11d. Interim quarterly dividends of 12s. 6d. per cent. on the ordinary, and £1. 5s. per cent. on the preferred stock were paid on Nov. 1 (absorbing £43,750), leaving £64,444. 1s. 11d. out of which the directors recommend final dividends of 17s. 6d. per cent. on the ordinary, and £1. 15s. per cent. on the preferred stock, payable Feb. 4, amounting together to £61,250, and making a total distribution for 1904 of £2. 15s. per cent. on the ordinary and £5. 10s. per cent. on the preferred stock. The balance of £3,194. 1s. 11d. is carried forward. The cables and land lines of the company are in good working order.

CAR & GENERAL INSURANCE CORPN. (LTD.)—The chairman (Mr. E. Manville) presided at the first annual meeting on Wednesday, and congratulated the shareholders upon the results of the first year's operations. The volume of desirable business was very gratifying. Their organisation consisted of 10 branch offices, together with over 1,600 representatives distributed throughout the United Kingdom. The net result was an available balance of nearly £1,900, but the directors recommended that this be utilised to wipe off preliminary expenses. They were desirous of cultivating insurances under the Workmen's Compensation Acts, although during the past 12 months the amount which they received of such business had been insignificant. The retiring directors (Messrs. E. S. Smith, W. Birtwistle, J.P., and J. M. Gorham, M.Inst.C.E., M.I.E.E.) were re-elected.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—An extraordinary general meeting will be held on Wednesday next to consider and pass resolutions approving a memorandum of agreement between the company and the holders of the founders' shares, and authorising the directors to proceed with the bill introduced into Parliament entitled "a Bill for the extinction of the Founders' shares of the Chelsea Electricity Supply Co. (Ltd.), and the substitution therefor of ordinary shares in the company and for other purposes."

CITY & SOUTH LONDON RAILWAY CO.—The report of the directors for the half-year ended Dec. 31 states that the receipts from all sources amounted to £74,891. 18s. 1d., and the cost of working has been £35,368. 16s. 10d., leaving a profit of £39,523. 1s. 3d. Inclusive of balance from June half-year the net revenue is £40,224. 11s. 3d. After making provision for debenture stock interest, and transfer to renewal fund of £1,500, £27,445. 8s. 7d. remains available for dividend. The directors recommend that the full 5 per cent. preference dividend be paid on the 1891, 1896 and 1901 stocks, and that a dividend at the rate of 1½ per cent. per annum be paid upon the consolidated ordinary stock for the half year, leaving £1,449. 16s. 1d. to be carried forward. During the half-year 8,401,846 passengers (exclusive of season-ticket holders) were carried, and the receipts (including season tickets) were £70,705. 10s. 11d., against 9,226,987 passengers and £76,387. 14s. 1d. in the June half-year and 8,711,062 and £72,286. 3s. 6d. in the December half-year of 1903. Since the opening of the line 134,709,114 passengers have been carried, and the receipts have been £1,075,616. 13s. The directors regret that there has been a decrease in traffic compared with the corresponding period last year, but they attribute this to the exceptionally fine and dry weather which prevailed during the greater part of the half-year. The arrangements with the various railway companies in respect to the Euston extension being now completed, a contract will be entered into for the construction of the extension. In providing the capital necessary for the work it is found to be more economical to issue the stocks as part of and ranking with the other stocks of the company and liable to dividend in the usual course, but arrangements are in progress by which the amount payable as dividend on these stocks will, it is anticipated, be met by receipts from other sources. The interchange traffic with the Great Northern & City Railway is increasing satisfactorily, and through bookings over the line with the suburban stations of the Great Northern Railway are now in operation.

DUBLIN UNITED TRAMWAYS CO. (LTD.)—At the meeting on Wednesday the chairman (Mr. W. M. Murphy) said that for the first time in the history of the company the half-year's receipts, which amounted to £139,001, exhibited a falling off compared with the corresponding period of the previous year. A saving of £1,572 had been effected in expenditure.

METROPOLITAN RAILWAY CO.—The report of the directors for the half-year ended Dec. 31, states that the installation at the Neasden power station is so far completed as to enable a service of passenger trains to be run between Baker-street and Uxbridge, and that the number of such trains is being gradually increased. Working was commenced on Jan. 1, and it is intended shortly to run the whole service on this section by electrically-driven trains. The work on the Inner Circle is being proceeded with rapidly, and electric traction will follow on there as soon as the equipment is finished.

NEW COMPANIES, STATUTORY RETURNS, LIENS, REGISTERED, &c.

NEW COMPANIES.

FOREIGN ELECTRICAL BLEACHING PATENTS (LTD.) (83,289).—Reg. Jan. 19, capital £15,000 in £1 shares to acquire and work the Vogelsang electric bleaching patents, &c., for all countries except England, Germany and Austro-Hungary, and to carry on the business of bleachers, dyers, &c. Reg. office, St. Michael's House, Basinghall-street, London, E.C.

LANGDON-DAVIES MOTOR CO. (LTD.) (83,306).—Reg. Jan. 20, capital £5,000 in 4,195 shares of £1 each and 16,100 shares of 1s. each, to adopt an agreement with the Langdon-Davies Motor Co. (Ltd.) for the acquisition of certain patents and other rights and properties and to carry on the business of suppliers and sellers of alternate-current motors, manufacturers, buyers and sellers of electric motors, gas, oil, petrol or other engines and motor-car parts and accessories, electricians, electrical engineers, manufacturers of dynamos, apparatus and fittings, &c. The subscribers are F. B. O. Hawes, C.E., A. W. Cree, C. E. Cree, F. W. Hartman, engineer, D. M. A. G. Hawes, engineer, W. R. Sidwell and E. Yatman. First directors F. B. O. Hawes, A. W. Cree, F. W. Hartman and E. Yatman. Reg. office, 101, Southwark-street, London, S.E.

STATUTORY RETURNS.

AUTOMATIC ELECTRICAL ADVERTISING SYND. (LTD.)—Return to Dec. 27 gives capital as £4,500 in £1 shares, all of which have been taken up. £3,000 has been paid and £1,500 is considered as paid. Mortgages and charges, nil.

BRITISH ELECTRIC LIGHT WIRING CO. (LTD.)—Return to Dec. 10 gives capital as £10,000 in £1 shares, of which 156 have been taken up. £1 per share has been called up on 149 and 10s. per share on seven shares, and £152. 10s. has been received. Mortgages and charges, nil.

CAPE ELECTRIC TRAMWAYS (LTD.)—According to return to Dec. 7, the capital is £500,000 in £1 shares, of which 491,222 have been taken up. £91,222 has been paid and £400,000 is considered as paid. Mortgages and charges, nil.

CONCORDIA ELECTRIC WIRE CO. (LTD.)—Return to Nov. 25 gives capital as £2,000 in 2,000 shares of £1 each, all of which have been taken up. £1 per share has been called up on seven shares, and 5s. per share on 1,993 shares. £505. 5s. has been received. No mortages or charges.

ELECTRICAL CORPORATION (LTD.)—Return to Nov. 9 gives capital as £30,000 in £1 shares, of which 3,007 have been taken up and paid for in full. Mortgages and charges, nil.

ELECTROLYTIC ALKALI CO. (LTD.)—Return to Dec. 8 gives capital as £500,000 in 200,000 preference and 300,000 ordinary shares of £1 each, of which 100,000 preference and 202,818 ordinary shares have been taken up. £1 per share has been called up on 100,000 preference and 127,218 ordinary, and £226,997 have been received, leaving £221 in arrears. 75,000 ordinary shares are considered as fully paid. Mortgages and charges, £12,750.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—In return to Dec. 27 capital is £350,000 in £1 shares, of which 204,056 have been taken up. 17s. 6d. per share has been called up on 99,056 and £86,662. 12s. 6d. has been received, leaving £11. 7s. 6d. in arrears. 105,000 shares are considered as fully paid. Mortgages and charges, nil.

POROUS ACCUMULATOR CO. (LTD.)—In return to Dec. 20, 1904, the capital is £3,000 in £1 shares, all of which have been taken up. £1,007 have been received. £1,993 is considered as paid. Mortgages and charges, £16,000.

SHERARD COWPER-COLES & CO. (LTD.)—Return to Jan. 13 gives capital as £25,000 in 7,000 preference and 18,000 ordinary shares of £1 each, of which 6,856 preference and 18,000 ordinary have been taken up. £1 per share has been called up on 6,856 preference and 500 ordinary, and £7,356 has been received. 17,500 ordinary are considered as fully paid. Debentures, £6,500.

MORTGAGES AND CHARGES.

CARL OPPERMANN ELECTRIC CARRIAGE CO. (LTD.)—Issue on Jan. 5 of £4,450 debentures, part of series created Dec. 31, 1904, to secure £5,000 charged on company's undertaking and property, present and future, including uncalled capital and leasehold premises Nos. 5-6, Halkin-street, London, W. No trustees. No previous issue of same series.

ELECTROLYTIC ALKALI CO. (LTD.)—Issue on Jan. 12 of £1,550 debentures, part of series created July 9, 1904, to secure £50,000, charged on company's undertaking and property, including uncalled capital. Trustees, Liverpool Mortgage Insurance Co. Previously issued of same series, £12,200.

JOHN W. SUTCLIFFE & CO. (LTD.)—£2,000 debentures, created and dated Dec. 30, 1904, charged on the company's undertaking and property, have been registered. No trustees.

MINEHEAD ELECTRIC SUPPLY CO. (LTD.)—£2,000 debentures created Dec. 29, 1904, and, as collateral security, a mortgage dated Jan. 2, 1905, covering same sum, have been registered. Property charged (by debentures): Company's assets, present and future, including uncalled capital. (By mortage): Land, with electric lighting station at Quay-lane, Minehead. Holders: Misses Clarke and A. E. Clarke and T. Joyce.

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—Issue on Jan. 6 of £10,000 and on Jan. 12 of £200 debentures, part of series created Jan. 18, 1904, to secure £100,000. Property charged, company's undertaking and property, present and future, except uncalled and unpaid capital. Holders, T. E. Hodgkin and J. W. B. Pease. No trustees. Previously issued of same series, £76,800.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Jan. 21	1,041	− 10	34	47,762	+ 5,770
Airdrie	,, 18	176	...	2	309	...
Ayr Corporation	,, 21	165	− 1	36	11,398	+ 529
Barnsley	,, 13	116	+ 5	2	259	+ 25
Barrow	,, 13	180	...	2	312	...
Bath Electric Trams, Ltd.	,, 19	560	− 25	3	1,637	− 304
Bexley District Council	...	...	...	...	...	...
Birkenhead	...	...	...	...	...	...
Birmingham Corporation	,, 21	310	...	3	1,001	...
*Birmingham & Mid.	,, 13	1,061	+ 199	2	2,047	+ 379
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 13	256	+ 1	42	44,435	+ 6,041
Blackpool and Fleetwood	,, 21	151	− 39	3	459	− 101
Blackp'l, St. Anne's & Lytham	,, 19	111	− 31	¶12	1,420	− 272
Bolton Corporation	,, 21	1,502	− 110	43	78,858	+ 101
Bournemouth Corporation	,, 16	531	− 9	‡42	45,023	+ 2,164
Bradford Corporation	,, 21	3,459	− 14	40	168,416	+ 20,331
Brighton Corporation	,, 23	696	+ 9	42	43,702	+ 3,517
Brisbane Tramways	...	...	...	...	...	...
Bristol Trams & Carriage	,, 20	4,301	− 190	21	177,789	+ 2,226
Buenos Ayres & Belgrano	...	...	...	...	...	...
Burnley Corporation	,, 21	882	+ 60	16	3,348	+ 3,127
Burton Corporation	,, 22	254	− 16	¶42	14,572	...
Calcutta Tramways Co.	,, 21	a41,096	+ a7,012	3	a133,946	+ a23,080
Camborne-Redruth	,, 21	95	− 3	12	1,300	− 308
Cardiff Corporation	,, 14	1,927	+ 65	41	84,559	+ 2,156
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 21	7,425	+ 325	3	21,502	+ 591
Chatham & Dist. Lt. Rys.	,, 19	559	+ 50	3	1,549	+ 44
*City of Birm'gh'm Tram Co.	,, 18	5,385	+ 312	2	9,751	+ 535
City & South London Rly.	,, 22	3,144	− 63	4	12,616	− 185
Colchester Corporation	,, 19	148	...	25	6,211	...
Cork Electric Trams Co.	,, 19	397	− 1	3	1,111	− 90
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 13	460	− 6	2	866	+ 11
Dover Corporation	,, 21	155	− 7	43	[illegible]	− 136
Dublin & Lucan Railway	,, 20	90	− 7	3	271	+ 11
Dublin Southern District	,, 20	703	+ 12	3	12,714	+ 147
Dublin United	,, 20	3,587	− 33			
Dudley—Stourbridge	,, 13	747	+ 22	2	1,315	+ 67
Dundee Corporation	,, 18	769	+ 21	¶34	29,775	+ 247
East Ham Council	,, 21	581	+ 13	42	30,118	+ 1,611
Gateshead & Dist. Trams	,, 13	887	− 2	2	1,564	+ 106
Glasgow Corporation	,, [illegible]	18,578	+ 4	†34	491,473	+ 23,194
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 13	199	− 9	2	337	− 30
Gt. Northern & City Rly.	,, 21	1,592	+ 24	3	4,713	...
Greenock & Port Glasgow	,, 13	470	+ 55	2	991	+ 177
**Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, [illegible]	230	− 6	2	450	+ 23
Huddersfield	,, 21	1,104	+ 5	42	57,619	+ 8,614
Hull Corporation	,, 21	1,966	− 21	43	92,620	+ 10,849
Ilford District Council	,, 21	318	+ 8	¶42	19,054	+ 931
Ilkeston Corporation	,, 18	97	− 23	16	1,760	− 283
Ipswich Corporation	...	...	...	...	...	...
Isle of Thanet Co.	...	...	...	...	...	...
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	,, 13	93	+ 3	3	164	+ 4
Kirkcaldy Corporation	,, 18	190	+ 1	...	...	...
Lanarkshire Trams Co.	,, 19	573	+ 30	3	1,966	+ 73
Leeds Corporation	,, 21	4,929	− 91	43	247,010	+ 13,698
Leicester Corporation	,, 21	1,619	...	3	5,078	...
Liverpool Corporation	,, 14	9,981	+ 400	2	20,203	+ 1,006
Liverpool Overhead Rly.	,, 22	1,451	− 46	4	5,449	− 358
*London County Council	,, 14	12,620	+ 3,586	§41	526,542	+ 116,544
Lowestoft	,, 21	113	− 11	3	365	...
Maidstone Corporation	,, 19	86	...	27	3,783	...
Manchester Corporation	,, 21	10,866	+ 77	42	613,797	+ 22,168
Mersey Railway	,, 21	1,612	+ 13	3	4,926	+ 306
Merthyr	,, 13	173	− 14	2	299	− 17
*Metropolitan Elec. Trams	,, 13	1,999	+ 931	2	3,545	+ 1,567
Middleton	,, 13	252	+ 74	2	456	+ 51
Nelson Corporation	,, [illegible]	96	+ 8	43	5,089	+ 1,880
Newcastle-on-Tyne Corp.	,, 21	3,358	− 87	3	10,495	+ 189
Newport (Mon.)	,, 21	474	+ 62	16	6,146	+ 1,162
Oldham, Ashton & Hyde	,, [illegible]	477	− 6	2	865	− 31
Oldham Corporation	,, 22	1,806	+ 276	43	58,517	+ 3,146
Perth (W. A.) Elec. Trams.	,, 20	1,559	+ 186	3	4,317	+ 228
Peterborough	,, [illegible]	108	...	2	185	− 4
Poole and District	,, [illegible]	220	+ 1	2	407	+ 6
Portsmouth Corporation	,, 21	1,311	+ 29	§42	81,728	+ 6,269
Potteries	,, 13	1,687	+ 137	2	2,965	+ 173
Reading Corporation	,, 19	537	+ 21	3	1,706	+ 1.9
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 13	39	+ 3	2	108	− 12
Salford Corporation	,, 23	3,686	− 22	42	172,490	+ 2,408
Sheerness	,, 11	57	+ 10	2	87	+ 15
Sheffield Corporation	,, 22	4,178	− 39	§43	300,721	+ 4,853
Southampton Corp'ation	...	...	...	...	...	...
Southend Corporation	,, 16	211	+ [illegible]	42	15,070	+ 1,516
Southport Tramways	,, [illegible]	226	− 4	2	486	+ 18
S. Staffordshire Trams.	,, [illegible]	442	− 57	2	1,164	− 21
Stockport Corporation	,, 20	344	+ 45	42	25,329	+ 8,195
Sunderland Corporation	,, 22	1,018	− 6	42	58,667	+ 1,881
Swansea Trams	,, 13	450	− 10	2	798	+ 1
Taunton Trams	,, 13	41	− 8	2	72	− 11
Tynemouth and District	,, [illegible]	164	− 32	2	320	− 37
Tyneside Trams Co.	,, 18	800	+ 34	3	825	+ 58
Wallasey District Council	,, 21	560	− 18	§42	31,640	+ 2,158
Walsall	,, 21	849	...	3	1,263	...
Warrington Corporation	,, 12 ,, 19	313 285	+ 35 − 11	43	13,504	+ 476
West Ham Corporation	,, 19	965	...	47	45,194	...
Weston-super-Mare	,, 11	22	+ 10	2	42	+ 18
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 18	356	+ 17	2	619	+ 60
Worcester	,, 18	261	+ 116	2	472	+ 224
Wrexham	,, 18	91	− 5	2	158	− 3
Yorkshire Woollen District	,, 18	542	+ 36	2	942	+ 99

(a) These comparisons are with the corresponding period last year. † Minus 8 days ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. ** Fortnight. * Partly electrical. *‖ Not in operation last year.

CITY NOTES.

MEMORANDA (Jan. 26).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 28⅛d. per oz. Consols 88⁷⁄₁₆—88⁹⁄₁₆ for money, 88⁷⁄₁₆—88⁹⁄₁₆ for account; 2½ per cent. annuities 87¼—87½. Consols Pay Day, Feb. 1. Stocks and Shares Continuation Days, Feb. 7 and 22; Ticket Day, Feb. 3; Pay Days, Jan. 27 and Feb. 9; Mining Share Carry-over Days, Feb. 6 and 21.

CENTRAL LONDON RAILWAY.—The directors announce a dividend for the past half-year at the rate of 4 per cent. per annum on the ordinary stock, and a similar distribution will be made on the preferred and deferred stocks. £30,000 has been placed to reserve and £22,000 carried forward. The dividends are the same as for the corresponding period last year, when £10,000 was placed to reserve and £36,000 carried forward.

CLEVELAND & DURHAM COUNTY ELECTRIC POWER CO.—At an extraordinary meeting last week resolutions were passed creating £156,000 5 per cent. debenture stock, to be issued at the discretion of the directors.

DUBLIN & LUCAN ELECTRIC RAILWAY CO.—The directors propose to pay 10 per cent. on the preference shares (reducing arrears to three months); paying £200 off electrical equipment account, and carrying forward £275.

HAVANA ELECTRICITY CO. (LTD.)—During the week this company has invited applications for £150,000 5 per cent. debentures at 95 per cent.

LIVERPOOL OVERHEAD RAILWAY CO.—The accounts for the past half-year show an available balance of £10,134. 18s. 6d., and the directors recommend payment of the preference dividend and at the rate of 1½ per cent. per annum on the ordinary shares (against 1½ per cent. for the corresponding period last year); balance forward £3,743, against £4,132.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The directors recommend a dividend for the half-year ended Dec. 31 of 7s. 6d. and a bonus of 2s. per share on the ordinary shares, making with interim dividend (paid in August) a total distribution of 14½ per cent. for the year.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed Feb. 23 as special settling day in the further issue of £29,000*l* sterling 500 year 4 per cent. redeemable debenture stock of the *Commercial Cable Co.*, and the further issue of 10,000 £5 fully-paid 6 per cent. cumulative preference shares of *Edmundson's Electricity Corporation (Ltd.)*

WATERLOO & CITY RAILWAY CO.—Dividend on the ordinary stock at the rate of 3½ per cent. per annum for the half-year ended Dec. 31 is recommended, carrying forward £255. Last year the dividend was 3 per cent. per annum, with £355 forward.

WESTMINSTER ELECTRIC SUPPLY CORPN (LTD.)—The directors recommend, subject to audit, a dividend at the rate of 15 per cent. per annum, less tax, for the half-year ended Dec. 31, payable March 1, making with interim 14 per cent. for the year.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., Jan. 25.	Rate per Cent. Yield.*	Dividend Due.	Business, Week to Jan. 25. High est.	Business, Week to Jan. 25. Low est.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	2/0	Anglo-Argentine Ord. Shares	5½—5¾	3 10 7	Ap, Oc	5¾	5⅝
5	2/6	Do. 6% Cum. Pref.	6⅛—6¾	4 7 9	—	6¼	5⅞
St.	6%	Do. Permanent 6% Deb. Stock	140 —143	4 3 11	—	141½	140½
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 —106	4 15 3	—	105	104½
10	6%	Barcelona Tramways Ord.	12 —12½	2 8 0	—	12½	12⁷⁄₁₆
10	6/0	Do. 6% Cum. Pref.	9½—10	6 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	96 —100	4 10 0	—	—	—
100	5%	Do. 5 per Cent. Debs.	99 —102	4 10 8	—	..	..
1	..	Brisbane Electric Trams. Invest Ord.	1½—2	..	..	1⅝	1½
5	2/6	Do. 6 per Cent. Cum. Pref.	3½—4½	5 17 8	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	94 —96	4 11 10	..	..	..
St.	6%	British Columbia Elec. Rlwy Def. Ord.	100 —105	5 16 5	—	101½	..
St.	5%	Do. Pref. Ord. Stock	100 —103	4 17 2	—	..	—
10	5/0	Do. 5% Cum. Perp. Pref.	10 —10½	4 10 11	—	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Dbs	102%—104%	4 6 9	—	..	..
100	4½%	Do. Vancouver Power Debs.	97 —100	4 10 0	..	..	..
5	1/6	Buenos Ayres and Belgrano Ord.	4 —4½	5 5 11	—	4⅜	4¼
5	5/0	Do. 6 per Cent. "A" Cm. Pref	5¾—6¼	4 18 1	—	6⅛	5¾
5	4/0	Do. "B"	5½—6	6 6 8	—	..	..
St.	5%	Do. 5 per Cent. Debs.	105 —107	4 13 5	—	106½	—
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	101 —104	4 16 2	—	103½	102½
St.	6%	Buenos Ayres Elec. Trams (1901) Ltd.	94 —97	5 2 1	..	..	..
5	2/6	Calcutta Tramways	5½—5¾	3 7 6	—	5⅝	5½
100	4½%	Do. 4½% 1st Deb. Stock (red.).	106 —108	4 3 4	—	..	..
	0/6	Cape Electric Tram Shares	1⅛—1⅜	2 14 0	..	1¼	1⅛
St.	5%	Colombo Trams & Ltg. 5% 1st Mt Deb. (red)	102 —104	4 19 1	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	101 —103	4 17 3	Ja, Jul	..	..
100	5%	Montreal St. Ry. St'g 5% Mort Debs. (1908)	100 —103	4 17 3	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 —105	4 6 9	..	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	101 —104	4 16 2	..	..	..
		ELECTRICITY SUPPLY.					
5	3/0	Calcutta Electric Supply Ord.	8½—8¾	3 14 4	..	8⅝	8½
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	89 —91	5 9 11	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	—	—	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	[illegible]	..	—	..	..
1	..	Rand Electric	1 —1½	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	100 —103	4 8 9	Ap, Oc	..	..

* In calculating the yield, allowance has been made for accrued interest, but no for redemption.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Jan. 25.	Rate per Cent. Yield.	Dividend Due.	Business Week to Jan. 25. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
1	..	Bath Elec. Trams Pref. Ord.	1⅛—1⅜	..	..	⅞	..
1	11·40d.	Do. 5% Cum. Pref.	¾—1	5 0 0	..	1	..
10	8%	Bristol Tramways and Carriage Ord.	19 —20	4 0 0	Feb, Aug	..	—
10	6%	Do. Cum. Pref. (fully paid)	10 —10½	5 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 16 0	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	9¾—10¼	5 14 4	..	9⅞	9¾
10	6/0	Do. 6 per Cent. Cum. Pref.	11⅛—11⅝	5 10 0	Feb, Aug	11⅝	11½
St.	5/0	Do. 5 per Cent. Perpetual Debs	119 —121	4 2 8	—	121½	119½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	97 —99	4 10 11	..	98½	97⅞
St.	4%	Central London Ordinary Stock	91 —93	4 6 0	June, Dec	92	91½
St.	4%	Do. 4 per Cent. Pref. Stock	101 —103	3 17 9	—	101½	..
St.	4%	Do. Deferred Stock	86 —87	4 12 0	—	..	..
100	4%	† Do. 4 per Cent. Debs.	107 —109	3 13 5	—	108½	..
5	2/6	City of Birmingham Trams 5% Cm. Prf.	4½—5½	4 17 6	—	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	101 —104	3 17 5	..	..	..
St.	2¼%	City and South London Rly. Con. Ord.	45½—46½	4 16 10	Feb, Aug	47	46½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 3	Feb, Aug	123½	..
St.	5%	Do. (1896)	119 —122	4 2 0	..	120½	..
St.	5%	Do. (1901)	117 —120	4 3 4	..	118½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	105 —108	3 14 1	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13½—14½	4 2 9	..	..	..
10	6/0	Do. 6 per Cent. Pref.	16½—17½	3 12 9	—	..	..
10	3/0½	Gt. Northern & City Rly. Prf. Ord. (4%)	6½—6⅞	4 8 10	—	6½	6½
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8½—9½	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19 —20	4 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	15 —15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	111½—112½	4 0 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¾—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3½—3⅞	3 18 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10½—10¾	4 13 0	..	10⅝	10½
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 —106	3 15 6	—	106½	106
St.	..	Mersey Con. Ord. Stock	6 —9	..	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10 —12	..	—	..	..
1	..	Metropolitan Electric Trams Def	½—¾	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	1⅛—1¼	4 17 0	—	1	..
St.	4½%	Do. 4½% Deb. Stock	103 —105	4 5 9	..	104½	—
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—1½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —102	4 8 3	—	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
..	6%	Underground Elec. Rys. Co. of London	97½—98½	6 1 6	..	98½	97½
St.	3%	Waterloo and City Ord.	90 —92	3 5 3	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —102	4 0 0	Jan, July	..	..
10	..	Amazon Telegraph	1 —1½	..	Jn, Dec ..	1	..
St.	12/6	Anglo-American	66 —67	4 13 9	F,My,Ag,N	67½	..
St.	26/0	Do. Preferred	101 —103	5 1 9	F,My,Ag,N	104	101½
St.	3/0	Do. Deferred	10½—11	6 18 1	F,My,Ag,N	12	10½
100	8%	Commercial Cable Capital Stock	170 —190	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	96 —97	4 2 5	Jn,Ap,Jy,O	96½	96
10	5/0	Cuba Submarine Ord.	8½—9½	5 5 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	17¼—17¾	5 14 3	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3¼—3¾	5 11 9	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7½—8½	6 1 3	April, Oct	8⅛	..
50	4½%	Do. 4½ per Cent. Deb.	100%—102%	4 10 0	Jan, July	..	..
20	3/0	Direct United States Cable	10½—10¾	5 10 4	Ja,Ap,Jy,O	10¾	10½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 —101	4 9 1	Jn, Dec ..	..	..
St.	26/0	Eastern Ordinary	134 —137	5 2 2	Ja,Ap,Jy,O	136½	136
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —89	3 18 3	Ja,Ap,Jy,O	88½	87½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —107	3 14 9	May, Nov	106½	..
10	3/6	Eastern Extension	13½—14	5 0 0	Ja,Ap,Jy,O	13⅞	13½
St.	4%	Do. 4 per Cent. Deb. Stock	106 —108	3 14 3	Feb, Aug	106½	106
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	101 —103	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 5	May, Nov	..	..
10	3/0	Great Northern (of Copenhagen)	29½—29¾	5 1 2	Jan, July	..	..
10	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	99 —101	4 9 1	June, Dec	..	..
25	12/6	Indo-European	45 —47	5 6 5	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	86 —89	4 10 11	June, Dec	..	—
10	4/0	West African Telegraph Shares	7¼—7¾	6 9 2	—	..	..
2½	..	West Coast of America	⅛—⅞	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	99 —101	4 0 0	Jan, July	..	..
10	..	West India and Panama	¾—1	..	May, Nov	..	..
10	7/0	Do. 6 1st Pref. ex 7 on act. of arrears	7½—7¾	7 17 0	May, Nov	..	..
10	—	Do. 6 per Cent. 2nd Pref.	6½—7½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 —103	4 17 1	Jan, July	..	..
10	3/0	Western Telegraph	13½—14	5 0 0	Mr,Je,O,D	13⅞	13½
100	5%	* Do. 5% Debs. (2nd Series, 1909)	101 —103	4 17 1	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	100½—102½	3 18 0	—	..	..
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	6¼—6¾	5 9 10	August ..	..	.
1	0/7½	Monte Video Telephone Ord.	1⅛—1⅜	2 11 9	..	..	..
St.	6%	National Co. Pref. Stock	108½—109½	5 9 7	—	109½	108½
St.	5%	Do. Def. Stock	108 —110	4 10 11	..	110	108½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	15 —16	4 0 0	Feb, Aug	15½	15½
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12 —13	4 12 4	Feb, Aug	—	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—6½	4 10 11	Feb, Aug	5½	5½
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	96 —98	3 11 5	June, Dec	97½	97½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101 —103	3 17 8	..	102	101
..	24/0	Do. Do. Prov. Certs, all paid	101 —103	3 17 8	..	..	..
1	0/7½	Oriental	1—1½	5 18 6	April, Oct	1⅛	—
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼—1½	4 16 0	..	..	..
St.	10/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	100 —103	..	..	..	..
5	3/0	United River Plate	6¼—6½	5 18 6	July......	6⅜	6¼
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 17 9	June, Dec	5⅛	—
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104 —106	4 14 4	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	5/0	Elec. & Gen. Investment 5% Cum. Pref.	4¾—5½	5 17 1	—	..	..
10	3/0	Globe Telegraph and Trust	10¼—10¾	5 4 9	Ja,Ap,Jy,O	10½	10⅜
10	5/0	Do. 6 per Cent. Pref.	14 —14½	4 3 9	Ja,Ap,Jy,O	14⅜	14⅛
100	6%	Submarine Cables Trust (Cert.)	120 —125	4 16 4	April, Oct	..	..

Share.	Last Dividend	Name.	Price Wed., Jan. 25.	Rate per Cent. Yield.	Dividend Due.	Business Week to Jan. 25. Highest.	Lowest.
		ELECTRICITY SUPPLY.		£ s. d.			
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12 —12½	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10	4 10 0	..	10	—
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 —105	4 5 9	—	..	.
5	3/0	Bromley (Kent) El. Lt. & Power Shares	5¼—5¾	5 8 7	..	5½	..
St.	4½%	Do. Do. 1st Debs	101 —104	4 7 0	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..	..	—
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 5 1	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105 —108	3 14 1	..	..	..
5	4/0	Charing Cross & Strand Electric Sup...	8½—8¾	4 11 6	Feb, Aug	8½	8⅜
5	2/3	Do. 4½ per Cent. Pref.	5⅛—5⅜	3 16 8	Feb, Aug	5½	5⅜
St.	4%	Do. 4% Deb. Stock (red.)	101 —103	3 17 8	..	102½	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	—	5	..
5	2/3	Do. Do. (1903)	4¾—5	4 10 0	..	..	..
5	2/3	Chelsea Electric Supply Ord.	6¾—7¼	4 0 3	March ..	7	6⅞
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108 —110	4 1 10	Jn, Dec ..	..	..
10	8/0	City of London Electric Lighting Ord.	11¾—12¼	4 1 8	Feb, Aug	12	11¾
10	6/0	Do. 6 per Cent. Cum. Pref.	13½—14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —125	4 0 0	Jn, Dec ..	..	—
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —103	4 7 3	..	—	..
10	4/0	County of London Elec. Supply Ord.	9 —9½	4 4 2	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —12½	4 16 0	Mar, Sept	12¼	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 —110	4 1 10	—	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 —103	4 7 5	..	102	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 9	—	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	102 —105	4 7 0	—	..	—
5	3/6	Hove Electric Lighting Ord.	7½—8	5 6 3	..	..	..
St.	4½%	L of W. Elec. Lt. & Power 4½% Db. St. (red.)	100 —102	4 8 9	..	..	..
5	5/0	Kensington & Knightsbridge Ord	11¾—12¼	4 10 7	..	11⅞	11¾
5	6%	Do. 6 per Cent. 1st Pref	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —104	3 17 8	—	..	..
3	..	London Electric Supply Ord.	2½—2¾	..	—	2⅝	2½
5	3/0	Do. 6 per Cent. Pref.	5⅞—6⅛	5 3 3	..	6⅛	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 —98	4 1 8	Mr,Jn,S,D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	17½—18½	5 1 4	April, Oct	18¼	18
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½—5¾	4 0 0	Jan. July	5⅝	5½
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —115	3 18 3	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 —98	3 11 3	..	96	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	92 —95	4 15 0	..	..	—
10	5½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	12½—13	5 15 8	Feb, Aug	..	..
5	8%	Newcastle Elec. Supply Ord.	8 —8½	4 19 8	Feb, Aug	..	..
5	6%	Do. 6 per Cent. Non. Cum. Pref.	6½—6¾	3 19 2	Feb, Aug	..	..
1	1/-	Northern Counties Elec. Sup. 17/- paid	15/3—16/9	3 6 0	Mar, Sep	..	.
10	6/0	Notting Hill Electric Ord.	14½—15	4 0 0	March....	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	102 —104	3 17 0	..	103½	.
5	2/6	Oxford Electric Ord.	6½—6¾	5 2 2	March ..	6½	..
St.	4%	Do. 4% Deb. Stock	98 —100	4 0 0	..	..	.
5	5/0	St. James' & Pall Mall Elec. Ord.	13¾—14¼	5 0 0	Feb, Aug	14⅛	13⅞
5	3/6	Do. 7 per Cent. Pref.	8½—9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98 —100	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3¼—3¾	6 3 1	—	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	85 —87	4 12 6	..	..	..
5	5/0	South London Electric Supply Ord.	4½—4¾	3 3 3	—	—	..
1	..	South Metrop'n Elec. Lt. & Power Ord.	¾—1	..	—	⅞	..
1	0/8½	Do. 7% Cum. Pref.	1⅛—1⅜	4 16 9	—	..	..
St.	4½	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	107 —110	4 2 2	—	109	..
5	2/0	Urban Electric Supply Ord.	5 —5½	6 17 5	..	5⅜	5¼
5	2/6	Do. 5% Cum. Pref.	5⅛—5⅜	4 16 6	..	5⅛	..
St.	..	Do. 4½% 1st Mort. Deb.	106 —107	—	..	106½	106½
5	6/0	Westminster Electric Supply Ord.	12 —12½	5 0 0	Mar, Sept	12¼	12⅛
5	2/6	Do. 5 per Cent. Cum. Pref.	6½—6¾	3 14 0	—	6¼	6⅛
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	½—⅝	6 14 2	..	..	..
1	6d.	Aron Elec. Meter 5% Cum. Pref.	¾—⅞	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5 —5½	6 19 2	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5½—6½	5 4 4	Jan, July	..	—
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —104	4 6 6	—	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 10 6	—	..	..
5	3/0	British Westinghouse 6% Pref.	2¾—3¼	..	—	2¾	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	86 —88	4 11 0	..	86½	..
2	..	Brush Electrical Engineering	½—¾	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼—1½	8 0 0	Mar, Sept	1½	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	93 —96	4 14 6	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	74 —77	5 17 0	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	9½—10	5 5 0	Jan, July	9⅝	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 13 0	Jan, July	5½	5⅜
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —106	4 4 11	Nov, May	..	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1⅜—1⅝	4 5 4	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	96 —98	4 13 4	..	..	..
1	0/6½	Chadburn's (Ship) Telegraph Ord.	¾—1⅛	3 17 6	..	..	—
2	1/6	Crompton and Co. (Nos. 1 to 54,000)	2½—2¾	3 0 3	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	93 —96	5 2 0	Jan, July	—	..
5	10/0	Dick, Kerr & Co. Ord.	8 —8½	5 17 5	Sept	8⅜	..
5	3/0	Do. 6% Cum. Pref.	5½—6	5 0 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	106—107	4 4 0	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 —82	4 17 3	June, Dec	77	.
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 —81	6 0 6	..	..	—
5	2/6	Edmundson's Elec. Corp. Ord.	5½—6¼	5 12 0	H'lf-yearly	6⅛	—
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 16 0	—	6⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106 —108	4 3 3	..	107	.
2	1/0	Electric Construction Co.	1½—1¾	6 8 0	July	1⅝	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2¼—2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —99	4 0 10	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	—	..	—
10	6/0	General Electric (1900) 6% Cum. Pref.	9½—10	6 0 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91 —93	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½—11	5 7 3	Feb, Aug	11	10¾
5	2/3	Do. 4½ per Cent. Pref.	5¼—5⅝	4 3 9	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	110 —112	4 0 10	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	15 —16	6 5 0	Feb, Aug	16⅛	15⅞
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11 —11½	4 7 0	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	38 —40	5 18 6	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101½—102½	3 17 5	Jan, July	..	..
5	—	Willans and Robinson Ord.	1 —2	..	Apr, Oct	..	..
5	—	Do. 6 per Cent. Cum. Pref.	3 —4	—	Apr, Oct	..	..
..	4%	Do. 4 per Cent. 1st Mort. Debs.	74 —79	5 1 3	May Nov	..	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quot- these

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REVIEWS—*continued.*
  Students [Bottone]; The Science Year Book [Baden-Powell]; The Fan, including the Theory and Practice of Centrifugal and Axial Fans [Innes]; Annuaire pour l'an 1905.
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NOTES.

WE publish this week our annual Electric Traction Supplement, completing the series of Tables commenced with our second January issue. Following the system we adopted last year, we have placed the tramways having their own particular power houses in a separate Table from those which are supplied from combined lighting and traction stations, and our readers will find particulars of these combined stations in Table II. of the series, published with our issue of January 20th. The policy of combining the stations has now found approval with the majority of local authorities who own electric lighting undertakings as well as tramways, and the result is manifest in the Tables, which show that the number of tramways with independent generating stations has practically remained stationary, while the list of lines supplied from combined works has increased considerably.

THE total mileage of electric tramways in this country is now no less than 1,770 miles of route, equivalent to 2,740 miles of single track. In addition to this, there are now 17 miles of tube railways, about 7 miles of ordinary tunnel railways and 84 miles of electrically-driven surface lines in operation, representing 212 miles of standard gauge railway track; and this total will be increased to about 380 miles when the new lines under construction and those undergoing the process of "electrification" have been completed.

THE selection of suitable Papers for reading at the meetings of the Institution of Electrical Engineers is a difficult task, for as a rule the Council has too few Papers in its hands before the beginning of the session, while by the time the session is half over it is overwhelmed with excellent contributions and offers of more. This makes it all the more necessary that the Institution should be jealous of the time expended upon the discussions of Papers during the months of January and February, when it becomes apparent that more Papers deserve attention than can be dealt with adequately in the time at its disposal. It was, therefore, with increasing wonderment that we listened last week to a long drawn-out lecture suitable for an elementary chemistry class, and delivered by Mr. J. B. C. KERSHAW during the time which had been allotted to a practical discussion by engineers experienced in the design and management of boiler-house plant in electricity works. For three-quarters of an hour the meeting patiently watched the lecturer performing such elementary experiments as boiling water in a paper bag, lighting a Bunsen burner above a piece of gauze, and other tricks with which almost every schoolboy is familiar. Notwithstanding the deference due to the President, and notwithstanding the fact that Mr. KERSHAW was a visitor, the meeting would have been well within its rights if it had refused to allow its time to be wasted in this manner. Mr. SIEMENS should have been reminded that it was his duty as President to interrupt the lecturer's tedious discourse. There were at least a dozen members present prepared to discuss the Paper, but the result was that four speakers only could contribute to the discussion,

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., Jan. 25.	Rate per Cent. Yield.	Dividend Due.	Business, Week to Jan. 25. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
1	..	Bath Elec. Trams Pref. Ord.	½–1½	..	..	¾	..
1	11·40d.	Do. 5% Cum. Pref.	¾–1	5 0 0	..	1	..
10	8%	Bristol Tramways and Carriage Ord.	19 –20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 –10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 –108	3 14 0	Feb, Aug	..	..
10	8/0	British Electric Traction Ord.	9¾–10¼	5 14 4	..	9¾	9½
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–11¾	5 10 0	Feb, Aug	11¾	11½
St.	6/0	Do. 5 per Cent. Perpetual Debs	119 –121	4 2 8	—	119½	118½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	97 –99	4 10 11	..	98½	97½
St.	4%	Central London Ordinary Stock	91 –93	4 6 0	June, Dec	92	91½
St.	4%	Do. 4 per Cent. Pref. Stock	101 –103	3 17 9	—	101½	..
St.	4%	Do. Deferred Stock	85 –87	4 12 0	—	..	..
100	4%	† Do. 4 per Cent. Debs.	107 –109	3 13 5	—	108½	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4¾–5¼	4 17 8	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	101 –104	3 17 8	..	..	..
St.	2¼%	City and South London Rly. Con. Ord.	45½–46½	4 16 10	Feb, Aug	47	46½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 –125	4 0 3	Feb, Aug	123½	..
St.	5%	Do. (1896)	119 –123	4 2 0	..	120½	..
St.	5%	Do. (1901)	117 –120	4 3 4	..	118½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	105 –108	3 14 1	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13½–14½	4 2 9	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15½–16½	3 12 9	—	..	..
10	3/0½	Gt. Northern & City Rly. Prf. Ord. (4%)	6¾–6¾	4 8 10	—	6½	6½
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8½–8½	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19 –20	4 5 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	15 –15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	111½–113½	4 0 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½–4	5 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 –93	4 6 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3½–3¾	3 18 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 –10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10½–10¾	4 13 0	..	10¾	10½
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 –106	3 15 6	—	106½	106
St.	..	Mersey Con. Ord. Stock	6 –9	..	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10 –13	..	—	..	..
1	..	Metropolitan Electric Trams Def	½–¾	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	1–1⅛	4 17 0	—	1	..
St.	4½	Do. 4½% Deb. Stock	103 –105	4 5 9	..	104½	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½–1½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	8 –9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8½–9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 –102	4 8 3	—	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
..	6%	Underground Elec. Rys. Co. of London	97½–98½	5 1 6	..	98½	97½
St.	5%	Waterloo and City Ord.	90 –92	5 8 8	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 –103	4 0 0	Jan, July	..	..
10	..	Amazon Telegraph	1 –1½	..	Jn, Dec ..	1	..
St.	12/6	Anglo-American	56 –57	4 13 0	F,My,Ag,N	57½	..
St.	25/0	Do. Preferred	101 –103	5 1 9	F,My,Ag,N	104	101½
St.	2/0	Do. Deferred	10½–11	0 18 1	F,My,Ag,N	13	10½
100	£8	Commercial Cable Capital Stock	170 –190	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95 –97	4 2 6	Jn,Ap,Jy,O	96½	95
10	5/0	Cuba Submarine Ord.	8½–9½	5 5 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16½–17½	5 14 3	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3½–3½	5 11 9	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7½–8½	6 1 3	April, Oct	8½	..
50	4½%	Do. 4½ per Cent. Deb.	100%–105%	4 10 0	Jan, July	..	..
20	8/0	Direct United States Cable	10½–10¾	5 10 4	Ja,Ap,Jy,O	10¾	10½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 –101	4 9 1	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	134 –137	5 2 3	Ja,Ap,Jy,O	136½	135
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 –89	3 18 8	Ja,Ap,Jy,O	88½	87½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 –107	3 14 9	May, Nov	106½	..
10	2/6	Eastern Extension	13½–14	5 0 0	Ja,Ap,Jy,O	13½	13½
St.	4%	Do. 4 per Cent. Deb. Stock	106 –108	3 14 3	Feb, Aug	100½	100
100	4%	* Eastern & S. African 4% Mrt. Deb. 1900	101 –103	3 18 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%–103%	3 18 5	May, Nov	..	..
10	8/0	Great Northern (of Copenhagen)	29½–29½	5 1 2	Jan, July	..	..
10	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	99 –101	4 9 1	June, Dec	..	..
25	12/6	Indo-European	46 –47	5 6 5	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	66 –69	4 18 11	June, Dec	..	—
10	4/0	West African Telegraph Shares	7½–7¾	5 9 2	—	..	..
2½	..	West Coast of America	½–⅝	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	98 –100	4 0 0	Jan, July	..	..
10	..	West India and Panama	⅛–¼	..	May, Nov	..	..
10	7/0	Do. 6% 1st Pref. ex 7 on act. of arrears	7½–7¾	7 17 6	May, Nov	..	..
10	—	Do. 6 per Cent. 2nd Pref.	6½–7½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 –103	4 17 1	Jan, July	..	..
10	2/0	Western Telegraph	13½–14	5 0 0	Mr,Jn,O,D	13½	13½
100	5%	* Do. 5% Debs. (2nd Series, 1900)	101 –103	4 17 1	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	109½–109½	3 13 0	—	..	..
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	5½–5¾	5 9 10	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	1½–1¾	2 11 9	..	..	..
St.	6%	National Co. Pref. Stock	108½–109½	5 9 7	—	109½	108½
St.	5%	Do. Def. Stock	108 –110	4 10 11	..	110	108½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 –15	4 0 0	Feb, Aug	14½	13½
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12 –13	4 12 4	Feb, Aug	—	..
5	2/6	Do. 6 per Cent. Non-Cum. 3rd Pref.	5½ –5½	4 10 11	Feb, Aug	5½	5½
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	95 –98	3 11 5	June, Dec	97½	97½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101 –103	3 17 8	..	102	101
..	24/3	Do. Do. Prov. Certs. all paid	101 –103	3 17 8	..	..	..
1	0/7½	Oriental	1–1½	5 18 6	April, Oct	1½	—
1	0/7½	Do. 6 per Cent. Cum. Pref.	1½–1½	4 16 0	..	..	..
St.	90/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	100 –103	..	..	..	..
5	5/0	United River Plate	6½–6¾	6 18 6	July	6¾	6½
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5¼	4 17 9	June, Dec	5½	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104 –106	4 14 4	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4½–5½	5 17 1	—	..	..
10	2/0	Globe Telegraph and Trust	10½–10½	5 4 9	Ja,Ap,Jy,O	10½	10½
10	6/0	Do. 6 per Cent. Pref.	14 –14½	4 3 9	Ja,Ap,Jy,O	14½	14½
100	6%	Submarine Cables Trust (Cert.)	120 –125	4 18 4	April, Oct	..	..

Share.	Last Dividend.	Name.	Price Wed., Jan. 25.	Rate per Cent. Yield.	Dividend Due.	Business, Week to Jan. 25. Highest.	Lowest.
		ELECTRICITY SUPPLY.		£ s. d.			
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12 –12½	6 8 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½–10	4 10 0	..	10	—
10	6/0	Do. 6% Cum. Second Pref.	11 –12	5 0 0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.) ...	103 –106	4 5 9	—	..	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	3½–5½	2 9 7	..	3½	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 0	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½–11	4 10 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10½–10¾	3 8 1	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105 –108	3 14 1	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8½–8¾	4 11 5	Feb, Aug	8½	8½
5	2/3	Do. 4½ per Cent. Pref.	5½ –5¾	3 18 3	Feb, Aug	5½	5½
St.	4%	Do. 4% Deb. Stock (red.)	102 –106	3 17 3	..	102½	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½–5	4 10 0	—	5	..
5	2/3	Do. Do. (1903)	4½–5	4 10 0	..	..	..
5	2/3	Chelsea Electric Supply Ord.	6½–7½	4 0 8	March ..	7	6½
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.) ...	108 –110	4 1 10	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	11½–12½	4 1 5	Feb, Aug	12	11½
10	6/0	Do. 6 per Cent. Cum. Pref.	13½–14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 –126	4 0 0	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 –103	4 7 3	..	—	..
10	4/0	County of London Elec. Supply Ord.	9 –9½	4 4 2	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 –12½	4 16 0	Mar, Sept	12½	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 –110	4 1 10	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –103	4 7 6	..	102	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5½–6	4 11 9	—	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	102 –105	4 7 0	—	..	..
5	3/6	Hove Electric Lighting Ord.	7½–8	5 6 3	..	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	100 –102	4 8 9	..	..	..
5	5/0	Kensington & Knightsbridge Ord	12½–12½	4 10 7	..	12½	12½
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 –104	3 17 3	—	..	..
5	..	London Electric Supply Ord.	2½–2¾	..	—	2½	2½
5	3/0	Do. 6 per Cent. Pref.	5½–5¾	5 3 8	..	5½	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 –98	4 1 8	Mr,Jn,S,D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	17½–18½	5 1 4	April, Oct	18½	18
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½ –5½	4 0 0	Jan, July	5½	5½
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 –115	3 18 3	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 –98	3 11 3	..	96	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	92 –95	4 16 0	..	..	—
10	8/0	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	13½–17½	5 16 5	Feb, Aug	..	..
5	2/6	Newcastle Elec. Supply Ord.	8 –8½	4 19 2	Feb, Aug	..	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	6½ –6½	3 19 2	Feb, Aug	..	..
1	..	Northern Counties Elec. Sup. 17/- paid	15/3–16/9	3 6 0	Mar, Sep	..	..
10	6/0	Notting Hill Electric Ord.	14½–15	4 0 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	102 –104	3 17 0	..	103½	..
5	2/6	Oxford Electric Ord.	6½–6½	5 2 2	March ..	6½	..
St.	4%	Do. 4% Deb. Stock	98 –100	4 0 0	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	13½–14½	5 0 0	Feb, Aug	14½	13½
5	3/6	Do. 7 per Cent. Pref.	8½–9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.) ...	98 –100	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2½–3½	6 3 1	—	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	83 –87	4 12 0	..	..	..
5	3/0	South London Electric Supply Ord.	4½–4½	3 8 8	—	..	..
1	..	South Metrop'n Elec. Lt. & Power Ord.	¾–1	..	—	..	..
1	0/9½	Do. 7% Cum. Pref.	1½–1⅛	4 16 9	—	..	..
St.	4½	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. &com.)	107 –110	4 2 3	—	109	..
5	2/0	Urban Electric Supply Ord.	5 –5½	4 17 6	..	5½	..
5	2/6	Do. 5% Cum. Pref.	5½–5¾	4 18 6	..	5½	..
St.	..	Do. 4½ 1st Mort. Deb.	105 –107	—	..	106½	106½
5	6/6	Westminster Electric Supply Ord.	18 –18½	5 0 0	Mar, Sept	18½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	6½–6½	3 14 0	—	6½	6½
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 6% Cum. Pref.	½–½	5 14 2	..	..	..
1	6d.	Aron Elec. Meter 6% Cum. Pref.	½–¾	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6 –6½	6 10 2	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5½–5¾	5 4 4	Jan, July	..	—
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 –104	4 5 6	—	..	..
St.	4½%	British Thomson-Houston 4½% 1st Mt. Db.	101 –103	4 10 6	—	..	..
5	3/0	British Westinghouse 6% Pref.	2½–2¾	..	—	2½	2½
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	86 –88	4 11 8	..	86½	..
2	..	Brush Electrical Engineering	½–¾	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½–1½	8 0 0	Mar, Sept	1½	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	93 –96	4 14 6	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	74 –77	5 17 0	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	9½–10	5 5 0	Jan, July	9½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½–5¾	4 18 8	Jan, July	5½	5½
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 –106	4 4 11	Nov, May	..	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1½–1¾	4 5 4	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	96 –98	4 13 4	..	..	..
1	0/9½	Chadburn's (Ship) Telegraph Ord.	½–1½	5 17 6	..	..	—
5	1/6	Crompton and Co. (Nos. 1 to 54,000) ...	2½–2¾	3 0 5	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	99 –98	5 2 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	8 –8½	5 17 8	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	5½–6	5 0 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	105–107	4 4 0	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½–¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 –1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 –82	4 17 8	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 –84	6 0 6	..	..	—
5	2/6	Edmundson's Elec. Corp. Ord.	5½–5¾	6 18 0	H'lf-yearly	5½	—
5	3/0	Do. 6 per Cent. Cum. Pref.	6 –6½	4 18 0	—	6½	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	105 –108	4 3 3	..	107	..
2	1/7½	Electric Construction Co.	1½–1½	6 8 0	July	1½	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2½–2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 –99	4 0 10	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	—	..	—
10	5/0	General Electric (1900) 6% Cum. Pref.	9½–10	5 0 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91 –96	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½–11	6 7 3	Feb, Aug	11	..
5	2/3	Do. 4½ per Cent. Pref.	5½–5½	4 3 9	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	110 –112	4 0 10	Feb, Aug	..	..
10	8/0	India Rubber, Gutta Percha, &c., Wrks.	15 –16	5 5 0	Feb, Aug	15½	..
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 –102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11 –11½	4 7 0	Mar, Sept	..	..
12	12/6	Telegraph Construction & Mainten'ce.	38 –40	5 18 6	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101½–103½	3 17 3	Jan, July	..	..
5	—	Willans and Robinson Ord.	1 –2	..	Apr, Oct	..	..
5	—	Do. 6 per Cent. Cum. Pref.	3 –4	—	Apr, Oct	..	..
..	4%	Do. 4 per Cent. 1st Mort. Debs.	76 –79	5 1 3	May, Nov	..	—

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

WE publish this week our annual Electric Traction Supplement, completing the series of Tables commenced with our second January issue. Following the system we adopted last year, we have placed the tramways having their own particular power houses in a separate Table from those which are supplied from combined lighting and traction stations, and our readers will find particulars of these combined stations in Table II. of the series, published with our issue of January 20th. The policy of combining the stations has now found approval with the majority of local authorities who own electric lighting undertakings as well as tramways, and the result is manifest in the Tables, which show that the number of tramways with independent generating stations has practically remained stationary, while the list of lines supplied from combined works has increased considerably.

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THE total mileage of electric tramways in this country is now no less than 1,770 miles of route, equivalent to 2,740 miles of single track. In addition to this, there are now 17 miles of tube railways, about 7 miles of ordinary tunnel railways and 84 miles of electrically-driven surface lines in operation, representing 212 miles of standard gauge railway track; and this total will be increased to about 380 miles when the new lines under construction and those undergoing the process of "electrification" have been completed.

◆

THE selection of suitable Papers for reading at the meetings of the Institution of Electrical Engineers is a difficult task, for as a rule the Council has too few Papers in its hands before the beginning of the session, while by the time the session is half over it is overwhelmed with excellent contributions and offers of more. This makes it all the more necessary that the Institution should be jealous of the time expended upon the discussions of Papers during the months of January and February, when it becomes apparent that more Papers deserve attention than can be dealt with adequately in the time at its disposal. It was, therefore, with increasing wonderment that we listened last week to a long-drawn-out lecture suitable for an elementary chemistry class, and delivered by Mr. J. B. C. KERSHAW during the time which had been allotted to a practical discussion by engineers experienced in the design and management of boiler-house plant in electricity works. For three-quarters of an hour the meeting patiently watched the lecturer performing such elementary experiments as boiling water in a paper bag, lighting a Bunsen burner above a piece of gauze, and other tricks with which almost every schoolboy is familiar. Notwithstanding the deference due to the President, and notwithstanding the fact that Mr. KERSHAW was a visitor, the meeting would have been well within its rights if it had refused to allow its time to be wasted in this manner. Mr. SIEMENS should have been reminded that it was his duty as President to interrupt the lecturer's tedious discourse. There were at least a dozen members present prepared to discuss the Paper, but the result was that four speakers only could contribute to the discussion, although the sitting was prolonged until past the usual hour for adjournment. The whole time-table of the session may thus be upset, as the dates for the next two Papers are already fixed. We trust that our President will show a firmer hand on future occasions.

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MR. H. M. SAYERS' Paper on "Tramway Overhead Equipment Materials," read before the Society of Arts, and published in our last two issues, was a meritorious example of condensed information, and it provoked an interesting discussion, an abstract of which appears on p. 633 of this week's *Electrician*. The differences in the practice of England, America and the Colonies in several points of detail were well brought out in the debate. Glass, for instance, which is used to a considerable extent as a material for insulators in the United States is unsuitable in the British climate, and the horn-type of lightning arrester, which Mr. MORDEY had used with good results in South Africe, offers too wide a spark-gap for the comparatively mild thunder storms at home. Considerable criticism was devoted to the standard sizes of tramway poles adopted last year by the Engineering Standards Committee. The three sizes recommended by the Committee, for light, medium and heavy work respectively, have diameters, at the base, of 7½in., 8½in., and 9½in., while the minimum thickness of metal is specified at ¼in. Mr. A. J. LAWSON thought these poles too weak, and suggested increasing the diameters by ½in. in each of the three cases. It is obvious, of course, that the most economical way to increase the strength of the pole is to increase its diameter,—economical, that is to say, so far as expenditure of material is concerned,—yet there are equally important reasons, mentioned by Mr. FELL, Mr. SAYERS and Mr. BOOTH, why it is preferable to increase the strength, when this is necessary, by an augmentation of the thickness of metal. Mr. BOOTH raised the question of the bow collector *versus* the trolley, and although Mr. SAYERS, in his reply, professed to know little about the former, he pointed out a disadvantage which we do not rememember having heard before—viz., that the lubricating material, which is necessarily employed, would drop on the passengers riding on the double-deck cars which are almost an essential feature of tramway practice in this country.

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THE Pollak-Virag writing telegraph is one of the most ingenious pieces of apparatus that it has been our privilege to inspect. The instruments which have been undergoing trials, with the help of the British Post Office, during the past few weeks, are unexpectedly robust and simple, in view of the complicated and delicate process they carry out, although the mechanical problem which is solved in them is by no means an easy one. A brief article upon the most recent development of the system appears on another page of this issue. Previous articles and announcements made by the manufacturers of the instruments have claimed certain very high speeds of working, and undoubtedly extremely high speeds are attainable, exceeding those with the Wheatstone automatic system. But it must be borne in mind that the Pollak-Virag system requires a loop line, while the Wheatstone automatic can be worked with an earth return and can be duplexed. Thus, if the speeds are to be compared, the Wheatstone speeds should be multiplied by four. Then, again, a perfectly-balanced telephone line is required for the Pollak-Virag system—one as carefully balanced and in as good condition as would be needed for the so-called duplex telephony or for simultaneous telephony and Hughes working. And further, if this line forms one of a group of telephone lines, as would of necessity be the case, there is danger of induction disturbances on the latter should there be the slightest local defect. In comparing the speeds, we may take a line of fair length—say about from London to Birmingham. On such a loop, if in average condition, no less than 500 words per minute could be transmitted successfully by the Pollak-Virag apparatus. With Wheatstone automatic instruments under similar conditions 300 to 400 words per minute could be transmitted simultaneously each way on each wire, so that nearly three times the output could be got out of the line on the older system.

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ON the other hand it is only fair to mention that these high speeds of Wheatstone working are seldom employed in actual practice, chiefly on account of the difficulty of handling the strip turned out at so fast a speed. Thus, as a rule, Wheatstone working is limited, we believe, to about 100 words per minute. This difficulty of handling the slip is less on the Pollak-Virag system owing to the column printing. It has also been suggested that the Pollak-Virag strip is sufficiently legible even to the uninitiated for it to be pasted up directly on the forms sent out to the addressee; but we think that this would not prove to be the case in practice, and the necessity of even a few repeat messages would detract considerably from the practical working of the system. For press messages, on the other hand, the Pollak-Virag scrip may be suitable, for editors, sub-editors and printers are all schooled to read cryptic handwriting. We will admit that the Pollak-Virag instrument which we have tested writes more clearly than many of our esteemed contributors; but, on the other hand, it certainly takes far longer to decipher its writing than that of the average telegraph clerk, so that the Post Office economies would be to some extent at the expense of the newspaper proprietor.

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THOSE of our readers who have followed the history of municipal telephony in Glasgow will not be surprised to learn that the Glasgow Telephone committee has definitely decided to abandon the obsolete call-wire system—a system already obsolete when it was adopted at Glasgow—and to replace it by an automatic calling and clearing system. The debate on the committee's report will be found elsewhere in this issue.

◆

THE reply of the Postmaster-General to the deputation to protest against the disfigurement of the country by telegraph poles has given rise to some correspondence in the daily papers. There is always a difficulty in obtaining way-leaves over private property for alternative routes. In some cases it is possible to run the lines along the railways, but sometimes this is not possible in the case of telephone cables as they would be too near to the telegraph lines and induction disturbances would result. The sins of the Post Office in Epping Forest were particularly insisted on by the Commons and Footpaths Protection Society's deputation, and they suggested the Great Eastern Railway as an alternative route. The Postmaster-General stated, however, that the company would not guarantee in this case that there should be no induction disturbances, but the general manager of the railway company now writes to say that his company is prepared to have the telephone wires erected on separate poles and revolved in the approved manner, so that they would be quite immune from disturbance. By showing a proper spirit of compromise, such matters may frequently be settled, although we despair of its being possible to extend our telephone trunk lines adequately without sometimes offending the delicate susceptibilities of the Commons and Footpaths Preservation Society and others whom the uncharitable call cranks and the more charitable designate merely as enthusiasts.

◆

Junior Institution of Engineers.—The "Coming of Age" dinner of the Junior Institution of Engineers will be held at the Hotel Cecil on Saturday, February 11th, at 6:30 for 7 p.m. The president, Mr. W. H. Lindley, will take the chair.

Wireless Telegraphy.—It is announced that the steamships "Caledonia" and "Columbia" of the Anchor Line are to be fitted with Marconi wireless telegraph apparatus, and that these are the first steamers trading from Glasgow to adopt wireless telegraphy.

Glasgow Local Section of the Institution.—The annual smoking concert of the Glasgow Local Section of the Institution of Electrical Engineers will be held at the Grosvenor Restaurant, Gordon-street, Glasgow, on Saturday. Mr. Robert Robertson will occupy the chair, and the proceedings will commence at 7:30 p.m.

Free Lamps.—A Chicago contemporary is responsible for the following item of news:—

> A cocker spaniel dog owned in North Tonawanda, N.Y., is said recently to have swallowed two coloured electric-light bulbs that had been used to decorate a Christmas tree. Shortly afterwards the little animal while playing in front of the house playfully snapped at the heels of a pedestrian, who turned and kicked the dog. The bulbs exploded, killing the spaniel.

Cable Interruptions and Repairs.

	Date of Interruption.		Date of Repair.
Cayenne—Pinheiros	**Aug. 13, 1902**	..	—
Baissi-Issa (Yemen)—Camaran	**Oct. 22, 1902**	..	—
Tarifa—Tangier	**Jan. 18, 1904**	..	—
Cayenne—Paramaribo	**July 13, 1904**	..	—
Sitka—Valdez (Alaska)......	**Nov. 11, 1904**	..	Jan. 28, 1905
Cap Haytien—Puerto Plata ..	**Dec. 27, 1904**	..	—
Marnaritza-Rhodes..........	**Jan. 30, 1905**	..	—

Society of Arts Lectures.—Mr. Dugald Clerk will give a series of four Cantor lectures on "Internal Combustion Engines" before the Society of Arts. The lectures will be delivered on the following Mondays:—February 13th, 20th, 27th and March 6th, commencing at 8 p.m. in each case. The following Cantor lectures have also been arranged later in the session:—Mr. Herbert Laws Webb on "Telephony," four lectures, March 13th, 20th 27th, and April 3rd; Mr. H. W. Ravenshaw, on "The Uses of Electricity in Mines," two lectures, May 15th and 22nd.

Royal Society.—Among the Papers down for reading yesterday were the following:—"On the Compressibility of Gases between One Atmosphere and Half an Atmosphere of Pressure," by Lord Rayleigh, O.M., F.R.S.; "On the 'Blaze Currents' of the Gall Bladder of the Frog," by Mrs. A. M. Waller (communicated by Dr. A. D. Waller, F.R.S.); "Note on the Determination of the Volume Elasticity of Elastic Solids," by Dr. C. Chree, F.R.S.; "Theory of the Reflection of Light near the Polarising Angle," by Prof. R. C. Maclaurin (communicated by Prof. J. Larmor, F.R.S.).

American Visit of the Institution of Electrical Engineers.—Dr. D. K. Morris read a Paper on this subject before the Birmingham Local Section of the Institution of Electrical Engineers on January 25th, and illustrated his discourse by numerous lantern slides. In the discussion, the large size of some of the American power houses, as compared with similar plants in this country, was duly recognised, and one speaker particularly was sceptical with regard to the efficiency of 97 per cent., mentioned by Dr. Morris, for 5,000kw. three-phase generators. In his reply, Dr. Morris averred that even a higher efficiency—viz., 97·2 per cent. was obtained for 25 per cent. overload.

Obituary.—*Nature* announces the death, at the age of 75, of M. Victor Serrin, the inventor of the first automatic regulator for electric arc lamps used in public service. He died at Neuilly-en-Tel on January 22nd.

We regret to announce the death of Mr. C. J. Sutherland, electrical engineer to the Worcester Corporation, which took place at his residence at Worcester on Sunday evening. Mr. Sutherland, who was born in 1871, received his early training at the Faraday House Training Institution, and from the commencement of his professional life has been wholly associated with central station work. After having been connected with the Eastbourne Electric Light Co., the House-to-House (now Brompton and Kensington) Electric Supply Co., and the St. Pancras Vestry for comparatively short periods, he was appointed assistant electrical engineer to the Hanley Corporation in 1893, under Mr. G. H. Cottam. When Mr. Cottam was appointed engineer to the Hampstead Borough Council in 1895, Mr. Sutherland succeeded him at Hanley, and was responsible for the large extension of the undertaking during the following three years. In 1898 he transferred to Worcester, where he designed a large combined lighting and traction station which was completed in 1902. It was since coming to Worcester that signs of ill health manifested themselves, and early in 1900 Mr. Sutherland was granted 12 months' leave of absence by the Corporation, Mr. F. E. Hoadley being provisionally appointed city electrical engineer in the meantime. Mr. Sutherland resumed his duties in 1901, but a recurrence of his illness necessitated his resignation a few weeks ago.

Musgrave Heaphy Testimonial.—An influential and representative meeting of the subscribers to this testimonial was held in the board room of the Phœnix Fire Office on Friday afternoon last. In the unavoidable absence of the Right Hon. Lord Avebury, Chairman of the Committee, Mr. H. B. Guernsey, manager of the Phœnix Fire Office, occupied the chair. The chairman, in his opening remarks, said that Mr. Musgrave Heaphy was an old and esteemed friend and had been in the service of the office a great number of years. It was always Mr. Heaphy's desire that installation work should be done in the best possible way, and the electrical profession, the fire offices, and his co-workers had every reason to be proud of the work he had accomplished. He was confident that he expressed the feeling of the meeting and of friends unavoidably absent in wishing Mr. Heaphy long enjoyment of the rest which he had so splendidly earned and at so great a price. The address, which was read by Mr. Albion T. Snell, was proposed by Mr. John H. Croft and seconded by Mr. Alexander Siemens, who gracefully referred to the fact that to Mr. Heaphy belonged the honour of preparing the first set of rules for guidance in the erection of electrical installations. It was subsequently decided that the presentation should take the form of an engrossed address, a gold watch and chain, and an album with the signatures of the subscribers. As Mr. Heaphy is in indifferent health it was decided that a public presentation was undesirable, and it was arranged that the joint honorary secretaries, Mr. S. B. C. Russell and Mr. Albion T. Snell, should make the presentation privately on behalf of the subscribers.

Electrically-controlled Planing Machines.—In a Paper, entitled "Some Features in the Design and Construction of American Planing Machines," read before the Institution of Mechanical Engineers on January 20th by Mr. A. Kenrick, jun., mention is made of some reversing mechanisms which differ from the usual belt striking gear. Some American firms, according to the author, employ friction clutches in the drive, especially for the larger machines. These are easier to throw than belts, and they give rise to less variation in the length of stroke. Still better results in this direction were obtained by a new device on an 8ft. square machine, where at the points of reversal a cock opens admitting compressed air which blows the clutch across from one gear to the other. Friction-clutch machines are motor-driven very conveniently without a countershaft. In another arrangement, an electromagnetic clutch was pulled alternately to the direct and to the reverse gear. In yet another case, the knockers threw a switch which reversed the field magnetism and so the rotation of the motor, and also gave it a quick return speed. This seems to be the most direct way of all.

Damping in Electrically-vibrating Systems.—Prof. Slaby, in a recent communication to the *Elektrotechnische Zeitschrift*, gave measurements of spark-gap resistance in wireless telegraph senders, which were duly noted in these columns. In another article he now discusses modes of reducing the damping produced by the spark gap. One mode he has already described—namely, that of dividing the spark-gap into a series of smaller gaps, discharging at the same total voltage. Another method described and tested in the present article, depends on the fact that the resistance of a spark-gap during discharge is smaller the larger the current. To increase the current, several parallel wires may be connected as a composite air-wire through one spark-gap; this arrangement constitutes the "harp" radiator. Or, instead, a capacity may be connected by a short wire to the air-wire near the spark-gap. Again, if a condenser have one plate connected to the air-wire side of the spark-gap and the other to the earth or to the earthed end of the gap, an oscillatory circuit is formed closed through the spark-gap. Evidently, to obtain the utmost effect in the way of increasing the current through the gap, the additions above mentioned must have, including the gap portion, a proper frequency exactly the same as that of the air-wire. In this case the arrangement last described is that usually known as Braun's direct-coupled oscillating circuit. Prof. Slaby gives the results of actual measurements of spark resistances with various composite air-wires. With sparks less than 15mm. long the reduction of resistance produced by joining two similar air-wires is very considerable. Prof. Slaby next discusses that portion of the damping which of necessity accompanies the radiation of energy from a vibrating system. The question of how this part of the whole damping is affected by the coupling to the sender of an independent syntonic oscillating circuit is very complicated. Prof. Slaby only goes so far as to examine by laboratory experiments the effect on the rate of radiation, of varying the length of that portion of the air wire included in the coupled oscillatory circuit. He starts with only the spark-gap included in the oscillatory circuit, which is thus arranged as a shunt across the gap. Then, by moving the terminals away from the gap on either side of it, more of the radiator is included in the oscillatory circuit. The period of this circuit must be kept in agreement with that of the radiator by removing an appropriate length of wire from the main part of the circuit. He estimates the rate of radiation from the composite radiator by measuring the current in a tuned receiver. He finds thus that the rate of radiation first increases and then diminishes as the amount of wire common to the radiator and the oscillatory circuit is increased. The effect is more pronounced the greater the capacity of the condenser in the coupled oscillatory circuit.

Tramway Speeds.—In our issue of December 16th we referred to a letter addressed by the secretary of the Tramways and Light Railways Association to the Board of Trade, asking that speed limits on tramways should not be more restricted than those allowed for motor cars on the same roads, and suggesting that the Board of Trade should, as a general rule, adopt the speed limit of 20 miles an hour in the regulations made by them for electrically-worked lines on public roads. In reply to this communication Sir Herbert Jekyll has stated that the Board of Trade is unable to accept the view expressed by the Association. The Board of Trade is of the opinion that in order to discharge properly the duties imposed upon them by Parliament, so that the public may be adequately safeguarded and, at the same time, that the highest speed may be authorised consistent with safety it is necessary to maintain their present practice of dealing with each route according to the special circumstances affecting it. The Board of Trade, in its desire to assist tramway enterprise and to promote public convenience, will be prepared to consider carefully any increase of maximum speed which the authority responsible for the official working of a particular line may feel justified in proposing. To this communication the secretary of the Tramways and Light Railways Association has sent a reply expressing the very great regret of the Council of the Association at the contents of Sir Herbert Jekyll's letter. The great stringency of the present tramway limits, it continues, has seriously hampered the tramway industry of Great Britain and Ireland, and it is the deliberate and unanimous opinion of the Council that the present speed limits could be generally extended without any risk to the public safety. In order to demonstrate this they are willing to organise tests of comparative stopping power of a tramcar and any other motor vehicle, which might guide the Board of Trade in judging whether this opinion is correct. Observations have been taken as to the speeds of the motor omnibuses now running in West London, one such observation indicating 12 miles an hour including stops, and a running speed of considerably over 14 miles an hour, a rate of travelling which had been maintained with perfect safety to the great convenience of the public. In comparison with this, the letter cites the maximum running speeds on the London County Council tramways which do not exceed 10 miles an hour except for a small stretch near Clapham Common, and are limited to 8, 6 and 4 miles an hour at other places. Similarly, the London United Company are limited to 12 miles an hour on 6 miles of route out of 35 miles, and on the remaining 29 miles, 10 miles an hour or less is the maximum, in spite of the fact that none of these tramways are within 4 miles of Charing Cross. Similar limits have been laid down for the North and East London suburbs. Thus, in London there was the curious contrast of a high speed for public service cars (other than tramways) in crowded central streets and a low speed for tramwars in outlying suburbs. The Council of the Association respectfully ask that even if the Board of Trade refuses to proceed by general regulations, where any tramway company or municipality ask for an increased speed limit the Board should not refuse the request except on the written report of a responsible officer after a local inquiry.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, February 3rd.

Institution of Electrical Engineers: Manchester Students' Section.

7.30 p.m. Meeting in the Municipal School of Technology. Paper to be read: "The Electric Equipment of Automobiles," by V. H. Mahler.

Junior Institution of Engineers.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read: "Recent Developments in Electric Lighting," by Prof. H. T. Davidge.

SATURDAY, February 4th.

Glasgow Technical College Scientific Society.

7.30 p.m. Meeting at 38, Bath-street. Paper to be read: "Cathode Rays and Allied Phenomena," by Prof. Blyth.

Institution of Electrical Engineers: Students' Section.

Visit to Messrs. Evershed & Vignoles Works, Acton-lane, Chiswick, W.

MONDAY, February 6th.

Institution of Electrical Engineers: Newcastle Local Section.

7.30 p.m. Meeting at the Durham College of Science. Paper to be further discussed: "Description of Some Plants Inspected During a Recent Visit to the States," by H. L. Riseley.

Society of Engineers.

7.30 p.m. Ordinary General Meeting at the Royal United Service Institution, Whitehall, when the President-Elect, Mr. Nicholas J. West, will deliver his Inaugural Address.

THURSDAY, February 9th.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting. Messrs. Booth & Kershaw's Paper on "Fuel Economy in Steam Power Plants," will be further discussed. The following Paper will then be read: "The Value of Overhead Mains for Electric Distribution in the United Kingdom," by G. L. Addenbrooke.

Institution of Electrical Engineers: Dublin Local Section.

8 p.m. Meeting at the Royal College of Science. Paper to be read: "Some Notes on the Running of a Private Lighting and Power Station," by P. T. Blissett.

FRIDAY, February 10th.

Physical Society.

8 p.m. Annual General Meeting at the Royal College of Science, Exhibition-road, South Kensington, when the President-Elect, Prof. J. H. Poynting, F.R.S., will deliver an Address on "Radiation Pressure."

SUB-STATIONS AND AUTOMATIC SIGNALLING ON THE DISTRICT RAILWAY.

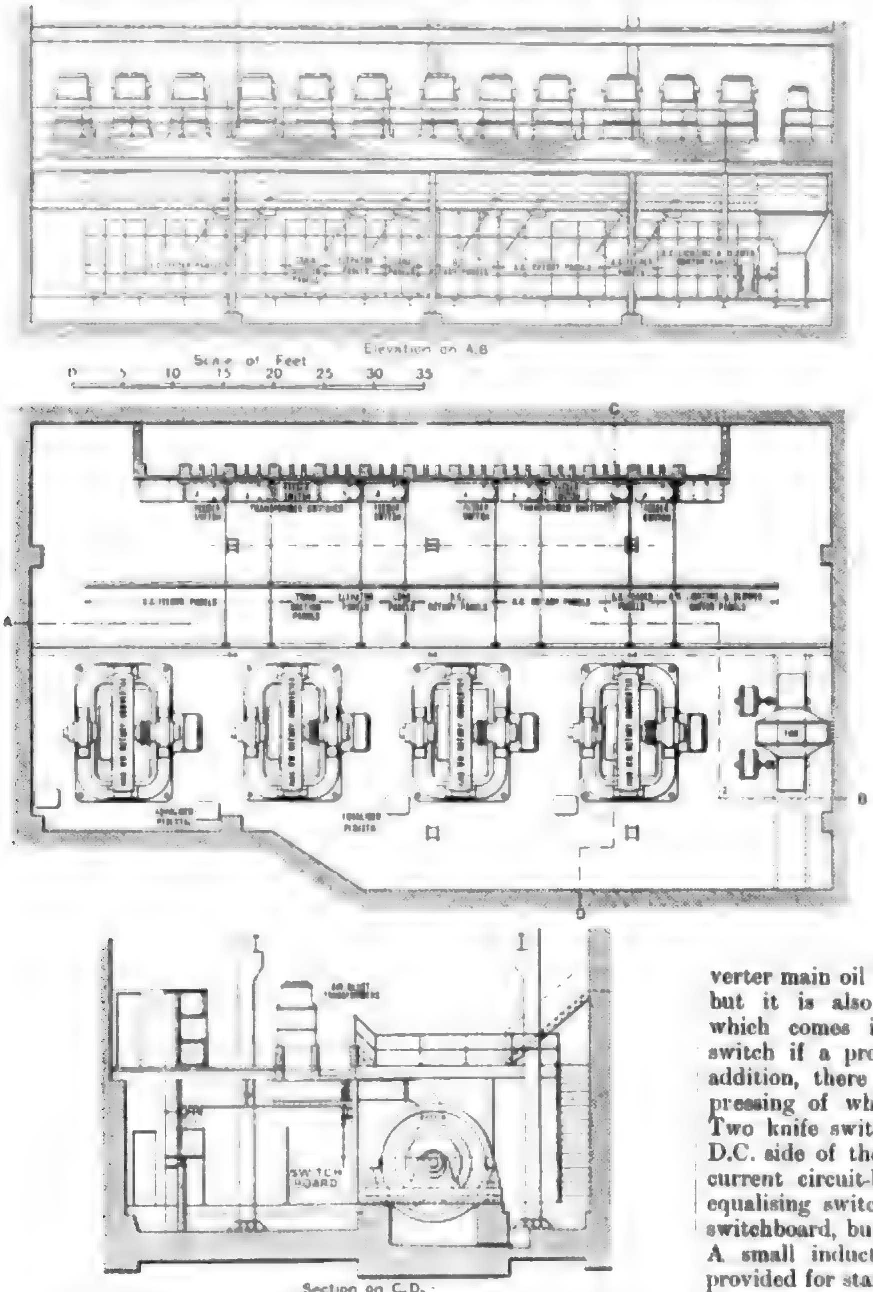

FIG. 1.—GENERAL ARRANGEMENT OF CHARING CROSS SUB-STATION.

The sub-stations of the Metropolitan District Railway will supply continuous current to the southern half of the Inner Circle, and to a wide area extending from East Ham to Hounslow and from Sudbury to Wimbledon and Richmond. These points form approximately the extremities of the company's system, which will all be supplied from the power house at Lot's-road, Chelsea.* As all the sub-stations are to a great degree similar in design and construction, it will suffice to select one of them—viz., that at Charing Cross (Fig. 1) for description.

Three-phase current at 11,000 volts is supplied to this sub-station from Chelsea by means of four feeders, and after being converted to continuous-current at approximately 600 volts, is conveyed by 24 cables to the track rail. In addition, there are D.C. feeders that supply current to the tube stations for operating the lifts, and A.C. feeders are set apart for the lighting of the stations and tunnels. The connections at the Charing Cross sub-station are similar to those at the Metropolitan Company's sub-stations, one of which was described in *The Electrician* of December 30th, p. 418.

Westinghouse spark-gap lightning arresters protect the E.H.T. feeders directly upon their entrance into the building, after which the latter pass to isolating knife switches operated by a long insulated pole fitted with a hook at the end. These switches are, of course, only used upon rare occasions, their function being to cut the pressure off from the oil break feeder switches when cleaning or repairs are to be undertaken; similar arrangements are made upon the other side of the oil switches. Reverse current relays are installed for the protection of the E.H.T. feeders from the sub-station end, and thus, if a short-circuit occurs on any feeder, current will not flow to it from the sub-station 'bus bars.

The main E.H.T. 'bus bars are divided into four sections, each of which has one feeder and one rotary converter connected to it. By the agency of selector switches of the same type as the isolating switches, these 'bus bar sections may be so connected as to use the feeders separately or in parallel as desired, and similar selector switches being included in the rotary circuits, a very flexible and convenient arrangement is secured. The pressure transformers used in connection with the measuring instruments are also provided with selector switches, and may thus be fed from any particular pair of 'bus bars if necessary. By connecting the transformers for the A.C. lighting circuits to the middle set of 'bus bar selector switches, it is possible to supply the load from either pair of incoming feeders.

The circuit to the primaries of the step-down transformers is completed by isolating and main oil switches in series, and connection is made from the secondaries to the collector rings of the rotaries through sets of three single-pole knife switches. Each converter main oil switch is, in the ordinary way, hand-operated, but it is also fitted with an overload time-limit relay, which comes into operation and automatically trips the switch if a prolonged short-circuit or overload occurs. In addition, there is a push button on the switchboard, the pressing of which will open the main switch electrically. Two knife switches, one for each pole, are provided for the D.C. side of the rotary converter, and there is also a reverse-current circuit-breaker in the negative side and the usual equalising switch; the latter, however, is not placed on the switchboard, but on a cast-iron pillar close to the machine. A small induction motor, coupled directly to the shaft, is provided for starting each rotary, and its switch is placed on the A.C. converter panel of the switchboard.

As continuous current is supplied from this sub-station to three railway systems controlled by the Underground Electric Railways Co., it has been necessary to split the positive 'bus bar up into three sections on the far side of the main load panel, and in each of these is interposed a suitable D.C. integrating wattmeter. The first and second measure the energy delivered to one train section and four track feeders, and the third, that to two track feeders; the three other cables that convey the current for operating the lifts are fitted in a like manner.

All lighting is carried out on the three-phase system, each sub-station being responsible for as much as lies half-way between it and the neighbouring ones. By the use of interconnecting switches it is possible, however, to couple up the sections, so that the lighting will not be interfered with in the event of a sub-station breaking down or being stopped. A Westinghouse type B triple-pole automatic oil switch is interposed between the main switchboard and the high-tension lighting panels, which are mounted separately and distinct from the former. Current is transformed down, and then passes through a triple-pole switch and a separate small set of 'bus bars to the low-tension A.C. 'bus bars, which are divided up into three sections, each feeding two lighting circuits. These run in duplicate to the District Railway, the Charing Cross, Euston & Hampstead Railway and the Baker Street & Waterloo Railway respectively: each is provided with an integrating wattmeter for measuring the consumption.

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* A fully illustrated article on the Lot's-road power station appeared in *The Electrician*, October 21st, p. 4.

The instruments and controlling gear are mounted upon polished blue vermont marble panels, which have an aggregate length of 69ft. 4in. Referring to Fig. 2 and beginning from the right-hand side, there are first the six A.C. lighting panels referred to above. Each pair of these contains two double-pole circuit-breakers, two ammeters, one integrating wattmeter, two 800-ampere triple pole knife switches, and one triple-pole 1,000-ampere switch for connecting the sub-lighting 'bus bars and the main 'bus bars. There are also two triple-pole two-way 100-ampere switches for starting the fan motors that supply cooling air to the transformers, and one triple-pole main switch for disconnecting the lighting transformer on the low-tension side. The usual swinging arm is attached to these panels, in this case carrying a 300-volt instrument, and plugs and sockets are provided that will allow of its connection to any phase and any low-tension feeder for purposes of voltage measurement. Adjacent to the lighting section of the board are two instrument panels, to which are brought the four incoming E.H.T. feeders. These panels are fitted each with six 300-ampere ammeters, two synchroscopes, two integrating wattmeters, and two polyphase reverse-current relays; adequate illumination of the instruments is obtained by four incandescent bracket fittings. Two red signal lamps below the ammeters are so connected with the two main feeder switches that they will light up, and thus warn the attendant, in the event of either of these opening automatically on a fault. These panels also contain two push buttons for tripping the main oil switches, and two voltmeter switches, one for each feeder. Following the feeder section of the board there are four A.C. low-tension panels for the rotary converters, each of which contains a large illuminated dial ammeter, one power-factor meter, and one polyphase, overload, time-limit relay. Red lamps are also fitted and connected with the mains switches for the purpose described above. The A.C. side of the rotary is controlled by three large single-pole knife switches placed conveniently on the lower portion of the panel, and the sub-base of each contains a starting switch for the induction motor used for starting the converters. Centrally above the four panels is a Westinghouse synchroscope mounted on a double-jointed bracket that enables it to be turned in any direction.

The four D.C. panels for the same machines stand next, and each contains one 4,000-ampere circuit breaker with a reverse current relay attachment, one large illuminated dial ammeter, one voltmeter plug awitch, two 4,000-ampere single pole knife switches, and, on the sub-base, a rheostat dial switch. Then follows the main-load panel, upon which are mounted an illuminated dial voltmeter for the 'bus bars, and another similar one for the machines, and an illuminated dial ammeter that measures the total 'bus bar current. Next is the wattmeter panel containing three instruments of 8,000, 6,000 and 4,000 amperes capacity respectively, which are used for metering the power supplied to the three lines before mentioned. The lift panels, of which there are three, follow this, and each is fitted with a suitable wattmeter for measuring the power absorbed by each railway in its lift circuit. After these come 12 train section and track feeder panels with a capacity of 3,000 amperes each. They are individually fitted as follows:—Two single-pole 3,000-ampere circuit breakers, one 4,000-ampere illuminated dial ammeter, and two 3,000-ampere single-pole knife switches; this double-pole arrangement is necessary, as both the positive and negative current rails are insulated from earth throughout. The 'bus bars, which are built up of 6in. by ¼in. copper strip, are arranged with a ventilating space between adjacent sections instead of being clamped together solid as is frequently the case. All small wiring of the switchboards, which so often constitutes a danger, has been very carefully carried out, and is neat and at the same time thoroughly mechanical. The low-tension A.C. ammeters are all operated by small series transformers, each of which consists only of a magnetic circuit and a secondary winding. It is merely necessary to slip them over the switch studs which form the primary, and the current flowing in the latter suffices to induce the secondary current which operates the instrument.

By the arrangement of the whole of the E.H.T. gear, such as cable ends, series transformers, &c., on an incombustible brick wall divided into small cells, fire and life risks are minimised to a great degree. In similar but horizontal cells the E.H.T. 'bus bars are placed, and the lightning arresters have each a separate cubicle with a fireproof door completely isolating them but rendering access easy.

Hand operation of the oil-break switches (Fig. 3) is effected through gearing by large levers; as previously mentioned the switches are electrically tripped. They are erected in a masonry structure, with each of their three poles and the oil tank in which they are immersed in a separate fireproof compartment. Two stationary contacts mounted in large porcelain insulators are provided for each pole, one being connected to the incoming lead and the other to the outgoing. The movable contact, as shown in the illustration, consists of a copper bridge-piece mounted on the end of a strong wooden rod, which latter is fastened at the upper end to a cross bar common to all three poles. In closing, the magnets mounted on the top lift the contacts with the assistance of a pair of balance springs and through the agency of a system of levers that give a straight line motion. A toggle joint, which automatically locks the levers, keeps the switch closed, but upon putting the tripping gear into action, the toggle is released, and gravity, assisted by a powerful spring, causes the cross bar and contacts to drop to the open position. The oil tanks, which may be readily disengaged from the contacts, are constructed of heavy sheet metal and lined on the interior with an insulating cement moulded to fit closely round the terminals and moving contacts. An exceedingly small amount of oil is required, and the fire risk is thus reduced to a minimum, while the wooden rod carrying the contact piece is effectual in keeping apart the two terminals of each pole. A gauge-glass that shows the oil level at sight is fitted to the tank, and draining and refilling arrangements are provided that allow the oil to be changed without putting the switch out of service. A small double-pole two-way knife switch, mounted on the top of each case, is connected in the red lamp indicating circuit above mentioned, and is operated by the movement of the main switch levers, changing its position as the switch moves from "on" to "off" or vice versa. The essential features of this oil-break switch may be shortly summarised as follows:—A positive and direct action, the maintenance of the open position by gravity, the immersion of all live parts in oil, high insulation and great freedom from fire and shock risks, and accessibility for cleaning and repair. The contract for all the District Railway sub-stations was awarded to the British Westinghouse Company, who are responsible for the design, manufacture and installation of all the buildings and plant.

In anticipation of the more strenuous conditions caused by the shorter headway planned, the District Railway Co. has had installed a system of signalling for which great improvements over all earlier systems are claimed. This plant presents features of more than ordinary interest, and is, moreover, the first installation of its kind in this country. The section of line between Hanger-lane Junction and South Harrow has now been worked electrically by the District Railway for over a year, with results that augur well for its success on the more important sections of the line. This trial section has a length of about 5 miles of double track, and it is divided into block sections, varying in length from 1,400ft. to about 3,500ft. On the District Railway generally there are both positive and negative insulated traction rails, the running rails not being used as conductors of traction currents. The distance between stations is usually divided into two blocks, that is, a "starting" and a "berth" block, while the signalling is on the "normal clear" principle.

The old signals themselves are of the ordinary mechanical type, and are in no way specially adapted for power or automatic working; consequently, they are being replaced by special arms with Westinghouse electro-pneumatic signal motors fitted close under the semaphores, and the ordinary counterweight is replaced by one directly on the signal arm. The motors are enclosed in cast-iron casings, and, being essentially strong and simple, are not affected by climatic conditions. They are controlled by small pin valves worked by means of electromagnets in the local signal circuit. Signal cabins are required only at each end of the branch, or where there is a cross-over road; in the latter case they are normally closed, being opened only when required. No great saving in first cost is probable from an automatic installation, as the initial expenditure is probably as great as that incurred in laying down the mechanical system. On the other hand, the working expenses are very much reduced, the saving in labour being a most important item, and the cost of renewals and repairs trifling. Undoubtedly, however, the greatest advantage of an automatic system is its suitability to the requirements of a very frequent and quick service. The blocks may be made as short as is compatible with the running speed and brake power of the trains, the strain on the signalmen, inseparable from such a service, is abolished, and the safety of passengers is thus independent of the personal equation.

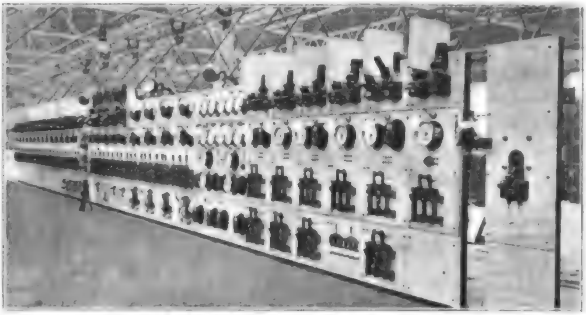


FIG. 2.—FRONT OF CHARING CROSS SWITCHBOARD.

The principles of the Westinghouse system may be best understood by reference to Fig. 4. One of the track rails is electrically continuous throughout its whole length, and constitutes the positive conductor from the generator to the individual track sections. The other rail is cut up into block sections by means of special rail joints insulated with fibre. All uninsulated rail joints are bonded to ensure electrical continuity. Power for the operation of the system is generated at 65 volts by motor-generators placed centrally, the negative terminals of which are connected to an insulated negative main running the entire length of the system. This main is connected to each section of the sectionalised track rail at a point near the latter end of the block—*i.e.*, the end at which the train leaves, as distinct from the end at which it enters. Resistances, R, are interposed in the connections between the negative main and the sectioned rail which reduce the P.D. between the rails to, in the present instance, from 3 to 6 volts, according to the length of the block and various local conditions.

Considering the circuit for a single block unoccupied by a train, it will be seen that current from the positive brush of the dynamo flows along the continuous rail, and thence through the two relays A and B, one at each end of the block, and through the ballast between the rails, all in parallel, to the sectioned rail. From this it flows through a relatively large resistance to the negative main and back to the machine. A train entering block 3 would obviously cause the current to flow through the practically negligible resistance of the car wheels and axles from one rail to the other, and would thus shunt the relays A_1B_1, with the result that the signal S is allowed to go to danger. The "track battery" resistances R connected between the negative main and the sections of the sectionalised rail prevent the generator being short-circuited when the track circuit is shunted by the axles of the train. In fact, these resistances bear such a relation to the combined resistance of the road bed from rail to rail and the two relays, all in parallel, that the shunting of the track cuts out only a small percentage of the total resistance of the circuit. Thus the current increase in a circuit, when shunted, is not great; this is important, as it is advisable to keep the track potential as nearly as possible constant. An increase of the total current, resulting from the blocks being occupied by trains, affects the potential between the rails of unoccupied sections, increasing the transmission loss in the negative main. The loss in the continuous track rail may generally be neglected on account of its large section. Another circumstance directly affecting this track potential is the variation of the resistance of road bed according to weather conditions. Broken stone forms much the best ballast from an electrical point of view, and cinders the worst. It may here be mentioned, however, that, though on several occasions recently the track rails on this system have been flooded, the operation of the signal has, we are informed, been in no wise interrupted.

Coming next to the consideration of the circuits of the track relays which control the signal circuits, the track coils of the relays are permanently connected across the rails at that end of the block at which the relay is placed. Between the polepieces a polarised armature is suspended from a pivot. This armature is in series with a winding R_1 of considerable resistance, and is connected between the positive rail and the negative main through a contact operated by the track coil armature—which is closed when the track coils are energised. To the polarised armature is rigidly connected an arm which actuates a contact, the function of which is to open or close the local circuit controlling

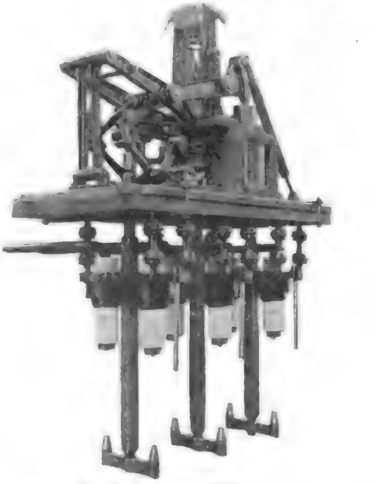


FIG. 3.—OIL BREAK SWITCH.

the signal motors. The operation of the relays is then as follows:—When a difference of potential exists in the normal direction between the rails—*i.e.*, when there is no train on the block, the relay track coils are excited and draw up the armature which closes the circuit through the polarised armature. The polarised armature is then attracted to one of the poles of the relay, and, swinging over, closes the contact in the local signal circuit. As already mentioned, there are two relays in each block, one at each end; these are duplicates, and operate normally in a precisely similar manner, each working a contact in the local signal circuit. These contacts are in series, as shown clearly in Fig. 4, and unless they are both closed no current can flow through the signal magnet, and the signal will, therefore, remain at "danger" by gravity.

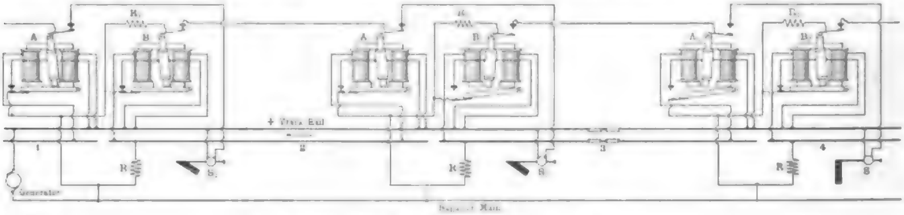


Fig. 4.—Diagram of Connections of Automatic Signals.

The position of the apparatus when the block is empty has been indicated above; both relays are energised, the local signal circuit is closed, and the electro-magnetic valve operating the pneumatic signal motor is consequently open, admitting compressed air to the motor, which holds the signal arm "off." As soon as a train enters the block, the relays are short-circuited by the car axles, and thereby de-energised, permitting their armatures to drop, and thus breaking the circuit through the polarised armature coils. The polarised armatures then swing back from their position in contact with one of the track-coil pole-pieces, and in doing so break the signal circuit at two points in series. The electro-magnet operating the admission and exhaust valves of the pneumatic signal motor is de-energised, and the exhaust is opened, permitting the signal to return to "danger" by gravity. It is, of course, a canon of successful automatic signalling that any interfering influence must, if it has any effect at all, cause the signal arms to go to "danger," and not bring them "off." Experience has shown, however, that the greatest obstacle to the success of automatic signalling, on electric railways in particular, is the liability of the relays being operated by extraneous currents so as to cause a false "clear" indication when danger should be shown. The particular claim of the system under consideration is that it is impossible for an extraneous current, from whatever source, to bring the signal arm to the "off" position when it should stand at "danger."

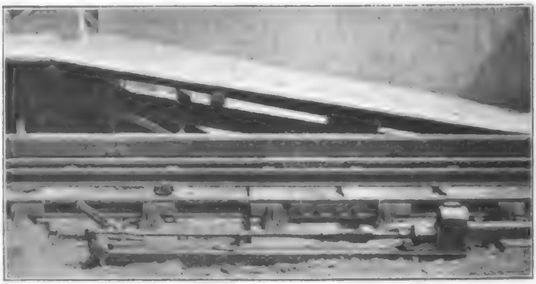


Fig. 5.—Train Stop.

The main source of extraneous currents affecting the signals is the 500-volt traction power circuit, and when, as is the case at Ealing, the track is not used as a return, the presence on the block sections of current from this source is abnormal. Faulty insulation of the train equipment, positive and negative rails, positive cables, &c., are the most frequent causes of leakage to the track rails. Whether currents other than the signalling current on the track rails are normal, as would be the case were one of the track rails used as a power return, or abnormal, as in the present case, is immaterial; such currents would be equally disastrous to a susceptible system, and are, it is said, impotent to affect the system considered. Faults in the main power circuit occur with sufficient frequency to demand the closest attention on account of the disorganisation of the traffic which they may cause, but even if they were rare the least liability to give false signal indications of safety would forfeit all claims for consideration. Although in the present system, it is possible for the extraneous currents to energise either one or both relays while the train is in the block, these latter are so interconnected that it is not possible for them both to be energised in the normal direction at the same time by extraneous currents.

The various conditions which may occur with a train in the section may be catalogued as follows:—

Both relays shunted, no extraneous current. Result: normal condition.

One relay shunted, the other energised normally. Result: signal circuit broken at one point.

One relay shunted, the other energised in a reverse direction. Result: signal circuit broken at two points.

Both relays energised, one normally and one in a reverse direction. Result: signal circuit broken at one point.

As will be plainly seen, the circuit through the signal magnet is designed to be always open at one point when a train is in the section, and often at two. With regard to reliability, the only parts of the mechanism which can be described as in any way delicate are the relays, and these are enclosed in weatherproof boxes, where they can readily be examined at intervals. The air pressure used is about 70lb. per square inch, which enables compact motors to be used for signals, points, stops, &c. The air motors employed work, we are told, year in year out without giving the least trouble.

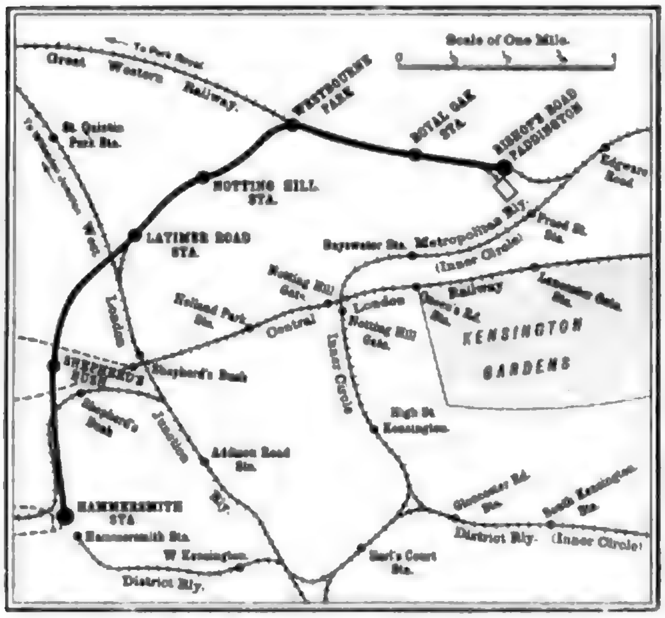
The piping is compact, the electrical wires few and small and the alterations to the track of a trifling nature. This system is applicable where track return is used with either third-rail or overhead trolley wire. The signal motors, relays and other special apparatus were manufactured at the London works of the Westinghouse Brake Co., and supplied direct to the Underground Electric Railways Co. of London, who installed the apparatus themselves.

Fig. 5 shows an automatic stop designed to prevent trains from over-running home signals. This consists of an iron arm between the track rails actuated by a compressed air motor acting in unison with the adjoining signal motor. When the signal goes to "danger" this arm is elevated to a position in which it engages with a cock on the air-brake system of the train: thus the brakes are instantly and automatically applied if, for any reason, the driver should run past the signal.

ELECTRICAL EQUIPMENT OF THE GREAT WESTERN SUBURBAN LINES.

Progress is being made with the electrical equipment of the Bishop's Road–Hammersmith section of the Great Western Railway, which runs in connection with the Inner Circle of the Metropolitan and Metropolitan District Railway Cos. The work on the line is being carried out by the railway company itself, Messrs. Kennedy & Jenkin acting as consulting electrical engineers.

The decision by the Great Western Railway Co. to adopt electrical working was largely influenced, and no doubt accelerated, by the arbitration proceedings as to the method of electric traction to be put into operation upon the Inner Circle. At an early stage in these proceedings, Mr. E. Moon, K.C., on behalf of the Great Western Railway Co., made an application for a locus standi to appear and watch the proceedings on that company's behalf. The application was unsuccessful, but, as we pointed out at the time, we doubted the validity of the decision, for the Great Western Railway Co. possess the right to go to arbitration over the question of change in the system of traction of any portion whatever of railway over which they have running powers. Fortunately a satisfactory arrangement with the Great Western Railway Co. was arrived at, and the further delay, which would undoubtedly have been occasioned had the Great Western Company taken legal action, was avoided. The company has now decided to equip its suburban lines which run in conjunction with those of the Metropolitan and Metropolitan District Railway Cos. upon the system adopted by these latter concerns.



Portion of the Great Western Railway to be electrically equipped shown thus ▬▬▬

Other Railways shown thus —┼—┼—┼—

Electric Tramways shown thus - - - - - -

The total length of route of the first section to be so equipped, referred to above, is 3·69 miles of double track and standard gauge, the track rails being 97½lb. bull-headed rails. The line, shown on the map, includes no gradient steeper than 1 in 50 and no curve sharper than 400ft. radius. An insulated third and fourth rail system has been adopted in order, as already pointed out, that there may be inter-communication between this line and the Inner Circle. The conductor rails are inverted channel rails of 10 sq. in. section, having a guaranteed average conductivity of 15·5 per cent., that of pure copper. They are being supplied by the Frodingham Iron & Steel Co., the bonds and connecting cables having been supplied by Messrs. W. T. Henley's Telegraph Works. The rails are supported on Doulton porcelain insulators, spaced at an average distance of 9ft. apart, the third rail being carried 19in. outside the track rail on either side and the fourth rail being spaced centrally between the running rails.

Power will be generated at Park Royal, which is 3½ miles distant from the line. The boiler plant consists of 10 Babcock & Wilcox boilers, each having an average evaporative capacity of 19,200lb. per hour. These boilers will be fitted with chain grate stokers and self-contained superheaters. There are to be eight generating sets each of 750kw. capacity, and consisting of 1,250 B.H.P. Belliss engines, coupled to three-phase 50 ∼ Electric Construction Co.'s three-phase alternators, generating current at 6,600 volts per phase. The engines will be of the triple-expansion three-crank vertical enclosed type, to work at a steam pressure of 190lb., and with steam superheated to 500°F. Messrs. Belliss and Morcom are also supplying the surface condensers, which will have independent steam-driven pumps. Four Klein towers will be employed to cool the circulating water. The make-up feed is to be taken from a well. In addition to the main sets four auxiliary sets will be provided: a continuous-current and a three-phase generator, each driven by a Belliss engine, and two E.C.C. motor-generators. The contract for the coal and ash conveyors has been given to Messrs. Spencer & Co., coal-measuring boxes to Messrs. Babcock & Wilcox, and the cranes to Messrs. Marshall, Fleming & Jack.

Current will be supplied from the generating station through Siemens three-core paper-insulated lead-sheathed and armoured cables, laid in Howard asphalte lined-steel troughing to two sub-stations, where it will be converted to 600 volts continuous current by means of Bruce Peebles-La Cour motor-generators, in parallel with which will be Tudor batteries. From the substation to the rails Siemens concentric lead-sheathed and armoured feeders are to be employed, laid in Howard troughing in trenches, either in the fairway or outside the tracks.

The trains will be made up of two motor cars and four trailers, the former seating from 40 to 48 passengers, and the whole train seating 304 to 320 passengers. There will be four motors on each motor car controlled on the multiple unit system, but the contract for this latter equipment has not yet been let. Westinghouse air and hand brakes will be used. The average speed, including stops, will be 16 miles, and the maximum 30 miles an hour.

We are indebted to Messrs. Kennedy and Jenkin for the information contained in the above article.

ELECTRIC DRIVING IN WOOD-WORKING SHOPS.

On account of the very intermittent manner in which machine tools in wood-working shops are used, the application of electric driving to such cases leads to considerable economies as compared with other means of driving. This is due to the fact that, although the load-factor may be extremely small, yet the whole shop shafting has to be kept going continually where a gas or steam engine is used. There is also a further loss due to the fact that at such times the engine is lightly loaded and works at a low efficiency.

In the case of electric driving, the motors employed are usually ordinary shunt-wound or compound-wound motors, which drive by belts or through spur gearing or by a combination of both. Of course the motors and starting and regulating rheostats have to be suitably enclosed, so that the sawdust is prevented from interfering with the smooth working of the installation. While there is nothing very unusual to be recorded as far as the general arrangement of the motors and driving gear are concerned, it is to be hoped that the following notes will be of interest, as they include the results of a series of actual experiments, carried out for determining the power required for various wood-working machine tools under different conditions.

These tests were made by Electromotors Ld., and we have recently been afforded the opportunity of inspecting two of their installations. The first was in the premises of Messrs. W. H. Archer & Son, builders and contractors, of Gravesend. All woodwork there was formerly done manually, but a year ago the firm decided to instal machine tools. It was at first intended to drive the various machines by belts from a line shafting driven by a gas engine, but this idea was finally dropped for economic reasons, and electric driving was decided upon. The plant has been running since last April. Altogether there are five motors, all semi-enclosed and all compound-wound, with the exception of a ½ H.P. motor, which is shunt-wound. The voltage of supply is 460 volts in all cases. Each motor has its starter fixed near to it on the wall, and the starting rheostats are of the Sturtevant make enclosed in an iron box, the lid of which is fitted with a spring catch.

The circular saw bench can take any size of saw up to 3ft. in diameter, and the maximum thickness of wood which may be cut is 13in. This machine is driven at about 1,000 revs. per min. by a 12 H.P. motor placed in a brick-lined pit underground, and power is transmitted by a 5in. link-leather belt, this belt being completely enclosed by a wooden casing. Mr. C. F. McInnis, electrical engineer of Gravesend and consulting engineer for this installation, found that the saw bench, when taking a 10in. cut at the rate of 6ft. per minute on 10in. × 7in. damp pitchpine, required 13·8 B.H.P. to drive it. Some further tests, taken a few days ago by Mr. J. Meech, of Electromotors Limited, will be found in the following table :—

Average amperes taken by motor.	Kind of wood.	Depth of cut.	Length of timber.	Time in secs.	Size of saw.
*4·25	..	..	..	..	24in. × ⅛in.
*6·0	..	..	..	..	36in. × 3/16 in.
13·5	Deal	6½in.	10ft.	25	24in.
12·5	,,	2in	7ft.	7	24in.
11·3	Pitchpine	5in.	6ft.	15	24in.
18·7	Deal	9in.	6ft. 6in.	43	36in.
12·5	,,	3in.	5ft.	8	36in.

* Motor and saw running light.

The tenoning machine is driven at 2,700 revs. per min. by a link belt from a 5 H.P. motor running at 1,200 revs. per min. This machine can do various kinds of work, according to the tools with which it is fitted at the time. When running light, its motor took 5·5 amperes and when the machine was tenoning pitch pine, removing 3½ cubic in. of wood in 10 seconds, the current consumption amounted to 9·5 amperes.

Sagar's planer and thicknessing machine, which is designed for 8in. by 24in. planks, is driven by belt from a 5 H.P. motor running at 800 revs. per min. The planer itself runs at approximately 4,000 revs. per min. The following figures are the result of some tests :—

Average amps. taken by motor.	Kind of wood.	Width of wood.	Thickness of cut.	Length of plank.	Time in seconds.
†2·5	..	..	..	..	..
5·5	Pitchpine	9in.	¼in. under cut	8ft. 6in.	25
5·2	,,	5in.	⅛in. over cut	6ft.	20

† Motor and planer running light.

Another 5 H.P. motor, running at 1,200 revs. per min., drives a band saw and a vertical spindle machine. Both machines are driven by belt and for this purpose the motor is provided with a pulley 20in. in length which is supported at its extreme end away from the motor by a third bearing. The vertical spindle turns at about 4,000 revs. per min., and the speed of the band saw is 4,800ft. per min. When driving the belts only the motor took 2·4 amperes, and when driving the belts and band saw, running light, 3·5 amperes. Some test results are tabulated below :—

Average amps. taken by motor.	Kind of wood.	Depth of cut.	Length of wood.	Time in seconds.
5·6	Deal	4½in.	18in.	10
7·0	Pitchpine	9in.	15in.	20
‡3·5	..	..	..	..
§4·75	..	..	..	
3·75	Deal	Moulding extracted in the form of a triangle, the sides being ⅜in., ½in. and ⅞in.	11ft. 6in.	20
5·5	Pitchpine	2¼ × ¼	2ft. 6in.	20
3·5	..	..	..	..

‡ Motor and vertical moulding spindle running light. § Motor, vertical spindle and band saw running light. Vertical spindle with rabbeting cutters used for the previous test on spindle running light.

An emery wheel used for grinding tools is belt-driven at 1,640 revs. per min. by a ½ H.P. motor running at 1,200 revs. per min. When the motor and belts were running light, the current consumed by the former was 0·7 amperes; when grinding a straight moulding cutter on the hollow emery wheel, the current ranged from 1 to 2 amperes. It may be mentioned that the motors rest upon sliding bedplates, which readily allow any sag in the belts to be taken up. The guaranteed efficiencies at full load are :—86 per cent. for the 12 H.P. motor, 83 per cent. for the 5 H.P. motors and 78 per cent. for the ½ H.P. motor.

Electricity is also employed for lighting the shops by incandescent lamps, two being wired in series. Current is conveyed to them by lead covered twin cables. The power current is measured by an Aron meter with a time relay. From 5 p.m. to 10 p.m. in winter and from 6 p.m. to 10 p.m. in summer, current is charged for by the Gravesend Corporation at the rate of 5d. per unit, but during all other hours the price per unit is 1d. only. The amounts paid by Messrs. W. H. Archer & Son for electrical energy for the last two quarters were £3. 1s. 6d. and £2. 12s. 11d., respectively, and we are informed that the last-named amount includes only 3 units for which the higher price of 5d. has been paid.

Another electrical installation, very similar to the one just described, was carried out by Electomotors Limited for Messrs. Styles & Sons, builders and carpenters, Golden-square, W. All the motors are shunt-wound and semi-enclosed. They are fed from the mains of the St. James' & Pall Mall Electric Light Co. at 214 volts. At the request of the fire insurance company the motors were enclosed in sheet metal casings, through which the driving shaft protrudes, but the Ward-Leonard motor starters are not protected by any cover.

A band saw is driven by a 3½ H.P. motor by means of spur gearing (raw-hide pinion) and a belt. The speed of the motor is 1,250 revs. per min., and the gearing is such that the band saw runs at a speed of 3,600ft. per minute. When both motor and saw were running light the current taken was 4·5 amperes. Some interesting tests carried out with this machine are recorded below.

Average amperes taken by motor.	Kind of wood.	Depth of cut.	Length of wood.	Time in seconds.
9·0	Deal	6in.	2ft.	25
7·5	Mahogany	2in.	1ft.	4
10·5	Oak	4½in.	1ft. 6in.	15
10·0	Beech	2¾in.	1ft.	15

The circular saw is driven by a 7 H.P. motor by spur gear only, and as the gear ratio is approximately 1:1, the speed at the motor shaft, *i.e.*, 1,050, is the same as that at the saw spindle. Although the bench can accommodate a saw with a diameter of 24in., the saw in actual use is 19in. only, and when running light requires 7·5 amperes.

Average amperes taken by motor.	Kind of wood.	Depth of cut.	Length of wood.	Time in seconds.
17·5	Deal	2in.	6ft. 2in.	10
14·0	,,	1¼in.	4ft. 2in.	5
15·0	,,	1¾in.	7ft. 3in.	8
18·0	,,	6in.	2ft.	20

A French vertical spindle runs at the high speed of 5,000 revs. per min., and is belt-driven by a 2½ H.P. motor running at some 1,300 revs.

Average amperes taken by motor.	Description of work done.
5·0	Motor and spindle running light.
6·0	Sash work in deal, cut ¼in. deep by ⅜in. wide. Length of about 7ft. Time 15 seconds.
7·5	Motor and machine running light, but a large cutter (5in. in diameter) fixed to spindle.
13·0	Ditto, moulding work.

Sagar's over and under planer, designed for planks 20in. by 8in., is driven through spur gearing and a belt by a

5 H.P. motor running at 1,200 revs. per min. The following table refers to some tests with this machine :—

Average amps. taken by motor.	Kind of wood.	Width of wood.	Length of wood.	Thickness of cut.	Time in seconds.
7*	..	..	..	..	..
15	Deal	9in.	7ft. 2in.	$\frac{3}{16}$ in.	45
16	Deal	18in.	3ft. 8in.	$\frac{3}{32}$ in.	17

Finally, there is an emery wheel grinder in the shop, which is driven by a 2½ H.P. motor running at 1,300 revs. The gearing is again a combination of spur gearing and belt gearing, and the 6in. emery wheel rotates at 1,860 revs. per min. Some test figures relating to this machine will be found in the following table :—

Average amperes taken by motor.	Nature of load.
2·5	Motor and belts only.
4·5	Emery wheel light.
5·5	Emery wheel grinding moulding cutter.

The electric motor equipment described above has been running for the last two years, and the tests recorded were taken a few days ago. It may be of interest to learn that the number of units consumed by all the motors enumerated amounted last quarter to 488, for which, at the rate of 3d. per unit, £4. 13s. 6d. was charged. The rebate amounted to 6s. 8d., however, so that the actual cost of electric energy during the quarter came to £4. 6s. 10d.

Our thanks are due to Mr. J. Meech, of Electromotors Limited, for conducting us over the two works and for carrying out the valuable tests recorded above.

ELECTRICITY METERS.†

BY C. H. W. GERHARDI.

(Continued from page 575.)

Ferranti Alternating-current Meter.—The Ferranti alternating-current meter is an integrating watt hour meter of the induction motor type of a design which differs considerably in appearance to those previously described, as will be seen by referring to Fig. 18 (which shows the meter with its cover removed) and to the sectional drawings, Fig. 19. The dial plate, which is porcelain faced, is in consequence very bold. The train of wheels eventually gears in the usual way with the main spindle, which carries an aluminium disc D (Fig. 19.), the latter acting as the rotor of the motor and the brake disc, passing at the back through the air-gaps of the two permanent magnets P M. The series coils S E.C are wound round the poles created by slotting the iron yoke which is fixed above the disc, a wave form of winding being adopted. The shunt circuit consists of a single coil S H.C wound on a bobbin placed round the core C of a tubular magnet T M. This magnet is provided with four projecting poles P_1, the core having three poles P_2, and it will be noticed that the latter are almost immediately under the slots of the upper or series magnet. Compensation for friction and adjustment at low loads is effected by turning the series poles about the axis of rotation of the disc. This causes the shunt coils to exert a torque on the disc. If the series pole be turned clock-wise the disc will tend to turn in the opposite direction. The two screws S_1 S_2 butt up against the frame and keep the series magnet in position. By loosening the one and tightening the other it is possible to alter the position of the series magnet where necessary by the desired amount. The high-load adjustment is easily performed by raising or lowering the series magnet, thus altering the air-gap and making the field weaker or stronger. The series magnet has a threaded spindle T S which runs up or down the nut N. When the necessary adjustment is made the spindle is clamped by means of the clamp C L and screw S_3.

The meters may be adjusted to start on about one-hundredth of full load, the torque is, however, rather low (approximately 0·88gr.-cm. at full load), consequently any additional friction would cause greater errors at low loads than if the torque were larger. The wheel train is well made and the rotor light, so that friction ought to remain fairly constant. The speed of meters of all sizes is 40 revs. per min. at full load, which simplifies testing.

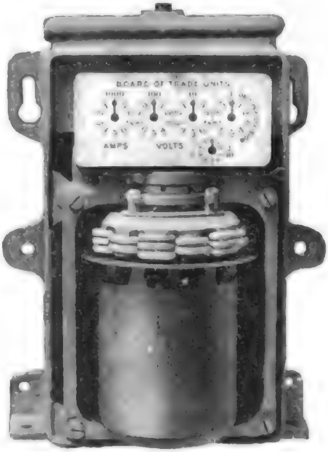


FIG. 18.—METER WITH COVER REMOVED.

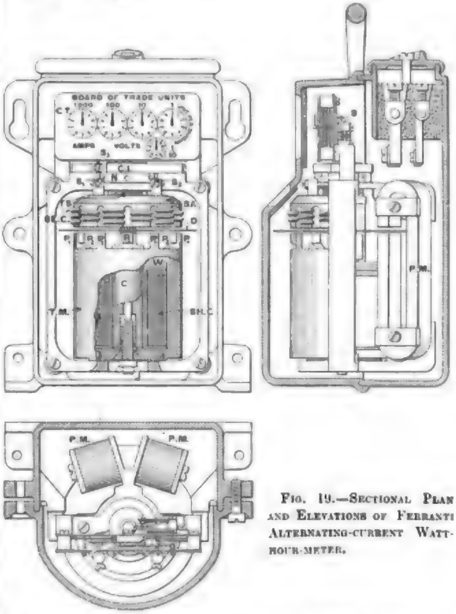


FIG. 19.—SECTIONAL PLAN AND ELEVATIONS OF FERRANTI ALTERNATING-CURRENT WATT-HOUR-METER.

Hookham Induction Motor Meter.—This meter is illustrated in Fig. 20, which shows clearly the working parts. The spindle B carrying the disc A is driven by the shifting magnetic field set up by the shunt magnet D (on which is wound the shunt coil E) and the two main coils F. Only one of these is seen in the figure, the other being exactly behind it. The shunt magnet D is fitted with adjustable pole-pieces, G, on its upper pole, by means of which irregularities in the curve of the meter may be corrected. The meter illustrated possesses no compensating device for altering the angle between the fluxes, and is intended for use on non-inductive circuits. In using uncompensated meters care should be taken that they are not installed for the purpose of metering energy supplied to enclosed arc lamps or other inductive apparatus.

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* Planer running light, at 3,100 revs. per min.

† From a forthcoming book to be published by "The Electrician" Printing and Publishing Co. All rights are reserved.

The brake field is, as usual, produced by a permanent magnet, which is of a somewhat different type to that found in meters of other makes. The lower pole of this magnet is reduced in section just below the pole-piece, with the object of making the "permanence" remain. When testing this meter the case must be kept closed, as being constructed of iron it affects the brake. The effect of the door being open has been found to cause a difference of 4 per cent. on a meter of this type (the meter being slow with the door open). The meter is provided with a clamping gear.

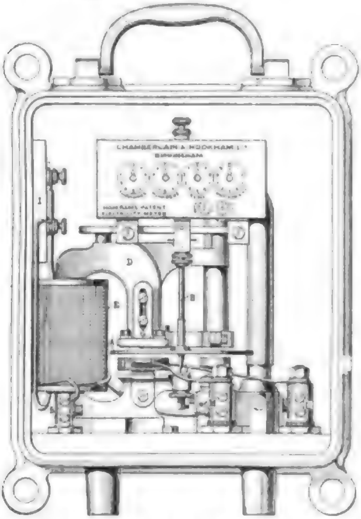


Fig. 20.—Chamberlain and Hookham A.C. Meter.

The Hummel Induction motor meter is manufactured in Germany for the Electrical Co., and is an example of good workmanship, it being extremely well made. Fig. 21 illustrates this meter with its cover removed. The motor is on the left and the brake magnet on the right. The meter is fitted with a cyclometer dial train worked by a worm on the main spindle. On the right of the meter is a choking coil, which is in the shunt circuit. The motor consists of a three-pole core (Fig. 22) with a laminated yoke above the disc. The shunt windings are placed on the outer limbs, the series coil being divided between the middle limb and one of the outer ones.

The shunt windings produce a torque if their magnetic effects are different, and this is made sufficient to overcome mechanical friction, the meters being slightly over-compensated, which causes them rather to over-register than to under-register at light loads. In order to prevent registration on open circuit when thus compensated, a small piece of iron wire fixed to the disc is attracted by the brake magnet and is just sufficient to pull the armature up when in the position of maximum effect. The turns of the series coil on the outer limb are in the opposite direction to those of the shunt coil on that limb. If only one series coil were employed, the field of that coil would affect the fields of the shunt coils, strengthening one and weakening the other. To prevent the strengthened pole becoming saturated, the series winding is put on that limb. The bottom of the main spindle rests on a steel ball, which replaces the pivot, and rotates on a jewel in a bath of watch oil. The jewel mount is held in position by a piece of spring brass, and is removed for inspection with comparative ease. A novel feature in these meters is the top bearing. Instead of the top of the spindle being turned down to a small diameter and running in the bearing, the spindle is enlarged and carries a small piece of brass, which forms the bearing. A straight piece of steel wire of small diameter, fixed at its upper end, protrudes at the bottom of a tube of much larger diameter than the wire, and passes through the bearing at the top of the spindle. In this way a flexible bearing is formed, and the rim of the tube serves as the top stop of the clamping gear. The full-load torque, which is about 4·8 gr.-cm., is very high, and as the friction is small the meter should remain accurate, provided that the cyclometer train does not introduce variable friction.

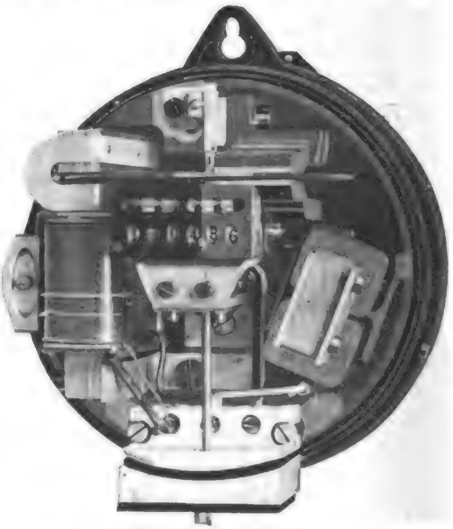


Fig. 21.—Hummel Meter.

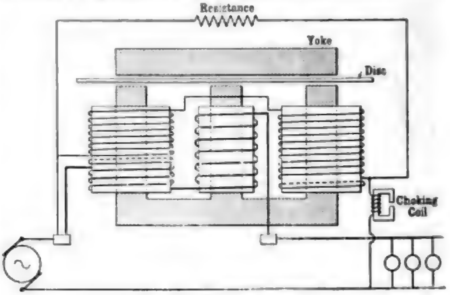


Fig. 22.—Hummel Meter.

The meter has a small full-load drop (about 0·5 volt for a 5-ampere meter) and a shunt current which is about the average. The shunt current of a 200-volt 5-ampere meter is 0·06 ampere, which makes the apparent watts 12·0. The true watts being 1½ per 100 volts—that is 3—the lag of the shunt current is approximately 75deg.

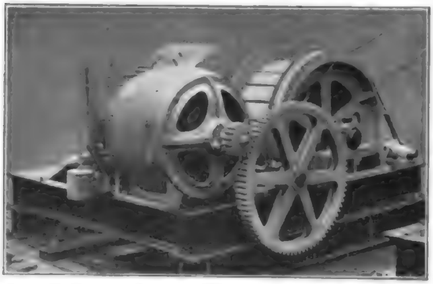
(To be continued.)

ON THE EFFICIENCY OF ELECTRICAL HAULING GEARS.

BY ARNOLD G. HANSARD, B.A.

There appears to be great doubt amongst engineers as to the efficiency obtainable with spur gearing, and the following experience may be of interest to some manufacturers and consultants. The writer recently had to obtain quotations for some electrically-driven haulage gears required for the slate quarries of Messrs. J. W. Greaves & Sons (Ltd.), Blaenau Festiniog, North Wales. The motors were to run on a 500-volt direct-current circuit, and double reduction gearing with cut steel teeth was specified. The full load required was a tension on the rope of 5,000lb. at 330ft. per minute with approximately constant speed at other loads; efficiency was of considerable importance, and the contractor was asked to guarantee, under a strict bonus and penalty clause, the combined efficiency of motor and gearing on a three-quarter-load test.

Twelve first-rate firms were asked to quote, and of these five refused to guarantee any efficiency at all, evidently being much in doubt as to what figure it would be advisable to give; seven firms offered to guarantee the efficiency, and their figures varied from 64 to 78½ per cent. at three-quarter-load. The order was finally placed with the Sandycroft Foundry Co. (Ltd.), of Chester, and the illustration shows one set as erected in their shops. In this case two drums are provided, with clutches so that either can be worked independently. It will be seen that besides hand-brakes on the drums a magnetically operated no-current brake acting on the motor shaft is provided. The actual reduction of speed is from 600 revs. per min. at the motor shaft to 24·6 revs. per min. at the drum, the ratios being 16 to 83 and 17 to 80.



SANDYCROFT ELECTRICALLY-DRIVEN HAULAGE GEAR.

In order to determine the efficiencies the working brakes were replaced by a pair of Prony brakes and a series of tests were made. For the three-quarter-load test the mean of a dozen readings was taken; none of these differed very greatly from each other. The electric measurements were taken by means of Addenbrooke electrostatic instruments, which enable a high degree of accuracy to be obtained. The result of these tests showed a combined efficiency (*i.e.*, power at brakes ÷ electric power delivered to motor) of 85 per cent. at three-quarter-load, a figure which the writer would have been inclined to doubt as being too good had not every precaution been taken to eliminate errors. The figures for full load and half load were 84·6 and 83·1 respectively. The efficiency of the motors had been separately determined by a Hopkinson test, and after making due allowances for belt losses may be taken as not less than 90·5 per cent., but this figure is not as trustworthy as the figures for the overall efficiency, and it is therefore not possible to give the exact efficiency of the gearing considered separately. The results, however, show that a very much higher efficiency can be obtained with cut gearing than is generally supposed, provided sufficient attention is given to the matter; but, of course, such results are only attainable with the best possible workmanship and design.

POWER PLANTS IN PARALLEL.*

BY R. F. HAYWARD.

Three large systems have grown up in California under the control of the Los Angeles Edison Electric Co., the Standard Electric and California Gas & Electric Cos.; the State of Utah is almost covered by the lines of the Utah Light & Railway Co. and the Telluride Power Co.; in Canada the Montreal Light, Heat & Power Co. is operating a large parallel system; and in the State of New York the Hudson River Power Co. is making great developments in this line.

In Utah, where the author's lessons in transmission have been learnt, the first water-power plant was started in June, 1896, and from the very first was operated in parallel with the steam plant in Salt Lake City. Other plants were constructed immediately after, and by consolidation and reorganisation were joined together into one system. The Pioneer Power Plant at Ogden was run in parallel with the Big Cottonwood Plant, 50 miles away, for the first time in March, 1898. Since then there has been a continuous growth of the business, until the beginning of 1904 found the two systems of the Utah Light & Railway Co. and the Telluride Power Co. running in parallel, covering a district 160 miles long from north to south and including six water-power plants, two steam plants, 420 miles of high-tension transmission line and nearly 500 miles of circuit. The maximum demand on the two systems was about 10,000kw., and the load consisted of lighting, street railway, and power for all kinds of service, including flour mills, cement works, brickyards, smelters, air-compressors, cyanide mills and other mining enterprises.

It is impracticable to operate many power plants in parallel without private telephone service between all power houses and substations. It is good practice to build independent telephone lines parallel to the transmission lines, but this is by no means necessary, as perfect service can be obtained with telephone lines properly arranged on the same poles, either with or without a grounded neutral on transmission line, and the indications on a telephone are invaluable in giving warning of impending troubles, in locating breakdowns and in indicating high-volt surges. For the telephone line itself the best of insulation can be obtained by using porcelain insulators designed for 2,000 volts lighting service, and it pays to do this. All wiring inside and outside of buildings should stand a puncture test of 2,000 volts. All plugs and jacks should be replaced by knife switches. Knife switches should be arranged so that both bell and telephone can be cut off from the line. The telephone should be connected on only when in use. For protection of telephones and operators in case of cross with high-tension lines, a simple spark-gap to ground between two large metal cylinders has been found quite effective. These should be placed in a fireproof cell or outside the building. Strength is best obtained by using porcelain insulators and No. 8 iron wire. No copper wire of less size than No. 6 B. and S. will stand the stress of weather without breaking, and iron works very well. Good service can be procured by placing telephone wires close together and transposing once in half a mile. With high-tension lines untransposed there is considerable induction between telephone line and ground. On a 45 mile 28,000-volt line in Utah, the voltage between telephone line and ground from this cause is about 1,000, but in spite of this the telephone service is perfect even in wet weather. Of course any one ground renders the line inoperative, but the transposing of the high-tension line will remove this difficulty.

For any given set of conditions, covering cost of construction of water power and price of steam coal, there is a certain load-factor at which it costs the same to generate by steam as water power. If the load-factor is less than this amount, it pays best to generate by steam, if greater by water. The load-factor of a mixed system of lighting, street railway and general power and mining service is no higher than 35 to 40 per cent. and the tendency is not upwards. Even in smelters or mining camps, where operations are carried on day and night, the load-factor is never much greater than 40 per cent.; and while flour mills, pumping plants and some other operations may be continuous, there are always many intermittent services to affect them. It is this low load-factor that limits the economical distance of power transmission more than anything else.

If a number of power plants operating in parallel were each equipped with the same kind of governor, each governor being adjusted to act on the controlling mechanism at the same time, it would be found that an increase of load would be first taken up by the steam plants, next by the water-power plants which were running on a constant stream with impulse wheels and deflecting nozzles, next by turbine plants with short pipes and ample forebay, and a long time after these by impulse wheel or turbine plants where the regulation was performed by varying the velocity in long pipes. In order to make such an aggregation of plants govern simultaneously, so that each should take its share of load variations, it would be necessary to adjust the governors of all to the time limit of the slowest plant In practice it has been found almost impossible to do this, and it will generally be found that the governing of a system of this kind is done from the largest water-power plant or by a steam plant, or possibly by both. When a steam plant is running in parallel with water-power plants it is generally necessary to have an adjustable dashpot on the governor to make the action slow, otherwise the steam engines will have to take up all the variations.

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* Abstract of a Paper on "Some Practical Experiences in the Operation of many Power Plants in Parallel," read before Section D of the St. Louis International Electrical Congress.

The requirements for good voltage regulation on a large system running several plants in parallel are: (1) Good speed regulation. (2) The control of the whole system by one engineer operating from the main receiving and distributing centre. (3) Good inherent regulation of all generators. (4) Lines of ample carrying capacity and small drop. (5) Ample transformer capacity at all points where inductive apparatus is used. (6) Low-tension distributing systems laid out for small drop in feeders, transformers and secondary mains. (7) The proper control of idle currents between stations. (8) The regulation of the power-factor, on stations or on distributing system.

If these points are all attended to, good service can be given with a mixed load consisting of lighting, railway and power service: if any one of these is neglected, bad service must result on part, if not on the whole, of the system. As regards the fourth requirement it may be pointed out that a transmission system having a large drop is justified only when the load is constant and the loss of power immaterial from a financial point of view. The fifth requirement is also fully appreciated now and all transmission men know by experience the importance of providing ample transformer capacity for induction motors which have to be started against load. With a given transformer capacity, the resistance-in-armature type of motor will start against a much heavier load than the squirrel-cage type, simply because the large starting current of the latter type reduces the voltage so much more than the small starting current of the former. In regard to the sixth requirement it may be stated that automatic feeder regulators of the three-phase induction type are being used with satisfactory results for regulating the 2,000 and 4,000-volt feeders in Salt Lake City. These regulators not only compensate for drop in feeders, transformers and secondaries, but also for speed variations caused by slight accidents or short-circuits on the system.

A great deal might be written on the subject of the seventh and eighth requirements. The operating engineer at the main receiving centre should have the control of the voltage, while the power-house operators should take care of the speed. In a mixed system of lighting, railway and power service, the maximum loads at different points of the system occur at different times. Consequently it has been found best to have approximately constant voltage at the receiving stations, to compensate at the power house for drop in transmission lines only, and to compensate for variations of drop on the distributing feeders by regulating apparatus at the receiving end. No special difficulty has been found in regulating for a mixed load of lights and induction motors. A variable load driven by an induction motor has a useful tendency toward self-regulation for the low power-factor at light loads causes nearly the same drop of volts as the high power-factor at full load.

A line of great capacity, such as the Telluride Power Co.'s 40,000-volt lines, requires a heavy inductive current at light loads to compensate for the rise of volts due to the capacity. On a single 80-mile line from this company's Logan power-house, delivering 750kw. at Salt Lake City at a power-factor of 100 per cent., the power-factor at the power-house is about 60 per cent.

On a mixed system, the power-factor can be kept at any value between 90 and 100 per cent. by the use of synchronous motors driving railway generators; but for the regulation of voltage, synchronous motors are not of much value unless used for that purpose alone, because when loaded with working current they have not sufficient current capacity for regulating. Unless synchronous motors are under the control of the power companies' operators, pumping and other regulating difficulties will be caused by wrong adjustment of exciting current. Sixty-cycle rotaries are too sensitive to be used as regulators, and to operate them in parallel without pumping, variations of speed and voltage must be very small. If any trouble occurs on a 60-cycle system it is generally aggravated by rotaries.

When operating in parallel, cross-currents between power-houses introduce conditions which may seriously affect the voltage regulation. If the exciting current of the power-houses is not properly adjusted, some will tend to produce higher voltage at the receiving end than others and idle currents will flow which will be lagging with respect to the former and leading with respect to the latter. The amount of these currents is dependent upon the relative difference in excitation, the load and the line constants. These idle currents may be eliminated in two ways: first, by adjusting the excitation of the several power-houses; second, by voltage regulators placed in circuit between the transmission lines at the receiving end, which can be adjusted to maintain the difference of voltages between lines which is required to prevent the flow of cross-currents.

Formerly the desired results could only be obtained by trial and experience. Now, however, by the use of power-factor meters on every generator on the system, the adjustments can be made with accuracy to meet any conditions of line or load. The power-factor meter has become an indispensable adjunct in the operation of all synchronous machinery on large systems.

The fact that the excitation of the power-houses depends on variable conditions on different parts of the system, seems to point to the impracticability of using any automatic device for controlling exciting currents on large parallel systems.

The trend of experience in line construction points to the use of long spans of stranded copper with steel towers, porcelain insulators and rigid iron pins. There is a tendency to increase rather than to diminish the cost of construction, so that the cost of copper and, therefore, the choice of voltage is by no means the greatest consideration in designing transmission lines. In locating a line it should be remembered that accessibility for patrol and repairs is more important than saving of distance. Between every important power house and distributing centre there should be at least two lines, and sometimes two routes are advisable. On very long transmissions there should be section switch stations (see Fig. 1) so arranged that portions of the line can be cut out for repairs without putting the whole line out of service. Unless this is done, each line must be designed to carry the maximum load transmitted with a small drop.

In systems consisting of several power plants located near one another and transmitting power to a distant point, the arrangement does not materially differ from that of a single power house. In this case it is usually best to treat the smaller plants as generating units of the most important power house, as represented in Fig. 1. In systems where the power house and distributing points are scattered, the transmission lines will take either the form of a duplicate 'bus, to which will be connected all the power houses and receiving stations, as shown in Fig. 2, or else they will be laid out in the form of a ring main as shown in Fig. 3.

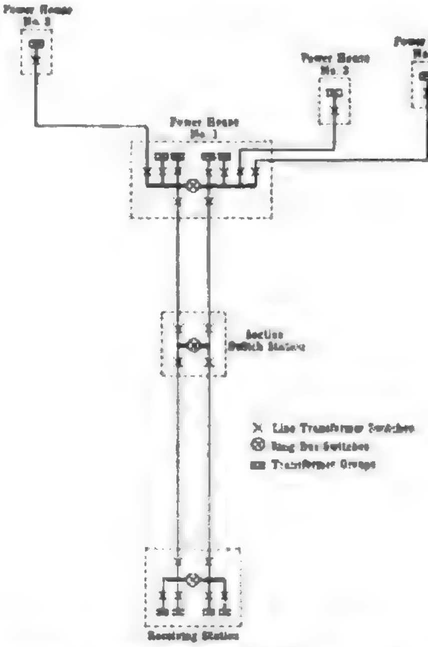

FIG. 1.—General arrangement of High-Tension Lines and Switches for a number of Power Houses in same locality supplying Power to a distant Distributing Centre.

Whether for station 'bus bars or transmission lines, the ring main divided into sections as shown in Figs. 3 and 5 has been found to be the most practical arrangement to operate. If the business between any two points on the ring becomes so important as to warrant a duplication of lines between them, the system can generally be resolved into two or more rings all passing through the important centre as shown in Fig. 4.

Fig. 5 shows the ring system as applied to power houses and transformer stations, from which it will be seen that it is practically equivalent to a group-switch system. With this layout any group of transformers, feeders or generators with its corresponding transmission line can be separated from the rest of the system in an instant by opening the high and low-tension ring 'bus switches. This arrangement in a transformer house is ideal when each group of transformers has capacity to carry all the power that can be delivered over the corresponding line.

In a well laid out parallel system no failure on transmission lines can cripple the whole system, and rotaries and motor-generators

k. S. deck ck D. deck ck S. deck		and slipper		
ruck D. deck	50	Hand and electric	2	Pai
leck S. truck	14	Hand and electric	2	The l
deck.........	30	Shoe, slipper, electric and magnetic	3	Th L
deck.........	14	Hand, slipper and electric	3	Ply C
ruck D. deck	17	Hand, slipper and electric	3	Bou k
uck D. deck (4) uck D. deck (14) uck S. deck (11)	29	Hand, rheostatic, Spencer & Hewitt, or Rhode-track, B.T.H or Westinghouse mag.	2 or 3	Th I
uck S. deck (3) uck D. deck (27)	30	Hand, rheostatic and Spencer track	3	Th I
ck S. truck (100) ck D. truck (50)	150	Hand and electric	2	Th
h D. deck (15) sh Electric Car , D. deck (3)	18	Two hand & one electric	3	Se (
ruck D. deck	12	...	2	Th
leck S. truck	49	Hand and electric	2	Th l
and D. deck	22	Hand and rheostatic	2	Th l
uck D. deck (17) uck S. deck (9)	26	Ordinary hand & electric emergency	2	Th
ruck D. deck	21	Brush standard	2	So
uck D. deck uck box and S. ck combination	50	Hand & Westinghouse magnetic	2	Th
seats, S. truck d D. bogie	86	Electric and hand	2	St
versed stair uck D. deck	30	Hand, electric, and pneumatic	...	Th
ll truck, S. ad D. deck	64	Hand and electric	2	Th
ruck D. deck	9	Hand & Westinghouse magnetic	2	Th
truck D. deck versed stairway	6	Hand and electric (emergency)	2	T
truck D. deck truck D. deck	...	...	...	T
truck D. deck	22	Hand, slipper and electric	...	T
ruck D. deck (6) ruck D. deck (18)	24	Newell magnetic, slipper and ordinary hand	2	Ne O
deck and top covered	30	Ratchet, hand and electric	2	U
deck S. truck	28	Hand, slipper and electric	3	T
ast Rack S. deck open	6	Hand	2	
truck D. deck	21	Hand (2) and electric (2)	4	T
ck, Milnes ordinary stairway (50) ck, Brush Co's stair- case (35)	85	Hand and electric	2	T
ruck S. deck (4) ruck D. deck (8)	12	Hand and electric	2	
deck S. truck (15) deck bogie (36)	51	Hand and electric and Newell magnetic	2	T
truck and D. deck	40	Hand and electric	2	
truck D. deck	15	Hand, electric and slipper	3	
deck.........	10	Hand, electric, scotch electric, hand track	4	
truck D. deck	14	Hand and electric	2	
deck S. truck	66	Hand and Newell track	2	

his Company's Act, granted in 1901, which will extend through Clenter Moor lothy. Consulting engineer, Sir Douglas Fox.

tramways. Agreement with Hove and Worthing Co. for running powers. No and circumstances are such as to render any immediate action inexpedient.

ways and for the acquisition of the undertaking of the York Tramways Co. payers. Further negotiations proceeding with the York Tramways Co., with

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ILWAYS.

REMARKS

ising the formation of a company for the construction of 3½ and Brixton. In 1903, however, the powers of the Company London Railway Co.

y Co. received powers to construct a tube railway under its sion House. In 1903 it was sought to increase considerably the sittings of the Royal Commission on London traffic, the

vers to adopt electric traction upon any of the Company's lines.

line on the surface, connecting up with the Charing Cross, Company is affiliated to the Underground Electric Railway Co. o Watford was sanctioned in 1903.

ruction of a tube railway between Marble Arch and Cricklewood, ted in 1903. It is intended to extend the line from Marble Arch nect it with the Great Central Railway terminus to Marylebone, when the London Traffic Commission has reported.

ded powers to adopt electric traction upon any of the

adopt electric traction.

were granted in 1901.

use of electric traction upon the Company's steam

ial Act last year authorising the Company to use

the construction of an overhead monorail between Manchester An unsuccessful attempt was made in 1903 to raise the neces-

on of light (electric) railways in these districts.

he construction of a tube railway under the River Tyne, hields.

by steam between Liverpool Overhead Railway and the Cheshire n. Act empowers Liverpool Overhead Railway Co. to work the service.

ugh communication between Portsmouth and the Isle of Wight, was was granted in 1904.

in 1903, the use of electric traction upon any of the d.

electric traction. 26½ miles. A joint committee of the Mersey be formed to carry out the powers of the Act. S. B. Cottrell,

LES

LIG

OVERHEA	
System. SS = side running swivelling trolley. CS = centre running trolley with swivel head. CF = ditto, with fixed head.	G Tr or c
C	
Third-rail	
SS	
SS & CS	0
SS	
Mostly CF	
SS	
...	
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SS	
Third-rail	Steel 2¼in. ⅝in.
SS	·
...	·3
SS	0 an
SS	·3
C. and bar collector	·340
SS	·
SS	
SS & CS	
CS	·4
Underground	T-secti

n" of January 20

free by post.

s V. and VI. &c., SEE OVER.

PUBLISHED ANNUALLY SINCE 1889.

F THE UNITED KINGDOM.

1904–1905.

ACTION ONLY.—IN OPERATION.

BOOSTERS.				REMARKS.	
ve.	Negative.				
Kw.	No.	Kw.		Power House Equipment.	General.
...	2	15	1	Two Admiralty Wheeler condensers (11,000lb. per hour each), with combined steam-driven air and circulating pump; steam and electric feed-pumps. 240-tube Clay Cross economisers. Hand firing. Natural draught.	Numerous curves on all routes. Very hilly in places.
...	None	...	2	Water-driven station.	No batteries. Each motor car hauls 3 to 4 trailers. By 1900 Act Newry, Keady & Tynan Light Ry. Co. was formed to purchase the line and add new lines; but no scheme yet developed.
100	None	...	3	Wheeler & Klein surface and jet condensers. Cooling towers. Blake-Knowles feed pumps. Three economisers. McDougall stokers. Washed slack, at 9s. 5d.	Lighting from separate station.
...	...	...	4	A { B. & W. chain grates. Rough slack 6/3. Green economiser. Harris purifier. Weir steam and Mather & Platt electric feed pumps. Weir and Brush condensers.	Two sub-stations: Birmingham, three 200kw. B.T.H. rotaries. Oldbury, three 100kw. B.T.H. rotaries.
...	None	...	5	B { Worthington feed pumps. Hand stoking. Fuel: Hamstead slack. Nat. draught. One 35 B.H.P. Bumsted & Chandler engine direct connected to one 25kw. 500v. shunt dynamo for night lighting.	Trolley system replaced accumulator system in May, 1901. (For **Birmingham Corporation Tramways** see Table overleaf.)
50	2	45	6	D { Blake & Knowles duplex feed pumps. 192-tube Green econ. Hand stoking. Rough slack, 6s. 9d. per ton at the boilers. Nat. draught. Wheeler condenser. Motor-driven air and circulating pumps.	{ Three sub-stations: one at Coalbournbrook near Stourbridge, containing Tudor battery (250 amps. for 3 hrs.) and Crompton reversible booster; others at Old Hill and [illegible], receiving curr. at 2,750 volts 2-phase 50 ~ from Mid. Power Co. Dudley Corporation supplies within Dudley boundary.
...	None	...	7	F { Surface condensers. Two vertical steam-driven pumps. Fuel: slack	Includes lines owned by West Bromwich, Handsworth, Tipton and Kings Norton Local Authorities, leased to the Co. Power for West Bromwich lines supplied by the Corporation.
20	1	20	8	Ledward ejector cond. Weir and Worthington pumps. Green econ. Klein 800 H.P. water coolers. Hand stoking. Natural draught.	Two Chloride accumulator sub-stations, each of 180kw. hours.
...	5	30 each	9	Wheeler surface condensers. Electrically-driven circulating pumps. Green economiser. River water. Mechanical stokers. Natural draught.	......
...	1	14½	10	Wheeler surface condenser 1,600 sq. ft. Cooling ponds with Harrison spraying nozzles. 2 Pearn quadruple-acting steam-driven pumps, 2,500 galls. per hour. Lowcock econ, 288 tubes. Vicars stokers. Nat. draught	Circular route with branches. Includes lines leased from Rochester Corporation.
...	None	...	11	Browett Lindley surface condensers. Condensing pumps, beam-geared to main engines. Worthington feed-pumps. 240-tube Green economisers. No water coolers. Bennis automatic stokers and coal conveyor. Fuel: screened slack. Natural draught	Rails partly cast-welded and Thermit welded. Under Special Act, 1903, extension of 2¼ route miles (2¾ miles single track) now under constr'n. by New Gen. Traction Co. & R. W. Blackwell & Co.
...	None	...	12	Wheeler condensers. Green economiser. Cooling pond. Electrically driven pump.	Line exceptionally hilly, running through sparsely populated district. Three locomotives and eleven trailers also in use. One car with top cover. Trigger life-guards.
...	4	70	13	Three Wheeler surface condensers, 1,500 H.P. each. Two Blake & Knowles steam pumps. One Weir pump. Two 384-tube Green economisers. No water coolers. Vicars stokers. Fuel: nut coal. Natural draught	Direct-current transmission to all except two sections. These are worked by 3-phase transmission with stationary and rotary transformers in 3 sub-stations. Includes Dublin-Dalkey line.
...	None	...	14	Water power station. Power-house also charges cells for lighting the Causeway Hotel.	Track very hilly. Overhead system. This is the first electric tramway built. Opened in 1883, with a side iron conductor rail. Altered to the overhead system in 1899. Rolling stock includes six trailers. Train seats 34 passengers.
None	22—sub-stations only	Total 660	15	Main generators 6,600 volts 25 ~. Two rotary convertors 500kw. Surface condensers, circulating and air feed pumps electrically driven. Economisers, mechanical stokers, feed water filters.	Five sub-stations, 22 W'house 500kw. rotaries, 74 W'house 200kw. transformers 30kw. negative booster coupled to each rotary. Fitting top roofs on 100 cars. Running powers over Paisley Co.
...	None	...	16	Two Wheeler condensers. Two duplex Blake & Knowles steam-driven feed-pumps. 96-tube Green economiser. No water coolers. Hand stoking. Shire Oaks steam coal. Natural draught.	Flat. Three or four sharp curves and very narrow streets through town. The power for the lines within the Borough of Grimsby is supplied from Grimsby Corporation Electricity Works.
...	...	...	17	Edwards & Barnes condensers. Worthington and Edwards & Barnes pumps. Own water coolers. Welsh steam coal. Steam blast draught during extra heavy load. Destructor supplies some of the steam.	Current supplied for driving workshop machine tools, and shop lighting. 8 trailers in use, each seating 22 to 52 passengers.
...	1	4	18	E.C.C. Jackson plunger 3-throw electric driven feed and condensing pumps. One Weir feed pump. Two Berryman feed water heaters. Hand stoking. Fuel—double-screened nuts. Natural draught.	Original line joins East and West Hartlepools. Two suburban lines in West Hartlepool. 55 E.P.S. 31K. batteries.
...	None	...	19	250-volt gas-driven station, using town gas	Bull-head rails. Train consists of one motor car and two trailers. The motor car has two 50 H.P. motors. The motor car takes 28 passengers; the trailers 41 each.
Agg. 44	...	...	20	Two elec. feed pumps and injector. 2 elec. air compressors for Westinghouse brake tanks. Battery 3½ miles from Sutton. 250 Tudor cells 209 amp.-hours capacity.	Numerous curves and continuous gradients, the longest length being 1¼ miles of 1 in 20. Line runs half distance on public roads, remainder on Company's lands. One goods car.
...	7	124·5	21	Vicars stokers Musgrave superheaters. Blake & Knowles feed pumps. 96-tube Green economisers. No water coolers. Natural draught. Woolley Moor coal 6s. 7d. per ton delivered at station.	... ..
...	None	...	22	Belliss surface condensers. 3-throw ram pumps driven by Parker motors. Green econs. Vicars and Hodgkinson stokers, all motor-driven. S. Yorks. pea nuts. Natural draught.	Track on wood stringers. Some "phono-electric" wire.
...	None	...	23	Ledward evaporative condenser. Worthington feed and condensing pumps. 96-tube Green economisers. Bennis stokers. Fuel: slack at 12s. Natural draught.	No batteries.
Total 87	...	...	24	System: 7,000-volt 3-phase 25 ~ with 5 rotary converter sub-stations, and partly direct 500 volt generation. Steam plant supplemented by 2 Victor turbines directly coupled to 83kw. gen'r and 16kw. booster. Hand stok'g. Nat. draught	Two accumulator sub-stations; total capacity 1,600 ampere-hours. Tudor cells. Thury reversible booster. Rolling stock includes 34 trailers. Entry includes Snaefell Mountain Rly.
...	...	...	25	Wheeler surface condenser. Direct-acting steam pumps. Green econ. No water cooler. Hand stoking. Fuel—slack.	......
...	2	14 each	26	Wheeler condenser. Cooling ponds, with Harrison spraying nozzles. Two Pearn duplex pumps. No economisers. Hand firing. Local coal. Natural draught.	......
Total 499	6	Total 576	27	Single-acting Fowler condensers, and double-acting Green & Weir feed pumps. Three Green econ. Bennis stokers. Slack at 7s. 7d. per ton. Steam jet draught. Graham Morton coal conveyors and elevators.	111 street arcs supplied. Thermit rail-welding much used. Dixon's point controller at six junctions. 15 cars are fitted with top covers. Running powers over Wakefield Co.
60	1	20	28	Mirrlees Watson surf. con. (25,000lb. per hr.). Elec. Edwards pumps. 3 steam Hall feed pumps. 300-tube econ'r. Bennis stokers. Nat. draught. Tudor 240-cell battery, reversible booster, with Thury regulator.	21 cars with canopy tops. Trigger life-guards.
...	...	...	29	Musgrave surface condenser. All auxiliaries electrically-driven. Green economisers. Chain grate stokers. Natural draught Remote motor	General system is 3-phase gen. at 6,600v, reduced to 550v. at sub-statns by rotaries. Power house under construction. Temp.

will stay in step through many shorts. Under normal conditions there is no difficulty in cutting generators and synchronous motors in or out of service, or in synchronising power houses on lines at any point in the system, but when everything is thrown out of step or stopped by a severe short-circuit, synchronising is altogether too slow. All synchronous motors should be self-starting from the alternate-current end, or at least should be designed so that the alternate current can be switched on after they have been given a preliminary spin. 200 H.P. synchronous motors have been regularly started without any compensators for a long time in Salt Lake City. Power-house generators can be synchronised very rapidly, but time can be often saved by running them to speed approximately and switching on to the live circuit before closing the exciting circuit. In the Los Angeles system, it is a rule to open the exciting circuits on all generators and synchronous motors, except at the largest station, whenever a short-circuit occurs. As soon as the trouble is cleared, the main station generators bring up speed and volts, the other generators and motors are pulled into step and the station operators close the exciting circuits. This is a very good method of starting, but is not applicable to every condition.

It is in clearing short-circuits on transmission lines that the ring system as illustrated in Figs. 1, 3, 4 and 5 is so superior to the duplicate 'bus system shown in Fig. 2. When a short-circuit occurs which does not clear itself at once, the ring 'bus switches can be opened up so as to resolve the system into two or more separate parts complete with their own power houses, lines and loads. This immediately locates the trouble, the short-circuited line can be quickly cut out, and the load on the short-circuited section transferred to the adjacent portion of the ring without any delay for communicating between stations. Automatic circuit breakers can be used for these ring 'bus switches with great advantage, but, except on unimportant branch circuits, they can be used nowhere else on a transmission system of this kind. Reverse-current circuit breakers for cutting out a short circuited line will not work, for under normal conditions on a parallel system power may be coming from either direction at any time.

So far as the operation of large parallel systems is concerned, it appears that the question of transformer windings, star or delta connections and grounded neutrals are likely to be settled by circumstance rather than by design. A delta-connected system can operate without a grounded neutral, a star-connected system cannot. Large parallel systems are almost certain to have both star and delta-connected transformers working together; and questions of cutting out one transformer in a bank, or of abnormal voltage caused by breakdowns, become unimportant on account of the large number of banks in use. The fact that with a grounded neutral, the breakdown of a single insulator makes a short-circuit, is not important if the lines are properly laid out, and when breakdowns occur the quicker something burns off and the line is cut out the better. Lightning arresters, transformers and switches should as far as possible be in separate fireproof rooms. High-tension wires should be covered with high-volt insulation and supported on insulators.

Short-circuits on large systems operating in parallel are liable to be more severe than on single systems, due chiefly to the extra inertia. High-volt surges may be started simultaneously from two points and meet crest to crest, and if a short-circuit occurs between two power houses it may break when the two plants are out of step and then twice the normal voltage may be suddenly impressed on the line.

The disturbances due to short-circuits, switching and static charges are trifling compared with those that may be set up by lightning discharges. It must be confessed that no real progress has been made in apparatus to protect against these disturbances, and to-day the choking effect of the transformers and the high insulation of the windings, both of the oil and air-blast type, is their own best protection. This has been demonstrated over and over again by discharges from terminal wires of transformers to case, across sparking spaces many times greater than the total gaps on the lightning arresters, and in spite of the protection of choke coils of the most recent design.

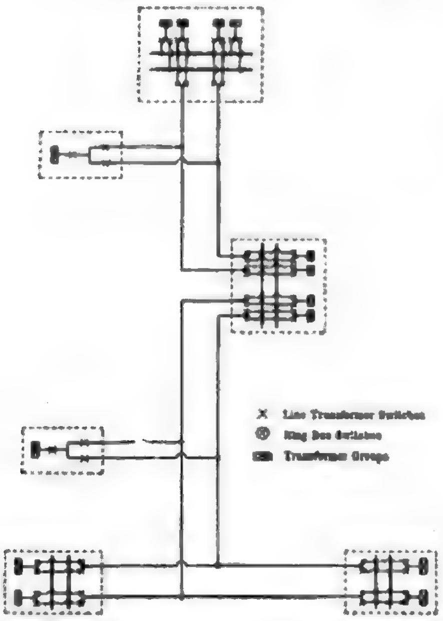

FIG. 2.—General arrangement of High-Tension Lines and Switches for a number of Power Houses and Receiving Stations scattered over a large district. Laid out on Duplicate Main System.

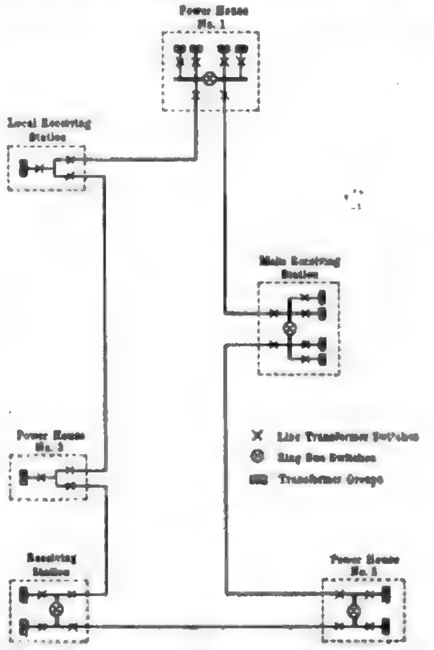

FIG. 3.—General arrangement of High-Tension Lines and Switches for a number of Power Houses and Receiving Stations. Laid out on the Ring Main System.

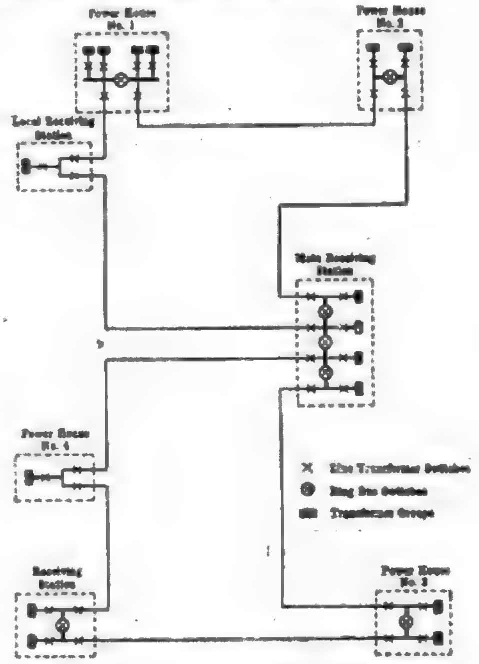

FIG. 4.—General arrangement of High-Tension Lines and Switches for a number of Power Plants and Receiving Stations. Laid out on the Ring System, with two rings passing through the Main Receiving Station.

The sudden raising of the voltage of the line to the breakdown point, due to lightning, will send static waves along the line. The voltage of these waves and the distance at which they may be effective depends chiefly upon the strength of line insulation. With wooden pole lines the insulation to ground may be very high in dry weather, and under these circumstances the static wave may be of very high voltage. Some waves have passed from line to ground across a 12in. dry air-gap on a 40,000-volt line. This has occurred on several occasions without damage to transformers.

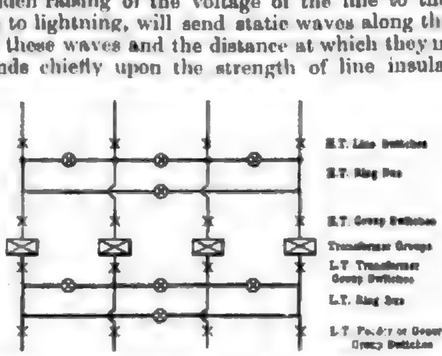

FIG. 5.—General arrangements of High-Tension and Low-Tension Bus Bars and Switches for Generating and Receiving Stations. Laid out on the Ring System.

A lightning discharge which occurs near a line without striking it may set up, by electromagnetic induction, a high-frequency high-voltage current between line and ground, the circuit being completed by the breaking-down of spark-gaps or insulation in two or more places. Under these conditions a very great amount of energy may be passed over the line in an extremely short space of time. A case, apparently of this kind, recently occurred in a small sub-station near Salt Lake City, where the station was completely destroyed by the action of the lightning and not by any current following from the power houses. It follows, from what has been written above, that the extending of a system to cover a very large area, while exposing it to the action of more storms, and consequently increasing the number of the disturbances, does not by any means increase the severity of the secondary disturbances which are limited by the insulation of the line. Transformers should be insulated between layers of high-voltage windings to withstand shocks that will break down the line insulation. Money spent on extra insulation inside the transformers will probably bring better returns than the same expenditure on outside protective devices. It seems probable that steel towers will be ideal for protecting stations and apparatus from the more severe effects of lightning disturbances.

DEVELOPMENT OF THE POLLAK-VIRAG WRITING TELEGRAPH.

The Post Office authorities have been carrying out trials with the Pollak-Virag system of rapid telegraphy with a view to investigating the suitability of this system for use on some of their routes. Full information regarding the history and the development of this very ingenious system, up to the summer of 1903, will be found in *The Electrician*, Vol. XLIII., p. 835, Vol. XLV., p. 958 and Vol. LI., p. 451. The arrangement of the apparatus, the apparatus itself and the method of connecting up the various instruments have undergone no change since our last description, but a number of improvements in detail have been made.

It will be remembered that the transmitting and receiving stations are connected by two line wires. Two circuits are made use of. The first is made up of the loop formed by the two line wires while the second circuit is formed by the two line wires in parallel and the earth as return path.

The lines are connected together at the transmitting end through an impedance coil, the centre point of which is connected to the apparatus, this arrangement being similar to that frequently employed for the signalling currents in telephone working. Current impulses of various duration and at three different voltages (the voltages being both negative and positive in sense) are sent in rapid succession through these two circuits. The two series of current waves are superposed on one another where the two circuits have conductors in common, but as the return paths are distinct the two groups of impulses do not influence each other. At the receiving end is an apparatus consisting of two pairs of coils and diaphragms as are used for a telephone receiver. Each series of current impulses acts on one of these two devices, which are fixed side by side. The diaphragms are thus set in vibration, the character of which evidently changes with the nature, frequency, &c., of the current waves in the corresponding circuit. A small vertical mirror, resting on three points, is provided in front of the two telephone diaphragms. One point is fixed, but each of the other two points of support is made to follow the movements of one of the telephone diaphragms. A beam of light is thrown, in a manner presently to be described, on to this mirror, from whence it is reflected on to sensitive photographic paper. A current impulse through circuit 1 (assuming no current to flow through circuit 2) will cause the spot of light to describe a vertical line on the sensitised paper, while a current impulse through circuit 2 (assuming no current to flow through circuit 1) will cause the bright spot to move horizontally. It is clear that the spot of light may be made to describe any kind of curve (any figure or letter, for instance) by sending current impulses of certain intensities and direction through both circuits simultaneously. In addition to these motions the spot of light is made to move at uniform speed from the left to the right of the sensitive strip of paper; the spot is produced by an incandescent lamp surrounded by a cylindrical screen which revolves about a horizontal axis, and in which a helical slit is cut. The sensitised paper is wound off its bobbin at a uniform speed. Since the slit is merely one turn of a helix, the spot travels across the paper from left to right, and when it gets to the right hand end, it starts again on the left hand side. By the travel of the paper, the line of the writing is made slanting, the beginning of each new line being in a horizontal line with the end of the preceding line. It often happens that words are cut up, one part being at the right-hand side, the remainder being at the left of the next line. In order to avoid errors from this source, the helical slot of the cylinder is a little longer than one complete turn, so that just near the end of the travel of the spot of light two spots appear at the same time, one at the extreme left, the other at the extreme right. Thus the last part of the writing on any line is repeated on the left of the new line. The sensitised paper is inserted into the apparatus in the form of rolls, which contain lengths of paper up to 82ft., the width being about 2¾in. It is stated that from about 10,000 to 12,000 words may be written on this size of paper. After being written upon by the spot of light, the paper is drawn through a developing bath and then through a fixing bath, from which it emerges nearly dry, some seven to ten seconds after being written upon. When the attendant, who may watch the process of writing through a yellow glass window, observes that the message is finished, he pulls a trigger which cuts off the photographic paper written upon, and stops at the same time the remainder from being wound off. This action of the attendant also cuts out one of the writing telephones, substituting in its place a relay which re-inserts the "telephone" and sets the photographic paper moving as soon as a starting current is received by means of an alternating current sent through the transmission line from the other end. This alternating current is produced at the sending station by a small alternator which is given a few turns by the operator previously to sending the message. It is thus seen that the receiving apparatus is started from the sending station. At the latter place there is also a small switch, by means of which the telegraphic apparatus is disconnected from the lines, ordinary telephones being substituted.

At the sending station the messages have to be punched on a paper tape, as is the case with the Wheatstone automatic. This is done by a perforator, which has a keyboard similar to that of an ordinary typewriter. A distinction is, however, this, that the actual punching is done by a powerful electromagnet, the depression of any key serving merely to establish the proper combination of punches corresponding to this particular key. There are altogether 34 punches of various diameters grouped in a close bunch, and the selection amongst these for any key is done by a number of metal combs which are provided with an unevenly distributed set of irregular-shaped teeth. By depressing a key, some of these combs shift to the right, some to the left and some remain stationary. These manifold movements—the number of combinations of which is very large—cause certain of the punches to drop, while the other punches are prevented from doing so. By fully depressing the key, the paper is drawn down upon the protuding punches and the requisite holes are thus punched. The paper tape is now drawn forward by a suitable gripping arrangement, and everything is in readiness for the next letter. The holes in the paper tape are arranged in six rows.

In the transmitting apparatus, the strip of perforated tape passes over a drum with six slip rings, and six corresponding brushes press on the tape and make contacts with the slip rings wherever there is a hole in the tape, and a succession of current impulses corresponding to the desired letters are sent to line. Three rows of holes correspond to the one circuit mentioned, while the three others correspond to the other circuit. The three different voltages which are employed for producing the current impulses are chosen according to the line resistance. We are informed by Mr. Pollak that for a line resistance of 1,000 ohms, for instance, the three voltages for the circuit producing the vertical movements of the bright spot are +30, −35 and −50 respectively, while the voltages between the three brushes and slip rings of circuit 2 are +10, −7 and −17 respectively. These figures also vary to a certain extent with the capacity of the line.

We have had an opportunity of inspecting the apparatus at the General Post Office in London, where transmitting and receiving apparatus was installed for a short time for experimental purposes. The legibility of the telegrams transmitted across the room left little to be desired. Successful tests have been carried out on loops radiating from London, the distance covered being gradually extended. Final trials have been made between London and Glasgow.

FUEL ECONOMY IN STEAM POWER PLANTS.*

BY WILLIAM H. BOOTH AND JOHN B. C. KERSHAW, F.I.C.

(Continued from page 586.)

AIR SUPPLY.

The advantages to be gained by a pre-heated air supply are very great, and it is surprising that hitherto so little attention has been given to this subject. It 1881 Hoadley, in the United States, published details of some unfavourable experimental trials relating to the use of preheated air, and possibly these unsuccessful results may have deterred others from experimenting along similar lines. But the gain in economy and efficiency by raising the combustion temperature inside the furnaces by the use of heated air is great, especially if heat otherwise wasted is applied to heat the incoming air.

The ideal system would be to reduce the exit flue gases to atmospheric temperature by means of economisers, air heaters, and preliminary feed-water heaters—chimney-draught being dispensed with and the draught produced by fans. The preliminary feed-water heaters would be placed last in such a system, and the whole of the remaining heat would be removed from the exit gases by spraying the water through them, or by use of a tower filled with tiles or flints.

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* Paper read before the Institution of Electrical Engineers, Jan. 19th

Little or no unconsumed carbon would be produced under the conditions obtaining with a very high temperature in the combustion chamber of the furnaces, and the sulphur dioxide and CO_2 absorbed by the feed water would be neutralised in the water-softening operation. It must be remembered here that the sulphur would finally appear in the boiler as sodium sulphate, but the authors suggest that it (the sulphur) might be recovered in some way, and made a source of revenue to the feed-water purification plant. The air heater would be of the type used in the regenerative gas furnace—lengthened contact with a considerable surface of heated brickwork being necessary to heat air, which is a poor conductor of heat and demands time for its temperature to be raised.

As regards the thermal advantages of heating the air used in the combustion process it may be pointed out that from 20lb. to 25lb. of air are usually required per pound of fuel burned, and if this air could be raised to 300° F. before entering the furnace the final temperature after combustion would be increased practically by a like amount. A gain of 300° F. in the furnace temperature is not to be despised.

According to Stromeyer's experiments [*] the usually accepted formula for the relation between the rate of heat transmission (a) and temperature (t) is incorrect, and in place of the former varying as the square of the temperature difference, or $a \sim (t_2 - t_1)^2$, the ratio is expressed by the formula, $a \sim (t_2 - t_1)$. Even though the ratio be not as the square of the temperature difference the formula shows that a much greater efficiency will be obtained from a high than from a low initial furnace temperature.

The most important causes of low initial furnace temperature are excessive air supply to the furnaces and too sudden contact of the half-burnt gases with the water-cooled tubes or plates. Larger combustion chambers and refractory furnace linings are the proper remedy for the latter evil, and gas-testing is the check and remedy for the former.

Furnace temperatures might, in many plants, be raised 500° F. or 1,000° F. by attention to these two points alone, but even then the limit of what is attainable in this direction would not be reached. By the use of a heated air supply in conjunction with closed-in ash-pit and induced or forced draught, much higher temperatures can be attained in the boiler furnace; and should Rowan's suggestion [†] for working such furnaces under two or three atmospheres' pressure be adopted, further increases of 715° F. and 493° F. could be attained. The possibility of obtaining far higher evaporative efficiencies from boiler plants than any yet attained, by intensifying the combustion along these lines, is therefore strikingly manifest, and it is surprising that hitherto so few attempts have yet been made to put these suggestions to a practical trial in new plants or extensions.

The authors have, however, recently inspected one plant where mechanical draught, closed ash-pits and a heated air supply have been installed. This station has recently been designed and erected under the charge of Mr. S. E. Fedden, for the Sheffield (England) Corporation at Neepsend, and is at present equipped with 2 × 1,500kw. turbo-generators of the Parsons type. It has not yet commenced full work; but excellent results are said to have been obtained with the same system of induced draft and heated air supply at the older generating station of the Sheffield Corporation, and it is believed that these results will be surpassed in the new station. A full description of this plant has already been published.[‡]

The limit of improved efficiency possible in this direction is that imposed by the ability of the steel used for boiler construction to withstand very high temperatures under steam pressures of 150lb. or 200lb.; but no doubt the resisting qualities of steel plates in this respect could be greatly improved, and the more general use of refractory linings to the boiler furnaces would also assist in meeting this difficulty.

BOILERS AND FURNACES.

The choice of a boiler will depend on the circumstances of each particular case.

There are three general types of boilers:—(*a*) The large shel type such as the Lancashire and Marine. (*b*) The large water-tube. (*c*) The small water-tube.

For long-continued steady work such as electric tramway work the type (*a*) is good. For lighting work and large installations type (*b*) is good. Type (*c*) is suitable for the peaks of loads of short duration, and can be heavily forced without danger.

In every case there are certain stand-by losses to be reduced by attention to airtight brickwork and heat insulation. The rate of loss can be found by closing the dampers and observing the rate of pressure or temperature reduction of a standing boiler. The losses thus observed may be greater than those from a boiler at work, for they include air-leakage loss, which may be less with a working boiler than with one at rest. That a boiler contains much heat in a large mass of water is no reason why its stand-by loss should be great. Small stand-by loss is rather a question of external heat radiation and of convection by air currents. Hence the importance of tight dampers. The type of boiler to be employed is less a matter of heat storage than of rapidity of steaming from colder conditions. Once the temperature of full pressure has been attained, the boiler containing much water will answer as rapidly as the flash boiler to an increased urgency of fire. The conditions of an electric light station may be held to point to the use of light water-tube boilers of the express type fired by liquid fuel. This policy will be the more suitable as the load peak becomes of greater height and shorter duration. The expense of fuel will be counterbalanced by the staff reduction which a purely mechanical plant renders possible.

The economy to be secured by employing cheap and uneconomical engines for getting over brief peaks of the order of those in a lighting station must not be allowed too great weight in view of the fact that a wasteful engine makes a greater demand on the boilers and too big a saving in engine cost will demand too great an expense in extra boiler power or too large an increase of fuel combustion if the boilers are unduly forced to supply the extra steam. But it may well form a point to be considered whether a boiler that can be heavily forced for short periods is not most suitable for high peak loads. On this point engineers should distinguish between an installation for home and for abroad. Abroad, in many places, one need often only count upon forcing boilers for the few minutes either side of the maximum peak. The same forcing cannot be done for hours at a time, as might be required any winter in a big English city during a fog which may last a week. It behoves the designer, therefore, to proportion boiler plant cautiously for lighting work, and somewhat more boldly for mere power work. But he should certainly consider the possibilities of superior fuel used for short periods only.

Where coal is the fuel the provision of a second supply will present difficulties that may be more serious than the provision of more boilers; but with a system of liquid fuel, the conveyance of the fuel to the furnaces is a simple matter, and it may well pay to employ expensive liquid fuel during heavy loads of short duration, if capital outlay is thereby reduced together with rent and attendance.

This seems for Great Britain at least the proper use of liquid fuel, and this view is forced on us by a consideration of the relatively small output of liquid as compared with solid fuel. Any more general employment of liquid fuels would deplete the market and raise prices.

The Lancashire Boiler.—This type of boiler has the advantage of larger water contents, and will respond to a sudden demand for more steam with less loss of pressure than is possible with boilers containing less water. In every type of boiler the water is at the temperature of the steam, and only awaits the addition of its latent heat to become steam. Obviously, therefore, the urging of the fire to greater activity will promote an increased production of steam proportionate to the increase of heat units generated by the fire, no matter what the weight of water in the boilers.

The Lancashire or shell type of boiler has the advantage of small heat-radiating surfaces, especially where several boilers are set in a battery. With most water-tube boilers there are at least two side walls to every two boilers. There are only two side walls to any number of Lancashire boilers, and heat radiation is confined to the front end and top. The chief disadvantage of the Lancashire type of boiler is the furnace. It is narrow in width, has a low crown of water-cooled plate inimical to good combustion, and it cannot be lined with firebrick without considerably reducing its dimensions, nor so far do we know of any very successful lining having been done in this country except in dust firing.

The shell boiler has a large water surface, and gives off steam quietly and fairly dry. It costs very little to maintain, and, being certain and reliable, can be employed with a less proportion of spares than other boilers. In large installations the advantage of a larger water contents is reduced because the steam output of dozen or 20 water-tube boilers may average out to a steady curve. But for small stations the shell boiler offer better prospects of steady pressure.

The Water-Tube Boiler.—Though this boiler does not possess the steady steaming qualities of the larger shell boiler, this fault decreases as the number of boilers increases. It is more apt to prime, and it has greater liability of stand-by losses and larger radiation losses and maintenance. Being externally fired, it possesses great furnace potentialities, which are easily secured. The water-tube boiler can take full advantage of the external furnace provided that the process of combustion is allowed to be carried out in conformity with the known facts of physics and chemistry.

The Small-Tube Boiler.—This boiler is merely another step forward in the process of splitting up the heating surface and reducing water contents. Carried to still greater lengths, it produces the flash boiler.

As the water contents are small steam can be got up quickly from cold water, but even here, as shown in Fig. 1, considerable heat is absorbed by the brick lining of the casing, so that the full output of steam does not begin until the boiler has been some time steaming. Hence the bend at the beginning and end of the coal and water lines in the diagram, showing heat absorbed and given off by the brickwork. These small boilers appear to offer themselves for supplying emergency steam. Fired by liquid fuel, some of these boilers, such as the Solignac, could instantly be put in full work if filled up with fully heated feed-water from a thermal store tank. The full fire might be started almost as soon as the water had been turned into the empty boiler.

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[*] Memorandum to the Manchester Steam-users' Association, 1902.

[†] *Cassier's Magazine*, December, 1903.

[‡] *The Electrician*, Vol. LIII., p. 465.

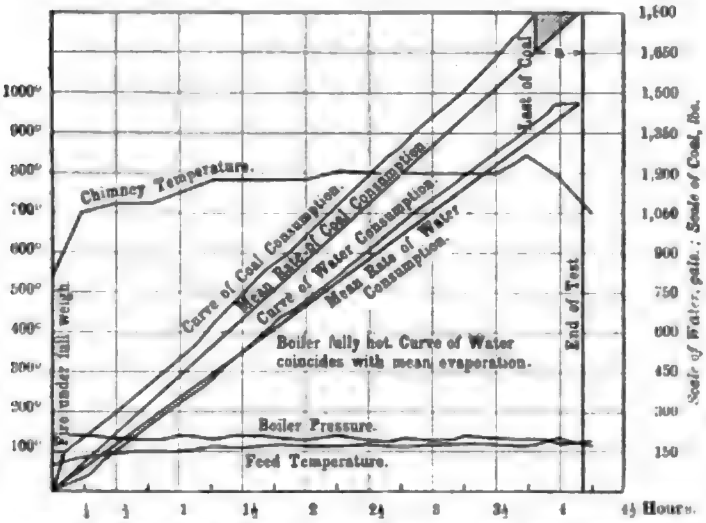

FIG. 1.—Boiler test. Curves showing heat storage in brick casing of Solignac Boiler.

FURNACES.

The economy possible from many appliances lies entirely in the possibility of using a cheaper fuel. Unscientifically designed furnaces are unfortunately of lowest first cost. There are certain essentials to the perfect combustion of bituminous coal which, if wanting, render necessary more expensive Welsh coal. The three essentials for the proper use of bituminous coal are a furnace so arranged that the gases given off the green fuel and air to burn those gases shall travel over the length of the fire together, under a draught velocity of not less than 30ft. per second. The mixed gases must have a free unencumbered space beyond the furnace in which to complete combustion, and this combustion will be complete if the third essential of temperature be present.

In shell boilers of the Lancashire type without cross tubes, with roomy brick flues and a 200ft. chimney, a careful hand stoker will burn bituminious fuel without smoke. But this boiler has a water-cooled furnace, and is at just about the critical point as regards smoke production. With a less skilled man or a less active draught smoke will be produced. The presence of water cross-pipes beyond the bridge will render smoke still more easy to produce. Observations of some thousands of boilers, with and without cross-pipes, have demonstrated to the authors the great influence of this detail on smoke production.

The ordinary furnace of the usual types of water-tube boiler is hopeless. No perfect combustion can possibly take place where the gases rise vertically from the grate and pass directly between the cold tubes above. The essential sweeping effect is absent; there is no air mixture, and there is no sufficient temperature. Yet almost invariably this common and inefficient setting is accepted for the few pounds of saving effected in first cost, with the result that the whole cost of the boiler in a year or two is paid away in the shape of more costly coal.

The water-tube boiler, in common with most or all externally-fired boilers, can be supplied with a furnace of perfect form, of refractory material, and with suitable air admission. Such a furnace will be smokeless and economical. The water-tube boiler has thus undoubted potential advantages over the shell boiler which has a furnace, perfect it may be in form, but covered with a water-cooled arch difficult to line with refractory temperature-conserving material (Figs. 2 and 3). That air mixture and time are recognised to be factors may be judged from the fact that, in the Belleville boiler, jets of compressed air have been blown into the furnace to produce rapid horizontal movement and mixture of the gases, and to compel combustion by lengthening the path of the gases between the fire surface and the water tubes. The effect of the air jets is to diminish smoke, but they are a poor and uncertain substitute for proper form of furnace. The familiar class-room experiment of extinguishing a candle by cooling the flame by means of the heat-radiating power of a cone of wire helps one to realise the conditions under which bituminous coal is ordinarily burned.

As between Welsh coal and bituminous, the thermal units of the latter per unit of cost are usually superior to those of the former, and it is easy to understand why large power-stations prefer to pay an occasional £100 in smoke fines rather than to abandon one coal for another of twice the cost, though it is less easy to understand why correctly formed furnaces are not employed. In existing stations, with floor lines fixed, basements occupied, and pipes difficult to alter, the change to good furnace conditions may involve considerable difficulty, but, in laying out new plant, it should be possible to afford the necessary head-room to give good furnace arrangements. The appearance of 99 out of any 100 boiler-houses tends to the impression that the designer has acted on *laissez-faire* principles, or has been denied the small additional cost that would be added to the lowest tender which, irrespective of future trouble and expense, rules his employers' judgment.

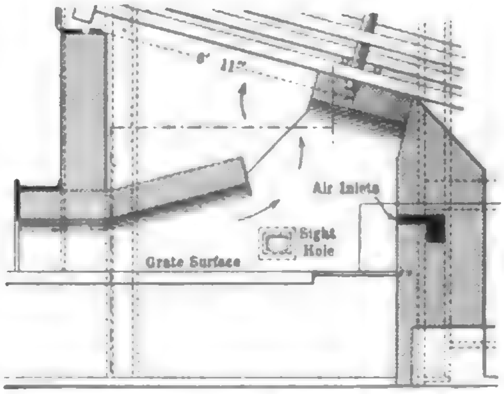

FIG. 2.—Refractory Furnace of Babcock Boiler (Kensington and Notting Hill). Form—Correct. Environment—Good.

In running a station, coal is one of the principal items of cost, and the ability to employ cheap coal justifies a reasonable expenditure on furnaces to enable such cheap coal to be used. Only, however, by suitable furnaces can the minimum of cost be secured, and the great economy usual as between Welsh and bituminous coal, is only to be had where furnace forms, draught, and lining are correct. Possible only with care in internally fired boilers, this correctness is easy to obtain with externally fired boilers, but is rarely attempted. Smoke is looked upon as inevitable, and the engineer may make all the smoke he wants if he can show that he has used ordinary plant.

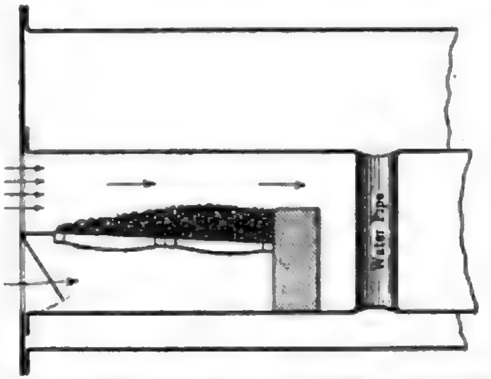

FIG. 3.—Ordinary Furnace of Lancashire Boiler. Form—Correct. Environment—Bad.

Heating Surface Efficiency.—Particularly in water-tube boilers, provision must be made to ensure that all heating surface is effective. Gases from the furnace will flow by the path of least resistance to the chimney, and while this path must not be unduly baffled, the area of the path must be sufficiently small to compel the travelling gas to search out every part of the heating surface.

It is perhaps easier to apply suitable tile baffles where the path of the gases is parallel with the tubes than when it is across them. Since the gases shrink in volume as they traverse the heating surface, the cross-sectional area of this space should be progressively reduced if necessary, to prevent short-circuiting. Where final temperature is high after passing a reasonable area of heating surface, the explanation may be sought partially in this direction.

(*To be continued.*)

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Electrode Potentials.—In view of the fact that the investigation of the dependence of electrode potentials on current density is one of the most important problems of contemporary electro-chemical research, it is very desirable to have independent methods for the determination of the rate at which changes of concentration occur in the layer of electrolyte adjoining the electrode. When the diffusion coefficients required for calculating these changes of concentration are not known, the most reliable method for arriving at an estimation of their rapidity is afforded by the investigation of the behaviour of stationary liquids free from convection currents. This method has been adopted by H. J. S. Sand for the examination of copper solutions. To avoid convection currents he placed the cathode horizontally at the top of the apparatus and connected it with the anode through a combination of narrow and wide tubes. He measured the potential of the liquid by tapping off a portion near the electrode and leading it up to a standard non polarisable electrode. When the salt has been removed from the electrode by the current, a sudden drop of the potential of the electrode takes place. The diffusion coefficients of the salts experimented on may be calculated when the time is known which elapses until the concentration of the salt in the layer of liquid at the electrode becomes zero, and this time may be taken as that at which the break in the curve takes place. For the diffusion coefficient of copper at 18deg. the author found values varying between $4{\cdot}45 \times 10^{-6}$ and $4{\cdot}86 \times 10^{-6}$. The author applied his results to find out whether concentration changes are sufficient to account for results obtained in various electro-chemical investigations. He finds that if the concentration of a liquid is maintained continually at its original value by stirring at 0·1mm. distance from the cathode, it cannot be lowered more than 5·3 per cent. Thus in Haber's experiments changes of concentration amounting to 86 per cent. cannot have taken place, and the variations of electrode potential with current density observed by him can therefore not be explained as the result of concentration changes at the cathode.

[H. J. S. SAND, *Philosophical Magazine*, January, 1905.]

Measurement of Small Alternating Currents.—W. Duddell describes two new instruments for measuring small alternating currents of high frequency, such as telephone currents and some currents used in wireless telegraphy. The first is based upon Ayrton and Perry's twisted ribbon instrument, but it is compensated for errors due to change of temperature and its zero is constant. It indicates currents of less than 1 milliampere and is very portable. In the second instrument, a resistance traversed by the current to be measured heats by radiation one of the junctions of a Boys' radiamicrometer, and so produces a deflection. The resistance, which may be of platinum or kruppin, is 3mm. or 4mm. long, and has a resistance of about 10,000 ohms. This instrument is much more delicate than the first, and responds to noises in a telephone or to the small currents produced by whistling into it.

[W. DUDDELL, *Journal de Physique*, January, 1904.]

Ponderable Emanation.—G. W. A. Kahlbaum and M. Steffens describe some experiments which tend to confirm Blondlot's discovery of a ponderable emission by solid bodies which is capable of producing a photographic effect. The method used consisted in placing a sensitive plate in a horizontal position, and over it a piece of paraffined paper, a number of strips of various metals, another piece of paraffined paper, and another photographic plate with the sensitive side downwards instead of upwards. On developing after an exposure of five days, the lower plate showed more or less blackened images of all the strips, and the upper plate none. The metals employed were aluminium, zinc, iron and lead. Zinc produced an impression on the upper plate when the latter was not protected with paraffined paper, and aluminium a feeble impression, but the other metals produced no impression at all on the upper plate, though they produced a strong impression on the lower plate. The upward action of zinc and aluminium may be stopped by exposing the strips for 15 minutes to X-rays or radium rays. The images are produced equally well when the sensitive plates are freely suspended, instead of being enclosed in a box. The authors even succeeded in obtaining two successive impressions, by placing two plates below. The second plate showed a distinct impression through the glass and the emulsion of the first plate. If the impressions are due to a ponderable emission, that emission must be in a much more finely divided state than any state hitherto known. If the emission is projected, it must, as Blondlot pointed out, be projected with a certain velocity, and if the particles are projected horizontally under the influence of gravity, they must describe parabolic paths. The authors endeavoured to determine these paths by placing two sensitive plates vertically and pretty close together, and mounting between them a piece of lead foil, touching the one at one vertical edge and the other at the opposite vertical edge, so as to make equal angles with both. The images then obtained showed a variation of width amounting to several millimetres. The authors also endeavoured to increase the action of the gravitational force by adding to it a centrifugal force. For this purpose they swung the box containing the two plates and the metal in a vertical circle of 70cm. radius with 120 revs. per min., and found a distinctly increased effect. This would go to show that the ponderable emission also possesses ordinary inertia, but the authors warn against hasty conclusions on account of the extreme difficulty and delicacy of the experimental work.

[KAHLBAUM and STEFFENS, *Physikalische Zeitschrift*, January 15, 1905.]

Law of Brightness.—R. Lucas harmonises Rasch's empirical formula of brightness with the Wien-Planck law of the distribution of energy. In Rasch's formula

$$\text{Log } \Phi = c - (K/T),$$

Φ is the total brightness, T the absolute temperature, and c and K are constants. Rasch calls this the fundamental psycho-physical law. Now, Wien's law for monochromatic light may be put into the form

$$\text{Log } J = c - (K/T),$$

and then $c = \log(c_1 \lambda^{-5})$ and $K = c_2/\lambda$. Wien's constant c_2 has a value of about 14,500. For visible light, extending from $384\mu\mu$ to $768\mu\mu$, K lies between the limits 37,730 and 18,870. From Lummer and Pringsheim's data, Rasch calculates a value intermediate between these—viz., 26,750. On calculating the "mean" wave-length from the equation

$$26{,}750 = 14{,}500/\lambda,$$

we obtain $\lambda = 542\mu\mu$, a value which is remarkably close to the point of maximum sensitiveness of the retina ($\lambda = 535\mu\mu$).

[R. LUCAS, *Physikalische Zeitschrift*, January 1, 1905.]

Sensitiveness of a Galvanometer.—It is usual to express the sensitiveness of a galvanometer in such terms that with a certain resistance and distance of the scale it is stated what fraction of an ampere or coulomb corresponds to a deflection of 1mm. This has the disadvantage that the greater sensitiveness is expressed by the smaller number and vice versa. The sensitiveness of a balance, on the other hand, is expressed by the deflection, in scale divisions, produced by 1 milligramme at a certain charge. This gives the greater number for the greater sensitiveness. Some years ago Du Bois and Rubens, in conjunction with Ayrton, Mather and Sumpner, proposed a method of indicating the sensitiveness of galvanometers which is free from this objection. This method has not been adopted since, probably because it was not advanced as an independent proposal but formed part of a larger work. Max Iklé now urges its acceptance, and formulates it as follows:—The sensitiveness for current is the permanent deflection in scale divisions per microampere when the distance of the scale is 1,000 scale divisions and the complete period is 10 seconds; the ballistic sensitiveness is the deflection in scale divisions per microcoulomb when the distance of the scale is 1,000 scale divisions and the period is 10 seconds. The resistance of the coils is eliminated by introducing the normal sensitiveness of a galvanometer of 1 ohm resistance. The quantity at present usually called the "sensitiveness" of the galvanometer $\left(\frac{1}{S} \times 10^{-6}\right)$ might be in future called the "scale value" or "constant" of the instrument.

[M. IKLÉ, *Physikalische Zeitschrift*, January 15, 1905.]

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ELECTRIC TRACTION IN LONDON.

One of the most striking peculiarities of London considered as an entity, is its remarkable freedom from self-consciousness. The average Londoner knows less of the daily incidents of any part of the City, other than his business or residential quarters, than he learns of those of second and third-rate provincial towns if his morning train journey is long enough to exhaust his particular halfpenny sheet. And not only daily incidents, but slow movements that eventually change the face of the town and alter the conditions of life, of business and of pleasure, work themselves out almost unperceived by the great mass of the people. The reasons for this state of things are not all on the surface; mere size does not seem a sufficient explanation, for the other great cities of the world seem to have a stronger sense and more vivid feeling of their life progress.

We are thinking of one change which is being wrought almost silently and in darkness, the results of which will soon begin to be felt—results which should go some way to make London less a province of houses and more of a human society than it has been for the last 60 years at least. Speculation on the social changes and alteration of habits that may be brought about is a tempting theme, but we must look at more material results. Within a few months there is every reason to believe that underground electric railways will encircle Central London and also cross it on lines cutting some of the most densely populated districts and busiest resorts of men, linking up suburbs that have been hours apart. The dweller at Clapham who has had to catch an early morning train at Paddington or Euston—or, worse still, to get to his home late at night from those remote termini—will not feel so unhappy at the prospect of these crossings when the tubes offer him a dry, speedy run at less than 'bus fare rates. Other changes will readily suggest themselves to the imaginative Londoner when he realises the number and lay-out of the tubes now in course of construction, and the difference in comfort and time between a steam and an "electrified" Inner Circle.

A lecture delivered by the Hon. R. P. PORTER at the Society of Arts last week was apparently designed to arouse the interest of the average man, and to create some anticipations of a good time coming as the result of the burrowings in progress. It was popular and not technical, but the popular aspect of such works must be considered by the thoughtful engineer, who realises that the application of the forces of Nature to the service of his fellows is his chief end. The congestion of London traffic and the best methods for its relief have been the study of a strongly-constituted Royal Commission for the last year and a-half. Merely to look through the great pile of evidence offered to that body gives one the feeling that it might fairly take as long again to consider its report, or even fail to come to any coherent conclusion at all. But the earnest application of capable minds even to such a complex problem must result in some straightening out, and some clearer statement of the problem itself, - the first step either to its solution or the demonstration of its insolubility. We may even hope for some definite proposals so convincingly right that the obstructions of prejudice, vested interests and sectional feeling will have no chance against them. That the Royal Commission will find a panacea for all the troubles of London traffic in any one device is not to be expected; we may, perhaps, anticipate, however, that a new Board will be created as a result of the Commission's labours, whose one business will be to meet the needs of London traffic.

In the meantime, while the Royal Commission has heard much evidence, and even long before it was appointed, work has been steadily progressing, which will have a marked effect upon our traffic, and will have to be reckoned with in any future general arrangement. We will confine ourselves to electrical schemes. First comes the existing deep tubes. The City and South London was the pioneer, not only in London, but in the world. We have before now pointed out the excellent technical results attained in the face of much discouragement. The story is one of which the English engineer may be proud. The usefulness of this railway to the population served is well shown by the growth in passengers, the annual number carried having risen from 5,000,000 to 21,000,000, the latter figure including the traffic on the extended line to Islington. The further extension to Euston and King's Cross will doubtless bring about a more than proportional increase in traffic, for Euston will then have for the first time a speedy direct railway connection across the City and the Thames. The Central London Railway has touched a larger mass, and has sprung into a position of greater importance, paralleling, as it does, the most important line of street communication from the western suburbs to the centre. Its traffic in 1904 was well over 50 million passengers. The Great Northern and City Railway has hardly had time to develop its full capacity. The suburbs it serves having already two steam railways to City stations, its growth may be less rapid than that of its east and west forerunners. But already the traffic is at the rate of 14,000,000 annually, and the 20 millions originally estimated for will doubtless be reached soon enough. Of the work in hand, and near completion, the electrification of the Metropolitan and Metropolitan District lines stands first in magnitude and importance. The present travellers on the underground lengths of these railways use it only because they have no practicable alternative as to time and cost. Electrification will make a great difference in that respect,—dirt, darkness and Stygean smells will give way to pleasanter surroundings. Higher speeds, better service, and lower fares will add to comfort, convenience and economy. We shall not be surprised if complaints of overcrowding arise before the regenerated lines have been in operation many months. Of the new tubes the Baker Street & Waterloo line is rapidly approaching completion, and the Great Northern & Brompton and the Charing Cross & Hampstead railways are making good progress. Probably 18 months hence all will be open for traffic.

The facilities which these tubular railways will afford cannot be properly appreciated by considering only their individual positions on the map. Communicating stations will admit of easy change from one line to another, and, if common sense rules the managements, through booking will encourage the fullest use of these facilities. Already at the Bank station, the City & South London, Waterloo & City, and Central London are thus connected. At Moorgate Street the Great Northern & City and the City & South London have not only subway connection, but through booking. A ticket may be bought at Clapham Common for Finsbury Park, and there is no need to look up "Bradshaw" for connecting trains.

In the future, the Baker Street & Waterloo will connect with the City & South London at the Elephant & Castle, with the Waterloo & City and the South-Western at Waterloo, with the District at Charing Cross, with the Brompton & Great Northern at Piccadilly Circus, the Metropolitan at Baker Street, and the Great Western at Paddington. This is a sample, and a study of the tube map opens up possibilities of ease and rapidity of getting across London that quite excite the imagination. No longer will old friends parted by the seven miles between Hampstead and Clapham manage, at the cost of a Sabbath day's journey, to see each other two or three times a year—or meet for an evening hour with as long again to spend in the rattling 'bus or the costly cab. Friendship, affection and public spirit will all gain. A few figures as to the time which such cross journeys are expected to take will bring home to anyone who travels between the points named some of the possibilities and the changes which they will entail. The figures were given by Mr. PORTER, who speaks with some authority:

Hammersmith to Piccadilly 20 minutes, Hammersmith to King's Cross 30 minutes, Charing Cross to Euston 10 minutes, or to Hampstead 19 minutes, Elephant and Castle to Paddington 25 minutes. It is beyond question that this network will prove an enormous boon to long-distance London travellers, but how will it affect the congestion in the central areas where the evil is most serious? Clearly the tube passengers will all come to the surface somewhere, and most of them to the streets already crowded. It may be granted that there will be some relief to the streets in respect of the passengers crossing the centre of London by the tube lines, but these do not to-day form a very large proportion of the whole. By an analogy the traffic facilities to be afforded will be rapidly taken up by the natural increase of population and the new traffic will create added facilities. The Central London is a case in point. The omnibuses on the parallel streets were nearly as many in 1903, three years after its opening, as they were in 1895, five years before. According to the evidence of the present Lord Mayor, the omnibus traffic in passengers very rapidly recovered the temporary effect of the tube competition. Probably no one will say that the streets from Oxford Circus to the Bank are less congested to-day than they were in 1899. Yet 337 trains, equal to 4,381 omnibuses, run to the Bank every day. There appears to be little reason to suppose that the additional tubes will relieve the streets much more than those now in operation have done.

There seems to be no really practicable way of diminishing the number of people using the streets in the central congested area during business hours, and when the facts are carefully considered we think it will be recognised that no such effect can be expected from anything short of an extensive decay of the commerce and population of the great city. To get from suburban residences to central shops and offices, to get from suburb to suburb, or from one railway terminus to another across the centre, the tube lines and electrified Undergrounds will fill a most useful place, but to improve the surface conditions some thing else will be needed. How far tramways may be practicable within the central area is a controversial question on which we do not give a dogmatic opinion, but on which we hope the Royal Commission report will afford clear and well-seasoned guidance. It is quite certain that such an incomplete tramway system as now exists in London could be made vastly more effective by some moderate extensions and linking up. A single authority having the powers of one of the great provincial Town Councils would have made much greater progress than has been possible to the London County Council, hampered as it is by the veto of the 29 road authorities and by a certain amount of political feeling which should have been kept out of the consideration of London traffic facilities.

If the Royal Commission's report does no more than lead to a reasonable and practicable solution of this tramway question it will have justified its existence. If beyond this it results in some central control, unifying and co-ordinating all the available powers and methods, it will indeed have deserved well of the country and be worthy of monumental celebration.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Modern Electric Practice. Edited by Magnus Maclean, M.A., D.Sc. Vols. IV. and V. (London: The Gresham Publishing Co.) 9s. each.

In Vol. IV. of this series the applications of electricity in the propulsion of vehicles are dealt with by five different writers. Mr. J. Everson Winslow is responsible for the articles on overhead construction, tramway feeders and surface-contact systems; Mr. A. G. Seaman for that on conduit systems; Mr. H. C. Buckmaster, rolling stock and equipments; Mr. W. W. Beaumont, electric boats and motor cars; and Mr. Philip Dawson, electric traction on railways. In the pages devoted to overhead construction there is a large amount of valuable information, and the author is to be congratulated on the practical manner in which he has dealt with his subject. Guard wires receive rather sharp criticism, it being maintained that the actual amount of protection afforded by them is in most instances very slight. Co-operation between owners of tramways and owners of telegraph wires is urged, and Mr. Winslow argues, not unjustly, that tramway authorities should not be compelled to bear the entire burden of protecting other people's property. Safety devices for earthing broken trolley wires receive scant attention, and are condemned as being little better than useless. The chapter on tramway feeders is also excellent in many respects, but might well have included more detailed information regarding the application of boosters. All the principal surface-contact systems are described and copiously illustrated by diagrams. An exceedingly sensible view of them all is taken by the author, who concludes by saying that none appear to be entirely satisfactory for application to an extended and complicated system of tramways. In his descriptions of conduit systems, Mr. Seaman has dealt impartially with a subject which caused no little controversy among tramway engineers and others a few years ago; in comparing the cost with that of an overhead system he does not fall into the common error of basing his calculations upon the capital expenditure per mile of single track. That portion of the book by Mr. H. C. Buckmaster dealing with rolling stock and equipments can hardly be considered up to the standard attained by the previous chapters. Admittedly, the subject is one which it is not easy to cover adequately in a few pages, but even so, there are several important points which have either been omitted altogether or alluded to in only a cursory fashion. Mr. W. W. Beaumont disposes of electric boats and motor-cars in 24 pages, and in view of the limited application of electricity to these vehicles this share cannot be said to be disproportionately small. Some interesting details of the Immisch electric launches are given, these little craft being provided with accumulators and motors which permit of a speed of about 8 miles per hour. The average draught is not more than 2ft. 6in., and they are arranged to run for 30 miles on one charge. Mr. Beaumont has written his contribution to "Modern Electric Practice" in a semi-popular style, and this is to be regretted since the work is intended solely for engineers. For instance, he informs his readers that when the batteries of electric launches are charged in series with a resistance "there is a great waste of energy entailed"! However, he may be forgiven this defect of scarcity of technical details, owing to the fact that there are so few to give. In his article on electric traction on railways, Mr. Philip Dawson touches upon the question of boosters, but does not give the technical information concerning them which is lacking in Mr. Winslow's article. It must be confessed that Vol. IV. is disappointing from a technical point of view, as the majority of writers have adopted a semi popular style, and have refrained from entering into details to any great extent.

As a frontispiece to Vol. V. the photographs of the various contributors are reproduced on two pages of art paper, and the chapters and their authors are as follows:—"Steam Boilers," by J. K. Stothert; "Steam Engines and other Prime Movers," by H. O. Beckh, M.A.; "Condensing and Auxiliary Plant," by W. H. Booth; and "Electro-chemistry and Electro-metallurgy," by John Shields, D.Sc., Ph.D., F.I.C. Just 70 pages are devoted to steam boilers, and there is a great deal of useful information given therein. Various types of shell and water-tube boilers are described and illustrated (one notable omission, however, being the "Climax" boiler), and there is a chapter on the care of boilers. Mr. H. O. Beckh gives excellent descriptions of modern high-speed reciprocating engines, but there are less than three pages on steam turbines, and the details are very meagre. Nothing whatever is said of the Curtis turbine, and the author has certainly not done justice to a subject of such great importance. The chapter on condensing and auxiliary plant deals with this subject in as much detail as can be expected in this class of book. Various kinds of condensers, air-pumps, economisers, feed-heaters, feed-pumps, &c., are described and illustrated. The last section of the volume, electro-chemistry and electro-metallurgy, is covered in 54 pages, and consists of brief outlines of the various processes which have been suggested and used since water was first electrolysed by Carlisle and Nicholson in 1800.

Maxwell's Theory and Wireless Telegraphy. Part I. Maxwell's Theory and Hertzion Oscillations, by H. Poincaré, translated by F. K. Vreeland. Part II. The Principles of Wireless Telegraphy, by F. K. Vreeland. (London: Archibald Constable.) 10s. 6d.

Telegraphie und Telephonie ohne Draht. By Otto Jentsch. (Berlin: Julius Springer.) 5 marks.

These two works are in some degree supplementary—quite accidentally—to one another. The volume of Messrs. Poincare and Vreeland has as its aim the elucidation, so far as elementary methods allow, of electromagnetic theory and the rationale of Hertzian telegraphy, technical detail being avoided; while that of Ober-Postinspektor Jentsch is mainly a description of the apparatus used in all sorts of telegraphy and telephony without wires.

That portion of the former book which deals with Maxwell's theory is a translation by Mr. Vreeland of M. Poincaré's contribution to the French "Scientia" series of manuals. The translator has carried over very happily a great deal of the charm and sparkle and all the lucidity of the French original; and he has considerably helped his readers by the generous provision of numerous new diagrams. Of M. Poincaré's treatment of Maxwell's theory we may say at once it is intended for the electromagnetic infant in arms. M. Poincaré opens with a wail expressing the fruitlessness of attempting to find a complete dynamical explanation of electrical phenomena, and passes on to a gibe at the English taste for concreteness in attempts to illustrate electromagnetics. Forgetting the sneer, he then plunges into a series of analogies involving pails of water, pipes, taps and pendulums, which are used so ably as completely to justify the soundness of that English taste before alluded to. And having thus carried the beginner into the mechanics of electrical oscillations, the author sketches with very light touch the history of the experimental physics of electromagnetic radiation, and tells rapidly the tale of its identification with light.

To the narrower issue of the story of wireless telegraphy Mr. Vreeland applies himself with more satisfying thoroughness. He brings to his task much of the lucid spirit which animates the preceding half of the book. Unencumbered by needless detail and aided by excellent analogies the reader sees the inner working of modern wireless telegraph systems unfolded before his eyes with a clearness, and, withal, an accuracy, not hitherto, we think, vouchsafed to the beginner. Indeed, many wireless experts might here find assistance in the crystallising of their ideas. The scope of the work is shown in the fact that one-third of the space available is devoted to selective methods. In the discussion of these especially the writer shows his grasp of his subject and his working knowledge of the peculiarities of oscillations on wires.

Mr. Otto Jentsch in his "Telegraphie und Telephonie ohne Draht" seems to have set himself the task of describing all the varieties of wireless telegraph machinery that have existed in fact or on paper. He has acquitted himself with German thoroughness. The book is a compilation from patent schedules and current periodicals of details of all kinds of big systems and little systems, and sometimes unimportant information crowds out more valuable matter. In every respect, throughout the whole work, ample justice is dealt to German workers in this field. To the different modes of electrical signalling treated, separate sections are devoted, each with its theoretical introduction. But the theoretical parts are not the strong parts of the book.

While we think of it we take this opportunity of expressing the wish that writers on electrical oscillations when speaking of nodes and loops would say clearly whether current or potential is meant. They rarely do. The matter is of some importance, since, often, a node of current is a loop of potential and vice versa.

Petrol Motors and Motor Cars. By T. Hyler White. (London: Longmans, Green & Co.) 4s. 6d.

This excellent little book, intended mainly for designers of petrol motor cars, fits naturally into a vacant space amongst English books on motors, and we hope that it will meet with such success as will encourage the author to produce a more extensive volume on the same lines. It abounds in formulæ, which, however, have been found reliable in the practice and experience of the author; and, further, the mathematics are of the simplest description.

The articles on cylinder and valve design are very complete without introducing complications. The space given to the various parts of the motor seems unevenly distributed; more information on bearings, gearing, &c., might have been expected, and there are no remarks on such things as steering gear or frame design. Electric ignition is clearly described, but magnetos are merely mentioned.

Under the head of carburettors a simple and ingenious form is proposed by the author which should maintain a constant mixture at all speeds of the engine. In this book, as elsewhere, the fact that the suction on the jet varies as the *square* of the velocity of the ingoing gases and so of the engine speed is not pointed out, and yet this is the prime factor in the production of variable mixturesand never appears to be properly appreciated by the many inventors of "automatic" carburettors.

There is a generous supply of tables in the appendix; but with the exception of a few tables, such as fractional roots, metric threads, &c., the appendix is similar to the tables in, for instance, the "Practical Engineer" pocket-book; the object is no doubt to save reference to several books, but the space might have been more profitably employed by a more extended discussion of several parts of the motor and its accessories that appear to have been too lightly passed over. The illustrations are exceedingly clear, and the book generally well got up and notably free from misprints.

A Handy Book of Logarithms with Practical Geometrical Appendix. (London: Blackie & Son.)

There are a large number of logarithm and mathematical tables published, and we hardly think that there is a necessity for a scheme combining these tables with elementary geometry. The tables are plainly printed, and can be read to give six figures by interpolation; the first two figures of the logarithms are given only at the beginning of each line of logarithms, the remaining four decimals being given for each logarithm. These tables occupy about 20 pages. About 60 more pages comprise tables of hyperbolic logarithms, trigonometrical and logarithmic trigonometrical functions, &c., whilst the last 30 pages explain how to bisect a straight line; how to inscribe a circle within a polygon, and about 50 problems of a similar nature.

How to Read a Workshop Drawing. By W. Longland. (London: Dawbarn & Ward.) 6d.

Beginners in the workshop and drawing office will find in this clearly-written little booklet many hints and rules which they otherwise might have to learn by degrees, and possibly at some cost.

Electrical Engineering for Students. By S. R. Bottone. (London Guilbert Pitman.) 2s. net.

The author has filled some 144 pages with matter that is adequately dealt with by other elementary books, equally good or better.

The Science Year Book. Edited by Major B. F. S. Baden-Powell. (London: King, Sell and Olding.) 5s. net.

Among the contents of this book are a list of scientific and technical institutions with their chief officials and the amount of the annual subscriptions for membership, a biographical directory, a large diary, a glossary of scientific and technical terms erroneously called new, and articles on various branches of science. A brief article on electrical engineering has been contributed by Dr. J. A. Fleming, and consists principally of a résumé of progress during the past year. There are, however, two or three points in which Dr. Fleming has been misinformed; he announces, for instance, that a large station has been established in Cornwall for sending out electric current at high voltage to be employed for power purposes. On another page he says, ". . . it is now a usual practice to instal in municipal stations double-current generators, that is, dynamos giving out both continuous current for electric tramways and alternating current for lighting."

For reference purposes the book is not without value, and no notice of it would be complete without mention of the excellent portrait of Lord Kelvin, which is inserted as a frontispiece.

The Fan; including the Theory and Practice of Centrifugal and Axial Fans. By Charles H. Innes, M.A. (Manchester: The Technical Publishing Co.)

The author of this book is obviously master of his subject, and those who desire to gain any information regarding the theory or practice of fans may safely refer to it. There is a commendable absence of trade matter, and the entire volume gives abundant evidence of careful thought and research.

Annuaire pour l'an 1905. Compiled by Le Bureau des Longitudes (Paris: Gauthier-Villars). 1fr. 50c.

The chief features of this annual are—as in former years—the extensive astronomical tables, which cover nearly 350 pages. The other contents do not include anything electrical, as in earlier editions, but are devoted to geographical, statistical, commercial and other general subjects.

TRAMWAY OVERHEAD EQUIPMENT MATERIALS.

The following is an abstract of the discussion which took place after the reading of Mr. H. M. Sayers' Paper at the Society of Arts on January 13th. The Paper itself was published in *The Electrician* for January 20th, p 553, and January 27th, p. 598.

Mr. W. M. MORDEY, referring to Mr. Sayers' dislike to an insulator made of materials that contain carbon and his preference for porcelain, stated that in America the most largely used insulator was made of glass and fixed on wooden pins. He had often wondered why these insulators were not more commonly used here. Was it because our climate was too moist, and the effect of the condensation of water on the glass told against their use. He should have thought that the difference between a glazed insulator and a glass insulator would have been very small indeed in this respect. He thought the glass insulator, for mechanical reasons, would be better without the wooden pins. With regard to vulcanite, he had been surprised to find in one of our largest electrical factories, that with oil switch work there had been a return to vulcanite for the insulators supporting the metal parts in the oil. He was informed that, under those conditions, the vulcanite did not deteriorate on the surface and did not crack. In fact, it was more durable than porcelain, marble or any similar materials previously used. The paragraphs in the Paper on lightning were interesting. He had seen lightning on the South African veldt which continued for minutes at a time, the flashes sometimes averaging 23 to the minute. For tramway work, the ordinary diverging type of lightning arrester, referred to by Mr. Sayers, in which the arc, being started at the bottom, was carried up by magnetic repulsion as well as by the current of air, had been found to be very effective in South Africa.

Mr. A. J. LAWSON considered that all the three poles recommended by the Engineering Standards Committee were too light. The diameters were too small and a very slight increase of weight, by increasing the diameter, would have given a much stronger pole. The weakest section of all was the bottom section, which was subjected to the greatest stresses and the greatest corrosion; yet the factor of safety in some cases was only about 2½ with ordinary strains. Within the last few years he had put up a great many poles even heavier than the standard, which had not been satisfactory. Some had bent and others had given way at the top joint and even the second joint. He would suggest that the medium pole, agreed upon by the Engineering Standards Committee should be No. 1 pole, the present heaviest pole should be the medium pole and that a pole weighing something like 1,370lb. or more should be the heaviest pole, the diameters being 8in., 9in. and 10in., respectively. The standard fittings of the British Electric Traction Co. could be made to fit these sizes with but very slight alterations. The section insulator which Mr. Sayers showed had been designed by Mr. Hewer. He had used it for the last three years almost exclusively, on some 50 miles of line at least. He had one objection to the insulating material used in the insulator, however; it decomposed and cracked. With regard to porcelain insulators, the ordinary stock insulator of this type was no good, and toughened glass, as suggested by Mr. Mordey, would be better. Mr. Mordey had said these insulators would be better without wooden pins. He had had experience with the latter and had never had any difficulty provided he had good oak pins. Centre poles were much more rigid than span-wire construction, but he thought the best construction was the span wire, which was the most flexible and gave the easiest running with the least hammering. In Birmingham, where he had been compelled to put up some miles of double-bracket-arm construction, this had been ostensibly put upon the company so that fire escapes could pass through, and the cost had been increased about £100 per mile. Now, however, the manager of the Birmingham tramways insisted that all new work should be on the span-wire principle. His own idea of proper overhead construction was a nicely-designed pole with a nice final and no scroll work at all. In such places as Peterborough, where there were trees on both sides of the roads, a construction of this character was hardly noticeable. He took exception to the estimates in the Paper of cost of construction. From his experience he did not think there would be a fair profit to the contractor in the figures mentioned in the Paper, and to the figures of £1,000 and £1,200 respectively he would add £100 in each case. He was speaking of the total cost, including the raising of telegraph and telephone wires. If the latter were excluded there might be a fair profit in Mr. Sayers' estimates.

Mr. W. H. BOOTH said he would like to hear something about galvanising the span wires and the proper preparation for doing this. With some very hard wire which he had had to deal with some years ago, the galvanising chipped off when the wire was bent, and underneath the wire was quite polished. With the soft wire used nowadays this did not happen, and the wire underneath, when examined, was found to be considerably rougher. Something softer than zinc was required. He would also like to know whether there was any very real objection to allowing the trolley wire to dip a lot more than at present, except so far as the appearance was concerned. Had Mr. Sayers ever found the poles to become waterlogged in the bases? With regard to the strength of poles it always seemed to him that poles were too strong, but that the weakest part was at the junction of the pole itself with the surface of the ground; and the addition of a small thickness at this point, whilst only adding a few pounds to the weight, would add a considerable number of years to its life.

Mr. W. H. TURNER, referring to the question of waterlogged poles raised by Mr. Booth, said that this had been experienced at Sheffield, where in drilling the bottom of the poles for some special purpose it was found that the poles were filled with water almost to the ground level; but how it had got there he had never been able to find out. He had thought that possibly the finial at the top had been left off during construction and that the water had got in that way. It had always been his opinion that trolley-wire breakages were mostly to be found at the ear-pieces, and from the breakages on the Leeds tramways system this had proved to be the case.

Mr. E. W. DICKINSON said he had had a little experience with wooden poles. Some American engineers had specified wooden poles for a job in the tropics, and they sent down poles of American soft pine. In three years the bases of the poles were about as thick as pencils. They were replaced with a native wood, and they lasted many years. His opinion was that if the timber for wooden poles was carefully chosen it would be found to last 10 or 15 years. Mr. Sayers had spoken about ears, and remarked that soldered ears were the best form to use. The process of soldering tended rather to soften the trolley wire, for one thing, and the tendency at present was to go in for mechanical ears, using a grooved trolley wire. He exhibited a form of trolley ear which had given very satisfactory results.

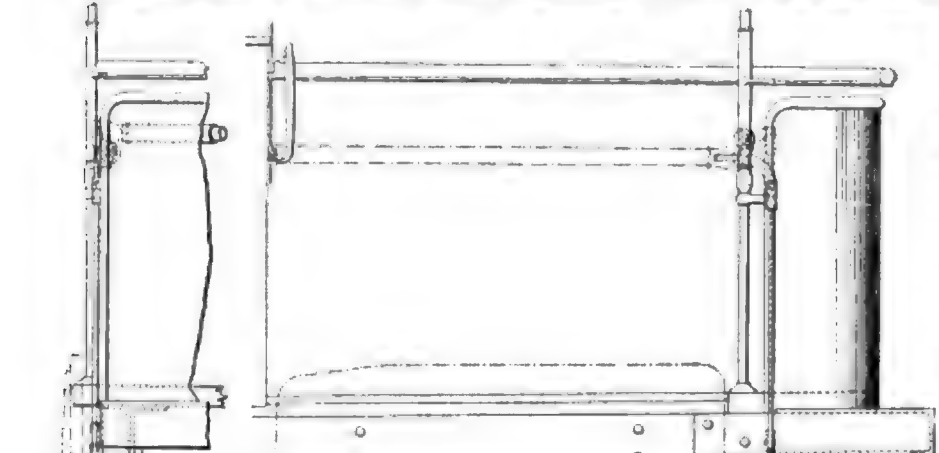
The CHAIRMAN (Mr. A. L. C. Fell), referring to the question of guard wires, remarked that he failed to see why the Post Office and the National Telephone Co. should be allowed to put up unsafe wires and then call on the tramway authorities to protect the general public. He had a case just before he left Sheffield in which the guard wires were new and perfectly put up, and the trolley wire was also new. Unhappily, the Post Office wires came down. They were covered with soot, and wrapped round the trolley wire and the guard wire, but instead of earthing properly as they should have done, the special appliances put in for this purpose by the Post Office failed, an arc was set up, and the instruments at Manchester were burned out. All this was brought about by defective overhead wires, which should really have been underground. With regard to the author's point about the No. 0 S.W.G. trolley wire, although there might be no electrical necessity for a larger size, it appeared from the records of various cities in this country that the majority of accidents from trolley wire breakages occurred with this size. We had not had a very long experience here, but in America and on the Continent a larger size was being adopted, and the accidents had decreased. He had had a great many tests made with ordinary trolley wire, and had discovered that by increasing the size somewhat, and giving it an extra draw through the vice, it was possible to increase the tensile strength very much, without decreasing the torsional strength. It was worth paying a little more to have this done than to put up an unsafe overhead wire. He had put up a good many miles of bronze and other special wires, but would only recommend them at important junctions. There was not the slightest difficulty in getting an ordinary trolley wire with a higher tensile strength than 20 tons; 25 tons could be obtained with 10 twists in 8in. Span-wire construction was the best system but it was very often difficult to adopt it because of the pipes, &c., buried under the pavements. In some cases it was necessary to put up a long bracket arm, and really there was no danger in putting up a bracket arm with a length of 23ft. It was certainly unsightly and ugly and in some cases the trolley pole had to be lengthened in order to get the proper angle of stay rod. There had been a rather violent test of an 18ft. bracket arm in Sheffield. A man was painting the arm when a cart came along and knocked the ladder from under him. The painter was left hanging at the end of the arm but there was no accident. The difficulty of anchoring trolley wires with span-wire construction was that it was necessary to form a very ugly fork, which might catch up the trolley head if the trolley left the wire. It might be better to effect the anchoring by means of an extra span wire, anchored down in a vertical plane so that if the trolley came off it simply went up in the air. The advantage of this was that if the wire broke at the section insulator, the ends of the wires were held up in position and did not drop down into the street and the cars could be kept running. He was afraid that Mr. Sayers only looked at the question of centre poles from an outsider's point of view. From a traffic point of view they were fatal. Taper poles for bracket-arm construction were not so satisfactory as the ordinary British section, because the crosspieces could not be lowered to take up the variations in the roadway. Mr. Lawson raised the point of having larger poles, but the greatest difficulty in dealing with the municipal surveyors nowadays was that they all wanted to try and decrease the size of the poles. By the use of some of the latest patent steel, however, which had a tensile strength of 80 tons to the square inch, it was possible to keep the size of the poles comparatively small. His opinion was that soldered ears were a mistake, because one could never be sure that the ordinary wireman would use the proper preparation. Another thing was that in putting the ears up the wiremen had a habit of marking off the wire where they had to go, and these marks developed into faults at which later on the wire broke. With a mechanical ear this was impossible. Fuses in the feeder pillars were a great mistake, for it was very inconvenient to have to run all over the line to put a fuse in. Everything as far as possible should be done from the generating station or the sub-station.

Mr. H. M. SAYERS, in reply, said that the use of glass insulators in America and on the Continent, but not in England, was purely a question of climate. With a glass surface in a damp atmosphere, the moisture accumulated in a continuous layer, and consequently there was considerable leakage. On a glazed surface, on the other hand, the moisture was condensed in isolated drops, and did not lead to nearly so much leakage. Glass had been extensively tried in telegraph work and had been dropped for that reason. The non-use of the horn type of lightning arrester was also due to climatic differences. Our periodical and moderate lightning potentials and discharges would very frequently pass without sparking across the wide gap of the horn pattern arrester. Mr. Lawson thought the standard poles were too light, but in the specification there was nothing to limit the thickness of the sections. It was also perfectly easy not to use the lightest section if it were not thought fit for the conditions. There was a practical difficulty in increasing the outside diameters of poles, in respect to which Mr. Fell had anticipated him—viz., the difficulty in finding sufficient room for them where they had to be planted. It was very often difficult to persuade surveyors, shopkeepers and others interested to agree to a larger diameter at the base than 15in. or 16in. In designing a pole to give a certain strength with the smallest amount of metal good results could be obtained, but there would be a smaller margin for corrosion. He had had sections cut out of poles which had been in use for 10 years, just about the ground line, but it did not appear that internal corrosion was very rapid. The pits in this case were about $\frac{1}{16}$in. deep, but it did not follow that this slow rate would obtain in every case, and he was inclined to think that it might be desirable to adopt some measures to prevent internal corrosion. One of the possible means was to fill the whole of the pole up with a weak Portland cement concrete. This might also add a certain additional stiffness to the pole. His estimates for the cost of construction did not include any expense upon telephone and telegraph wires, &c. In reply to a question by Mr. Booth, he said that there were only two lines in this country that used bow trolleys and it might be that there was no particular advantage in their use. The wear on the trolley wire had to be taken into account. Attempts at lubricating for increasing the life both of the wire and the bow had been made but the compensation for spoilt bonnets and hats of the passengers had neutralised any benefits obtained. With regard to galvanising, the important part of the process was the pickling. There was a divergence of practice in this respect but the house that had the best reputation in this country always used hydrochloric acid. The same firm also put a small quantity of tin with the zinc, which resulted in a more adhesive coating. The wire should go through the pot at a rate which allowed of a very slow amalgamation on the surface of the wire with the zinc, otherwise it was only a mere skin, which came off. There was an objection to slackening the tension of trolley wires and span wires. There had been a good deal of experience about the desirability of tightly stretched wires for telegraph work, and it would be found that telegraph engineers always pulled their wires up as tight as it was safe to do having regard to the range of temperature. Further, it was less liable to damage by wind, and, in his opinion, besides looking better, there was a greater co-operation of mutual support between the different parts of a tightly stretched structure. In countries where hard durable wood was abundant, and therefore cheap, he saw no reason why wooden poles should not come into useful application. In the south of Europe wood was very extensively used for telegraph work, amongst the varieties being eucalyptus, the ordinary blue gum. This was cheapest of all, but it was ugly because it twisted. It had a very good life, however, and might be used for trolley work either by planing down very large poles to the required size or by picking out the heaviest scantlings. With regard to soldering, he had always found this paradox—viz., that the hotter the bit the less heated the wire became and the less soft it became, because with a very hot bit the solder melted more rapidly and the time the bit was in contact with the wire was very much reduced. It was news to him that there were more accidents with No. 0 trolley wire than with a thicker wire. It did not seem that this could be the case, because if the stresses were worked out for a trolley-wire structure it would be found that a No. 0 wire had a bigger margin of safety than any other part of the structure as a rule. He did not quite understand from Mr. Fell how a stronger wire was obtainable by a different method of drawing. Perhaps it might be advisable to do it, however, if the price was not too high. He quite agreed with Mr. Fell that long bracket arms could be made safe, but there was a limit to the height of the standard as well as to the length of the arm. He had not advocated centre poles in the Paper; in fact, he would much rather be without them if he could avoid them.

A vote of thanks was then passed to Mr. Sayers.

NEW GUARD BAR AND FOLDING STEP.

The accompanying drawing shows a new combined guard bar and folding step made by the Brush Electrical Engineering Co. (Ltd.), and fitted by them to the cars they have recently supplied to the Gloucester and the Chesterfield Corporation Tramways.



THE "BRUSH" GUARD BAR AND FOLDING STEP. Scale, 1 : 20.

The step is secured to the platform arm by means of two hinged hangers which carry a rocking shaft having a curved lever attached to it at the dash-plate end. It will be seen that the platform guard bar is hinged to the end of a second curved lever which pivots in a bracket supported on the corner standard of the dash. The two levers are connected together by an adjustable rod, and it will be readily understood by reference to the drawing that the step is lowered into its normal position when the guard bar is raised. When this guard bar is lowered, however, thus barring access to the platform, the step is folded up as indicated by the dotted lines. An automatic catch is fastened to the end of the car body to hold the end of the guard bar when lowered.

Cars are supplied with either one or two guard bars per car. If two are supplied, the bar at the conductor's end of the car is folded close in front of the controller when the step is lowered. When one bar only is supplied, it is, of course, necessary for the driver to carry it with him just as he carries the controller handle from one platform to the other. The guard bar is collapsible so that in the event of an accident the end panel of the car is not damaged.

A NEW MULTIPLE-UNIT CONTROL SYSTEM.*

A patent has recently been issued to the Cutler-Hammer Mfg. Co. covering a new system for controlling motor driven cars, operated on the multiple-unit plan. The chief feature of this invention is the fact that both the direction and speed of the driving motors of the entire train are controlled by means of two wires running the entire length of the train, and by the use of a controller of about the same size as a standard field regulator for a 3kw. generator. The two wires constituting the train line are attached at each end of the car to automatic couplings C^1, C^2, which enable the cars to be shifted either end to, thus requiring no attention in coupling up so far as the electrical equipment is concerned. The maximum current carried by the two-wire train line is the output of a 8kw. 110 volt generator when used in connection with six cars equipped with four motors on each car, capable of developing 300 H.P. per car.

The drawings in the patent show the two driving motors on each truck treated practically as one motor, but provided with an independent solenoid reversing switch F, B, and two solenoid accelerating switches A for cutting out the starting resistance R. Two other solenoid switches, S, P, are also employed for connecting the motors on one truck, either in series with the motors on the other truck or in parallel therewith. Each solenoid used on the reversing switches F, B is provided with two windings. One of these windings is permanently connected between the trolley T or third rail and the ground G. The other winding is permanently connected to the train line. The coil on the forward solenoid reversing switch F is wound left-handed, and that on the back-up solenoid reversing switch B is wound right-handed. It is evident, therefore, that when the current is flowing in the train line in one direction, it will assist the winding of one of the solenoid switches and neutralise the action of the other solenoid winding, so that the desired solenoid switch will be energised in accordance with the direction of the current flowing in the two-wire train line. The windings of the accelerating solenoids and the series and paralleling solenoids are wound to actuate their plungers at different voltages. The operation of the system is briefly as follows:—

Each car is equipped with a 8kw. motor-generator, *m*, *g*, and two field regulators, F, having a double set of resistance buttons and segments. An ordinary 3kw. 110-volt starting rheostat, *b*, is also provided. The operator first starts the 8kw. motor by means of this starting rheostat. He then moves the field regulator lever F^1 in the direction in which it is desired to move the train. When the lever of the field regulator makes contact with the first step of the resistance, current is admitted through this resistance to the shunt-field of the 8kw. generator *g*, thereby causing same to impress a voltage on the two-wire train line of, say, 20 volts. This voltage is sufficient to supply enough current to energise the forward reversing solenoids F^1, F^2, and cause same to lift their plungers, assisted by the current taken directly from the trolley or third rail. The same voltage also supplies sufficient current to energise the winding of the series solenoid switch S, which attracts its plunger and closes the circuit of the four driving motors M^1, M^2, M^3, M^4 in series relation. The operator then moves his 8kw. field-regulator lever to the second notch, which increases the voltage on the two-wire train line to, say 40 volts, which is sufficient to energise the first of the solenoid switches A^1, A^3 for cutting out the first step of starting resistances R^1, R^2. The operator then continues to advance the 3kw. field-regulator lever, thus gradually increasing the voltage on the two-wire train line until finally the second step of resistances R^1, R^2 is cut out. The paralleling switch P is then energised and the starting resistances R^1, R^2 reinserted, which resistances are then again cut out until the driving motors are finally operating in parallel relation at full speed. The only wires which run the entire length of the car are the two-train wires capable of carrying about 30 amperes, and the four-wire cable connecting the two 3kw. field regulators, and capable of carrying a small fraction of an ampere in each wire. The solenoid switches controlling the driving motors are assembled in two sets near each truck, so that only four large wires are necessary for connecting the motors on the two trucks in series or parallel relation.

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* From the *Street Railway Journal* of New York.

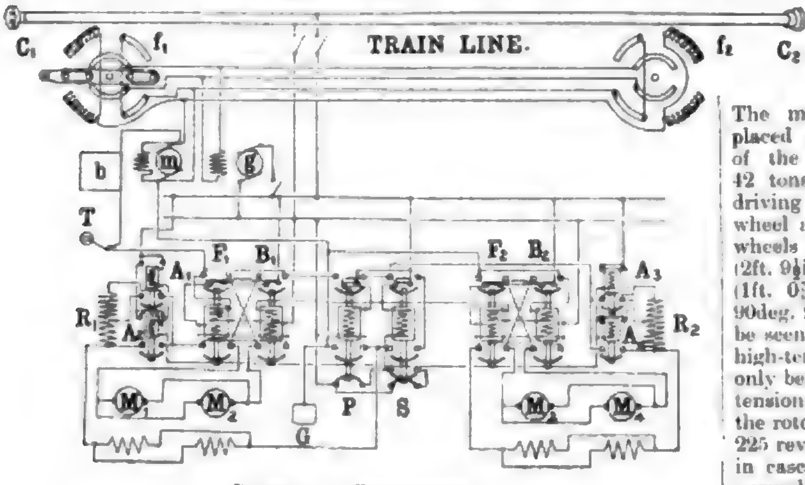


Diagram of Connections.

A second method, not shown in this particular patent, has been made the subject of another patent, and provides for a ½kw. motor generator on each car, the voltage of each generator being varied by the voltage of the train line. In this case the train line carries current sufficient only for energising the fields of six ½kw. generators at 500 volts, or about 6 to 10 amperes, the field windings being adapted for 500 volts and the armature windings having a maximum of 110 volts for supplying the various solenoid windings on each car. It is stated to be practically impossible for the operator to accelerate the train too rapidly, for the reason that the potential of the generators used will not respond instantly to changes in the energising current of their field magnets when designed with this feature in view.

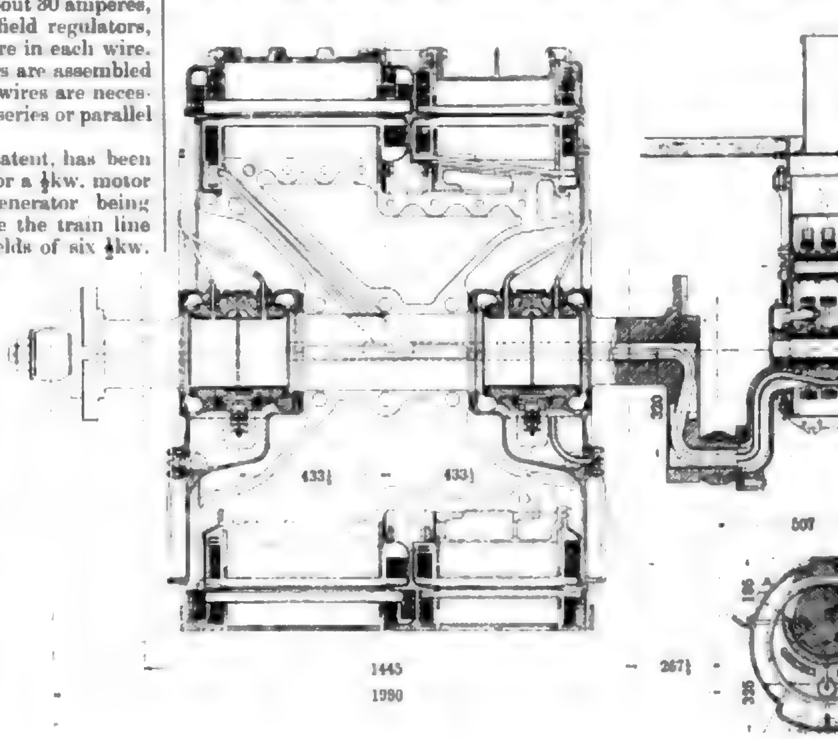
THE NEW LOCOMOTIVES OF THE VALTELLINA RAILWAY.

Since our description of the Valtellina Railway in Vol. LI., pp. 19 and 68, the rolling stock of this electric railway system has been increased by some new locomotives which embody many novel features of design.

According to *Elektrische Bahnen & Betriebe* the locomotives, of which three were ordered, are specified to run at two speeds, the change from the higher to the lower speed being effected on the well-known cascade principle. The high speed was specified to be somewhere between 60 and 70km. (37·2 and 43·5 miles) per hour, while the low speed was to equal half the high speed. These speeds refer to a frequency of 15 ∼ per second, the trolley voltage being 3,000 volts. Three-phase motors were to be used, these motors being of such power as to maintain a constant draw-bar pull of 3·5 tons at the higher speed and 6 tons at the lower speed. The locomotives were also required to accelerate a train weighing 400 tons on a grade of 1 in 1,000 from rest to a speed of 30km. (18·6 miles) per hour in 55 seconds, or a train weighing 250 tons on the same gradient from rest to a speed of 60km. (37·2 miles) per hour in 110 seconds. It was further specified that these figures should be maintained even if the supply voltage fell to 2,700 volts. Furthermore, the locomotive was to be capable of starting a 250-ton train on a gradient of 2 per cent. As regards temperature rise, it was specified that no part of the motor should rise in temperature more than 60°C. after a 10 hours' run at full load on the testing bed.

The locomotives were made by Messrs. Ganz & Co., of Budapest, and at the engine works of the Hungarian State Railways, the former being responsible for the electrical parts and the latter for the mechanical parts.

As it was not thought advisable to mount the rotor directly on the locomotive axle because of the difficulty of removing the rotor for repairs, and as toothed gearing was also objected to, it was decided to drive the wheels by connecting rods as is done in ordinary steam locomotive practice. There are three pairs of driving wheelsand two pairs of pony wheels, one pair at either end of the locomotive. The motors, (see illustration), are two in number and are placed between the driving axles. A few of the chief data of the locomotive are: Total weight 62 tons, useful weight 42 tons, length over all 11,540mm. (37ft. 10in.), wheel base of driving wheels 2,350mm. (7ft. 8½in.), wheel base between driving wheel and pony wheel 2,400mm. (7ft. 10½in), diameter of driving wheels 1,500mm. (4ft. 11in.), diameter of pony wheels 850mm. (2ft. 9½in.) The cranks of the rotor shaft have a length of 320mm. (1ft. 0⅝in.), and the crank at one end of this shaft is displaced 90deg. from the crank at the other end. Each motor-unit, as will be seen from the figure, consists in reality of two motors—viz., a high-tension motor and a low-tension motor, the latter, however, only being used at the lower speed. Both the high-tension and low-tension motors have eight poles, so that the synchronous speed of the rotor—when the high-tension motor alone is working—comes to 225 revs. per min. When, however, the two motors are connected in cascade, the synchronous speed is 112½ revs. per min. The normal speeds of the locomotive are 64km. (39·8 miles) and 32km. (19·9 miles) per hour respectively. Since the shaft of the rotor, having a crank at either end, is forged in one piece, it was necessary to construct the rotor spider in two parts, which were subsequently bolted together as shown in the accompanying drawing. The two rotor windings of each motor are directly connected. Each motor has four bearings; the two inner bearings are clearly shown in the drawing, and serve for keeping the rotor in its proper position relatively to the stator; the two outer bearings, which adjoin the two inner ones, are fixed to the locomotive frame, and serve to support the motor as a whole in its proper position. The motor is also supported by four bolts, suitably sprung from the frame of the locomotive; they chiefly serve the purpose of preventing the stator from turning. Attention must be drawn to the design of the slip rings, which are placed quite outside the motor proper and are readily accessible. Three slip rings only are required, as the two rotors are—as already mentioned—permanently connected to each other. A wrought-iron case, fixed to the locomotive frame, not only protects the slip ring gear, but also serves as support for the brushes, which are of carbon.



Details of Motors on Valtellina Locomotives.

STAND-BY CHARGES AND MOTOR LOAD DEVELOPMENT.

The following is an abstract of the discussion on Mr. A. M. Taylor's Paper on stand by charges and motor load development, which took place at the Birmingham Local Section of the Institution of Electrical Engineers on Dec. 14th. The Paper itself was published in abstract in *The Electrician* for Jan 13th, p. 503, and Jan. 20th, p. 544.

Mr. **TAYLOR**, during the reading of his Paper, gave the following additional information :—He laid stress on the importance of the diversity factor, and said that he found it to be in the limit equivalent to the reciprocal of the load-factor for the individual motor under consideration, illustrating his meaning by diagrams. He said that the system of charging a low rate to consumers who agreed to take no current for motive power between certain fixed hours during the winter months had proved a great success in Montreal. About 90 per cent. of the total H.P. connected is charged solely on this basis. The charge is roughly £9. 12s. per H.P. annum for a 5 H.P. motor. The system had been in operation four years, during which time it had not been found necessary to adopt precautions to ensure the switching off of the load at the stated times beyond those mentioned in the Paper.

The **CHAIRMAN** (Dr. Sumpner), in opening the discussion, expressed the opinion that electric motor development was delayed, not so much by the competition of good rival systems, as by the reluctance of owners of old and bad plant to change to a more efficient system. The amount of coal wasted in such old plants, say in the Birmingham district, was enormous, the total waste of coal throughout the country from this cause, being probably greater than the amount exported.

Mr. **VAUDREY** said that it was not possible to conceive that the average works would be willing to shut down during peak time as had been proposed, especially as the amount of energy used formed only a small proportion of the total works cost. Even supposing the peak load to be cut off, he did not believe it possible to bring the charge below 1d. per unit. He regarded the suggestion to instal accumulators on consumers' premises, especially on the small scale proposed, as impracticable. Had it been feasible, it would have been done long ago. With reference to the figures quoted by Mr. Taylor in connection with the Montreal supply scheme, he did not consider £9. 12s. per H.P. annum, as at all a cheap rate in the circumstances.

Mr. **JECKELL** (Coventry) questioned Mr. Taylor's assumption that 1 B.H.P. per hour required 1 unit of electrical energy. At Coventry where the average price obtained for motive power was 1·3d., the revenue obtained was only ½d. per B.H.P. hour. Lubrication in the case of a gas engine was a big item, frequently 10s. per B.H.P. per annum. In the case of electric motors it was small. As regards interest on capital, Mr. Taylor's figure of 0·31d per B.H.P. annum, for a 17 H.P. motor working 2,500 hours gave £54. 17s. 11d. per year. He could buy such a motor for £57. He knew an instance in Coventry of a 15 H.P. gas engine being replaced by a 15 H.P. motor. In the former case allowing for interest and depreciation, and gas at 2s. 6d. per 1,000, the cost was ⅝d. per B.H.P. The motor was hired, and allowing for rent and energy at 1⅜d. per unit, the actual cost per B.H.P. was ⅜d. In Coventry the restricted-hours system would not answer as the chief trade was a season's trade. They never had the full motor load superimposed on the lighting load. Many motors were off at 5:30, and the top lighting load did not occur till 7:30. Wages and repairs should have been considered, as here the advantage lay with the electric motor. All things considered, the figures given by Mr. Taylor did not show electric driving in anything like so favourable a light as they should do.

Mr. **CHATTOCK** (Birmingham) asked for a fuller explanation as to what was meant by continuous and intermittent loads for motors. At Bradford they had had a scale of 1d. for continuous, and 2d. for intermittently-loaded motors. By continuous they meant that the motor must be running all day, whether actually loaded or not. He had known people to run all day on no load, in order to obtain the low rate. The average rate was 1⅜d. Under these conditions they found that the motor load just paid for itself. He had suggested a sliding scale based on the amount of current consumed per H.P. per quarter. This system was tried for a short time, but consumers did not like it, and elected to go back to the old rate of charge. He felt sure that a charge of 1d. per unit, without restrictions, would not pay. It might at first, but after the load had developed, the average price received per unit would fall to too low a value. Switching off consumers at certain hours might do in trades where firms can pick their men. He ventured to think that the good results obtained in Montreal are traceable to the fact that they have no trades unions as we have. The trades unions insist on the men working certain hours, which hours overlap the peak of load curve. Another point not yet referred to, was that gas companies do not restrict the hours during which gas engines may be run. Mr. Taylor referred to traction load, in time of fog, saying that when the people are using the trams, they could not be in the workshop. He would also point out that during fogs less trams were run, so that this class of load was then reduced. He did not agree with the scheme of putting in cells to tide over the peak load. He believed this had been tried by a London company, but had been discontinued, as after two years, it was found that most of the cells were ruined.

Mr. **R. P. WILSON** said that a load that did not overlap lighting or necessitate capital expenditure was nothing more than a by-product. If gas companies' by-products were saddled with the cost of production on the same lines there would be no market for them. At Blackheath they were supplying electricity to several large firms at 2d. per unit, except between 5 p.m. and 10 p.m., when the price was 6d. He thought these prices financially disastrous as compared with 7d. or 8d. for two hours and 1½d. for 22 hours. At Dudley 6d. and 1½d. had been adopted. He found that manufacturers could almost always alter their hours to suit the price of power. If it was correct to say that the revenue from any class of consumer should be proportional to the plant they monopolise, then the time-switch produced the desired result, as was shown by the following figures relating to Dudley : Current consumed by shop, 25 per cent. of total ; plant monopolised, 43·5 per cent. ; revenue provided, 42·7 per cent.

Mr. **SHAWFIELD** (Wolverhampton) could not agree with the pessimistic view that the author had taken as regards cost of electrical energy. He considered it commercially safe to offer a low price for motive power. At Wolverhampton the cost of production was much less than that mentioned. He did not agree with Mr. Vaudrey's statement that a tramway load was more profitable than a motor load, as he found the load-factor was greater in the case of motors than for tramways. He criticised Mr. Taylor's statement that the load-factor was the reciprocal of the diversity factor. At Wolverhamton the diversity factor was about 2, but the load-factor was certainly not 50 per cent. The author's stand-by loss diagram should appeal to station engineers on account of its simplicity.

Mr. **PRINGLE** (Burton-on-Trent), in a written communication, referred to the question of fuel costs. He thought that allowance should be made for the fact that the boilers were not forced during the day to the extent they were at times of heavy load. They could therefore burn a cheaper-grade fuel during the day. The total charge to consumers of ¾d. per unit, estimated by Mr. Taylor, was, he thought, a very safe value, which he considered might well be reduced. Mr Pringle also wrote to suggest that the £70 additional capital outlay at the generating station per kw. at motor was high. Many stations (six to 10 years old) could to-day provide plant at the station, and allocate a fair proportion for mains at a much lower figure.

Mr. **MORCOM** considered that there was a strong case against shutting down at certain fixed hours. He had some figures relating to a factory in which the machinery was driven by electric motors. For every £1 of manufactured goods sold, they consumed about 1 unit of electrical energy. As one of the chief things that had to be looked to is to get stuff out of hand quickly, there would have to be a proportionally heavy drop in cost per unit in order to make it worth the while of a manufacturer to shut down his works. His experience was that the number of units used in machine shops was being continually pushed up on account of the higher speeds of working now adopted.

Mr. **GROVES** asked Mr. Taylor to explain the diagrams which he had shown relating to load-factor and diversity factor.

Mr. **FENNELL** (Wednesbury) said that the proposal to supply electricity to day users only at a low rate had been carried out for the past nine months (since commencement of supply) at Wednesbury, and that two-thirds of their motor load was already supplied on that system. To the long-hour user they offered, as an alternative, the maximum-demand system. They had no difficulty in connection with time of cutting off. The electrically-driven clock switch of the Reason Company was very satisfactory. It might also be made to act as a throw-over switch in connection with a two-rate meter, where the motor was required occasionally in the evening, a rate of 4d. or more being then charged. In Wednesbury there were a great many intermittent users, who may be reached by the special day-load terms, such as corn merchants, pork butchers, breweries, laundries, &c. There was little doubt in his mind that the actual field of the electric motor would be restricted to the short-hour and small-power consumer. In dealing with large manufacturers, he had found a difficulty in honestly recommending them to take electricity at even 1d. per unit, where it was proposed to run a 50 H.P. motor, say 60 hours per week at an average load of, say, 30 H.P. A suction producer plant would, in such a case, run with practically no attention, and cost of fuel at Wednesbury would not exceed ¼d. per unit.

Mr. **HOLDEN** said that in most works there was a certain proportion of motors that ran intermittently, and it was always possible to arrange to cut these off at certain fixed hours during the day. He thought that though few manufacturers would turn out existing engines to instal motors, yet many would put in a motor when extending, and in this way drive a number of intermittently-loaded machines. He could name a number of cases where he thought the proposed low rate with restrictions would be acceptable. In some wood-working factories, the machinery was only used three or four days per week, and in cases where power was required out of doors—hoisting, for instance—the machinery was only used during daylight hours.

Mr. **ARTHUR WRIGHT**, in a written communication, referred to the success of the Reason Mfg. Co.'s time switch at Brighton and other towns. At Brighton there were now 225 of these instruments in actual use. He did not agree with the author in reference to the diversity factor, as he considered that it would vary from a figure over 10 in the case of lift motors down to 1 in the case of pump motors. This question of diversity factor could not be treated except by the method of probabilities. He considered 5 as a better average figure than 1¼. In reference to the author's remarks respecting fog loads, it was an interesting fact that at Stepney, during the darkest fogs they had had this winter, the fog peak had never equalled the evening peak.

Mr. **CHRISTIE** (Brighton), in a written communication, said the system they used was most successful in every way. They fortunately had a large and steady demand for lighting in the evening, and the standing charges being met by the higher rate charged for this lighting they could, at a profit to themselves, supply as much current at 1d. per unit as their day-load consumers liked to use, as they had simply to pay for coal, repairs and attendance, which was easily covered by the sum charged. He did not know exactly what proportion of 1d. units were sold, but he estimated that it amounted to close upon three-quarters of a million units, which they would otherwise never have obtained, and which had a material effect in reducing the running costs.

Mr. GEORGE WILKINSON, of Harrogate (communicated), did not agree with the figures regarding gas consumption upon which Mr. Taylor had based his comparisons. Was Mr. Taylor aware of the wonderful advances made in the economy of working gas engines? He referred to the suction gas plant, by means of which gas was produced in a very simple form of producer, by the suction of the engine piston itself. Only recently he paid a visit to works where one of these plants was in operation. The engine was of 25 H.P., and the gas producer supplying its gas fuel was a very simple apparatus indeed, with no moving parts, the selling price of which was £90. This producer and engine was giving 1 B.H.P. per hour, for fuel costing $\frac{1}{10}$d. when using anthracite coal in the producer, and the engine had been running three months without any attention whatever. In his opinion, the power companies have more to fear from competition introduced by the ordinary gas engine and suction producer plant than from any other competitor, and it was difficult to see how, in face of such practical results as he had quoted, the power companies were going to enter into successful and profitable competition. He had had considerable experience with the Diesel oil engine, having had one under his supervision for nearly two years, but its economy was not better than the case he had cited, and the capital cost was much greater than for an ordinary Otto gas engine, plus the suction gas plant.

The Reason Mfg. Co. (Ltd.) forwarded an illustration and short description of their time switch, which could either be used to insert a demand indicator during peak hours, or to cut off consumers' supply during the same period. This switch was at present used in about 20 towns in the country.

Mr. TAYLOR, in his reply to the discussion, said that as regards the high prices charged at Montreal on the restricted-hours systems, he was informed that where this was not adopted the charge was no less than £17 per H.P. annum, the consumer being at liberty to use full power day and night. In reply to Mr. Jeckell he had assumed, for the purpose of comparison, that 1 B.H.P. required 1 unit. His figures were based upon the consideration of a 5 H.P. motor, whereas Mr. Jeckell had been talking about a 17 H.P. motor. The question of lubricant was such a small item that he had simply put in an amount amply sufficient for all purposes, and the same for each system. In reply to Mr. Shawfield, he might say that in calculating the charge to the consumer under case 1, he had considered a small lighting station of 2,000kw. capacity, with no traction load, and had taken 0·7d. as being an average figure for the works cost. In reply to a written communication from Mr. Pringle, Mr. Taylor said that the figure he had assumed of £70 per kilowatt (Fig. 8) was for cost of new station and mains, not for cost of extending, but probably the latter was the more correct way of looking at it. He wished he could endorse Mr. Wilson's statements, but all he claimed in the Paper was that, for intermittent loads and for units not larger than 5 H.P., electricity made the best showing. Only in favourable cases would continuously-loaded motors show so well. He thought that it was a most unsafe proceeding to allow consumers to remain on the cheap rate till such a late hour as 5 p.m., as at Blackheath, and he understood that at Aston, at any rate, the motor and lighting loads had clashed to a very considerable extent. It was very desirable to know the consumer's diversity factor as well as his load-factor, not necessarily with a view to charging him at a different rate, but in order that the cost to the station of each consumer should at least be accurately known, so that if a flat rate be adopted the most favourable class of load may be diligently fostered.

THE PRUSSIAN SYSTEM OF ELECTRIC TRAIN LIGHTING.

In a Paper read before Section E of the International Electrical Congress of St. Louis, Herr C. Roderbourg describes an ingenious system of train lighting by electricity, as adopted on the Prussian State Railways. A constant E.M.F. at the lamps is attained by the insertion of very thin iron wire in the circuit of each incandescent lamp. The wire is in small glass pear-shaped globes like incandescent lamps, containing hydrogen gas. By varying the pressure of these gases, as well as by the adoption of a special spiral form of wire, the temperature of the wire when current is passing is brought to the proper point. It is well known that if an iron wire is heated by electric current to a point at which it becomes barely visible in the dark, its electrical resistance increases with extraordinary rapidity with further increase of temperature. This phenomenon is illustrated by tests which showed that, in a particular circuit, when the E.M.F. was 50 volts, the current flowing was 8 amperes, whereas when the E.M.F. was raised to 86 volts, the current rose by only 0·7 ampere.

Two through trains connecting Berlin and Hamburg on the Prussian railway system, and subsequently two additional trains on the same line, and finally two trains between Berlin and Stettin, were similarly equipped. The trains are always operated as a unit, and each train is equipped with only one shunt dynamo, which is mounted on the boiler of the locomotive and driven through a 1 : 10 speed-reduction gear by a 20 H.P. De Laval steam turbine, running at 20,000 revs. per min. The storage batteries of the Accumulatoren Fabrik A.G., Berlin, are connected in parallel with this dynamo; a battery of 32 cells with a capacity of 76 ampere-hours at a three-hour discharge rate, is hung under each car. These storage batteries act mainly as a reserve, becoming operative only when the locomotive becomes separated from the train or if the dynamo should fail from any cause.

Since the baggage waggon always accompanies the train on the whole run, it appeared desirable to instal the dynamo in the baggage car. To drive the dynamo by any form of engine power, a petrol engine, for instance, appeared too complicated. The most convenient form of drive is, no doubt, that from the car axle. All such systems hitherto used are equipped with a circuit-breaker which interrupts the current if the speed of the dynamo falls below a certain limit, in order that the storage battery, whose E.M.F. is greater than that of the dynamo at low speeds, may not discharge into the dynamo. This circuit-breaker is automatic and is liable to derangement on account of shock. Herr Dr. Buttner, therefore, substituted for it an electrolytic rectifying cell, and succeeded, after experimenting with many different solutions, in finding a mixture which does not attack the aluminium plate nor diminish its efficiency even should the temperature to above 70°C. or 80°C. As a second electrode he uses iron plates in his cells and these aluminium cells, which act as a check valve in his train-lighting system, are inserted in place of the automatic circuit-breakers.

An arrangement is also applied to the dynamo to provide for the case of a car going in the opposite direction, the commutator brushes being carried forward until a point is reached at which the dynamo generates current in the same direction as before. This arrangement can be avoided if, in accordance with the suggestion made to Herr Dr. Büttner by Herr Liebenow, four aluminium cells are used instead of one in the conversion of alternating into direct current. In this case, however, the drop may reach 6 volts. Another arrangement is in preparation by which this also is avoided. The dynamo, which in general is designed as a shunt machine, is supplied with an opposing series winding which lowers the E.M.F. if the current becomes excessive. In this way the excessive charging of the storage battery at very high speeds is prevented; otherwise the arrangement is as above described. At the present time two trains are being operated between Berlin and Cologne on which the dynamo is installed in the baggage waggon, driven from the car axles by belts. Several through cars are now in construction in which the armature of the dynamo is mounted directly on the car axle.

NOTE ON THE ELECTROLYTIC RECOVERY OF TIN.*

BY F. GELSTHARP.

An experiment was made with an electrolyte of pure sodium hydrate in water, strength 10°Tw (sp. gr. 1·05), temperature about 80°C., anode and cathode of tin plate, area 19⅓ sq. cm. (3. sq. in.), placed about 4 cm. (1½in.) apart. After switching on the current a small quantity of hydrogen gas was liberated at the cathode, and a little oxygen at the anode, gradually diminishing. The voltmeter stood at 3½ volts and the ammeter at ½ ampere. The current was allowed to pass for about half an hour to see if the usual energetic electrolysis would commence; but no, the current continued to effect only a slight evolution of gas without stripping the tin from the anode. On examining the anode it was found to be very little attacked, but appeared to be covered with an extremely thin coat of a light brownish tint, which was not easily rubbed off. The current was again turned on without any different result.

The colouration was thought to be due to some low oxide of tin, which is a poor conductor of electricity. Therefore the effect of reducing it by means of hydrogen was tried, this being done by reversing the current for a moment. Then after reversing again the direction of the current the tin-plate anode was completely stripped of its coating of tin in a very few minutes, hydrogen gas being energetically liberated at the cathode, which also became coated with loose, spongy tin. While this reaction was going on the ammeter rose to 1½ amperes, and the voltmeter fell to less than 1 volt, and when the cathode was agitated so as to knock against the sides of the containing vessel, the ammeter rose to 2 amperes, and the voltmeter fell to about ½ volt.

Various pieces of tin-plate were tried under the same conditions, and it was noticed that the clean bright pieces acted in the same way as that just described; but pieces of old, oxidised and tarnished tin-plate were attacked at once, and quickly stripped. It was found that instead of reversing the current to make the reaction start, it could be brought about by placing in contact with the anode in the electrolyte for a short time a piece of clean iron, most effective being a piece of tin-plate which had just been stripped in the bath.

From the results of these experiments the writer conjectures, or suggests, that the clean, bright tin-plate (differing from tarnished or oxidised tin) at first becomes thinly coated with a black or brown oxide which is insoluble in sodium hydrate, and that the effect of reversing the current, or making contact with iron, causes a deposit of hydrogen on the anode, which reduces this oxide to metal, thus roughening the surface, and making it in a favourable state for forming the soluble oxide, and when once the formation of soluble oxide has commenced, the electrolysis goes on uninterruptedly.

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* Paper read before the Faraday Society, December 19, 1904.

I bring this reaction before the Society in the hope that some member who may have investigated it will endeavour to give a satisfactory explanation of it. After all the tin was stripped from the anode, the ammeter again fell to about ½ ampere, the voltmeter rising to 2½ volts; and when the current was continued the iron became coated with a reddish-coloured deposit (probably composed of oxide of iron), which was not easily rubbed off. I noticed that the deposited tin, when squeezed and placed in water, generated hydrogen gas. This evidently points to the fact that spongy tin deposited in a sodium hydrate electrolyte is not only an alloy of tin and hydrogen, but also contains some sodium.

The agitation of the cathode in a special way seems to be an important point so far as the consumption of electric energy is concerned. The resistance due to polarisation can be reduced to a minimum, not only by moving the electrode vigorously and quick circulation of the electrolyte, but by giving it a quick succession of shocks produced by striking sharply. By this means the electric energy can be reduced by 30 to 40 per cent.

Comparing the acid and alkali processes for tin recovery, it is beyond doubt that the latter process is superior. In the alkali process, iron apparatus may be used and mechanical appliances for continuous treatment of tin cuttings can be conveniently adapted; moreover, the electrolyte is continually being regenerated. In the acid process no suitable metallic apparatus can be used; therefore mechanical appliances are hardly admissible, and for the electrical treatment of tin cuttings to be a commercial success they must be handled very cheaply. This can only be done by mechanical means with a continuous process. For the manufacture of tin paste the acid is superior to the alkali process, as the deposited tin from the former is very light and amorphous, whilst that from the latter is much denser, and consists of minute crystals which are not so suitable for the uses to which this material is put.

PHYSICAL SOCIETY.

At a meeting of the Physical Society held at the Central Technical College on January 27th, Dr. R. T. Glazebrook, F.R.S., president, in the chair, a Paper on the

"Action of a Magnetic Field on the Discharge through a Gas,"

was read by Dr. R. S. Willows. It has been shown previously that a transverse magnetic field, if applied at the cathode, may in some cases reduce the P.D. at the terminals of the tube. It is shown in the Paper that the pressure at which this decrease commences corresponds to the pressure at which the voltage required to maintain this discharge, under normal conditions, is a minimum. This is also found to be the pressure at which the positive column is first completely striated. Reasons why such action takes place are given.

A Paper on the

"Action of Radium on the Electric Spark,"

by Dr. R. S. Willows and Mr. J. Peck, was read by Dr. Willows. In certain cases the authors have found that the spark from a Wimshurst machine is extinguished by the action of the radiations from radium and that the current passing is decreased. The action is altogether different according to the direction of the discharge. Using a spark-gap longer than 2cm. and making the larger knob of the machine used positive, the radiations had practically no influence. With the smaller knob positive the radium, in most cases, extinguished the spark. The phenomenon is found to be due to the action of the β-rays. Rontgen rays do not produce this effect, even if their ionising power at the spark-gap is some thousand of times greater than that of the radium. Lenard rays are, however, effective.

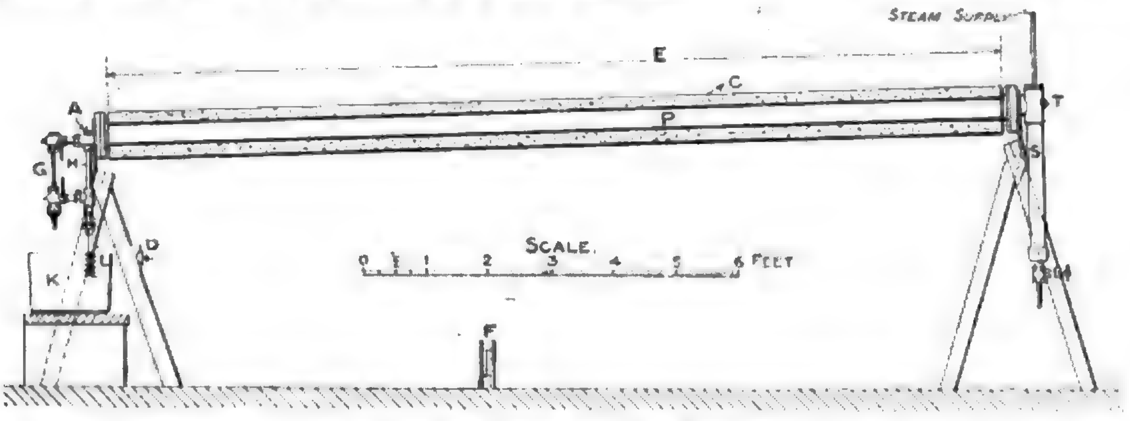
Prof. F. T. TROUTON expressed his interest in the Paper, and referred to the fact that the action of the radium depended upon the direction in which the current was passing. He could see no obvious explanation of this.

TESTS ON ASBESTOS STEAM PIPE COVERING.

We have received from Bell's Asbestos Co. the following report on some tests on their "Wadnit" steam-pipe covering carried out at the National Physical Laboratory:—

Apparatus.—The arrangement of the experimental steam pipe is shown in the figure. The test pipe is a 4in. steel pipe, 4·47in. external diameter and 14·94ft. in length, having a total radiating surface of 16·85 sq. ft. This is supported by the ends in a nearly horizontal position with a slope of 6in. in the length to ensure the condensed steam draining down to the collecting tube. The steam is admitted through a gravity separator into the top of the test pipe at the upper end and the temperature of the steam is taken as it leaves the separator. The condensed steam runs down to a collecting tube in which the level of the water is shown by a gauge glass. This level is kept constant during the experiments by adjusting the drain cock. The condensed steam is blown out through a cooling coil to prevent re-evaporation on reduction to the atmospheric pressure. To correct for the loss of heat from the flanges and collecting tube, a pair of similar flanges screwed on a nipple close to each other is used. When these are placed in between the two ends of the apparatus instead of the test pipe, the condensation due to these parts alone can be determined. The observations made were (1) weight of steam condensed, (2) temperature of steam, (3) temperature of air (at two different places), (4) temperature of outside of cover. From the steam temperature is found the pressure of the steam and the latent heat. The weight of water collected multiplied by the latent heat gives the total loss in B.Th.U. from the pipe. From this is subtracted the total heat loss from the flanges and ends, the net loss from the pipe being thus obtained. This net loss divided by the latent heat gives the condensation in the test pipe alone in pounds.

Particulars of the Cover.—This cover was in flat sections about 3ft. by 2ft., which were wrapped round the pipe and laced with copper wire. Mean thickness of cover = 1·53in. Total weight = 28·25lb. = 2·0lb. per foot run = 1·7lb. per square foot of external surface of 4in. pipe. A test was also made with the bare pipe for comparison.



APPARATUS FOR TESTING STEAM PIPE COVERINGS.

P. Test Pipe; C. Covering; G. Water Gauge; T. Thermometer; S. Separator; A. Air Cock; F. Flanges to replace pipe when measuring condensation in ends; H. Collecting Pipe; D. Drain; L. Cooling Coil; K. Cooling Tank.

Length of Pipe (E), 14·31ft.; Diam. of Pipe = 4·47in.; Surface of Pipe = 16·85 sq. ft.

Table of Observations.

	Asbestos-covered pipe.	Bare pipe.
Temperature of steam ..	393·4°F. ..	392·7°F.
Temperature of cover ..	103·6°F. ..	
Temperature of air ..	64·0°F. ..	67·7°F.
Steam condensed per hour	6·245lb. ..	30·52lb.
Calculated Results.		
Steam pressure (gauge) ..	215lb. square inch ..	213lb. square inch
Latent heat	837 B.Th.U. per lb. ..	837 B.Th.U. per lb.
Difference of temperature between steam and air ..	329·4°F. ..	325·0°F.
Total loss of heat per hour ..	5,225 B.Th.U. ..	25,550 B.Th.U.
Loss due to flanges and ends	2,245 B.Th.U. ..	2,170 B.Th.U.
Net loss due to pipe ..	2,980 B.Th.U. ..	23,380 B.Th.U.
Condensation per hour from test pipe	3·56lb. ..	27·9lb.
Ditto per square foot ..	0·213lb. ..	1·66lb.
Loss per square foot per hour per degree difference of temperature	0·54 B.Th.U. ..	4·27 B.Th.U.

From these figures the following table has been calculated, assuming an air temperature of 70 F.

Pressure by gauge in lbs. per sq.in.	Loss in B.Th.U. per hour per sq. ft. of 4in. pipe.		Steam condensed per hour per sq. ft. of surface of 4in. pipe, in lbs.	
	Asbestos covered.	Bare.	Asbestos-covered.	Bare.
190	168·4	1,339	0·200	1·59
200	170·6	1,357	0·203	1·61
210	172·7	1,373	0·206	1·64
220	174·6	1,389	0·209	1·66

Saving due to cover = 87 per cent. of total condensation.

(Signed) R. T. Glazebrook, Director.

FIRE AT THE LONDON WALL TELEPHONE EXCHANGE.

Twice within three years the London Wall telephone exchange has been put completely out of service by fire. The first occasion was on July 9, 1902, and the second on Friday evening last. Although the property is fully insured, there are some things which no amount of insurance can cover, and the National Telephone Co. doubtless has the sympathy of all telephone engineers in this country. To this sympathy must be added congratulations on the speed with which normal conditions of working were restored. On the first occasion it took about 16 days to renew the service to all subscribers; on this second occasion it took rather less than the same number of hours. This was possible only because the circumstances were exceptionally propitious. When the 1902 fire took place, a new exchange was being built at Holborn, and therefore it was comparatively easy to tranfer all the apparatus to London Wall. By a stroke of great good fortune, the new exchange built to replace the old London Wall exchange was nearly completed last Friday, and it was intended to transfer the operators from the temporary exchange alongside it to the new building in about a month's time. It was with this intent that the work was being carried on when the fire occurred and the company then had to do in a night what it had anticipated doing in a month. The circumstances that attended the outbreak are as follows:—At about 6:5 p.m. on Friday one of the supervisors in the old exchange noticed flames issuing from the test room, and with commendable promptitude told the operators to leave the building quickly but quietly. She then sounded the fire alarm, and every operator was out of the building and in safety at Salisbury House—on the other side of the road—in the space of a few minutes. By this time the test room resembled a roaring furnace, but the fire brigade was quickly on the scene, and soon got the fire well in hand. From the present appearance of the test room it seems almost miraculous that the outbreak was prevented from spreading further, as there is only a lath and plaster ceiling, and some of the cables in the next room were severely scorched. The new and old test rooms were connected by temporary cables and when the fire broke out these were cut off and the insulating pegs in the new test jacks removed. Unfortunately, however, the water ran down the temporary cables and thoroughly wetted a large amount of apparatus in the new test room. This had to be dried by means of dry-air pumps and braziers before testing could be commenced. Eventually, however, every line was tested, both inside the exchange and outside, and although the task of making the new connections was only commenced at 7:30 p.m. on Friday, all the subscribers and junction lines, with a very few exceptions, were connected up to the new switchboard in working order by 9:30 the next morning. The magnitude of the work may be gauged from the fact that there are 3,819 subscribers, 1,060 junctions and 1,080 through connections of the London Wall exchange. In addition, there were also 49 other metropolitan exchanges at which tests and alterations had to be made owing to the change from the magneto to the common battery system. The remarkably rapid change-over could not have been effected in the time if it had not been for the untiring energy of every one of the company's employees. From the highest official to the humblest workman all worked with hardly a pause, and it is principally due to their devotion that so little inconvenience was caused to the general public. One pleasing feature was the voluntary offer of several linesmen and others of their assistance.

CORRESPONDENCE.

WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

(*By Cable.*)

The publications in your issue of January 20th, *re* Government control of wireless telegraphy, are entirely incorrect. The report published was made last year, before the ability to prevent interference had been demonstrated. Since interference prevention has been demonstrated, the Government monopoly has been abandoned and the matter placed in the hands of the Bureau of Commerce. The present situation is that the Government monopoly is abandoned, and commercial companies are permitted to operate, the Government being only permitted to receive where there are no commercial stations.

Washington, Feb. 1, 1905. Fessenden.

ARMATURE COILS AND OZONE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of January 27th appears a very interesting communication by Mr. J. S. Highfield on the above subject. The experiences given and conclusions drawn therefrom agree entirely with my own. In 1898, when I was connected with the General Electric Co. of America, the problem of finding a suitable insulation for high voltage alternating-current generators was under consideration, and the very points brought forth by Mr. Highfield were then observed.

To avoid the detrimental effects of nitric acid produced by the brush discharges, mica tube insulation was discarded, and it was resolved to use a winding in which all moisture could be driven out by a vacuum process and the interstices of the coil completely filled with an asphalt compound which would be solid at the running temperatures of the machine. This filling, in addition to preventing the accumulation of moisture inside the coil through the movement of the air caused by the variation in temperature, also serves to conduct the heat out of the coil at a much faster rate than if air was present, and therefore leads to a lower temperature of the winding. The coils thus filled are covered with a number of layers of tape, each treated in such a manner that a glaze of oxidised oil is formed which is practically infusible, and which acts as a permanent seal to the fibres of the tape.

The finished cells are entirely moisture proof, remaining at the same time sufficiently flexible to lend themselves readily to bending and clamping, so that vibrations or severe strains, such as may be caused by wrong paralleling or short circuits of the system, have hardly any effect.

The first winding built in accordance with these ideas was for some 750kw. three-phase generators of 12,000 volts. They were installed in 1898 at Mechanicsville, U.S.A., direct connected to water turbines, and have supplied the Schenectady works of the General Electric Co. with power ever since, without, I believe, a single breakdown of the winding. A great number of other high-voltage machines using this style of winding have since been built, both by the General Electric Co. of America and the British Thomson-Houston Co., up to voltages of 15,000, and the operation has in all cases been equally successful, proving that the troubles referred to by Mr. Highfield have here been eliminated.

While Mr. Highfield recommends that only the slot portion should be filled with an insulating material, the winding described above uses this expedient all through the coil. Our wet climate calls for extraordinary precautions, and not only in extra high voltage machines, but also in lower voltage apparatus, one has to guard against the rotting of the insulation, as caused by the deposits of copper. Extraction of all moisture by a vacuum process and its permanent replacement by some moisture and acid-proof insulating material should never be omitted, if lasting reliability of the winding is to be expected.—Yours, &c., H. S. Meyer.

Rugby, Jan. 30.

PARLIAMENTARY INTELLIGENCE.

The Hammersmith, City & North-East London Railway Bill came before the Examiners of Private Bills this week for proof of compliance with standing orders. There were several petitioners against the bill at this stage, for whom Mr. Brown, Parliamentary agent, appeared. Mr Kennedy, Parliamentary agent, represented the promoters. One of the oppositions was by the Chelsea Borough Council, on the point that the plans deposited in Parliament were different to those deposited at the offices of the Council. The promoters admitted that certain alterations had been made, but only with the object of elucidating the plans. The Examiners decided that a non-compliance must be reported, but declined to express any opinion as to whether there had been any misdemeanour. A large number of petitions by private land and property owners were then gone into, the allegations being misrepresentation of such property. Some were dismissed and others upheld. The consideration of the bill has not yet been completed.

The Heckmondwike Urban District Council Bill has also been considered by the Examiners. One of the main opponents at this stage was the Yorkshire Electric Power Co., for whom it was argued that an agreement with the British Electric Traction Co. for a supply of electrical energy by the Council should have been scheduled to the bill. The Examiners upheld the objection and decided to report a non-compliance.

LEGAL INTELLIGENCE.

Re North-West London Electric Supply (Ltd.)

In the Chancery Division on Friday Mr. Justice Farwell again had before him a debenture-holder's application to appoint a receiver and manager of the above company. It was stated that an offer had been made by Hampstead Borough Council to buy the undertaking, exclusive of book debts, for £12,000. A resolution adopting the offer had been passed at a meeting of those interested. The undertaking was at present in the possession of prior lien debenture-holders, and all the debenture-holders other than the applicant opposed the present motion, which it was said was intended to prevent the sale going through

His Lordship referred the matter to Chambers without prejudice and with liberty to apply if necessary.

Iang v. British Electric Calibrated Fuse Co. (Ltd.)

In the Chancery Division, London, on Tuesday, Mr Justice Farwell heard a motion for judgment in default of defence in a debenture-holder's action, and his Lordship made the usual order.

Jandus Arc Lamp & Electric Lamp Co. (Ltd.) v. Arc Lamps (Ltd.)

In the Chancery Division on Monday this case was mentioned before Mr. Justice Kekewich.

Mr. Bousfield, K.C., for defendants, asked his Lordship to fix a day for the hearing of the further evidence which defendants proposed to bring forward with regard to the experiments which were being made as to the life of lamps made according to various specifications.

His Lordship fixed Feb. 13.

Callender's Cable & Construction Co. (Ltd.) v. Killarney Electric Lighting Co.

At Dublin, on Friday, in the Chancery Division, before the Master of the Rolls, application was made on behalf of defendants to appoint a receiver in place of the receiver at present acting for the Court. The present receiver had issued a notice that he would start doing the work of the defendant company, and counsel said if that intention were carried out defendants would lose the benefit of the provisional order and expose themselves to a fine of £2 per day. This would be fatal to the sale of the works as a going concern. The matter was adjourned for a week, and his Lordship intimated that on that day week he would receive sealed tenders for offers for the purchase of defendants' works.

Midland Electric Corporation v. Parsons & Sons.

At Wolverhampton County Court recently, Judge Howland Roberts delivered his reserved judgment in this action, which was tried before him on Oct. 17 last. Plaintiffs sought to recover £46. 19s. 3d. for electrical energy consumed by defendants at their works between Sept. 28 and Dec. 31, 1903. At the hearing of the action it was stated that defendants were under a contract to take electric power from the company at 4½d. per unit. On Dec. 21 a man in plaintiff company's employ went to defendants' works to take the reading of the meter. According to his reading, the meter on that date registered a consumption of 770 units. He was a man of little experience in reading meters, and it was evident he had made a mistake, because on a further reading of the meter on Jan. 5 it was found to register 1,770 units, although during the interval the works had not been in operation. There might have been a leakage, owing to a defect in the installation, but the plaintiff company were not responsible for that.

For defendants it was contended that they had not received the amount of electric current alleged to have been metered, and they denied that they had ever received any communication from plaintiffs that there was a defect in the installation.

The case was adjourned for independent expert evidence in regard to the meter, and Mr. J. B. Clarke, A.M.I.E.E., electrical engineer to Stourbridge Council, was called in to arbitrate. After investigation he communicated his decision to Judge Roberts, who now pronounced the electric meter to be correct in its readings, and gave judgment for plaintiffs.

Telephone Poles on Electric Tramway Routes.

In the Court of Session, Edinburgh, on Tuesday, Lord Low closed the record in an action brought by the National Telephone Co against the Aberdeen Suburban Tramways Co. for the recovery of £722. 15s. 1d., expense incurred by plaintiffs in the removal of telephone poles necessitated by the construction of an overhead electric tramway by defenders. Under a provisional order obtained in July, 1902, defenders constructed certain tramways, in connection with which the pursuers' district manager in Aberdeen found it necessary to do a considerable amount of reconstructing work in removing telephone wires and poles from the routes affected. Plaintiffs state that they hold wayleaves for the telephone wires, and the engineer in charge of the tramway work stated that defenders would pay for the removal of the poles in question, but defenders plead that the engineer referred to was in the employment of the contractors, and was never in the employment of or had any authority to represent or bind defenders. They plead that pursuers had no statutory right to erect the poles without authority, and further, that plaintiffs are barred from insisting in the action through their claim not having been timeously made. The case was sent to the procedure roll.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"National Engineering and Trade Lectures." Edited by Ben H. Morgan. Vol. I.: "British Progress in Municipal Engineering"; three Lectures by W. H. Maxwell. (London: Archibald Constable & Co.) 6s.

"Practical Electric Light Fitting." By F. C. Allsop. 6th edition. (London: Whittaker & Co.) 5s.

"Modern Theory of Physical Phenomena; Radio-activity, Ions, Electrons." By Prof. A. Righi. Translated by Prof. A. Trowbridge. (London and New York: Macmillan Company). 5s.

"Gas and Petroleum Engines." 2nd edition. Translated and adapted from the French of Henry de Graffigny and edited by A. G. Elliot. (London: Whittaker & Co.) 2s. 6d.

"Proceedings of the American Institute of Electrical Engineers." No. 1, Vol. XXIV. January, 1905. (New York: The Institute.) 50c.

"Proceedings of the Royal Society." Vol. LXXIV. No. 503. (London: Harrison & Sons.) 2s.

"British Standard Tables of Pipe Flanges." Report by the Engineering Standards Committee. (London: Crosby, Lockwood & Son.) 2s. 6d.

"Matriculation Directory, No. 39, January, 1905, with Articles on Text Books." (Cambridge: Burlington House.)

"Science Abstracts." January, 1905. Section A: Physics. Section B: Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

Iron and Steel Institute.—The annual general meeting of the Iron and Steel Institute will be held, by kind permission, at the Institution of Civil Engineers, on Thursday and Friday, May 11th and 12th, and the annual dinner—under the presidency of Mr. R. A. Hadfield—in the Grand Hall of the Hotel Cecil, on Friday, May 12th. The Council will shortly proceed to award Carnegie Research scholarships, and candidates must apply before February 28th; the awards will be announced at the general meeting. In order to be included in the voting list at the general meeting, applications from candidates for membership of the Institute must be submitted to the Council before the end of March. The autumn meeting will be held in Sheffield on September 25th to 29th, 1905. An influential committee has been formed in Sheffield for the reception of the Institute, with the Lord Mayor as chairman and the Master Cutler as vice chairman. The chairman of the executive committee is Col. H. Hughes, C.M.G., the vice-chairman Mr. J. Rossiter Hoyle, the hon. treasurer Mr. Francis Huntsman, the hon. secretaries Prof. J. O. Arnold and Mr. A. McWilliam, and the hon. assistant secretary Mr. J. Wortley. Members are invited to participate in an international congress of mining, metallurgy, mechanics and applied geology, to be held at Liege on June 26th to July 1st, 1905, in connection with the international exhibition, particulars of which may be obtained from the offices of the Iron and Steel Institute.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The position of chief foreman winder with Messrs. Dick, Kerr & Co. is vacant owing to the sudden death of Mr. B. Elliott, who has been chief winder at the company's works at Preston since their opening. See an advertisement.

Three additional assistants competent to give instruction in the theory and practice of electric machine design, construction and testing, are wanted in the department of electrical engineering of the City and Guilds Technical College. Commencing salaries £200, £150 and £150 per annum respectively. Applications to Prof. Ayrton. See also an advertisement.

An assistant is also required for the mathematical department, who possesses sound knowledge of elementary mathematics and of the elements of the differential calculus and integral calculus. Salary £100 per annum. Applications to Prof. O. Henrici. See also advertisement.

An assistant is required in the civil and mechanical engineering department of the City and Guilds Central Technical College, Exhibition-road, London, S.W., who can teach mechanical drawing and mechanism. Salary £150 per annum. Applications to Prof. W. E. Dalby. See also advertisement.

The Admiralty announce that there will be on April 1 several vacancies for assistant masters in H.M. dockyard schools. Salary £150, rising by £10 per annum to £250, with pension and chance of selection for promotion to senior masterships. Applications to Secretary (C.), Admiralty, Whitehall, London, S.W., by Feb. 6.

West Derby (Liverpool) Guardians require an electrical engineer for the infirmary. Applications (on official forms) by Feb. 7.

For the position of borough electrical engineer Hanley Town Council received 69 applications, which were reduced to the following:—Messrs. S. T. Allen (Plymouth), W. Adams (chief assistant at Hanley), W. Ainscough (Leeds), H. W. Angus (Eccles), A. E. Pullen (Ealing), W. F. Stamp (Devonport), E. B. Thornhill (Taunton) and C. H. Yeaman (Islington, London). The final voting was between Messrs. Yeaman and Ainscough, with the result that Mr. Yeaman received the appointment by 12 votes to 11 obtained by Mr. Ainscough.

For the position of tramways manager Newcastle Tramways committee have now selected the following three gentlemen, from whom the final selection will be made:—Messrs. E. Hatton (Salford), G. Conaty (Birmingham) and H. E. Yerbury (Sheffield). The chairman and vice-chairman of the committee and Mr. Cail are to go to the places where the selected candidates are now engaged and report.

Aberdeen.—In a report presented by the city electrical engineer (Mr. J. Alex. Bell) the Gas and Electric Lighting committee are recommended to put down additional plant at the Dee Village electricity works, including a 420kw. generator, at an estimated cost of £4,800.

Asylum Lighting.—Cumberland County Council have decided to put down independent electric lighting plant at the Garlands Asylum at an estimated cost of £6,007, with annual cost of £505 for maintenance, &c.

Automobile Exhibition.—Owing to differences in automobile circles on the subject of exhibitions the motor vehicle show now being held at the Crystal Palace, Sydenham, is but a comparatively small affair.

The only exhibitors of electrical motor vehicles are the Krieger Electric Carriage Synd. and the Scheele Electric Carriage Co. The former show a couple of highly-finished landaulets, in which two compound electric motors, each of 4½ H.P., drive the front wheels through spur gearing. A battery of 44 cells of the Fulmen type is carried, the capacity on a single charge being stated at 45 miles. The controller is adapted to give six forward speeds, two battery recuperating positions, a reverse motion and an electrical braking position. The Scheele Co. exhibit an eleven-seat 'bus and a victoria, the body of the latter being so arranged that it can readily be substituted by a brougham body. In these vehicles two 5 H.P. motors, suspended on springs, drive the rear road wheels through spur gearing. The battery comprises 40 cells of the Hagen type, with a capacity of about 190 ampere-hours, sufficient, it is claimed, for a run of 40 to 50 miles on one charge. The controller gives five forward speeds and two reverse. J. T. Riches & Co., agents for the Eisemann high-tension magneto ignition, show a variety of these devices suitable for use on motor cycles and cars. Petro & Radford have a display of P. & R. accumulators and other ignition specialities. Lithanode ignition accumulators are shown by Longstreths (Ltd.) and I. Lacoste & Co. have a fine show of ignition apparatus, one novelty being a small electric lamp for illuminating at night the drip feed tubes of dashboard lubricators. The Chloride Electrical Storage Co. show a good range of Exide accumulators. Accumulators and ignition apparatus are also exhibited by C. A. Vandervell & Co., and Kuettner & McDonell. The show closes to-morrow (Saturday).

Belfast.—At the meeting of the Corporation on Wednesday a resolution passed on Jan. 4 authorising the issue of free tramway passes to members of the Council was rescinded.

Work in connection with the conversion of the tramways to electric traction was commenced on Wednesday by Messrs. J. G. White & Co.

Brighton.—We reported in our last issue (p. 600) that Mr. Arthur Wright, consulting electrical engineer to the Corporation, had notified the Council of the termination of his agreement in April. The Council have now decided to defer consideration of Mr. Wright's letter, but have asked him to furnish them with a full report upon the position of the Southwick electricity works. The Lighting committee invite the Council to visit the works along with Mr. Wright.

Carlisle.—The second annual dinner of the staff of the Corporation electricity works took place on Thursday last week. The chief engineer (Mr. C. D. Burnet) presided and gave some interesting figures concerning the present and past working of the undertaking.

Chesterfield.—The official inspection of the Stonegravels and Whittington Moor electric tramway took place on Tuesday, and the line was opened for traffic.

China.—The China Light & Power Co., of Canton (of which Messrs. Shewan, Tomes & Co. are the general managers) have supplied current in this city since 1900. The population of the Canton district is 4,000,000 and at November last there were the equivalent of 13,800 8 c.p. lamps connected, the number of consumers being 1,380. The demand for electric current in the Canton district is rapidly increasing, and new plant is being constantly installed. Oil is the only competitor with electricity in the district. The plant consists of Babcock-Wilcox boilers, Belliss & Morcom engines and Johnson & Phillips alternators. The supply is from overhead cables.

The city of Canton is, like the majority of Chinese cities, unsuited for electric traction or, in fact, for tramways of any kind, as no single street exceeds 7ft. in width and neither horse-drawn nor other vehicle has ever yet been utilised within the city.

It is stated that several of the larger mission schools in the Hangchau district are considering the equipment of their schools with small electric light and power plants, both as a means of lighting and as affording a means for imparting instruction to students. 40 to 60-light plants are about the size needed for such work. We understand that several American electrical firms have under consideration the establishment of isolated plants in the Hangchau province, and the mission school installations are considered as likely to prove useful in providing object lessons of the usefulness and adaptability of small electric lighting plants, to give a needed incentive to the development of the electrical industry in this part of China. American manufacturing and supply houses are taking considerable interest in this business.

Croydon.—The poll of the ratepayers on the Corporation bill to extend the tramway system to Upper Norwood has resulted in 3,523 votes being cast in favour of and 3,435 against.

Cuba.—Among the public railway companies of Cuba is the Cuban Electric Co., which owns a line 2·6 miles in length. The remainder of the railways on the island, which aggregate a mileage of 1,481·6, are steam. In addition to these public lines there are a large number of plantation railways connecting up the various sugar, tobacco, fruit and other plantations to the main lines. These are steam lines varying from 61 miles to 0·6 miles in length. There are scores of these short lines, many of which have their own rolling stock, the remainder using the cars and locomotives of the main line railways. The total length of these plantation railways in Cuba is 871 miles.

In addition to the Cuba Electric Co.'s service there is that of the Havana Electric Railway Co., which operates a service of 48·22 miles. 161 closed motor cars are used on this service and 15 freight cars. The company's employés number 1,100. To June 30 last the gross receipts amounted to about £250,000. During 1904 the company constructed a new loop line, which included an elevated structure of exceptional design.

The Insular Railway Co. is a subsidiary of the Havana Co., and has powers to run its lines through the Province of Havana for about 100 miles. So far the company has 5½ miles of line built, which has been in operation since November, 1903. The company have under consideration an extension of between 30 and 40 miles in length, passing through Guanajay, the centre of the extensive pineapple industry. Mr. G. F. Greenwood is general manager of the Havana Electric Railway Co. at Havana, Cuba.

Dorking.—The Council have decided to apply for a further loan of £12,000 for extensions of the electricity undertaking. The present capital expenditure is £20,827. 12s., or about £1,000 in excess of authorised loans.

Ealing (London).—The borough electrical engineer (Mr. J. D. Knight) has reported on the question of the change of electrical pressure, and the Electricity Supply committee have instructed

Mr. Knight to report also upon the question of supplying outlying districts and future extensions at a pressure of 200 volts.

East Ham.—The borough electrical engineer (Mr. W. C. Ullmann is preparing plans and estimates for connecting the East Ham tramways with the Ilford lines on the Romford road. Tenders are to be invited for five further top-covered cars.

Edinburgh.—The city electrical engineer (Mr. F. A. Newington), in reporting on the subject of complaints received from consumers of current from the Corporation mains, says that lamps of an inferior make and below their stated capacity have been largely used. Mr. Newington recommends the Electric Lighting department to undertake the testing of consumers' lamps and to test lamps for wiring contractors at 6d. per dozen.

The Tramways sub-committee recommend the Corporation to obtain Parliamentary powers to convert the Gilmore Place tramway route, at present worked by horses, to electric traction.

Edinburgh-Queensferry Tramway.—The National Electric Construction Co. have given notice to Edinburgh and Queensferry Councils and the County Councils of Midlothian and Linlithgow of intention to promote a provisional order authorising the construction of electric tramways from Edinburgh to Queensferry.

Electric Driving of Works.—An electric lighting and power plant has recently been put in at the Manningham mills of Lister & Co., textile manufacturers.

Fenton.—Negotiations are proceeding between the Council and Stoke Corporation for the supply by Stoke of electricity in bulk to Fenton.

Frauds on Electricity Undertakers.—Joseph Wallace, a consumer on the Northern Counties Electricity Supply Co.'s mains at Spennymoor, was recently fined £1 at Bishop Auckland for fraudulently obtaining current by inserting a pin between the wires and thus cutting the meter out of circuit. Mr. H. Puttrick, who gave evidence on behalf of the company, said other consumers had defrauded the company in a similar manner.

A man named Stroudley was fined 40s. and costs at Manchester recently for having, without notice, re connected his house to the mains of the Corporation after the latter had discontinued supply in consequence of difficulty in collection of accounts.

Gloucester.—The city electrical engineer (Mr. W. J. Bache) estimates a net profit of £1,100 on the year's working of the electricity department ending March next, after payment of all charges, including interest and sinking fund.

The City Council at last week's meeting decided to offer Mr. R. A. Chattock, city electrical engineer of Birmingham, a fee of 50 guineas, plus travelling expenses, to report upon the plans and specifications prepared by Mr. Bache for extensions of the electricity works.

Hackney (London).—The Borough Council have refused the application of Leyton District Council to allow the use of the overhead trolley system along that portion of Lea Bridge road in the borough of Hackney.

The Finance committee reported at the Council meeting last week that insurances against fire had been effected with the Municipal Mutual Insurance (Ltd.), the approximate amount of the risks insured being £45,000.

Halifax.—The mayor (Ald. E. Robinson) on Wednesday started a new generating set at the electricity works.

Horsfall Dust Destructors.—In a note published on p. 598 of our last issue reference was made to a dust destructor made by the Horsfall Destructor Co. and erected at Zurich. The Horsfall Co. ask us to state that they themselves were contractors for the refuse destructor plant, and not sub-contractors, as might be inferred from our note. The building was designed by the engineers of the town, and the generating plant was supplied by Brown, Boveri & Co.

Hull.—The Council on Tuesday adopted the estimates of the city electrical engineer (Mr. H. Bell) for the expenditure in his department for the ensuing year. This is put at £38,000. Mr. Bell anticipates a revenue of £46,887, against £45,491 estimated for the present year (ending March) and a net profit of £8,087.

The town clerk is preparing a report on the subject of letting motors on hire.

Sanction has been obtained to a loan of £4,600 for electric lighting extensions.

Inquest.—On Tuesday an inquest was held at Tredegar (Mon.) into the death of John Daniel (described as an electrical pumpman), which occurred on the night of Jan. 20 whilst he was in charge of the underground pumping engine at No. 2 Ty Trist Colliery.

Daniel Jervise, fireman in the employ of the Tredegar Iron & Coal Co., said deceased had been pumpman about two years. He found deceased, about midnight, on the ground quite dead, but warm, with the exception of his hands, his feet being towards the engine. He was not lying across any electrical wires or apparatus.

Replying to H.M. Inspector of Mines (Mr. Martin), witness said he turned the handle to stop the machinery, which was working. After doing so witness noticed sparks issuing from the bottom of the switch, and he extinguished them with sand. Help came, and he went to the bottom of the pit to have the power turned off. The place was rather damp underfoot. When he turned the switch he felt a slight shock. He saw nothing wrong with the machinery when he entered, and it was working regularly.

Dr. G. A. Brown said he examined the body about noon, and noticed a burn over one of the knuckles of the right hand about the size of a florin. There was another burn over the right side of the forehead, about an inch in diameter at the widest part, and tapering off, the entire length of the wound being about 3in. He thought the marks resulted from the passage of an electric current sufficient to cause death.

Mr. W. A. Scott (Ernest Scott & Mountain) said the Tredegar Co.'s electrical plant was completed about two years ago, and was a three-phase alternating system, with a working pressure of from 500 to 600 volts. He examined the switch and the box on Monday week, and he found the whole of the gear in working order. The primary cause of the accident was the nipping of the fuse wire between the lid and the case of the cast-iron fuse box. A little piece of asbestos bridging the insulator might have caused an arc to form through the presence of some foreign substance in it. He suggested that the diameter of the flange of the insulator might advisably be increased to prevent such bridging as described. His opinion was that if the earthing had been effective the accident would not have happened; it could have been improved and maintained by taking more frequent tests, at least once a month. Witness had not in the course of his experience heard of a similar accident to this.

James Phillips, electrician to the Tredegar Co. during the past four years, said he found that two fuses had been changed. One had been left too long, and the slack end was nipped between the cover and the box. His theory was that deceased was screwing up the first box, which had 600 volts, whilst starting the motor at the same time, thereby completing the circuit. He agreed with Mr. Scott's view as to the asbestos. He had instructed that gloves should be used, not that they were always necessary, but as a precaution.

The Coroner (Mr. Dauncey) pointed out that the cause was purely hypothetical, and the jury returned a verdict "That deceased was accidentally killed by being electrocuted, he having come into contact with a live current whilst in the performance of his duties."

Import Duties.—The normal duties upon electric light apparatus and instruments and parts thereof imported into Japan is 10 per cent. It is proposed to increase this to 15 per cent. The same increase is also imposed upon scientific, chemical and other instruments, and upon telephones and telephone parts, copper wire, copper bars, rods, plates and sheets, and copper nails, pipes, and tubes.

Leeds.—The Tramways committee propose to try as an experiment to introduce two motor omnibuses as auxiliaries to the tramway service, and, if they should prove remunerative, to establish a larger service.

Lewisham (London).—The Council resolved on Wednesday to ask London County Council to obtain powers for constructing additional tramways in the Lewisham district.

Lincoln.—The Corporation, who decided recently to abandon their original intention of constructing their electric tramways to 3ft. 6in. gauge in favour of the adoption of the standard gauge, and have, in fact, eight cars already built for the wider gauge, have received a notification from the Board of Trade that a new Act of Parliament will not be required to authorise the change. It is found that the necessary 9ft. space between the outer rail and the kerb can be maintained throughout the route by a slight modification at one point.

Littleborough.—The Council are negotiating with Rochdale Corporation and the Lancashire Electric Power Co. for the supply of electricity in bulk. The revocation of the Littleborough order (obtained in 1900) has been deferred until August.

Liverpool.—The revenue of the electric supply department for 1904 was £236,404, of which £135,631 was from sale of electrical energy for lighting and power, £2,871 from street lighting, and £91,674 from tramways. Generation expenditure was £65,192, distribution £4,752, rent, rates and taxes £16,431, and management expenses £11,455. The net balance was £44,510, and it has been decided to transfer £16,285 to reserve, £11,289 to renewals, and £16,934. 9s. 5d. to general rate.

The Tramways committee estimate their working expenses for the current year at £367,845, interest £57,186, sinking fund, &c., £56,533, total £488,719, or £12,000 more than last year. The income last year was £557,325, which was £17,516 more than in 1903. A contribution of £27,000 towards relief of rates is estimated this year.

London County Council.—At Tuesday's meeting loans for electric lighting were made to Hackney (£2,086) and Hammersmith (£18,482).

Council Official's Invention.—The General Purposes committee reported that Mr. Watkins, an official in the Council's Engineer's Department, had asked to be allowed to take out a patent for a continuous-feeding system which he had invented for electric conduit tramways.—Agreed, subject to the condition that the Council be allowed the use of the patent without payment should it so desire.

Electric Lighting at the Education Offices, Victoria Embankment.—The Education committee recommended, as the demand for current is now much greater than formerly, and the present independent plant would need extending, this plant be disposed of. Supply be taken from one of the companies supplying in the district.—Agreed.

London County Council Electric Lighting Loans.—In a volume recording the work of the various committees for 1903-4, a schedule of loans granted to London local authorities by the Council for the period 1889-90—1903-4 inclusive is given for electric lighting (including meters and street lighting) as follows:—

	No. of loans.	Amount.		No. of loans.	Amount.
1889-90	nil.	nil.	Brght. forward	22	£455,647
1890-1	1	£10,000	1897-8	5	87,090
1891-2	1	60,000	1898-9	22	318,436
1892-3	nil.	nil.	1899-1900	25	521,144
1893-4	4	51,700	1900-1	31	529,362
1894-5	2	38,700	1901-2	50	577,998
1895-6	5	91,267	1902-3	26	549,371
1896-7	9	203,980	1903-4	35	248,701
Car. forward	22	£455,647	Total	216	£3,287,749

London Electric Power Schemes.—In a report on the Administrative County of London & District Electric Power Co.'s bill, the borough electrical engineer of St. Pancras (Mr. S. W. Baynes) points out that

Under the measure the company is not apparently compelled to supply any person or firm, the idea being (he urges) to select from all the districts every consumer that will be profitable at the price contemplated (1½d. per unit), leaving the unprofitable consumers to be compulsorily supplied by the local authority. Were the local authorities supplying energy under similar conditions, a figure of about 0·8d. per unit would prove a quite profitable charge. The company are not required to set aside the 30 years' and 42 years' purchase money exacted in the case of municipal loans for electricity undertakings, and that would give them a further advantage over local authorities. St. Pancras is (Mr. Baynes points out) already supplying current for power under certain conditions at 1d. per unit, and were the local authority allowed to choose their customers the price might be still further reduced. Mr. Baynes advises strenuous opposition to the bill, having regard especially to the fact that St. Pancras Council has invested £460,368 in its electrical enterprise on the understanding that other undertakings would not be permitted to enter the Council's area of supply.

Macclesfield.—Three years ago the Council obtained a provisional order, and though at various times the question of electricity supply has been discussed, nothing definite has been done to carry out the terms of the order. As a company is now applying for an order, the Council were recently asked by the Board of Trade as to the steps to be taken in order to carry out their obligations, and last week the Electricity committee decided to recommend the Council to appoint a consulting electrical engineer to formulate a municipal scheme for electricity supply, costing not more than £20,000.

Maidstone.—An inquiry was held on Wednesday into the application of Maidstone Corporation for authority to extend their present tramway system.

Manchester.—On Wednesday the Corporation were recommended by the Electricity committee to continue the appointment of Mr. S. L. Pearce as chief electrical engineer, for three years, on the following terms:—

Salary for first year at rate of £900 per annum; for second and third years, £1,000 per annum. Mr. Pearce to enter into an agreement to remain in the employ of the Corporation for three years from Feb. 1, 1905, and to devote the whole of his time to the duties of the position and in carrying out any electrical extensions or works in the future that may be required, the engagement to be subject to any arrangement which the Corporation may from time to time make with consulting engineers.

The chairman of the Electricity committee (Mr. Howarth) moved the adoption of the report and explained that the arrangements made with Mr. Pearce when Mr. Metzger retired had now terminated, and it was necessary that an appointment should be made. Mr. Pearce had been deputy chief engineer for four years, and since he had had sole charge he had given the committee entire satisfaction. The salary proposed was similar to that received by Mr. Metzger, and £100 a year less than that paid to Mr. Wordingham four years ago.

Mr. Hynes moved an amendment that the salary to be paid to Mr. Pearce remain at £800.

After discussion the amendment was defeated by 67 votes to 15.

The Tramways committee have also granted increases of salary to several officials of the tramways department.

The city electrical engineer (Mr. S. L. Pearce) has presented a report to the Electricity committee upon the proposed extensions of the plant at various sub-stations to meet the increased and anticipated demand for electric power.

It is intended to lay down extra plant at the Polygon, Bennett-street, Stuart-street, Queen's Park and Cheetham-hill sub-stations. Mr. Pearse states that the time has arrived when not only additional balancing plant is required at some of the stations, but an extension of the balancing mains is necessary in certain parts of the city. The approximate cost of the extensions is £22,830. It is also pointed out that as the Bloom-street station is well loaded up, future extensions must take place at Dickenson-street, and it is recommended that three 500kw. motor-generators be put down there. The expenditure on the proposed new machinery is as follows: Three 5,00kw. motor-generators £6,000, foundations £200, h. and l.t. switchgear £1,500, contingencies £400; total £8,100.

Manitoba.—A commission has been appointed by Manitoba Provincial Legislature to inquire into the advisability of the Government taking over the present privately-owned telephone system in the province.

Middlesex Light Railways.—The County Council have instructed their engineer to prepare plans for the construction of the light railway to the Herts and Middlesex boundary at Barnet.

The Cheshunt Light Railway order, authorising the construction of a light railway from Waltham Cross to Cheshunt in continuation of the Middlesex light railway to Waltham Cross, awaits the sanction of the Board of Trade, and certain suggested alterations as to the raising of stock to provide funds for the construction are still under consideration.

An extension of time is being applied for for the completion of the light railways in Friern Barnet, New Southgate, Willesden and Wood Green, authorised in 1901.

The electric tramway from Highgate Archway to Barnet, passing through Finchley and Whetstone, is nearing completion, and it is hoped that the line will be ready for opening in a few weeks.

Municipal and County Club.—This club held one of its successful house dinners on the 27th ult., the guest of the evening being Sir W. J. Collins, chairman of the Education committee of London County Council, when a number of distinguished members were present.

Mr. Laurence G. Gomme (clerk to the L.C.C.), in proposing the toast of the club guest, said Sir William Collins was known to all Londoners, and, indeed, to all municipal workers, as a distinguished member of London County Council, and as one of the ablest of its past chairmen.

In responding, Sir William Collins said it had been truly said that a sound system of local government was a sure keystone of our political liberties in as far as they found Parliament sometimes paralysed by the volume of work it endeavoured to undertake, so they would look more and more to the local administrators of the country to relieve a good deal of that administrative work which Parliament had found itself unable to battle with.

Municipal Telephony.—Last week Glasgow Telephone committee recommended—

(*a*) That the present telephone call wire system should be gradually superseded, and that in lieu thereof the automatic calling and clearing lamp system should be adopted; (*b*) that in the first place the new system should be applied to the Hillhead exchange—the probable cost being estimated at £1,500; and (*c*) that offers be invited for carrying out the necessary works.

The general manager (Mr. Macfee) reported that it was necessary to extend the switchboard in the Hillhead exchange, and it was agreed to get offers for the work.

The chairman (Mr. James Alexander) explained that the number of telephones now working was 12,097. Of the subscribers, 96 per cent. were on the unlimited system. A year ago a committee was appointed to consider the operating arrangements. When their system began they adopted the call-wire system, which was the best known at the time, and was in use throughout the country. The change was one which would benefit both operators and subscribers.

Bailie BRUCE MURRAY moved that the matter be referred back. He was a member of the committee appointed to consider the probable cost of altering the system, but despite every effort he could get absolutely no information. He was assured in committee by Mr. A. R. Bennett, and the Corporation received the assurance from Mr. Alexander, that the cost would be trifling. They were now asked to approve of an experiment without any information as to the cost of the alteration of the whole system or as to the financial position of the telephone enterprise, or as to how the money was to be provided, whether out of revenue or by an addition to capital. Taking the subscribers in Hillhead at 800, if it cost £1,500 to deal with these, how much would it cost to deal with 12,000 subscribers? If they went into the matter they would find that the expenditure involved would be £23,000 or £24,000. Despite glowing predictions that there would be a revenue of £10,000 by this time, he understood that the position of the department was actually worse than it was this time last year. The Corporation should seriously consider the position before authorising such a large expenditure. The whole method adopted by the committee from the day they began had been one of secrecy from both the Corporation and the public. That was absolutely wrong in municipal trading, and would give rise to hole-and-corner work. They expected to distract attention from the gross inaccuracies of their preliminary estimates and from the fact that the £5 rate was not paying. If they had any regard for their reputation as business men they would ask more information before they passed the minute.

Mr. W. F. Anderson said that when the Corporation inaugurated their telephone service four years ago the question of the switchboard was really in a transition state. They took the best advice they could get, and it was found that the lamp system was not an established success at that time, but supposing it had been, Mr. Bennett found that when it was introduced the proprietors of it were under obligations to the National Telephone Co. not to supply it to any other concern. The whole cause of their trouble to-day was that while the call wire system was a sufficient service with a limited number of subscribers, the Corporation system had developed in four years what it had taken any other company, including the National, 20 years to develop. Therefore, the system that was good enough for a small number of subscribers was inadequate. By allowing others to experiment with the system which they now proposed to introduce they would get it 50 per cent cheaper than four years ago.

The minutes were adopted by 44 votes to 9.

Parliamentary Notice.—The Midland Electric Corpn. for Power Distribution (Ltd.) will apply for leave to introduce a bill to enable the company to supply and distribute electrical energy in bulk in Stourbridge, to revive or extend the time fixed by the Stourbridge Electric Lighting order, 1899, within which Stourbridge Council are to lay mains and supply electricity within the compulsory area, and to alter, amend and extend the provisions of the Midland Electric Power Distribution and Lighting order, 1898, and the Council's 1899 order.

Plymouth.—For the quarter ended December the Electricity and Street Lighting committee sold 545,117 units of electric current, of which 224,505 were supplied to the Corporation tramways, 22,600 to Plymouth, Stonehouse and Devonport tramways, 250,185 to private consumers, 87,350 for arc lighting, 5,898 for private motors and 4,622 for miscellaneous purposes. The estimated receipts were £6,763, 9s. 6d., against £6,096. 7s. 4d. in the corresponding period of 1903, when the total consumption was 461,699 units. The equivalent of 48,735 8 c.p. lamps is connected, against 89,579 last year.

Presentations.—Mr. M. H. Volk, on resigning the post of works engineer of Brighton Corporation tramways to become engineer and general manager of Volk's electric railway, has been presented by the staff with a set of drawing instruments and a tramway textbook, and by the mechanics in the workshop with a walking stick.

On Wednesday the employes of Shoreditch (London) electricity department presented Mr. Sidney Herbert Thomas, electrician-in-charge, with a marble timepiece and ornaments on the occasion of his recent marriage. In the unavoidable absence of the engineer-in-chief (Mr. C. Newton Russell) the presentation was made by Mr. George Kemp, assistant engineer.

Preston Technical School.—On Monday the new electrical and mechanical laboratories of Preston Technical School were opened by Mr. Y. W. Booth. The trustees of the late Mr. J. B. Booth contributed £2,500 and Messrs. Dick, Kerr & Co. £500 towards the cost of equipping the laboratories.

Provisional Order Revocation.—The Board of Trade have revoked the Sudbury Electric Lighting Order, 1900.

Retford.—The Board of Trade have notified the Council of the revocation of the Retford electric lighting order, 1899.

Ripon.—The Mayor (Ald. Lee) stated at the Council meeting on Tuesday that several companies were applying for provisional electric lighting orders, though the Corporation already had an order. They could do nothing until they knew what the Power & Traction (Ltd.), who had already obtained a tramway order for Ripon, proposed to do.

St. Pancras (London).—At Wednesday's Council meeting the electrical engineer (Mr. S. W. Baynes) reported that a number of the bases of the arc lamp posts had been split by frost.

Salford.—Increases of salary have been granted as follows:—Electricity department: Mr. C. D. Taite, chief engineer, from £700 to £750. Tramways department: Mr. E. Hatton, manager, from £500 to £550; Mr. G. Holford, chief clerk, from £200 to £225; Mr. C. H. Chesters, traffic superintendent, from £200 to £220.

Southampton.—The borough electrical engineer (Mr. H. F. Street) has presented a lengthy report upon the subject of the depreciation of plant.

Mr. Street thinks it inadvisable to set aside a fixed percentage on capital, in addition to the amount for repayment of loans, as it might seriously interfere with the undertaking if the present condition of affairs were altered. In regard to the question of depreciation in connection with income tax assessments, there was only a small amount involved, possibly not averaging £200 per annum, and he did not think it wise to suggest high and impossible rates of depreciation for the purpose of evading the contribution to the National Exchequer, as, through quibbling over a small sum per annum, the undertaking might be committed in some future years for putting aside a sum higher than the revenue would admit without rate aid.

The Electric Lighting committee recommended the Council that no further sum be set aside for depreciation than the provision already made, and this was approved by the Council.

The Council have deferred the recommendation of the Electricity committee to increase the salary of the borough electrical engineer (Mr. H. F. Street) from £500 to £650 per annum (by annual increments of £50 per annum, commencing April 1) until a report from the Joint Electricity and Tramways committee has been presented

Stepney (London).—The Council have decided, on the advice of their consulting engineer (Mr. Arthur Wright), to apply for sanction to borrow £3,770 for storage tanks, water softening plant, &c., for the electricity works. The Electric Lighting committee report that the anticipated increase in the output next winter will necessitate the provision of an additional steam turbine generator at the station, and it has been decided to obtain from C. A. Parsons & Co. a duplicate of the machine recently installed, to be delivered by Sept. 1.

Stirling.—The Council have obtained sanction to a further loan of £4,000 for electric lighting extensions.

Sunderland.—The Electricity committee recommend the Corporation to enter into an agreement with Sir James Laing & Sons and Short Bros. for the supply of electric power to their shipyards for 10 years. Sanction to a loan of £15,000 of plant and mains in connection with these extensions is to be asked for.

The estimated gross expenditure of the committee during the half-year ending Sept. 30 next is £11,557 and the revenue £16,883. Interest on the capital of £280,394, less tax, will amount to £4,828.

Swansea.—The result of the ratepayers' poll on the Corporation tramways bill was 2,147 for and 1,387 against.

Tredegar.—The manager of the Tredegar Company's colliery department (Mr. A. S. Tallis) recently submitted proposals for supplying electricity in bulk to the Council, and at the last Council meeting a deputation was appointed to discuss terms.

Turkey.—The "Financial Times" reports that a Belgian syndicate has acquired a concession for the construction of electric light and power works and tramways at Damascus. The concession carries the right to utilise for the generation of electric power all the available water power within a distance of 18 miles of Damascus.

Wakefield.—On Monday the Council referred back a recommendation of the Electric Lighting committee to apply for sanction to a further loan of £18,000 for electric lighting extensions.

A recommendation that Mr. H. A Neville, chief assistant electrical engineer, be appointed city electrical engineer, at £300, rising by annual increments of £25 to £400 per annum, was also referred back, the voting being 10 to 9.

Whales and Submarine Cables.—Not for the first time a whale has succeeded in causing material damage to a submarine telegraph cable. In the Persian Gulf on one occasion a whale, in the course of its submarine gambols, became entangled in a cable, and in extricating itself succeeded in breaking the cable. On another occasion off the coast of South America a similar result followed a whale's entanglement. But the latest report (all the way from Alaska) is that a whale had its *teeth* embedded in a cable off the Alaska coast and became so fixed that it was unable to escape and was drowned, the body being found attached to the cable a considerable time after death. This is, anyway, the first case on record of such a break.

Wimbledon.—At the meeting of the Council last week the General Purposes committee reported that they had approved the recommendation of the Electric Lighting committee that the plant at the electricity station should be extended by the addition of three 1,000kw. turbo-alternators with condensers and the necessary foundations, that one 1,000kw. turbo-alternator with condenser be obtained and erected, and that the electrical engineer (Mr. H. Tomlinson Lee) be instructed to prepare plans and estimates for such foundations and one 1,000kw. turbo-alternator with condenser, &c. The recommendation was adopted.

Concert.—The Dynamical Cricket Club gave a concert at the Victoria Hall, Archer-street, Bayswater, London, on Thursday evening, Jan. 26, under the presidency of Mr. W. A. S. Benson. Among the items on the programme was a song by Mr F. W. Cowdray, the secretary of the club.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Stoke Newington (London) Council invite tenders for supply, delivery and erection of sub-station plant and mains, including transformers, three-phase motor generators, boosters, &c., extra h.t. and three-wire l.t. switchboards, storage battery and l.t. distribution mains. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Talbot & Stevenson), 26, Victoria-street, London, S.W., and copies obtained of the borough surveyor (Mr. W. F. Loveday), Town Hall, Milton-road, Stoke Newington, N., after Feb. 6. Tenders (addressed Electric Lighting committee) to the Town Hall by 4 p.m. March 8. See also an advertisement.

Fulham (London) Establishment committee are prepared to receive tenders for the supply and erection of condensing plant, boilers, economisers and stokers. Specifications, &c., from the borough electrical and consulting engineer (Mr. Arthur J. Fuller) after 8th inst. Tenders, on forms supplied and addressed to the Town Clerk, Town Hall, Fulham, by noon 22nd inst. See an advertisement for additional particulars.

Manchester Tramways committee are prepared to receive tenders for supply and erection of a main switchboard, auxiliary distribution boards, &c., for their car-repairing works. Specifications from the general manager (Mr. J. M. McElroy, 55, Piccadilly, Manchester) Tenders to chairman of committee by 10 a.m. Feb. 14. See also an advertisement.

Manchester Electricity committee invite tenders for supply and erection at Dickinson-street station and sub-stations of (*a*) motor gene rators and (*b*) five-wire balancers. Specifications from the secretary of the Electricity committee, Mr. F. E. Hughes. Tenders (addressed to the chairman) to the Town Hall, Manchester, by 10 a.m. 21st inst. See also advertisement.

Dublin Corporation invite tenders for supply of arc-lamp carbons. Specifications, &c., from the City Engineer, City Hall, Dublin, Tenders to the town clerk, Mr. Henry Campbell, City Hall, Dublin, by Feb. 23. See also advertisement.

The Council of the Metropolitan Borough of *Bermondsey* invites tenders for the supply of stores and articles for one year from March 31, 1905, including arc-lamp carbons, conduits, electricity meters, demand indicators and main fuses, engine oils, indiarubber cables and jointing material, lead-covered cables and meter boards. Samples may be seen at the electricity works upon application to the borough electrical engineer, Mr. W. H. Vincent. Forms of tender from the town clerk (Mr. Fredk. Ryall), to whom tenders by 4 p.m., Feb. 6.

Hammersmith (London) Council invites tenders for the supply of stores for the 12 months ending March 31, 1906, including arc-lamp accessories, globes, &c., brooms and brushes, carbons, commutator brushes, electrical goods, files, fire bricks, gauge glasses, incandescent lamps, insulated wires, lubricating oil, metals, meters, oilmen's goods, packing and jointing materials, screws, tools and Welsh smokeless and other steam coal. Tenders to the town clerk (Mr. Thompson) by 4 p.m. Feb. 8.

Bury (*Lancs.*) Electricity committee invite tenders for a 500kw. direct-current high-speed generating set. Specifications, &c., from the engineer and manager (Mr. S. J. Watson). Tenders to the Municipal Offices, Bury, by noon Feb. 14.

West Ham Borough Council invite tenders for engine room stores, cable, integrating wattmeters, double-pole house cutout boxes, transformers, incandescent lamps and coal. Tenders to town clerk by 4 p.m. Feb. 9.

Midland Railway Co. (Northern Counties committee), Ireland, require tenders by 10th inst. for 12 months' supply of stores, including telegraph ironwork, batteries, signal wire, &c. Tender forms from York-road Station, Belfast.

Barking District Council require tenders by 5 p.m. 10th inst. for dynamo, water-tube boiler, feed pump, water softener, travelling crane, &c.

Portsmouth Corporation require tenders by 15th inst. for street work (laying cables, &c.), and supply of electrical goods, ironmongery, &c., for 12 months.

Blackburn Electricity and Tramways committee invite tenders for stores for 12 months ending March 25, 1906. Tenders by noon of 16th inst.

Ashton-under-Lyne Electricity committee require tenders for a tube-well pump for their electricity works. Tenders by noon of Feb. 15.

Ilford District Council invite tenders for about 2,400yds of 0·4in concentric armoured cable. Tenders to chairman by 4 p.m. Feb. 7.

Leek District Council require tenders by 20th inst. for wiring and fitting the town hall for the electric light.

Todmorden Corporation invite tenders for supply of electricity meters.

Army Contracts.—Manufacturers who may wish to be invited to tender for army requirements should, by letter addressed to the Secretary, War Office, state the particular articles which they manufacture and the names of at least two well-known firms or public bodies who have purchased from them and are in a position to certify as to the quality of their productions. The articles to be purchased include electrical stores, cables, chemicals, clocks, copper wire, glassware, &c. Firms whose names are on the War Office list need not apply. Further particulars are given in an advertisement.

TENDERS RECEIVED AND ACCEPTED.

London County Council on Tuesday received the following tenders for roading and platelaying in connection with the construction of the conduit tramways from Clerkenwell-road to the Angel, Islington :—

John Mowlem & Co. (*accepted*)	£27,925	0	0
Muirhead, Greig & Matthews	31,619	15	6
J. G. White & Co.	31,218	7	10
Dick, Kerr & Co.	29,924	9	10
Wm. Griffiths & Co.	29,704	1	5
R. W. Blackwell & Co.	29,149	14	6

The Tranmere Bay Development Co., Birkenhead, have placed a contract with the Power-Gas Corpn. (Ltd.), 39, Victoria-street, London, S.W., for a gas-driven electric installation for their new shipyard. The installation consists of a power-gas plant of 8,000 H.P. capacity, the larger portion of the gas generated being intended for firing furnaces. The electric generating plant comprises two 400 I.H.P. gas engines, each direct-coupled to a Bruce Peebles 220kw. dynamo, and three 250 I.H.P. gas engines each direct-coupled to a Bruce Peebles 140kw. dynamo.

The tender of the Electrical Engineering & Maintenance Co. has been accepted by Camberwell (London) Council for keeping in order telephones and electric bells in the Town Hall, and the tender of May, Calder & Co. has been accepted for similar work at Grove Vale depot.

Ormskirk Guardians have accepted the following tenders :—

Morley Elec. Eng. Co., steam exhaust, &c., piping and erection of plant, at £463, and for a booster at £68 ; Hart Accumulator Co., storage battery (116 standard lighting type cells), £267. 9s., and £19. 15s. per annum for five years' maintenance ; H. Taffs & Co., wiring and cables, £998. 10s.

Swansea Corporation have accepted the tender of J. & H. McLaren for a 450 I.H.P. marine type triple-expansion engine ; that of Siemens Brothers & Co. for a 225kw. continuous-current dynamo ; and that of Herbert Morris & Bastert for an 8-ton travelling hand crane.

Sunderland Electricity & Lighting committee have accepted the tender of Balcke & Co. for a cooling tower at Hylton road station, and that of the Sunderland Forge & Engineering Co. for alterations to the plant at the sub-stations.

The D.P. Battery Co. (Ltd.), 11, Victoria-street, London, S.W., have received the order for the storage battery for Ramsgate electricity works, consisting of 260 L.S. type 13-plate cells in lead-lined wood boxes.

Hackney (London) Council have accepted the tender of Johnson & Phillips for arc lamps and pillars, and those of the Reason Mfg. Co. and the Schattner Electricity Meter (Ltd.) for demand indicators.

Pudsey Corporation have accepted the tender of Johnson & Phillips for underground cables, boxes and switchboard. The contract includes laying and erecting.

The War Office has placed an order with Johnson & Phillips for rubber and paper cables, with boxes, for the electric lighting, &c., at the Royal Small Arms Factory, Enfield Lock.

East Ham Council have accepted the tender of Meldrum Bros. for the supply and erection of two ranges of destructor cells and regenerator at £3,105.

Derby Corporation have placed an order with Callender's Co. for tramway feeder cable at £208. 10s.

Stepney (London) Council have placed an order with C. A. Parsons & Co. for a steam turbine generator at £5,900.

BUSINESS NOTICES.

Messrs. Richard C. Dieppe and W. T. Knorr, have started business under the title of the Universal Electrical Mfg. Co., at 14, Station-parade, Peckham, London, S.E., for the manufacture of switchboards, switchis and accessories. Mr. Dieppe has been for four years with Johnson & Phillips as chief draughtsman and works manager, and previously had considerable experience with leading electrical engineering and shipbuilding firms. Mr. Knorr has been with Johnson & Phillips for the past 14 years, in charge of switchboard, arc lamp and mechanician shops.

The General Contracts Co. (Ltd.), of 1, Fenchurch-avenue, London, E.C., have found it necessary, in consequence of increasing business, to remove to larger premises at 62, Rosebery-avenue, Clerkenwell, London, E.C.

John Sandford and Hy. Wm. Wartnaby Dix, electrical engineers, 44, Waterloo-st., Birmingham, have dissolved partnership.

Plant for Sale.—Messrs. Beanland, Perkin & Co., Leeds, have for sale two 50 H.P. Sentinel engines, direct coupled to 30kw. dynamos ; also a 35 H.P. gas engine, a 20kw. Taunton dynamo, two 33 H.P. Westinghouse engines with 18kw. Hartnell dynamos. See advertisement.

Mr. H. W. Bindon, 76, Rushey-green, Catford, S.E., has for sale a gas engine, dynamo, E.P.S. battery, &c. See advertisement.

Business for Sale.—A well-established mechanical and electrical engineering business is for sale by private treaty by Messrs. C. Baker & Co., 39, Bennett's-hill, Birmingham. See advertisement.

Premises for Sale, &c.—Messrs. Furber, surveyors, valuers and auctioneers, 3, Warwick-court, Gray's Inn, London, W.C., will offer for sale at the Mart, Tokenhouse-yard, London, on March 2 at 2 p.m., a substantial building, No. 158, Farringdon-road, comprising a warehouse and factory, of which particulars will be found in an advertisement elsewhere. These premises were formerly in the occupation of Messrs. Ely Bros., the well-known ammunition manufacturers, who have now erected new works at Edmonton, where the Farringdon-road branch of the business will be carried on.

A ground floor, area 2,700 super. ft., equipped with electric power, and suitable for general engineering, is to let. Applications to Messrs. Marshall & Co., Campbell Works, Stoke Newington, London, N. See advertisement.

Messrs. Stimson & Son, 3, Moorgate-street, E.C. and 2, New Kent-road, S.E., London, have extensive factory premises (close to Vauxhall and Nine Elms, with frontage to the main road) to let. See advertisement.

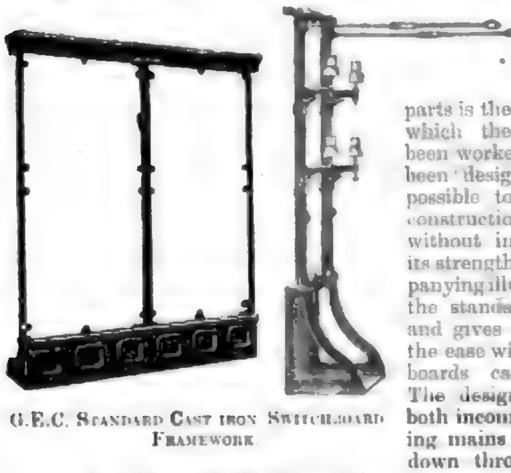
Electric Pendant.—A new form of electric pendant has been introduced by Messrs. Player & Mitchell, of Birmingham, who are sole makers of this device under Lea's patent (No. 13,169, 1904). The fitting is designed for the lighting of machine and other tools. It is claimed to be particularly adaptable to almost any apparatus for which an adjustable fitting of the kind is required. The fittings are made in four sizes, the largest for workshop and the smallest for office use.

Electric Fire Alarm Apparatus.—There are many claims made in a pamphlet just issued by the May Oatway Fire Appliances (Ltd.), 92 and 94, Paul-street, London, E.C., but it is fair to the company to say that these claims are justified by the proved results where May-Oatway fire appliances have been installed. And many of these installations are representative, for they include such huge blocks of buildings as those occupied by Messrs. Clark & Co. at Paisley, J. Templeton & Co. at Greenhead, the Midland Railway Co.'s buildings, at Heysham Harbour, Harrod's Stores at Brompton (London) Rowntree's confectionery works at York, and scores of other large works, premises, municipal buildings, theatres, schools, &c., at home and abroad. Besides being an excellent example of the printers' art, the book describing the May-Oatway apparatus, of which we have received a copy, contains information which is of interest both from its technical and general contents. Attention has been given to the illustrations as the subject deserves.

London City Lighting.—In connection with the lighting of some of the most important parts of the City arc lamps of the "Excello" type, supplied by the Union Electric Co., 151, Queen Victoria-street, London, E.C., are being employed.

Wireless Telegraph Code.—Marconi's Wireless Telegraph Co., 18, Finch-lane, London, E.C., have (as a consequence of the notice recently issued by the Postmaster-General in connection with the acceptance by the Post Office of messages to be forwarded over the system of the Marconi Co. to ships at sea) prepared for early publication a special telegraphic code for the use of senders of wireless messages. It is also intended to issue from time to time a register containing the names and telegraphic and business addresses of all persons who use the Marconi code, to enable persons both ashore and afloat to ascertain promptly the names and addresses of those with whom they can communicate by this means.

Catalogues, &c.—In a new switchboard list of the General Electric Co. various types of panels are illustrated and described. Most of these panels have been specially designed to meet particular requirements of central station engineers. The company have put down special plant at their Manchester works with a view to meeting the demand for special types of boards, and all parts have, as far as possible, been standardised. Among these standardised parts is the framework on which the panels have been worked. These have been designed as far as possible to simplify the construction of the board without interfering with its strength. The accompanying illustration shows the standard framework, and gives a good idea of the ease with which these boards can be erected. The design is such that both incoming and outgoing mains can be carried down through the cable channel, and thence carried direct through a suitable opening in the base of the frame direct to the terminals, thus ensuring a clear and free run for the mains. The high-tension switch gear illustrated in the new list is suitable for alternating-current circuits up to 10,000 volts. The switches and circuit-breakers are of the plunger type. In the same list is included the company's standard type of traction feeder pillar, and there is a good list of accessories and spare parts for both continuous and alternating-current work.



G.E.C. Standard Cast iron Switchboard Framework.

Recent railway disasters have called renewed attention to the subject of efficient signalling systems, and the opportunity is taken by the Miller Signalling Synd., Salisbury House, London Wall, London, E.C., to issue particulars of their system of railway signalling, which they claim would have prevented such accidents as that which recently occurred on the Midland Railway. The company regard as an additional reason for the most up-to-date systems of signalling being adopted on railways the fact that the increasing speed of trains finds the old-fashioned systems of signalling unequal to the demands made upon them. The Miller system was fully described in *The Electrician*, Vol. L., p. 680.

"Tangential Water Wheels" is the subject of a pamphlet issued by the Abner Doble Co., of San Francisco, U.S.A., and describes a variety of apparatus connected with water-wheel work manufactured and supplied by the company. One of the illustrations shows a Doble wheel installed at the works of the Edison Electric Co., at Los Angeles, after a year's continuous running under a head of water of 1,960ft. at 430 revs. per min.

From Messrs. Johnson & Phillips, Charlton, Kent, we have received an illustrated pamphlet descriptive of their cables and junction boxes. This firm manufactures rubber, paper and dry-core cables, and has in stock a large number of designs and patterns for disconnecting boxes for all classes of cable. The underground network disconnecting and fuse boxes are fitted with bell covers, and, being self-contained, it is unnecessary to provide brick pits for them. They are thus easy of access and there are no bolts or nuts on the covers.

Messrs. Siemens Brothers & Co. have issued some further leaflets (No. 507B, 548 and 549). The first deals with M.C. controllers for cranes and capstans of standard sizes from 50 to 400 amperes. The second deals with F generators (four-pole continuous machines) made in eight sizes, from 2kw. to 49kw. These have wrought-iron poles cast solid into the frame, which is circular in shape and of cast iron. The pole shoes are laminated and screwed to the pole face. While the bearing bracket at the driving end is cast in one piece with the frame, that at the opposite end is bolted to a circular seating of the frame. Each size is standardised for high, medium and low speeds at 110, 220 and 500 volts. The last-mentioned leaflet deals with motors of a corresponding design, ranging from 2½ B.H.P. to 58 B.H.P.

Part 1 (January, 1905) of Messrs. W. T. Henley's price list of paper-insulated cables for electric lighting, power and traction has been issued, and comprises particulars of a lengthy list of cables, including low tension, single, concentric, triple concentric, twin, three-core and high tension concentric cables. These particulars are tabulated in a form easily followed by those who seek the information which is given. There is, in addition, some introductory matter giving particulars of the process of manufacture. The tables are calculated upon the recently published report of the Engineering Standards committee.

The Simplex Steel Conduit Co. notify in a leaflet (No. 102) just issued that important percentage reductions in the price of "Simplex" material have been made. Copies of the leaflet can be obtained by the trade on request.

A circular list of iron-clad motor starters is issued by Ernest F. Moy (Ltd.), Camden Town, London, N.W.

New lists of vee cramps and blocks and of box jigs have been issued by Edward G. Herbert (Ltd.), Manchester.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Jan. 25 to 31, with the ports of destination:—

Aden—£47 (telegraph apparatus). ***Africa***—Alexandria, £738; Cape Town, £253 (including £73 telegraph material); Delagoa Bay, £87; Durban, £764 (including £319 telegraph material); East London, £46; Port Elizabeth, £41. *Argentina*—Buenos Ayres, £72. ***Australasia***—Adelaide, £10; Fremantle, £39; Launceston, £47; Perth, £159; Sydney, £683; Wellington, £425. *Azores*—£19 (telegraph material). *Brazil*—Rio Janeiro, £28. *Burma*—Rangoon, £38. *Ceylon*—Colombo, £45. *China*—Kowloon, £260; Shanghai, £207. *Cochin China*—Saigon, £10. *France*—Paris, £20. *Germany*—Hamburg, £59. *Gibraltar*—£275. *Holland*—Rotterdam, £40; Amsterdam, £69; Flushing, £54. *Hong Kong*—£209. *India*—Bombay, £139; Calcutta, £405; Madras, £132. *Italy*—Leghorn, £300. *Japan*—Kobe, £83; Nagasaki, £15; Tokyo, £8,527; Yokohama, £280. *Malta*, £13. *Straits Settlements*—Penang, £276; Singapore, £16 (telegraph material). Total £9,930, against £156,236 in the corresponding week last year (Jan. 27 to Feb. 2).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by **Messrs. Mewburn, Ellis & Pryor,** *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

December 5, 1904.

26,391 M. H. Smith. Mechanism for use with "Hertzian" wave apparatus.

26,439 E. Bickersteth. Electric light decorations.

26,445 V. I. Feeny (C. Wirt, U.S.). Brushes for electric machines.

26,446 V. I. Feeny (C. Wirt, U.S.). Rheostats.

26,449 S. B. Flynt and L. A. Maiden. Insulator for electric wires.*

26,458 O. D. Lucas. Mercury vapour lamps.

26,475 A. H. McNeil. Electric fire-alarms and thermo-indicators.

December 6, 1904.

26,527 A. Eckstein and H. J. Coates. Manchester. Electric ignition apparatus.

26,529 R. J. Crowley and A. Blackman. Storage batteries.

26,538 F. Herbert. Fuse boxes, ceiling boxes, wall plugs, &c.*

26,552 S. Bibeller. Lanterns for use in electric lighting.

26,557 A. J. Boult (E. A. Ashcroft, Algeria). Production of metals of the alkali group by electrolysis.

26,582 C. E. Davies. Direct-current dynamo electric machines.

26,588 B.T.-H. Co. (G.E. Co., U.S.). Electrical distribution.

26,589 B.T.-H. Co. (G.E. Co., U.S.). Switches.

26,602 J. Y. Johnson (Badische Anilin & Soda Fabrik, Germany). Producing reactions in gases by electric arc.

26,603 I. E. Winslow. Apparatus for holding or suspending trolley wires

December 7, 1904.

26,618 A. Taylor, jun. Glasgow. Appliances for shifting points of tramways or railways.

26,656 W. Goulton. Electric lamps.

26,679 W. Shaffer. Electric current protecting devices. (Date applied for, Dec. 9 1903, date of application in Germany.)*

26,686 Siemens Brothers & Co. and G. S. Grimston. Telegraphs.

26,696 S. Eisenstein. Apparatus for wireless telegraphy or telephony.*

December 8, 1904.

26,704 A. R. Walmsley. Halifax. Clips for supporting electric conductors.

26,708 C. W. Webster. Bradford. Automatic starters for electric motors.

26,709 A. S. Blackman. Bradford. Fuse or terminal boxes for electric mains.

27,746 J. Fiddes and J. F. Watt. Automatic fire-alarms.

26,748 Marconi's Wireless Telegraph Co. and E. Priddle. Controlling telegraphic recorders.

26,757 Siemens Brothers & Co. (Siemens & Halske A.G., Germany.) Electric bells.*

26,761 J. M. Wellington and W. F. Daniell. Arc lamps.

26,769 S. J. Williams. Coil trembler for electrical ignition apparatus.

26,772 H. H. Lake (C. J. Schwarze and A. M. Kelle, U.S.). Electromagnetic apparatus.*

26,785 G. G. M. Hardingham (Felten & Guilleaume Carlswerk A.G., Germany). Rendering insulation of conductors fireproof.

26,791 A. Heyland. Liverpool. Connections for compounding transformers, &c. (Date applied for, Dec. 8, 1903, date of application in Belgium.)*

26,799 J. C. Dean. Holders for incandescent lamps.

26,815 F. M. Lewis. Alternating-current electro motor.

December 9, 1904.

26,820 C. M. Dorman, R. A. Smith and H. G. Bass. Salford. Switches and cutouts.*

26,849 B. M. Bailey. Birmingham. Electro-deposition of metals.

26,887 P. MacMahan. Three-phase ground detectors. (Date applied for, Jan. 20, 1904, date of application in U.S.)*

26,906 J. R. Dick and Reason Mfg. Co. Demand indicators.

26,915 J. T. H. Dempster. Electrodes for arc lamps. (Date applied for, Dec. 10, 1903, date of application in U.S.)*

26,916 C. P. Steinmetz. Arc lamp electrodes. (Date applied for, Dec. 10, 1903, date of application in U.S.)*

26,917 W. R. Whitney. Electrodes for arc lamps. (Date applied for, Dec. 10, 1903, date of application in U.S.)*

26,918 J. Harden. Arc lamps and electrodes therefor. (Date applied for, Dec. 10, 1903, date of application in U.S.)*

26,919 J. Harden. Arc lamp electrodes. (Date applied for, Dec. 10, 1903, date of application in U.S.)*

26,920 C. F. Lindsay. Arc lamp electrodes. (Date applied for, Dec. 10, 1903, date of application in U.S.)*

26,921 and 26,922 W. S. Weedon. Arc light electrodes. (Date applied for, Dec. 10, 1903, date of application in U.S.)*

26,923 B.T.-H. Co. (G.E. Co., U.S.). Rheostats.

26,925 B.T.-H. Co. (G.E. Co., U.S.). Electrical measuring instruments.

[illegible] R. J. B. Mills (E. A. [illegible], U.S.). Storage batteries.*

[illegible] R. J. B. Mills (T. A. [illegible], U.S.). Continuous apparatus for metal plating.*

26,957 C. H. Pym and E. J. Witcombe. Bristol. Electric signalling.

26,985 G. Page, A. Holmes, J. H. Holmes, L. W. Holmes and E. Holmes. Switches.

26,986 H. V. James and R. A. Marples. Electrically controlled and variable speed gear.

26,997 W. M. Still and A. G. Adamson. Telephone apparatus.

27,000 D. L. Lindquist. Electromagnets.*

27,003 A. Benassy. Switches. (Date applied for, Dec. 17, 1903, date of application in Switzerland.)*

27,010 O. O. Kruh. Frequency changers. (Date applied for, Dec. 12, 1903, date of application in U.S.)*

27,011 O. O. Kruh. Vapour electric apparatus. (Date applied for, Dec. 12, 1903, date of application in U.S.)*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

28,662 Helberger. Electric chain-welding machines.

1904.

131 La Cour. Regulation of electric currents. (Date applied for, Jan 5, 1903.)

552 Bassompierre and Dardeau. Microphones. (Date applied for, Jan. 15, 1903.)

716 Raworth. Control and propulsion of electric vehicles.

2,063 Nehmer. Static electrical machines for lighting gas, ether and the like.

2,152 Raschen Clayton and United Alkali Co. Electrolytic cells.

2,456 B.T.-H. Co. (G.E. Co., U.S.). Machines for treating filaments.

3,998 Levis (G.E. Co., U.S.) Obtaining metals from compounds containing silicon.

4,234 Elphinstone. Electrical measuring and indicating instruments.

4,376 Tourtel & Tourtel Mfg. Co. Electricity meters.

4,640 Moore & Glasgow Electric Crane & Hoist Co. Crane equipment for shipbuilding berths.

4,676 H. P. Bradford, F. D. Ward and H. C. Furniss. Insulators for the conductors of electric railways.

4,770 B.T.-H. Co. (G.E. Co., U.S.). Automatic regulators for alternating-current motors.

4,771 B.T.-H. Co. (G.E. Co., U.S.). Controlling alternating current motors.

4,875 Marky. Switches.

4,925 Ross. Electric bell pushes.

4,944 Russo. Arc lamps and carbons therefor.

5,118 Dowsing. Electrical radiators.

5,164 Crompton & Co. and Hodgson. Arc lamps.

5,664 Ewart. Base or wall block.

7,267 Bornand. Switches.

9,306 Akt. Ges. Brown, Boveri & Cie. Automatic regulation of current for charging storage batteries. (Date applied for April 23, 1903.)

15,691 Mead. Advertising by electric lamps.

19,580 Duncan. Electricity meters. (Date applied for, Dec. 29, 1903.)

21,894 Gregory. Regenerative dry batteries.

24,200 Clark. Switches.

24,399 Schiemann. Electric tools.

25,112 Lake (Gould). Electric light systems.

25,404 Vollrath. Automatic fire-alarm.

25,592 Hunter. Switches.

26,043 Kitsee. Submarine telegraphy.

26,097 Eastwood. Magnetic clutches. (Date applied for, April 1, 1903.)

26,157 Nusch (Cotis). Arc lamps.

26,260 Sims. Arc lamps.

26,367 Thomson (Ges. fur Drahtlose Telegraphie). Wireless telegraphy.

26,449 Flynt & Maiden. Insulators.

COMPANIES' MEETINGS AND REPORTS.

City & South London Railway Co.

The forty-first ordinary general meeting was held on Tuesday, under the presidency of Mr. Charles Grey Mott.

The SECRETARY (Mr. W. F. Knight) read the notice calling the meeting.

The CHAIRMAN: I am sorry that we have to meet you again with a slightly reduced dividend. The great mass or bulk of the traffic of this line is a perfectly permanent and steady thing, and varies very little; but there is a fringe or margin of traffic which varies considerably according to the state of the weather especially, and other circumstances of the time. Now, during the past half year the effect of the weather upon this part of the traffic has been very considerable. The rainfall during that period was only half of what it was in the corresponding period of last year, and, of course, it is wet weather which affects us. When it is wet a certain number of passengers travel by us, but when it is fine they walk or go on the tops of omnibuses. The result is that we lose traffic in very fine weather, and in dry weather especially, and that is what has affected our traffic in the past half-year. But it has also been affected by the active competition of the tramways of the County Council, who do their best to draw the traffic from us by very low charges and by giving every possible accommodation they can to take away traffic from these underground railways, which, after all, are of vital importance to the comfort and convenience of the population of London, and which ought not, I think, to be attacked as they are. Nevertheless, we suffer from that. We have also suffered especially in the past half-year from depression in certain of the local trades of London, particularly the building trade. With these adverse circumstances, I think that we may congratulate ourselves that the falling off has not been greater than it is, amounting, I think, to about £1,600 in the half-year. We have raised no capital during the half-year. We have spent £2,288, which increases the debit balance to capital account to £24,872. As regards the revenue, there has been a decrease in passengers of 309,216 in numbers and of £2,938 in receipts. But an increase in season tickets is shown of 2,674. And season ticket receipts have increased by £1,857. From parcels the increase has been £44, from rents £591, and from sundry receipts £28, total £2,020, leaving a net decrease in receipts of £920. The expenditure, on the other side, shows that there has been a decrease in maintenance of £57, in locomotive and generating expenses of £471, in traffic expenses of £451, in law expenses of £1, and in rates and taxes of £226. There has been an increase in expenditure on carriage repairs of £263, in general charges of £26, and in passenger duty of £1, so that there has been a net decrease in the expenditure of £916 against the net decrease in the receipts of £920, and therefore the decreased balance to net revenue is only £4 on the half-year. Then you may say, why not pay the same dividend? We have got a net increase in the amount of interest paid of £48. Debenture stock interest has increased £199, but there is a saving in interest on loans of £151, so that there is only an increase of £48, as I have said. There was, however, a difference in the balance brought forward at the commencement of the half-year of £799, which we had to make good, and the result is that there is a reduced balance available for dividend of £851. We therefore could not pay the same dividend as last year, and we thought it better to reduce the dividend by ¼ per cent. and to transfer not only that £851, but £746 more, to the balance we carry to the credit of this half-year, and which will come to the good in this half-year's accounts. We thus carry forward £1,450 now. These items together, the £851 and £746 addition we carry forward, make the difference of ¼ per cent. in the dividend which we recommend you to declare. As regards our comparative returns and percentages, the miles run last half-year were 556,409, against 607,402 in the December half of 1903. We have run less mileage in order to meet the decreased receipts. The number of trains was 90,842, against 99,168 in the corresponding period of 1903. The number of passengers was 8,401,846, against 8,711,062, a reduction in the past half-year of 309,216. By reducing the trains we increased the number of passengers carried per train, and the number in the past half-year was 92·49, against 87·84 in the December half of 1903. The receipts per train were 15s. 9d. last half-year, against 15s. 8d. in the corresponding period of 1903, and the receipts per train-mile were 2s. 6·7d., as against 2s. 4·7d. The receipts per passenger were practically the same. The working expenses amounted to 47·22 per cent. in the past half-year against 47·86 per cent., showing a slight decrease. The expenses per train mile were 1s. 3·2d. against 1s. 2·8d. in the December half of 1903. That is to say, the decreased mileage made the average cost per train mile larger. The locomotive charges were 4·54d. as against 4·33d., and the traffic expenses were 6·77d. as against 6·38d. You will have noticed that we show a decided increase in our rents of £591, or nearly £600, in the half-year. I am glad to say that we are utilising our property wherever we can by making shops at King William street and at the Bank and letting them, and we hope that we shall get a still further accession to that amount. Besides that we have received a good amount from way-leaves, advertisements, &c., and our general manager has made many satisfactory agreements of different kinds which go steadily to increase our rent roll, which now amounts to over £7,000 a year from these sources. Turning to the report, we have been very anxious to get the Euston extension carried out, because we believe that it will add very largely to the prosperity of this company. We have had very difficult negotiations, however. We have had to negotiate with five different companies, besides local bodies and others, but these negotiations have, I am glad to say, been brought to a satisfactory conclusion, and we are, therefore, prepared to go on with that work. We have made our financial arrangements so that we feel that we are safe as regards the funds for carrying out the Euston extension, and we now propose (the plans are ready) to invite tenders for the work, and to proceed without delay in carrying it out. In the case of the Clapham extension, we have made arrangements whereby the receipts from interest and other things connected with the carrying out of the works will largely cover the dividend payable upon that stock. I am glad to say that the Great Northern & City Railway is progressing satisfactorily with its traffic. Its first effect was to rob us of a considerable amount of traffic by the opening of their stations at Essex-road and Highbury, but we get such a large and increasing amount of traffic from them in exchange here that we are getting back more now than they took from us at Islington. I hope that that will go on steadily. The system of through bookings right over the Great Northern & City line and our line and in connection with the Brighton has recently come into force and is extending, and I hope that that will do us good and promote traffic. Our extension to Euston has one great advantage in that it will give us a connection between the railways on the north and on the south, and it will give us the control and an interest in the long journeys. The long journeys form the most stable part of our traffic. They cannot be affected by any of those small reductions and low fares for short distances, which the County Council introduce, and this will, no doubt, place our traffic in the future, when we get to Euston, on a much more solid basis, and one which I believe will steadily tend to the advantage of this line and the considerable increase of its dividend. I now move the adoption of the report and accounts.

Col. PERRY: Is the level of the Baker-street & Waterloo Railway the same level as ours? When we get to Euston there will be the Euston & Hampstead Railway, and I understand that we can go on by the Hampstead line to Charing Cross. Is that railway on the same level as ours? Suppose the Baker-street & Waterloo line were to be connected with the Euston & Hampstead. I know that at present the Metropolitan Company are opposing that, but it is a question of levels. Could the Baker Street & Waterloo line be connected at that angle above Portland-road station with the Euston & Hampstead Railway just above Gower-street?

Mr. COLLINS: There is one matter which may be considered small by some, but which I think should be considered—I refer to the question of the lifts in connection with these railways. I think that the lifts ought to be as close as possible to the platforms. There should be no walking distance to go, and if possible there should be no stairs whatever. It is only in the matter of speed that the tube railways have an advantage over omnibuses, and if there is so much travelling between the lifts and the platforms, and the stairs, to get to the trains, I believe that many people will go by the omnibuses instead. I do not mean to say that that is the case with our line, but on the Central London Railway there is a long walk from one point to the other. There is thus a great deal of bother, and some people who are not in their early youth feel it a great trouble, whereas if the lifts could be put closer to the platforms and the stairs could be abolished, I believe that the tube railways would be infinitely more popular than they are.

The CHAIRMAN, in reply, said: With regard to the question of levels, if the gentleman who asked this question had heard all the evidence that has been given before all the different Parliamentary Committees sitting on electric railways, he would know that the idea has long since been given up of our being able to run over each other's lines, because the traffic must be so rapid that you cannot afford to allow another company to come in and interfere with you. On our own line now in the busy time we are running a train every 2½ minutes, and we could not, therefore, let another company run their trains over our line. It would be impossible to do so. It is recognised that at the junctions we must have exchange stations and must make them as convenient as possible, and we are trying to make such exchange stations as easy as possible by easy subways from one platform to the other. Everything has been done in that direction. Mr. Collins raised the question of lifts. We are trying wherever we can to meet public requirements in this respect, but the engineering difficulties are such that it is impossible to get over them in most of the cases.

The report was then adopted unanimously, as were resolutions approving the dividends and re-electing the retiring directors and auditors. A vote of thanks terminated the proceedings.

CENTRAL LONDON RAILWAY CO.—The report for the half-year ended Dec 31 states that the capital expended during the half-year was £12,665. 4s. 7d. Receipts were £176,281. 8s. 1d., an increase of £1,046. 4s. 4d., and working expenses £95,937. 12s. 3d., a decrease of £1,425. 16s. 11d., compared with corresponding period of last year, leaving £80,343. 15s. 10d. The number of passengers carried was 21,906,150, compared with 22,369,397 in June half-year and 21,774,850 in half-year ended December, 1903. The average receipt per passenger was 1·86d., the same as in the half-year ended December, 1903. After providing for debenture interest and other payments, the net balance is £122,579. 14s. 2d. The directors recommend dividends on the undivided ordinary and preferred stock at the rate of 4 per cent. per annum, and on the deferred ordinary stock at the rate of 4 per cent. per annum for the whole year. Of the unappropriated balance (£52,111. 15s. 9d.) the directors recommend that £30,000, with interest for half-year, be transferred to reserve, bringing the total to £61,730, the balance (£22,111. 15s. 9d.) being carried forward.

In the expectation that the report of the Royal Commission on London Traffic would be presented at an early date, the directors deemed it necessary to re-deposit the company's bill entitled "The Central London Railway (New Lines) Bill, 1905," which is practically identical with that deposited in 1902, but afterwards withdrawn in consequence of the appointment of the Royal Commission. It provides for the continuation of the Central London Railway, via Hammersmith, Piccadilly and the Strand, thence to Liverpool-street and the Bank, forming with the existing line a complete circular route through the centre of London. The Great Western Railway Co. have also deposited a bill which includes provision for a station adjoining that of the Central London Co. at Shepherd's Bush. This connection with the Great Western Co.'s railway, in addition to those proposed with the Great Eastern, the North London and South-Eastern & Chatham lines, gives further force to the view which the directors have previously expressed, that a continuous circular railway, with convenient exchange stations, though without physical junctions with other lines, will enable the company to provide the public with the best, safest and most economical service, and they therefore recommend the proprietors to approve the bill. The directors have approached the Charing Cross, Euston & Hampstead and Baker Street & Waterloo companies, with a view to the construction of low level subways for the exchange of passengers at Tottenham Court-road and Oxford Circus stations respectively. Nothing has yet been settled on these points.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—At a meeting held on Wednesday, under the presidency of Mr. J. Irving Courtenay, resolutions approving the bill to be introduced into Parliament for the purpose of abolishing the founders' shares in the company and substituting therefor an agreed issue of ordinary shares, was carried after a poll had been taken, resulting in 28,988 shares for the resolution and 160 against. At a meeting of the holders of founders' shares held subsequently, the same resolutions were approved on a poll, 400 votes being in favour of the course proposed by the directors and 3 against. There are 500 founders' shares, and it is proposed by the bill to allot 10 ordinary shares for each founders' share.

EAST LONDON RAILWAY CO.—At the meeting last week the chairman (the Hon. A. E. Gathorne-Hardy) said the most important matter referred to in the report was that dealing with the question of "electrification" and the future working of the line. The Metropolitan and District Companies had given notice that when the "electrification" of their lines was complete they would be unable to continue to work the East London Railway as at present, and the South-Eastern and Brighton Companies had arranged to run a service of trains to Whitechapel, where passengers would have to change into the electrical carriages of the Underground lines, and be carried by a service worked in the manner at present existing at Bishop's-road, Praed-street, Moorgate-street and Finsbury Park.

GREAT EASTERN RAILWAY CO.—The chairman (Lord Claud Hamilton) at the meeting this week said that the competition of electric tramways, which not only were now running in every part of their district, but in many cases running alongside their railway, was responsible for the decrease in traffic. As sensible men they could not for one moment find fault with those tramways when they were promoted and conducted by public companies, for, of course, they had just as much right to be there in the public interest as the Great Eastern had, but what they did complain of was the municipal tramways, supported by the rates, to which the company were the chief contributors as ratepayers. The net result of those municipal tramways was this, that if they were run at a loss they, as the chief ratepayers, had to make good the deficiency. If, on the other hand, they were run at a profit, that profit could only be obtained by abstracting passengers from their system. Whether Parliament would ever feel inclined to take the view that this was an inequitable state of things he did not know, but he strongly felt there ought to be some arrangement or a remission in rates given to a company, which was the chief ratepayer of the district, and which, at the same time, had to contribute towards competition with its own interests.

GREAT NORTHERN & CITY RAILWAY CO.—The traffic receipts for the six months ended Dec. 31 amounted to £36,509. 3s. 4d., against £19,354. 17s. 6d. for the previous 4½ months. The numbers of passengers carried for the same periods (excluding season ticket holders) were 5,227,595 and 3,711,152 respectively. The number of local season tickets issued during the half-year was 2,511. By arrangement with the Great Northern Railway Co., passengers from suburban stations north of Finsbury Park are now able to book through to stations on and beyond the company's line, and holders of season tickets from those stations to the City can travel (at their option) to the Great Northern and City Moorgate terminus, to Broad-street station on the North London, or to the Bishopsgate-street station on the Metropolitan Railway. The public have availed themselves largely of these facilities and of the opportunity thus given them of travelling over this company's system. By a supplemental agreement with the contractors, the working expenses retainable by them will be calculated for the first year of working at 60 per cent. and for the second and third years at 50 per cent. of gross receipts. Sir Charles Scotter having resigned his seat at the board, the Earl of Lauderdale has been elected chairman and Mr. Charles Steel deputy chairman of the company. Mr. C. G. Hyde, vice president of S. Pearson & Son (Ltd.), has been elected a director to fill the vacancy caused by the resignation of Sir Charles Scotter.

LIVERPOOL OVERHEAD RAILWAY CO.—The half-yearly report to Dec. 31 states that gross revenue receipts were £41,717. 2s. 6d., and working expenses £31,530. 6s. 6d.; 5,613,752 passengers were carried, against 5,624,421 in the June half-year and 5,896,503 in the half-year ended December, 1903. For the first time there has been a reduction in traffic, partly due to the quiet state of trade, but mainly to the competition of the frequent and rapid service of electric trains on the Liverpool and Southport line since its electrification. The falling-off in traffic has to some extent been met by economies in working expenses. The works to connect the line with the Lancashire and Yorkshire Railway at Seaforth are well advanced. As stated in our last issue the directors recommend the declaration of dividends at following rates (less tax): 5 per cent. per annum on preference shares (£3,266. 14s. 3d.) and 1¼ per cent. per annum on the ordinary shares (£3,125), leaving £3,743. 4s. 3d. to be carried forward.

LONDON, BRIGHTON & SOUTH COAST RAILWAY CO.—At the meeting on Wednesday the chairman (Lord Cottesloe) said that it was remarkable that, while there was a decrease during the half-year of nearly a million and a-half of third class passengers, there was an increase in the amount received from that class of traffic of £6,527. The falling off in numbers arose on the short distance or suburban traffic, no doubt due to tramway and other competition, and to stagnation in trade. The proposal to establish a system of electrical working on a part of the company's system had been under the consideration of the board, more particularly with a view to meet the growing competition of tramways and other rapid means of transit in the suburban area served by the company, and also to give relief at the termini by the more rapid handling of trains. The section of the South London Railway lying between Battersea Park and Peckham Rye stations had been selected as a convenient piece of line upon which to make an initial trial of electrical working, and the electrical engineer advising the board (Mr. Philip Dawson), with the aid of Major Cardew, had recommended that the overhead conductor system be used, thus avoiding the dangers which had been experienced with the third rail system.

METROPOLITAN RAILWAY CO.—The chairman (Sir C. McLaren, Bart., M.P.) stated at the meeting on Friday last that electric trains were now running regularly on the railway. They had been rewarded with an increase in their traffic. They had so far completed the electrical equipment of their line as to admit of the working of a portion of their trains, between Baker-street station and Uxbridge, through Harrow, by the new method of traction. They were gradually increasing the number of electric trains into and out of Baker-street, and they hoped shortly to be able to dispense with steam entirely on that section. On the Inner Circle the works were being pushed on, and they hoped very soon to run some electric trains on that section. He understood that the District Co. were also well forward with their installation, so that they might reasonably expect, in the near future, when both companies were ready, to see the trains on the Circle driven by the new power. So far as their section of the Circle was concerned, their contractors hoped to enable them to run a few trains as early as March. The affairs of the company were progressing very satisfactorily, and when they got their new mode of working thoroughly established the prospects would be good.

NATIONAL TELEPHONE CO. (LTD.)—At their meeting yesterday (Thursday) the directors resolved, subject to final audit, to recommend the following dividends for half-year ended Dec. 31, after payment of dividends on the preference shares:—At rate of 6 per cent. per annum on the preferred stock; at rate of 5 per cent. per annum on the deferred stock (less tax) carrying £115,000 to reserve, and about £10,000 forward. The transfer books will be closed from the 15th to 28th inst. inclusive.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)—The directors' report for 1904 states that the gross profit amounts to £6,269, compared with £6,691 last year. The net profit is £4,296. 17s. 4d., to which is added £1,262. 13s. 11d. from last year. £1,500 has been placed to general reserve, and a further £1,000 to depreciation. The directors propose to pay a dividend of 4 per cent. for the year, and to carry forward £1,659. 11s. 3d. Notwithstanding an increase in the number of lamps installed the amount of current sold in the markets has been less owing to general economy by consumers, due mainly to bad trade. A saving has been effected in the costs of production.

WATERLOO & CITY RAILWAY CO.—For the half-year ended Dec. 31 the gross receipts (less Government duty) amounted to £17,676. 6s. 10d., and the working expenses to £7,891. 14s. 9d., or 44·64 per cent., compared with 46·44 per cent. for corresponding period of 1903. The balance available for dividend, after providing for debenture interest is £9,030. 16s. 4d., and a dividend at the rate of 3½ per cent. per annum on the ordinary stock will absorb £8,775, leaving £255. 16s. 4d. to be carried forward. A dividend of 3 per cent. was paid for the corresponding period of 1903. The number of passengers carried during the past six months, exclusive of season ticket holders (1,645) was 2,256,832, an increase of 15,968.

NEW COMPANIES, LIENS REGISTERED, &c.

NEW COMPANIES.

BRITISH ELECTRIC CO. (LTD.) (83,338).—Reg. Jan. 24, capital £2,000 in £1 shares, to acquire from J. C. Dear, benefit of an invention relating to improvements in holders for electric incandescent lamps, and to carry on the business of manufacturers of and dealers in electrical and gas fittings, installers of electric light, &c. First directors, N. Vickery (manager), J. C. Dear and C. E. Best. Reg. office, 8, Mortimer-street, Berners-street, London, W.

RICHARD MELHUISH (LTD.) (83,264).—Reg. Jan. 17, capital £100,000 in £1 shares, to acquire business of manufacturers of and dealers in engineering, mechanical and other tools, and electrical fittings, ironmongers, metal merchants, &c., carried on by R. Melhuish, and to carry on the same and the business of hydraulic, ventilating and general engineers, &c. First directors, R. Melhuish (permanent governing; special qualification £10,000 shares), A. Melhuish, and G. A. Colvin. Reg. office 85, Fetter-lane, London, E.C.

STANLEY ELECTRIC CARRIAGE CO. (LTD.) (83,297).—Reg. on Jan. 19, capital £10,000 in £1 shares, to adopt an agreement with A. E. Gadd and G. Stephenson and to carry on the business of vendors and factors of and dealers in motors, motor cars, airships, launches, carriages and other vehicles (whether propelled by electricity or other power), electrical, mechanical and general engineers, &c. First directors, Maj.-Gen. Euston H. Satorius, V.C., C.B., A. E. Gadd and G. Stephenson (all permanent, subject to holding 2,000 shares). Reg. office, 19A, Carlyle-square, Chelsea, London, S.W.

MORTGAGES AND CHARGES.

ELECTRICAL BLEACHING CO. (1904) (LTD.)—Issue on Jan. 18 of £12,000 6 per cent. debentures, part of series created Dec. 21, 1904, to secure £14,000. Property charged, company's undertaking and property, present and future, except uncalled capital. No trust deed, but title deeds of company's property are to be deposited in joint names of nominee of board and nominee of debenture holders with a safe deposit company or bank. Present nominees are F. R. B. Lindsell and J. H. Haynes. No previous issue of same series.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—Issue on Jan. 5 of £500 and on Jan. 20 of £100 debentures, part of series created June 3, 1896, to secure not more than two-thirds of subscribed and paid-up capital, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £32,600.

BLACKPOOL & FLEETWOOD TRAMROAD CO. The accounts show a balance of £10,426 available for distribution. A final dividend of 6½ per cent. is recommended, making 9 per cent. for past year, £1,500 being appropriated for depreciation, £500 added to general reserve and £1,964 carried forward.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Jan. 28	1,065	+ 7	35	47,784	+ 5,818
Airdrie	,, 20	180	...	3	579	...
Ayr Corporation	,, 28	164	− 6	37	11,558	+ 523
Barnsley	,, 30	189	− 12	3	397	+ 13
Barrow	,, 30	167	...	3	479	...
Bath Electric Trams, Ltd.	,, 28	481	+ 7	4	2,180	+ 311
Bexley District Council	...	...	...	...	...	...
Birkenhead	...	...	...	...	...	...
Birmingham Corporation	,, 29	880	...	4	17,219	...
*Birmingham & Mid.	,, 30	1,439	− 13	3	4,476	+ 367
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 28	251	− 5	48	44,886	+ 6,049
Blackpool and Fleetwood	,, 28	183	+ 2	4	682	− 99
Blackp'l, St. Anne's & Lytham	,, 26	120	− 21	¶18	1,600	− 198
Bolton Corporation	,, 29	1,633	+ 8	44	60,791	+ 603
Bournemouth Corporation	,, 28	769	− 7	‡43	46,672	+ 2,161
Bradford Corporation	,, 29	3,555	+ 60	41	102,012	+ 25,471
Brighton Corporation	,, 29	789	+ 51	43	48,412	+ 3,509
Brisbane Tramways	Dec. 7	2,461	+ 84	24	47,350	+ 684
	,, 14	2,443	+ 165			
Bristol Trams & Carriage	Jan. 27	4,294	− 78	25	102,853	+ 2,147
Buenos Ayres & Belgrano	Dec. 25	3,290	− 179	11	36,040	− 807
	Jan. 1	3,348	− 131			
Burnley Corporation	,, 28	940	+ 182	17	4,288	+ 3,259
Burton Corporation	,, 29	269	...	¶43	14,841	...
Calcutta Tramways Co.	,, 28	a39,073	+ a2,600	4	a171,063	+ a25,639
Camborne-Redruth	,, 30	95	...	13	13,347	− 226
Cardiff Corporation	,, 21	1,778	− 2	44	88,117	+ 3,131
	,, 28	§ 1,750	− 82			
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 28	7,200	+ 209	4	29,002	+ 799
Chatham & Dist. Lt. Rys.	,, 28	528	+ 88	4	2,101	+ 125
*City of Birm'gh'm Tram Co.	,, 30	4,705	− 345	3	14,426	+ 198
City & South London Rly.	,, 29	2,994	− 204	5	15,610	− 149
Colchester Corporation	,, 26	141	...	26	4,852	...
Cork Electric Trams Co.	,, 26	398	+ 7	4	1,508	− 12
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 30	424	− 35	3	1,220	− 27
‖Dover Corporation	,, 28	161	...	44	9,717	− 127
Dublin & Lucan Railway	,, 27	90	− 2	4	361	+ 9
Dublin Southern District	,, 27	781	+ 39	4	16,972	+ 83
Dublin United	,, 27	3,625	− 98			
Dudley—Stourbridge	,, 30	618	− 98	3	1,933	− 35
Dundee Corporation	,, 25	765	− 16	¶16	30,560	+ 233
East Ham Council	,, 26	607	+ 25	43	30,770	+ 1,626
Gateshead & Dist. Trams	,, 30	806	− 46	3	7,269	+ 60
Glasgow Corporation	,, 28	13,625	+ 215	†35	488,108	+ 23,849
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 30	175	− 25	3	513	− 51
Gt. Northern & City Rly.	,, 28	1,596	...	4	6,307	...
Greenock & Port Glasgow	,, 20	480	+ 27	3	1,461	+ 204
**Halifax Corporation	,, 25	2,303	+ 40	48	62,517	+ 4,465
Hartlepool Tramways	,, 30	218	− 20	3	668	− 8
Huddersfield	,, 28	1,121	+ 16	43	58,740	+ 3,630
Hull Corporation	,, 28	2,001	+ 15	43	94,521	+ 10,865
Ilford District Council	,, 28	327	+ 37	¶44	19,411	+ 953
Ilkeston Corporation	,, 25	91	− 18	17	1,251	− 300
Ipswich Corporation	,, 28	500	+ 7	43	20,894	—
Isle of Thanet Co.	...	...	...	...	...	...
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	,, 30	68	− 4	3	182	...
Kirkcaldy Corporation	,, 25	171	− 19	...	...	...
Lanarkshire Trams Co.	,, 26	578	+ 19	4	2,534	+ 53
Leeds Corporation	,, 28	5,093	+ 115	45	252,106	+ 13,851
Leicester Corporation	,, 28	1,672	...	4	6,750	...
Liverpool Corporation	,, 21	9,275	+ 279	3	29,480	+ 790
Liverpool Overhead Rly.	,, 29	1,461	− 41	5	7,380	− 402
*London County Council	,, 21	11,470	+ 2,564	§42	536,018	+ 418,906
Lowestoft	,, 28	110	− 15	4	495	...
Maidstone Corporation	,, 26	68	...	26	3,267	...
Manchester Corporation	,, 25	11,267	+ 439	48	525,064	+ 23,027
Mersey Railway	,, 28	1,685	+ 116	4	6,511	+ 432
Merthyr	,, 29	152	− 40	3	451	− 57
*Metropolitan Elec. Trams	,, 30	1,730	+ 694	3	5,275	+ 2,231
Middleton	,, 30	240	+ 8	3	606	+ 54
Nelson Corporation	...	...	...	...	...	...
Newcastle-on-Tyne Corp.	,, 28	3,491	− 17	4	13,967	+ 115
Newport (Mon.)	,, 28	499	+ 65	17	8,681	+ 1,217
Oldham, Ashton & Hyde	,, 20	461	− 17	3	1,327	+ 16
Oldham Corporation	,, 29	1,360	+ 298	44	54,877	+ 3,444
Perth (W. A.) Elec. Trams	,, 27	1,507	+ 152	4	5,631	+ 300
Peterborough	,, 30	94	− 11	3	278	− 15
Poole and District	,, 30	197	− 24	3	611	− 17
Portsmouth Corporation	,, 28	1,294	+ 37	§43	52,922	+ 6,456
Potteries	,, 30	1,504	− 54	3	4,470	+ 319
Reading Corporation	,, 16	496	+ 4	4	2,301	+ 153
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 30	53	− 5	3	141	+ 17
Salford Corporation	,, 31	3,800	+ 114	48	176,490	+ 8,571
Sheerness	,, 18	52	+ 6	3	159	− 21
Sheffield Corporation	,, 29	4,393	+ 202	§44	205,115	+ 5,145
Southampton Corp'ation	,, 18	794	− 50	43	41,882	− 2,812
	,, 15	719	+ 13			
Southend Corporation	,, 25	198	+ 10	41	15,268	+ 1,581
Southport Tramways	,, 20	180	− 45	3	612	− 27
S. Staffordshire Trams	,, 30	567	− 89	3	1,731	− 105
Stockport Corporation	,, 27	405	+ 49	43	23,774	+ 8,244
Sunderland Corporation	,, 29	1,107	+ 85	43	54,714	+ 1,416
Swansea Trams	,, 30	420	− 6	3	1,318	− 5
Taunton Trams	,, 30	43	− 1	3	115	− 18
Tynemouth and District	,, 30	150	− 46	3	470	− 88
Tyneside Trams Co.	,, 25	319	+ 47	4	1,144	+ 105
Wallasey District Council	,, 18	602	+ 38	§43	52,270	+ 2,127
Walsall	,, 28	425	...	4	1,680	...
Warrington Corporation	,, 26	293	+ 12	43	13,707	+ 453
West Ham Corporation	,, 26	1,018	—	43	46,113	—
Weston-super-Mare	,, 18	31	+ 7	3	72	+ 21
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 30	226	− 37	3	905	+ 53
Worcester	,, 30	312	+ 106	3	681	+ 290
Wrexham	,, 30	81	− 16	3	232	− 20
Yorkshire Woollen District	,, 30	518	+ 1	3	1,453	+ 160

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. ** Fortnight. * Partly electrical. ‖ Not in operation last year.

CITY NOTES.

MEMORANDA (Feb. 2).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 28⅛d. per oz. Consols 88 7/16—88 9/16 for money, 88⅝—88¾ for account; 2½ per cent. annuities 87½—88. Consols Pay Day, March 1. Stocks and Shares Continuation Days, Feb. 8 and 22; Ticket Days, Feb. 9 and 23; Pay Days, Feb. 10 and 24; Mining Share Carry-over Days Feb. 7 and 21.

BAHIA-BLANCA & NORTH-WESTERN RAILWAY CO.—The directors have received the shareholders' sanction to engage in the business of an electric light and power company in Argentina.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—The transfer books and register of members will be closed from 4th to 14th inst., inclusive, preparatory to payment of dividends on the first and second preference shares for the half-year ended Dec. 31.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The directors have declared the usual half-yearly dividend on the 6 per cent. preference shares.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The amount of electricity sold in the company's London districts during the quarter ended December is estimated to realise £46,459, comparing with £40,699 for the corresponding period of last year.

HARROW & UXBRIDGE RAILWAY CO.—At a special meeting last week a resolution was passed approving the purchase of the undertaking by the Metropolitan Railway Co.

LONDON ELECTRIC SUPPLY CORP. (LTD.)—The net revenue for the past year was £65,300, against £36,200 for the previous year. The directors recommend the payment of the dividend on the 6 per cent. preference shares and also a dividend of 3 per cent. on the ordinary shares.

ROSARIO ELECTRIC CO. (LTD.)—This company is inviting applications for 8,000 6 per cent. cumulative preference shares of £5 each.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The share transfer books of this company will be closed from 8th to 22nd inst., inclusive, preparatory to payment of dividends for the half-year ended Dec. 31.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Feb. 9 a special settling day in a further issue of 11,232 £1 fully paid shares of the *Cape Electric Tramways (Ltd.)* and have ordered same to be quoted in the Official List. The committee have been asked to appoint a special settling day in 413,598 $100 common shares and 359,382 $100 preferred shares of the *Commercial Cable Co.*, and to grant quotations to 10,000 £5 fully paid 5 per cent. cumulative preference shares of the *Folkestone Electricity Supply Co. (Ltd.)*, and 42,750 £10 shares and £150,000 debenture stock of the *South Wales Electrical Power Distribution Co.*

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., Feb. 1.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Feb. 1. Highest.	Business, Week to Feb. 1. Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	3/0	Anglo-Argentine Ord. Shares	8⅜–8⅝	3 7 1	Ap, Oc	8½	8⅜
5	2/6	Do. 5% Cum. Pref.	5⅞–6⅛	4 6 0	—	5⅞	5⅞
St.	6%	Do. Permanent 6% Deb. Stock	140 –143	4 3 11	—	141½	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 –106	4 15 3	—	106	104½
10	6%	Barcelona Tramways Ord.	12 –12½	3 8 0	—	12	..
10	5/0	Do. 5% Cum. Pref.	9¾–10	5 0 0	—	..	—
St.	4½%	† Do. 4½% Deb. Stock (red.)	95 –99	4 10 11	—	..	..
100	5%	† Do. 5 per Cent. Debs.	98 –101	4 19 0	..	..	..
1	..	Brisbane Electric Trams. Invest Ord.	1⅛–1¼	..	..	1⅛	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾–4¼	5 17 3	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	94 –96	4 11 10	..	..	..
St.	6%	British Columbia Elec. Rlwy Def. Ord.	100 –106	5 16 6	—	..	..
St.	5%	Do. Pref. Ord. Stock	100 –103	4 17 2	—	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 –10¼	4 10 11	—	..	..
£	4½%	Do. 4½ per Cent. 1st Mort. Dbs	102% –104%	4 6 9	—	..	..
100	4½%	Do. Vancouver Power Debs.	97 –100	4 10 0	..	..	..
5	1/6	Buenos Ayres and Belgrano Ord	4 – 4½	5 5 11	—	4½	4
5	3/0	Do. 6 per Cent. "A" Cm. Pref	6¼–6¾	4 16 1	—	6⅜	6⅛
5	3/0	Do. "B"	5¾–6¼	5 6 8	—	6¼	..
St.	5%	Do. 5 per Cent. Debs.	106 –108	4 12 7	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov Certs.	103 –105	4 15 3	—	103½	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	94 –97	5 3 1	..	..	..
5	3/0	Calcutta Tramways	8½– 9	3 12 3	—	8⅞	8¾
100	4½%	Do 4½% 1st Deb. Stock (red.).	106 –108	4 3 4	—	..	..
1	0/6	Cape Electric Tram Shares	1⅛–1⅜	3 14 0	..	1¼	1⅛
St.	5%	Colombo Trams & Ltg. 5% 1st Mt Deb. (red)	102 –104	4 19 1	..	103½	103½
St.	5%	Madras Elec. Trams 5% Deb. Stk.	101 –103	4 17 3	Ja, Jul	..	..
100	5%	Montreal St. Ry. St'g 5% Mort Debs. (1908)	101 –104	4 16 2	—	..	..
100	4½%	† Do. Sterling 4½% Debs. (1922)	102 –104	4 6 7	..	..	..
St.	5%	Perth (W.A.) Elec. Trams, 1st Mt. Deb. Stk.	102 –106	4 15 3	..	103	..
		ELECTRICITY SUPPLY.					
5	3/0	Calcutta Electric Supply Ord.	8½–9	3 17 6	—	8⅝	8⅜
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	80 –81	6 0 11	..	..	..
10	..	Havana Electricity Co. Shares	9¾–10¼	..	—	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	⅞–1⅛	..	—	..	..
1	..	Rand Electric	1 –1¼	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	100 –102	4 8 9	Ap, Oc	..	..

*In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Feb. 1.	Rate per Cent. Yield. £ s. d.	Dividend Due.	Business Week to Feb. 1. High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
1	..	Bath Elec. Trams Pref. Ord.	[illegible]	..	..	..	..
1	[illegible]	Do. 5% Cum. Pref.	[illegible]—1⅛	4 14 1	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19 —20	4 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 16 0	Feb, Aug	..	..
10	8/0	British Electric Traction Ord.	9½—10½	5 14 4	..	10	9¾
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—11¾	5 4 4	Feb, Aug	11½	11¼
St.	5/0	Do. 5 per Cent. Perpetual Debs	119 —121	4 2 8	..	120½	119½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	97 —99	4 10 11	..	98½	98¼
St.	4%	Central London Ordinary Stock	92 —94	4 5 1	June, Dec	93	92½
St.	4%	Do. 4 per Cent. Pref. Stock	101 —103	3 17 9	..	..	..
St.	4%	Do. Deferred Stock	85 —87	4 12 0	—	86	..
100	4%	Do. 4 per Cent. Debs.	107 —109	3 13 5	—	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4½—4¾	4 17 6	—	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	101 —104	3 17 5	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	46 —47	4 10 5	Feb, Aug	47½	46
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 —125	4 0 3	Feb, Aug	[illegible]	..
St.	5%	Do. (1896)	119 —122	4 2 0	..	..	..
St.	5%	Do. (1901)	117 —120	4 3 4	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	105 —108	3 14 1	May, Nov	..	..
10	6/0	†Dublin United Trams. (1896) Ltd., Ord.	13 —14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	16½—16¾	3 12 9	—	..	..
10	3/0½	Gt. Northern & City Rly. Prf. Ord. (4%)	6½—6¾	4 8 10	—	6½	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8½—8¾	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19 —20	4 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	15 —15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	111½—113½	4 0 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	5 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	2½—2¾	5 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10½—10¾	4 18 0	..	[illegible]	[illegible]
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 —106	3 15 6	—	105	104½
St.	..	Mersey Con. Ord. Stock	4 —7	..	..	5	..
St.	..	Do. 3 per Cent. Perp. Pref.	10 —13	..	—	10	..
1	..	Metropolitan Electric Trams Def	[illegible]	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	[illegible]	4 17 0	—	1	..
St.	4½	Do. 4½ Deb. Stock	103 —105	4 6 9	..	[illegible]	104½
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—1½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	8 —9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9½—9¾	5 5 3	Feb, Aug	[illegible]	9½
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —102	4 8 3	—	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
..	1%	Underground Elec. Rys. Co. of London	67½—68½	5 1 6	..	69½	68
St.	5%	Waterloo and City Ord.	91 —93	5 4 6	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	4 0 0	Jan, July	100	..
10	..	Amazon Telegraph	1 —1½	..	Jn, Dec ..	[illegible]	..
St.	12/6	Anglo-American	56 —58	4 14 9	F,My,Ag,N	56½	..
St.	25/0	Do. Preferred	103 —104	5 5 9	F,My,Ag,N	102½	101½
St.	2/0	Do. Deferred	11½—11¾	8 17 0	F,My,Ag,N	[illegible]	..
100	8%	Commercial Cable Capital Stock	175 —190	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95 —97	4 2 6	Jn,Ap,Jy,O	96	95
10	5/0	Cuba Submarine Ord.	8½—8¾	5 8 0	Feb, Aug	8½	[illegible]
10	10/0	Do. Preference 10 per Cent.	16½—17½	5 14 3	Feb, Aug	17½	..
5	2/0	Direct Spanish Ord.	3½—3¾	5 11 9	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7½—8½	6 1 2	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	100%—102%	4 10 0	Jan, July	..	..
20	2/0	Direct United States Cable	10½—10¾	5 10 4	Ja,Ap,Jy,O	10½	[illegible]
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 —101	4 9 1	Jn, Dec ..	..	..
St.	15/0	Eastern Ordinary	135 —138	5 1 5	Ja,Ap,Jy,O	136½	135½
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —89	3 18 8	Ja,Ap,Jy,O	88½	87½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —107	3 14 9	May, Nov	107	106½
10	3/0	Eastern Extension	13½—14	6 0 0	Ja,Ap,Jy,O	13¾	13½
St.	4%	† Do. 4 per Cent. Deb. Stock	104 —106	3 15 7	Feb, Aug	..	..
100	4%	†Eastern & S. African 4% Mrt. Deb, 1900	99 —101	3 19 2	Feb, Aug	101½	101
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 5	May, Nov	[illegible]	..
10	5/0	Great Northern (of Copenhagen)	28½—29½	5 1 2	Jan, July	[illegible]	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	99 —101	4 9 1	June, Dec	..	..
25	12/6	Indo-European	45 —47	5 6 5	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	96 —99	4 10 11	June, Dec	..	—
10	4/0	West African Telegraph Shares	7½—7¾	5 9 2	—	..	..
2½	..	West Coast of America	[illegible]	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	99 —101	3 19 2	Jan, July	..	..
10	..	West India and Panama	½—1	..	May, Nov	[illegible]	[illegible]
10	7/0	Do. 6% 1st Pref. ex 7/- on act. of arrears	[illegible]	7 17 6	May, Nov	7½	..
10	—	Do. 6 per Cent. 2nd Pref.	6½—7½	..	May, Nov	[illegible]	..
100	5%	* Do. 5 per Cent. Debs.	101 —103	4 17 1	Jan, July	..	..
10	3/0	Western Telegraph	13½—14	5 0 0	Mr,Jn,O,D	[illegible]	[illegible]
100	5%	* Do. 5% Debs. (2nd Series, 1900)	101 —103	4 17 1	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	100½—102½	3 18 0	—	..	..
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	6½—6¾	5 9 10	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	[illegible]	2 11 9	..	..	..
St.	6%	National Co. Pref. Stock	108½—109½	5 9 7	—	108½	108¼
St.	5%	Do. Def. Stock	105 —107	4 [illegible] 5	..	[illegible]	105½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 5	Feb, Aug	13½	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12 —13	4 [illegible] 4	Feb, Aug	..	..
5	2/6	Do. 6 per Cent. Non-Cum. 3rd Pref.	[illegible]	4 [illegible] 11	Feb, Aug	[illegible]	[illegible]
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	96 —98	3 11 5	June, Dec	[illegible]	..
St.	4%	Do 4 per Cent. Deb. Stock (red.)	101 —103	3 17 9	..	[illegible]	[illegible]
..	24/0	Do. Do. Prov. Certs, all paid	101 —103	3 17 8	..	..	..
1	0/7½	Oriental	1—1¼	5 18 6	April, Oct	[illegible]	—
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼—1⅜	4 16 0	..	[illegible]	..
St.	30/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	100 —103	..	..	..	..
5	3/0	United River Plate	[illegible]	6 12 2	July......	7½	[illegible]
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 17 9	June, Dec	[illegible]	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	106 —107	4 13 5	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	5/0	Elec. & Gen. Investment 6% Cum. Pref.	[illegible]	5 17 1	—	..	..
10	7/0	Globe Telegraph and Trust	10½—10¾	6 4 9	Ja Ap Jy O	[illegible]	10½
10	6/0	Do. 6 per Cent. Pref.	13½—14½	4 4 11	Ja,Ap,Jy,O	14½	14
100	6%	Submarine Cables Trust (Cert.)	120 —125	4 18 4	April, Oct	..	..

Share.	Last Dividend	Name.	Price Wed., Feb. 1.	Rate per Cent. Yield. £ s. d.	Dividend Due.	Business Week to Feb. 1. High-est.	Low-est.
		ELECTRICITY SUPPLY.					
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12 —12½	6 8 0	..	[illegible]	[illegible]
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10	4 10 0	..	..	—
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	—	—	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 —105	4 5 9	—	[illegible]	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5½—5¾	3 9 7	..	..	..
St.	4½%	Do. Do. 1st Debs.	101 —104	4 7 0	—	[illegible]	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..	[illegible]	..
5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 6 1	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105 —108	3 14 1	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8½—8¾	4 11 6	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	[illegible]	3 16 8	Feb, Aug	[illegible]	[illegible]
St.	4%	Do. 4% Deb. Stock (red.)	104 —106	3 17 8	..	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	[illegible]	4 4 9	—	5	..
5	2/3	Do. Do. (1903)	[illegible]	4 4 9	..	[illegible]	5
5	2/3	Chelsea Electric Supply Ord.	6½—7½	4 0 8	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108 —110	4 1 10	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	12 —12½	4 0 0	Feb, Aug	12½	[illegible]
10	6/0	Do. 6 per Cent. Cum. Pref.	13½—14	4 5 9	Jan, July	[illegible]	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —125	4 0 0	Jn, Dec ..	—	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —104	4 6 7	..	[illegible]	[illegible]
10	4/0	County of London Elec. Supply Ord.	9 —9½	4 4 2	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —12½	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 —110	4 1 10	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 —103	4 7 5	..	101½	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 —104	4 6 7	—	..	—
5	3/6	Hove Electric Lighting Ord.	7½—8	5 6 3	..	—	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St (red.)	100 —103	4 5 9	..	..	..
5	5/0	Kensington & Knightsbridge Ord	11½—11¾	4 10 7	..	..	..
5	6%	Do. 6 per Cent. 1st Pref	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —104	3 17 8	—	..	..
3	..	London Electric Supply Ord.	[illegible]	..	—	[illegible]	[illegible]
5	3/0	Do. 6 per Cent. Pref.	5½—5¾	5 2 2	..	[illegible]	[illegible]
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 —98	4 1 5	Mr,Jn,S,D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	17½—18½	5 1 4	April, Oct	18	17½
5	2/3	Do. 4½ per Cent. Cum. Pref.	[illegible]	4 0 0	Jan. July	5½	[illegible]
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —115	3 18 3	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	90 —93	3 11 3	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	92 —95	4 15 0	..	95	—
10	[illegible]	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	[illegible]	5 15 8	Feb, Aug	..	..
5	8%	Newcastle Elec. Supply Ord.	[illegible]	4 19 3	Feb, Aug	..	..
5	[illegible]	Do. 4 per Cent. Non-Cum. Pref.	[illegible]	3 [illegible] 2	Feb, Aug	..	..
1	[illegible]	Northern Counties Elec. Sup. 17/- pd	15/3—16/9	3 6 0	Mar, Sep	..	..
10	6/0	Notting Hill Electric Ord.	14½—15½	4 0 0	March....	15¼	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	102 —104	3 17 0	..	..	..
5	2/6	Oxford Electric Ord.	[illegible]	5 2 2	March ..	[illegible]	..
St.	4%	Do. 4% Deb. Stock	98 —100	4 0 0	..	..	..
5	6/0	St. James' & Pall Mall Elec. Ord.	13½—14½	5 0 0	Feb, Aug	14½	14
5	3/6	Do. 7 per Cent. Pref.	8½—9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	95 —100	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	[illegible]	6 3 1	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —87	4 [illegible] 6	..	..	..
5	3/0	South London Electric Supply Ord.	[illegible]	3 3 3	—	[illegible]	[illegible]
1	..	South Metrop'n Elec. Lt. & Power Ord.	½—1	..	—	—	..
1	0/8½	Do. 7% Cum. Pref.	[illegible]	4 16 9	—	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. Acco.)	107 —110	4 2 3	—	..	..
5	2/6	Urban Electric Supply Ord.	[illegible]	4 17 3	..	..	..
5	2/6	Do. 5% Cum. Pref.	[illegible]	4 16 6	..	[illegible]	..
St.	..	Do. 4½% 1st Mort. Deb.	105 —107	—	..	..	..
5	6/6	Westminster Electric Supply Ord.	13 —13½	5 0 0	Mar, Sept	[illegible]	[illegible]
5	2/6	Do. 5 per Cent. Cum. Pref.	[illegible]	3 16 8	—	[illegible]	[illegible]
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	[illegible]	5 14 2	..	..	..
1	6d.	Aron Elec. Meter 6% Cum. Pref.	[illegible]	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	[illegible]	6 10 2	July, Feb	[illegible]	[illegible]
5	3/0	† Do. 6 per Cent. Pref	[illegible]	5 3 5	Jan, July	..	—
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —104	4 6 6	—	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 [illegible] 6	—	..	..
5	3/0	British Westinghouse 6% Pref	[illegible]	..	—	[illegible]	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	86 —88	4 11 0	..	..	..
2	..	Brush Electrical Engineering	[illegible]	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	[illegible]	5 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	95 —98	4 16 6	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	74 —77	5 17 0	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	9½—10	5 5 0	Jan, July	10	9½
5	2/6	Do. 5 per Cent. Cum. Pref.	[illegible]	4 13 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —106	4 4 11	Nov, May	..	..
1	[illegible]	Castner-Kellner Alkali Co. (fully paid)	[illegible]	4 9 5	..	[illegible]	..
St.	4½%	† Do. 4½% 1st Mort. Deb. (red.)	91 —96	4 13 9	..	..	..
1	[illegible]	Chadburn's (Ship) Telegraph Ord.	[illegible]	3 17 6	..	1	..
2	1/6	Crompton and Co. (Nos. 1 to 54,000)	[illegible]	3 0 3	Jan, July	[illegible]	[illegible]
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	93 —95	5 2 0	Jan, July	—	..
5	10/0	Dick, Kerr & Co. Ord.	[illegible]	5 17 6	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	[illegible]—6	5 0 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	106—107	4 4 0	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	[illegible]	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 —82	4 17 8	June, Dec	[illegible]	[illegible]
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	78 —84	6 0 0	..	..	—
5	2/6	Edmundson's Elec. Corp. Ord.	[illegible]	6 12 0	H'lf-yearly	[illegible]	..
5	2/0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 16 0	—	[illegible]	[illegible]
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 —103	4 5 5	..	[illegible]	..
2	[illegible]	Electric Construction Co.	[illegible]	6 5 0	July	..	..
2	[illegible]	Do. 7 per Cent. Cum. Pref.	[illegible]	5 [illegible] 3	July	[illegible]	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	[illegible]	4 0 10	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	[illegible]	5 5 3	—	..	—
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10	5 0 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91 —96	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½—11	6 7 3	Feb, Aug	11	..
5	2/3	Do. 4½ per Cent. Pref.	[illegible]	4 3 9	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	110 —112	4 0 10	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	16 —16	6 5 0	Feb, Aug	16	[illegible]
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 5	Mar, Sept	..	..
10	6/0	Mather & Platt 6 per Cent. Cum. Pref.	11 —11½	4 7 0	Mar, Sept	..	..
12	[illegible]	Telegraph Construction & Mainten'ce.	38 —40	5 18 6	Mar, July	[illegible]	[illegible]
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	102½—103½	3 17 3	Jan, July	..	..
5	—	Willans and Robinson Ord.	1 —2	..	Apr, Oct	..	..
5	—	Do. 6 per Cent. Cum. Pref.	3 —4	—	Apr, Oct	..	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	76 —79	5 1 3	May Nov	..	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

OUR esteemed contemporary, the *Daily Mail*, has discovered a new sensation. It has ascertained that experiments with motor omnibuses have been attended with a certain amount of success, and in view of this fact it has secured the services of an anonymous "Expert" to estimate that £60,000,000 have been wasted in the United Kingdom—largely by municipal authorities—on "out-of-date tramways." Electric traction engineers, shareholders in tramway companies, and last, but not least, the town councillors whom we elect to spend the rates for us, may rest assured, however, that there is no occasion for panic. Messrs. Tilling & Co., the omnibus proprietors, have found, as a result of an experiment extending over three short months, that the motor omnibus may be more economical than the horse omnibus, and have placed an order for 15 of these vehicles. The London General Omnibus Co. have made experiments with two petrol 'buses, and have ordered 50 double-deckers for further experiment. Altogether it would appear that the only data upon which the *Daily Mail* bases its alarmist article is that six of the existing omnibus companies have ordered between them 152 motor vehicles.

IN return for this information we will give our contemporary some figures from another point of view. During the busy periods of the day, no less than 436 electric tramcars, each with double the seating capacity of an electric motor omnibus, pass the Elephant and Castle per hour. That is to say, to carry the same number of passengers, nearly 1,000 motor 'buses would be necessary, or one motor 'bus in every four seconds. The passage of a single motor car causes some slight disturbance to traffic, and leaves a trail behind it unpleasant to the olfactory nerves, but the noise and stench arising from 15 or 16 cars a minute would be unbearable. The Elephant and Castle is, of course, the crossing point of a number of lines, but on either the Peckham or the Tooting line, the cars are scheduled to follow one another with from 1min. to] 1¼min. headway during the "rush" hours. On the Tooting road 91 cars run every day, and carry 100,000 passengers. What enthusiast would undertake to run such lines as these with motor omnibuses in place of tramways?

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THAT the motor omnibus will eventually replace the horse omnibus we do not doubt; neither do we deny that the London County Council has been unnecessarily extravagant in putting down a conduit system in places where the trolley system would have done equally well. But not only on the score of convenience, but also with regard to economy of working, and ease of starting and stopping, the balance of advantage is well in favour of the electric tramcar. The proper sphere of the motor 'bus will be as a feeder to the electric tramway and the suburban electric railway.

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IT is often urged against steam turbines that their condensing plant requires extraordinary amounts of cooling water to secure the high vacuum which is so necessary for the efficient working of this kind of engine. Mr. G. L. ADDENBROOKE, for instance, pointed out in the discussion of Messrs. MERZ and MCLELLAN'S Paper on "Power Station Design," read before the Institution of Electrical Engineers last session (see *The Electrician*, Vol. LIII., p. 185), that a 10,000kw. turbine-driven generating station required about 1,000,000 gallons of cooling water per hour. Mr. JOHN D. BAILIE contends, however, in a Paper quoted on p. 674 of this issue, that the more perfect design and arrangement of modern condensers and pumps enable vacua of, say, 28in. of mercury to be obtained with no greater allowance of cooling surface and cooling water than has hitherto been considered requisite for lower vacua. The interesting tests quoted by the author certainly go to show that high vacua are obtained in practice, and it is interesting to compare the amounts of condensing water with Mr. ADDENBROOKE's estimate. Taking the figures for the Manchester station, for instance, and assuming proportionality between cooling water and output, the cooling water required per hour for a 10,000kw. plant would amount to some 980,000 gallons, a figure not very far short of Mr. ADDENBROOKE's formidable estimate. It must be pointed out, however, that the temperature of the cooling water at Manchester was 82° F. —a high but not exceptional temperature. In the case of the Neepsend (Sheffield) generating station, on the other hand, much better figures were obtained, working out to 550,000 gallons per hour per 10,000kw., the vacuum in this case being 27·7in. with a barometer at 29·9in. and the temperature of the cooling water being 65·3° F. With the exception of the case of the Hulton colliery, the power taken by the pumps was but a small fraction of the total power generated, ranging, in fact, from 2 to 2·3 per cent. These figures are comparable with the 2·5 per cent. mentioned by Mr. J. R. BIBBINS (*The Electrician*, December 30, 1904, p. 426) for a 400kw. American plant.

DESPITE the outcry against the proposed elimination of Greek as a compulsory subject in the "Little Go" examination at Cambridge and Responsions at Oxford, it must be admitted that there is a distinct change coming over educational ideas and principles. Whether the authorities at Oxford and Cambridge will ever recognise this fact so far as to make any new departures remains to be seen. As Chancellor of the University of Birmingham, Mr. JOSEPH CHAMBERLAIN made some pertinent remarks on this subject on Monday. He said that modern universities had no desire whatever to compete with the older universities, nor could the old universities compete with the new. This was because the latter had a special work of their own—the teaching of the highest form of applied science. He agreed with Sir OLIVER LODGE, however, that whether compulsory or not, Greek could not be excluded from the idea of a complete and liberal education. We have no desire to enter into the arena of the compulsory Greek controversy; but we wish to raise another issue. Whether the study of Greek be compulsory or not, we maintain that science should be an obligatory subject in any scheme of education, whether at Oxford, Cambridge, or elsewhere. It will be admitted that the man who is familiar with the fundamental principles of general science stands a far better chance in the race of life than the man who is ignorant of them; but we will go further than this and claim that a man who is ignorant of these principles should be considered at the present day to be incompletely educated, whether he be proficient in the dead languages or not. Quite apart from the utilitarian side of the question, the educational value of science is unquestionably greater than that of Latin or Greek.

MR. R. WATSON's Paper on "Pattern Making," read before the Rugby Engineering Society and published in abstract elsewhere in this issue, is full of useful hints and we recommend its perusal to all engineers who have anything to do with pattern making or foundry work. The suggestions with regard to the protection of large patterns in the foundry are of particular value. Anyone who has witnessed the lifting and transport of large, though comparatively delicate patterns in the shops, will know how much they suffer from chains and ropes carelessly slung around them for lifting, and the author's recommendations in this respect will receive universal approval.

MR. RHODIN's recent Paper before the Faraday Society on "The Electrolytic Analysis of Muntz Metal" is of considerable practical interest to those in charge of works where the control of the composition of copper-zinc alloys is a matter of importance. At present alloys of the Muntz metal class, containing about 61·5 per cent. of copper and 38·5 per cent. of zinc, are made in comparatively small charges in somewhat primitive furnaces, and as the zinc which they contain is, from the moment of its addition to the charge, constantly volatilising and burning, irregularities in composition are not unlikely. It must be remembered that experience has shown that the permissible limits for the composition of Muntz metal are narrow and the judgment of the furnace men, aided by rolling tests on the casts as produced, is not infallible. Constant analytical control is, therefore, of the highest value. The problem presented to Mr. RHODIN was to make about 100 accurate determinations of copper per 24 hours and by a suitable modification of the usual electrolytic process he has succeeded in this. The design of his electrodes, the arrangement of their carriers, the whole systematic performance of every stage of the analysis have been carefully and thoughtfully considered, with the result that what seems at first sight an impossible task with any reasonable number of operators is executed as a matter of routine with certainty and accuracy.

AS an instance of American resource and "push" it is interesting to observe that many large American firms make a practice of having an annual assembly of salesmen at the head office or some convenient centre, where a course of lectures is given. These lectures are intended to bring out the salient points of the firm's newest productions, so that the salesmen—or, as we should call them, travellers—may be fully conversant with the advantages possessed by different articles when introducing them to clients. Not only, however, is instruction given with regard to appliances which the salesmen have to dispose of, but the defects of the products of rival firms are pointed out, to what end it is not difficult to imagine.

ONCE again we are promised a wireless telegraph service across the Atlantic by the Marconi Company. In the company's eighth annual report, just issued, for the year ended September 30, 1904, it is stated that "with the stations for transatlantic telegraphy in operation a new era in the company's affairs may be anticipated." In view of the extent of past dividends this is cheerful news for shareholders, but we have read nearly similar announcements before. Mr. MARCONI has been making experiments, and everything is being prepared for the service to be commenced. "The company is now in possession of all the data necessary for the equipment of stations for good commercial working between England and the Continent of America." A station is already being built in Canada, but the site for the station on this side has not yet been chosen—perhaps it will be by the time the ninth annual report appears. We were under the impression that the Poldhu station had been built for this purpose. There are wonderful and prophetic calculations tending to show that, if the system transmits an average of 15 words a minute for 10 hours a day for 300 days a year at 6d. a word, then a pair of stations will earn no less than £56,000 per annum! With regard to the balance-sheet, the only possible remark is that it is delightfully vague, the only three revenue items being "gross profit," "transfer fees" and "interest and discount."

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PROBABLY all of our readers are familiar with the influence of the load-factor on the price chargeable for electricity supply, but we need make no apology for publishing the popular article on the subject which will be found on a later page. The writer is the General Manager of the South Wales Electrical Power Distribution Co., and his position enables him to gauge accurately the best method of putting questions of differential charging before large potential power consumers. The article is brightly written, and will doubtless be of assistance to electrical engineers and managers of electricity works who have to expound these matters, not only to consumers, but also to directors or to town councillors, who cannot be assumed to possess a knowledge of technical terms or to follow with perfect ease the rapid line of thought with which the engineer arrives at his conclusions in these matters. The analogy upon which Mr. HILL bases his article is, of course, not perfect, but no analogy can be. It permits of being carried sufficiently far for the purpose, however.

Obituary.—We regret to announce the death on January 30th, after a brief illness, of Mr. James Edward Ransomes, chairman of Messrs. Ransomes, Sims & Jefferies (Ltd.), of Orwell Works, Ipswich.

Tramway Overhead Equipment.—We are asked to point out that Mr. H. M. Sayers' Paper on this subject, the discussion on which was reported and commented upon in our last issue, was presented to the Tramways and Light Railways' Association and not to the Society of Arts. The Council of the latter Society had kindly lent its rooms for the occasion.

Cable Interruptions.	Date of Interruption.
Cayenne—Pinheiros	**Aug. 18, 1902**
Reissi-Issa (Yemen)—Camaran	**Oct. 22, 1902**
Tarifa—Tangier	**Jan. 18, 1904**
Cayenne—Paramaribo	**July 18, 1904**
Cap Haytien—Puerto Plata	**Dec. 27, 1904**
Marmaritza-Rhodes	**Jan. 30, 1905**
Jamaica—Colon	**Jan. 10, 1905**

Nernst Lamps of 500 Volts.—In the course of a lecture on "Improvements in Lighting" delivered recently before the Elektrotechnische Gesellschaft, of Cologne, Prof. W. Wedding exhibited some 500-volt Nernst glowers. According to the *Elektrotechnische Zeitschrift*, which reported the meeting, he stated that these glowers passed a current of 0·25 ampere, giving 97 c.p. (Hefner units); the efficiency is, therefore, 1·3 watt per Hefner c.p.

Annual Dinner of the Leeds Local Section.—The second annual dinner of the Leeds Local Section of the Institution of Electrical Engineers will be held at the Hotel Metropole, Leeds, on Friday, March 3rd. The chair will be taken by Mr. W. Emmott,' chairman of the Leeds Section, and the Lord Mayor of Leeds, Mr. A. Siemens, President of the Institution, Mr. G. C. Lloyd, secretary, and the chairmen of other Local Sections will be present.

Transactions of the Faraday Society.—Volume I. Part 1 of the *Transactions* of the Faraday Society has just been issued, the society having decided to publish them independently and in quarterly issues. The present part contains the Papers and discussions during the last three months of 1904, and includes nine Papers, all relating to electro-chemistry, and amongst them is one contributed by a lady, Miss Buena Pool, B.Sc. The book is well and clearly printed. Non-members may obtain this first part at the price of 10s. 6d.

The Kearney-Thom Mono rail.—A model of this system was on view last week at an Arts and Industrial Exhibition held at the Battersea Town Hall. It is proposed to construct a short railway on the same principle in the grounds of the Crystal Palace this year, and those interested in the scheme state that Parliamentary powers for a line from London to a point on the south coast will be sought next year. So far only rough models have been constructed, and the electrical and engineering details have not been worked out yet.

Royal Society.—Among the Papers down for reading yesterday were the following:—"On the Conversion of Electric Oscillations into Continuous Currents by means of a Vacuum Valve," by Prof. J. A. Fleming, F.R.S.; "On an Instrument for the Measurement of the Length of Long Electric Waves, and also Small Inductances and Capacities," by Prof. J. A. Fleming, F.R.S.: "Report on an Area of Local Magnetic Disturbances in East Loch Roag, Lewes, Hebrides," by Capt. A. M. Field, R.N., communicated by Rear-Admiral Sir William Wharton, K.C.B., F.R.S.; "Phosphorescence caused by the Beta and Gamma Rays of Radium," by G. T. Beilby, communicated by Prof. J. Larmor, F.R.S.

The Yorkshire Power Co.'s Generating Station.—The Thornhill power station of the Yorkshire Electric Power Co. is now practically complete, and the company have commenced to supply electrical energy. Foundations were laid down in November, 1903, and in December of last year a supply of electricity was available, and 26 miles of cable were laid. The generating plant consists of three 1,500kw. turbo-generators and three 200kw. continuous-current exciters. Three-phase current is generated at 11,000 volts, and continuous-current at 230 volts. Contracts are already made for supply to a number of local authorities, collieries, mills and a variety of industrial applications. We hope to give a more detailed description of this undertaking at an early date.

University Intelligence.—It is expected that His Majesty the King will perform the opening ceremony in connection with the new University of Sheffield in the first or second week in October. A sum of £170,000 is required as an establishment fund, and a Sheffield gentleman, who desires to remain anonymous, has offered £10,000 if four others will subscribe £10,000 each towards the £57,000 required to complete this sum. As an alternative, he offers £5,000 if nine others will contribute a similar sum.

An arrangement has been arrived at between the Universities of Harvard (U.S.A.) and Berlin (Germany) whereby professors are temporarily interchanged. The Massachusetts and Berlin Institutes of Technology have come to a similar arrangement, and it is belived that considerable benefit will result.

Payment for Use of Water Power at Niagara.—According to the *Western Electrician* of Chicago, a Bill is to be introduced at the New York State Assembly providing for the payment of a tax by every person who makes use of the water at Niagara Falls, on the U.S. side, for power purposes. For each horse-power-year up to 20,000 H.P. the tax will be $1.50; from 20,000 to 30,000 it will be $1; from 30,000 to 40,000, 75 cents; and above this quantity 50 cents. A clause at the end of the Bill exempts all those who are now working under existing contracts with the State. It is estimated that the passage of the Bill would increase the revenue of the State from $700,000 to $1,000,000. For the purpose of comparison, it may be mentioned that the Canadian companies pay an annual rental and an additional tax of $1 per annum for each electrical horse-power generated over 10,000 E.H.P. and up to 20,000. Between 20,000 and 30,000 75 cents has to be paid for each electrical horse-power, and 50 cents for each above 30,000.

Wireless Telegraph Notes.—We are informed by the American De Forest Wireless Telegraph Co. that on January 10th the Mallory steamship "Denver," coming north, reported herself 10 miles south of the Diamond Shoals lightship off Cape Hatteras. This message was clearly read by the De Forest operator at Cleveland, Ohio, 530 miles away in a direct line, and was forwarded to the company's New York office for corroboration. The "Bermudian," of the Quebec Steamship Co., left New York on January 18th at 10 a.m., and at 10 p.m. the Cleveland station read a message from her stating that she was then 200 miles from New York, the total distance covered by the message being 580 miles. On January 21st, the "Philadelphia" left New York at 12 o'clock noon, and at 10 p.m. reported herself 130 miles out. This message was read by the De Forest operator at Port Huron, Michigan, some 600 miles away. These performances merit attention when it is considered that all the boats are equipped with 1kw. apparatus and with very short masts.

In Cuba a concession has been granted for the erection of several experimental wireless stations, including the Marconi, De Forest and the Fessenden systems. The De Forest Co. has already erected a station at El Vedado, a suburb of Havana, the Marconi Co. has imported material for a station and the Fessenden Co. has completed arrangements for a similar purpose.

Experiments are being carried out by the London, Brighton and South Coast Railway at Newhaven with wireless telegraphy. Interruptions occur at times, and it is thought that they are due to Marconi apparatus installed on passing ships. It is intended to maintain a permanent service, as the cable communications have to be transmitted via Havre, and sometimes occupy three to four hours in transit, thus arriving too late to prevent the departure of the boats in rough weather.

A New Map of London.—We have received from Messrs. Stanford & Co. a most useful map of London, expressly compiled to indicate the new metropolitan railways, tramways, and miscellaneous improvements, particulars of which were deposited with the London County Council by November 30, 1904, for the Parliamentary Session of 1905. The routes of the new "tubes" proposed by the Central London Railway Co., the Great Northern, Piccadilly & Brompton Railway Co. (bills Nos. 1 and 2), the Hammersmith, City & North-East London Railway Co. and the North-East London Railway Co. are marked, as well as that of the new tramways proposed by the London County Council and the London Southern Tramways. Although the proposed areas of supply are not defined, the land scheduled for generating stations and other purposes by the following companies are plainly indicated:—Administrative County of London & District Electric Power Co., Central Electric Supply Co., County of London Electric Supply Co., East London & Lower Thames Electric Power Co., Metropolitan Pneumatic Despatch Co., London County Council, and London Southern Tramways, in addition to that scheduled by the railway companies above mentioned. Other information of a miscellaneous character, in connection with which bills have been deposited in Parliament, is also given. The map further indicates the existing and authorised railways and tramways and all the other items usually shown upon a map of London. The scale is 3in. to the mile, and the price is 10s. 6d., the map occupying two sheets 60in. by 30in. The larger size has been necessitated by the increasing number of "tube" railways in operation and proposed and the difficulty of showing them on a smaller map.

Mineral Wealth of Ceylon.—A valuable report upon the results of the recent mineral survey of Ceylon, by Prof. W. R. Dunstan, F.R.S., has been issued officially. It contains much information regarding the mineral deposits which the survey has disclosed. Recent researches in connection with radium give the report an added value, and there are, besides, interesting remarks concerning mica, manganese, graphite, iron ores, corundum, kaolin, laterite and thorium. The pride of place in the report is given to mica, which is found in considerable quantities at various places in Ceylon. The specimens which have so far been forwarded for examination were of rather poor quality and commercially hardly worth consideration, but it is confidently hoped that better results will be obtained if further search is made, and especially if the mica is mined from greater depth than has hitherto been the case. A new mineral was discovered during the survey, containing some 76 per cent. of oxide of thorium (thoria), and this mineral Prof. Dunstan proposes to name "thorianite." It is radioactive, and will (Prof. Dunstan considers) be found to be an important source of radium and radio-active earths. Since the report was written, Sir W. Ramsay has stated that radium is present in the mineral, and that it furnishes considerable quantities of helium. The mineral is of fairly uniform composition. Another mineral, which the discoverer (Mr. Coomaraswamy) provisionally identified as monazite, turned out to be thorite and was chiefly composed of thorium silicate. Prof. Dunstan concludes his report with the observation that, apart from the scientific interest attaching to the determination of their composition, the discovery in Ceylon of two minerals rich in thoria may prove of considerable commercial importance. The analysis of the samples was made at the laboratory of the Imperial Institute, London.

Details of Tramway Construction.—The Board of Trade has issued a revised memorandum on details of tramway construction and equipment. The additions since the last memorandum are shown in italics:—

Clearance.—The space between the inner rails of a double line must depend upon the overhang of the cars. It is, however, necessary that there should be at least 15in. between the sides of passing cars and also a similar space between the side of a car and any standing work such as lamp, telegraph and trolley wire posts in a street. There should be at least 15in. between the side of a car and the kerb, whether on straight or curved roads. The clearance between the top deck of cars and the underside of bridges should not be less than 6ft. 6in.

Posts and Brackets.—Centre posts should not be used without the consent, in every case, of the Board of Trade. The stone kerbing round centre posts should not be such as to enable any person to stand upon it as a refuge, unless the clearance is ample for safety. Where bracket arms 16ft. in length will not suffice, it is desirable that span-wire construction should be used.

Permanent Way.—The weight of rail should not be less than 90lb. per yard, 100lb. being preferred. The groove of the rail should not exceed *one and an eighth inch* in width, but a groove not exceeding *one and a quarter inch* will be accepted on curves of less than one chain radius. The details of permanent way and mode of construction as approved by the Board of Trade should not be varied at any time without the Board's consent. *Cars.*—Staircases of the "reversed" type should be avoided, more especially on narrow gauge lines. Of existing types, the "trigger" lifeguard is the pattern which is preferred. The hanging gate should be as close to the ground as possible, and there should be at least 3ft. between it and the front of the guard. Both the guard and the gate should be at least as wide as the outside of the frame of the truck. In order not to interfere with the efficiency of the lifeguard it is desirable that folding steps should be adopted on all new cars. The use of covers for the top deck of cars cannot be approved in cases where the gauge of lines is 3ft 6in. or less. Top-deck railings should be at least 3ft. 6in. high. *The trolley standard must be connected with earth by a low-resistance fuse or automatic switch, and the warning signal, when the fuse or switch opens, should be an electric bell.* Where trolley ropes cannot be dispensed with or tied up, precautions must be taken to prevent the "slack" causing accidents. To prevent trolley booms being pulled out or trolley standards broken, "traps" should be minimised and detachable trolley heads provided. No material alterations should be made in cars after inspection, nor any fresh type of car adopted, without the consent of the Board of Trade.

Statistics of German Electricity Stations.—According to the statistical tables relating to German public electricity supply works, compiled annually by the *Elektrotechnische Zeitschrift*, the generation of electric current made considerable progress in Germany between April, 1903, and April, 1904, the date to which the information in the present tables refers. On April 1, 1904, there were 51 generating stations with a capacity of 2,000kw. or over. These 51 stations were distributed over 33 towns, and their aggregate capacity amounted to 290,700kw. The largest stations are three of those supplying Berlin: "Oberspree" (13,600kw.), "Moabit" (10,640kw.) and "Spandauerstrasse" (5,900kw.). Of the 1,028 stations which are enumerated in the tables, 843 supplied continuous current only, and of these 843 stations 803 were equipped with accumulators. It is interesting to note that the capacity of the storage batteries installed amounted on the average to nearly 40 per cent. of that of the generating plant. The 40 continuous-current stations without accumulators were mostly small ones. Besides those continuous-current stations there were about 80 stations which generated both continuous current and alternating current (mostly three-phase current), and finally there were more than 100 alternating-current stations, of which 63 supplied three-phase current only. Most of the largest stations supplied both continuous and alternating current. Steam power was used in 570 stations which included the largest; water-wheels and turbines furnished the motive power in 109 cases, while gas engines formed the power equipment of 96 stations. Among these 96 stations there were two using Diesel engines. In 208 stations both steam and water power were used, and in some 40 other cases various combinations of prime movers were employed. The total number of incandescent lamps connected up was equivalent to about 9½ million 8 c.p. lamps, and the motors supplied with current aggregated 263,000 H.P. It is remarked that the advance in electric power had been greater than that in electric lighting. The sum total of the capacities (including the accumulator capacities) of all the German electricity stations on April 1, 1904, was 531,000kw.

Society of Engineers.—The first ordinary meeting of the Society of Engineers for the present year was held on Monday evening at the Royal United Service Institution, Whitehall. Mr. D. B. Butler, the President for 1904, first occupied the chair, and presented the premiums awarded for Papers read during that year. These included the President's Gold Medal to Mr. William Edward Storey for his Paper on "Condensing Machinery," and a Society's Premium of Books to Mr. A. S. E. Ackermann for his Paper on "British and American Coal-cutting Machines." He then introduced the President for the present year, Mr. Nicholas James West, to the meeting and retired from the chair, receiving a hearty and unanimous vote of thanks for his services during the past year. In his inaugural address the President dealt mainly with the mechanical side of engineering, with reference to the historical use and improvement of pumping and marine engines and the application of the latter at various periods to vessels of different kinds, and he included a reference to the latest phase of turbine propulsion. He noted as an interesting point that, incredible as it might seem, for 50 years the use of the steam engine was confined to the pumping of water. It was not until 1780 that rotary motion was obtained from the steam engine by means of a crank. Watt objected to the use of his engine if the crank was attached to it, and invented the sun-and-planet wheel in place of the crank. In 1837 Cornish engines were first introduced for pumping water for the supply of London at the East London Waterworks. One was purchased in Cornwall having a 90in. cylinder and a 10ft. stroke. It worked most economically for 25 years, and was only removed when the pumping works were closed in 1892. This class of engine is extensively used by the large London and other water companies. The President then referred to the Severn Tunnel pumping plant, which, he observed, was the largest pumping plant he knew. It is installed at each side of the Severn Tunnel on the Great Western Railway, and is entirely of the Cornish type. The engines and pumps have a total pumping capacity of 66 million gallons in 24 hours, but the quantity dealt with under ordinary circumstances varies from 16 to 34 millions. The President observed that he was connected with that installation from commencement to finish, a period of about 13 years. Referring to the growth in size of steamships, he observed that the greater relative economy of motive power to burden in large vessels had contributed largely to the increase in dimensions, which was still proceeding. At the present day, with steel construction, the ratio of length to beam had increased to 10 and 11, the limit being found in the increased tendency to vibration, which was injurious to the hull and discomforting to the passengers. The machinery of the earliest steamers operated at very low steam pressures, and weighed about 1,700lb. per horse-power. As late as 1860 the weight was as high as 1,000lb. per horse-power. At the present day the weight of the propelling machinery in mail steamers is about 500lb. to 600lb., and in cargo steamers about 450lb. per horse-power. In torpedo boat work the reduction has been carried still further. Referring to the economy of the marine engine, the President pointed out that the steam turbine would seem to lend itself to still further economies. Steam turbines directly coupled to multiple centrifugal pumps were raising 400 to 600 gallons per minute against a head of more than 700ft., with a steam consumption of less than 30lb. per horse-power-hour measured in water lifted, including turbine losses, as well as pump and pipe resistances. Fan blowers driven by steam turbines were in use for supplying air to blast furnaces under a pressure of 5lb. per square inch at a rate of 100 cubic ft. per second, with a total combined efficiency of 40 per cent. Those results showed that the steam turbine offered possibilities far beyond those of its own economy in steam consumption. In conclusion, the President observed that the slow progress of the marine steam turbine at a time when the turbine was making such rapid strides on land seemed rather remarkable, but the experience with it up to 10,000 H.P. in ships of moderate as well as fast speed now justified the anticipation guided by theory, that the larger the engines the more favourable would be the results as compared with reciprocating engines.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, February 10th.

Tramways and Light Railways Association.

4 p.m. Annual General Meeting at the Society of Arts.

Physical Society.

8 p.m. Annual General Meeting at the Royal College of Science, Exhibition-road, South Kensington, when the President-Elect, Prof. J. H. Poynting, F.R.S., will deliver an Address on "Radiation Pressure."

SATURDAY, February 11th.

Institution of Electrical Engineers: Students' Section.

2:45 p.m. Visit to the Post Office Central Telephone Exchange. Meet at the Addle Hill entrance, G.P.O. south.

Birmingham and District Electric Club.

7:30 p.m. General Meeting at the Colonnade Hotel, New-street, Birmingham. Paper to be read: "Starting and Speed Regulation of Electric Motors," by E. R. Wood.

MONDAY, February 13th.

Junior Institution of Engineers.

6:30 p.m. Visit to the works of the Brockie-Pell Arc Lamp Co., 60, Worship-street, E.C.

Society of Arts.

8 p.m. Cantor Lecture I.: "Internal Combustion Engines," by Dugald Clerk.

Institution of Mechanical Engineers: Graduates' Association.

8 p.m. Special Lecture by Dr. J. T. Nicolson on "Results of Force Measurements with Cutting Tools and their Application to Lathe Design." Mr. J. Hartley Wicksteed, President of the Institution, will take the chair.

TUESDAY, February 14th.

Institution of Electrical Engineers: Glasgow Local Section.

8 p.m. Meeting at 207, Bath-street. Paper to be read: "Earthing," by W. W. Lackie.

WEDNESDAY, February 15th.

Institution of Civil Engineers: Students' Section.

2:30 p.m. Visit to the Lot's-road, Chelsea, generating station of the Underground Electric Railways Co. of London.

Institution of Electrical Engineers: Birmingham Local Section.

7:30 p.m. Meeting at the University. Paper to be read: "Applications of Electricity in Mines," by A. C. Anderson.

Institution of Electrical Engineers: Students' Section.

7:30 p.m. Meeting at 92, Victoria-street, London, S.W. Paper to be read: "The Electric Furnace," by W. J. Williams.

Royal Microscopical Society.

8 p.m. Meeting at 20, Hanover-square, London, W. Paper to be read: "Practical Micro-Metallography, with Experimental Demonstration," by J. E. Stead.

THURSDAY, February 16th.

Institution of Electrical Engineers: Leeds Local Section.

7:15 p.m. Meeting at the University. Paper to be read: "Permanent Way Construction and Depreciation," by James Lord.

SATURDAY, February 18th.

Glasgow Technical College Scientific Society.

7:30 p.m. Meeting at 38, Bath-street. Paper to be read: "High Speed Tool Steels from the Users' Point of View," by E. H. Robertson.

THE INFLUENCE OF "LOAD-FACTOR" ON THE COST OF ELECTRICAL ENERGY.

BY EDMUND L. HILL.

During the last few years the whole question of electricity supply has undergone a change. From being a luxury for the few it has become a necessity for the many, and as the uses of electricity have increased so have the costs of its production and the price at which it can be profitably sold been reduced. This is due, to but a small extent, to new inventions and improvements in the machinery and appliances used to generate and distribute electrical energy. Ten years ago, when electricity was almost solely used for lighting, generators could be bought that had an efficiency of about 93 per cent. To-day improved machines can be obtained whose efficiency is 96 per cent. Ten years ago the average price obtained for energy was about 7½d. per unit for all purposes. To-day, for lighting, it is 4½d. per unit, while for power prices vary from ½d. to 3d. per unit. It will be useful to see what has made the production of energy less costly than it used to be. It cannot be due to improvements in the process of production, as the machines of to-day are only 3 per cent. more efficient than those of 10 years ago. It cannot be due to cheaper labour or coal, as the price of both have steadily gone up. It certainly is not due to easier finance, because finance has seldom been more difficult than in the last four years or so, during which period electricity has made such gigantic strides

In order to explain the change I will use a simile. In a new and rapidly growing town an enterprising man, seeing the necessity for such a thing, builds a public hall suitable for lectures, religious meetings, dances, presentations, public business, boxing displays, &c. In other words, he equips his hall for every purpose of business and pleasure. To begin with, he caters for the pleasure-loving public. He knows that the public must dance and must attend thinly-veiled prize fights. He thinks he can reckon on 50 such functions per annum, and he then considers what price he must charge per meeting to pay his expenses and leave a reasonable profit. The building, a temporary one, cost him £1,000 (he would not spend more to start with because he was not quite sure how much his fellow townsmen were addicted to dances and prize fights). He borrowed this £1,000 from one or more friends, to whom he has to pay 5 per cent. interest, or £50 per annum. His caretaker costs him another £50. His rates, taxes and insurance another £25, and he estimates his lighting and firing bill at another £25, or a total of £150 per annum. He wants another £150 for himself, so he has to earn a revenue of £300 per annum. He therefore makes an inclusive charge of £6 per meeting, and on these terms he readily lets his hall and earns his £3 per week profit. After a while the convenience of his hall gets talked about; the town also rapidly increases in population, and, as usual, the population is mixed. All, however, are fond of pleasure, and the collier and the mechanic are as eager to attend a half-crown "hop" as their master is a guinea dance.

The collier and his mates, however, cannot afford to pay £5 for one night monthly. They therefore go to the owner of the hall and offer him £8. At first he will not listen to them, but after a while he tells them that if they will use the hall on Fridays, when the fashionable folk will not use it and the patrons of prize fights have not enough left to pay for it, he will hire it them at £4 per "hop." The bargain is closed. The owner of the hall receives £48 per annum extra. His extra disbursements are 12/365 extra gas or 16s. 6d. per annum. That is to say, by reducing his rate for special circumstances, and choosing his own time for letting his hall, he has increased his receipts by £48 per annum, while his costs have only been raised by 16s. 6d. per annum. This open his eyes and makes him look around for other business equally as good. He thinks, "I have a fine hall which I let out for one night a week to the gentlefolk and one night a month to the working people. That means that my hall is only used for 64 evenings in the year and never at all in the day time. Cannot I extend its use and make more money from it?" Straightway he goes to the collier and his mates, and offers them the hall twice monthly for £3 per night. They accept his offer and, in consequence, he earns an extra £24 per annum at an extra cost of 16s. 6d. per annum for lighting. A new feature, however, arises. He finds that the additional use of the hall is telling on its fittings and furniture, and this alarms him. When these are worn out he knows that he cannot borrow more money to replace them. Moreover, as he is not a town councillor, he would not do such a thing, so he thinks: "I used to make £150 per annum out of my hall; now, at a trifling extra cost, I make £222; I will therefore put aside £50 per annum to pay for the depreciation of my property. My spendable income will then be only £172 per annum, but I shall feel safe."

After voluntarily reducing his income as above he does not feel quite happy, and while he is wondering how he can augment it, the local Salvation Army officer comes along and offers him 20s. per Sunday for the use of the room. After a rapid mental calculation he accepts the offer, realising that it will mean an extra revenue of £52 per annum against a yearly cost of one seventh extra gas, or £8. 11s. 6d. He finds, however, that he has to pay his caretaker something extra for the Sunday work. Very shortly afterwards the urban district council of the town fall out with the vicar, the town being situated in Wales, and are no longer allowed to hold their meetings at the Church schools. Their clerk is therefore sent to interview the owner of the hall, and offers 2s. 6d. per night for the use of it, and further stipulates that his council may use the hall exclusively at any time on one hour's notice. After the usual amount of haggling, for which the clerks of Welsh urban district councils are notorious, they arrive at a compromise—10s. per meeting in the daytime, when no lighting is required, and 12s. 6d. per meeting in the evenings, when the flow of talk has to be supplemented by something in a lighter vein. The hours of use of the hall are also fixed for 12 months ahead, and are only allowed on those evenings when experience has shown that the hall is never wanted for other purposes.

By this time the owner of the hall is materially benefiting by and rapidly beginning to understand the meaning of the expression "load-factor." He sees that he must earn an amount sufficient to pay its standing charges and depreciation and at the same time leave him a living profit. He realises, however, that all he earns above this amount will be chiefly profit, his only extra costs being for lighting, firing, labour and depreciation. He, therefore, instructs his caretaker to turn an honest penny whenever he can, without detriment to the property or annoyance to their regular customers. The caretaker, therefore, earns £2 here and £1 there by hiring the hall at odd times to auctioneers, socialist lecturers, theosophists, fiscal reformers, and others of their kind.

The owner at the end of 12 months finds that he has done uncommonly well out of his hall, and at the same time realises that it is becoming too small for the requirements of the fast growing town. He accordingly builds a new hall, adjoining the old, and by strict attention to the needs of his fellow townsmen, and by careful catering for the wants of the stray theosophists, socialist lecturers, fiscal reformers and others, he is soon enabled to pay off his loan; he invests his depreciation fund in a similar concern in a neighbouring town and is on the high road to fortune.

He has studied "load-factor," and is rewarded accordingly.

The meaning and importance of "load-factor" in "electrics" is so little understood by the public, and of so much moment that I make no apology for the above laboured explanation.

I will indeed endeavour to amplify it electrically.

The hall is the generating station of a power distribution company, the owner, the shareholders and directors of the concern and the caretaker its staff. The dancers, prize fighters, Salvationists, auctioneers, socialist lecturers, theosophists, fiscal reformers, and urban district councillors, are the varying customers of the power company whose varying needs make up the "diversity-factor" of the system, and whose different hours of use of the plant give it its "load-factor."

The power company spends a certain amount on capital account to build, equip and lay down its system. On this amount it must pay interest. The buildings, plant and mains will depreciate, the amount of such depreciation being more or less constant and almost independent of the use. Increase the use tenfold and the extra depreciation will only reach a very trifling amount. The staff of the power company will also remain nearly constant, only increasing, in the lower grades (drivers, stokers and coal trimmers) as the load very materially increases. Each small increase in the staff will allow of an enormous increase in the output. Whether the power company sells 100,000 units or 20,000,000 units per annum, its general establishment charges (with the exception of the rates)—viz., its rent, insurance, salaries, &c., will remain constant or nearly so. By what then will its costs be increased as the output and revenue expand? By the coal, oil, stores and water, "the gas bill of the simile" and by those alone. As in the case of the public hall, these items will represent but a small fraction of the power company's total costs. The power company can depend on a certain amount of custom from those who will have electricity as a luxury or must have it as a necessity. Both these classes, like the dancers and the patrons of pugilism, can afford and should be made to pay a thoroughly good price. They cannot or will not do without energy, and they call for it at all kinds of times many of which clash and many of which are inconvenient. Others badly need electricity but cannot afford to pay the same price as the "wills" and "musts." They promise, however, to only take it at such times as are convenient to the power company. It pays the power company to give them special terms since the hours of supply can be settled for the most convenient times when the plant would otherwise be comparatively idle. By further slight concessions the power company can induce these users to treble their consumption, still at times convenient and therefore profitable. Sooner or later the urban district council comes along and gets far better terms than it deserves. This, however, seems to be inevitable and must be faced by the power company as a necessary evil.

The "casuals" and "specials" also come along and help to swell the profits of the power company; they either must or will have energy for special purposes and can be made to pay accordingly. The power company gets another class of customer which the owner of the hall could never hope to obtain. It is the man who says: "I want your power continuously day and night, year in and year out. On what terms will you give it me?"

The power company very carefully considers the question and, having learnt by experience, it sees that the cost of supplying these constant users will be only the extra cost of the coal, oil, water, stores, &c., that will be expended in supplying them plus a certain small amount for extra depreciation. It will also realise the immense value of these constant users in another way. By their regular employment of part of the plant, which will be allocated solely to their needs, the "load-factor" of the whole system will be raised, and the cost of *all the units sold* for every purpose will be reduced. A reasonable number of these constant users will also increase the economy of the whole system, because with a known constant supply the plant can be so arranged that engines and boilers can always be kept fully or nearly fully loaded, and therefore working under the most efficient conditions.

Bearing all this in mind, the power company will quote very low terms to a reasonable number of customers who require energy for such purposes as colliery ventilating, which never stops. By getting a reasonable amount of such constant work, not too little or the "load-factor" would not be sufficiently helped, and not too much or enough plant would not be left for supplying the better-paid units, for which there is an ever-growing demand, the power company finds not only that the back of its "works costs" is broken by the revenue so obtained, but also that it is making a larger profit on every other unit that it sells, because the cost of all the units is reduced. Moreover, when the power company studies its revenue account in relation to its capital outlay it finds that although the price per unit charged for the constant work is very low compared with its other charges, yet the revenue derived from the constant work is greater per £1 of capital than in the case of the higher-priced units. By reason of the demand being spread over 24 hours in each day the company can supply a far larger number of units without further capital expenditure than in the case of the intermittent higher-priced supply, where the "load-factor" is comparatively low.

The power company will, in all probability, have in its Act of Parliament a "most-favoured-nation clause" which will force it to supply at similar rates to all customers "whose circumstances are similar." This need not frighten it. "Whose circumstances are similar" is a delightfully elastic phrase. In time it may prove a gold mine to the lawyer and the expert witness. In the meanwhile, it is a "salted" mine that need not be taken too seriously. If there are two collieries—next-door neighbours—one of which requires 3,000,000 units per annum for surface work and underground haulage, and the other 500,000 units per annum for a fan, the power company will be quite safe in charging the fan user, say, ⅜d., while it makes the other colliery pay ¾d. per unit. The "circumstances" will be utterly dissimilar. In the one case the "load-factor" will be 100 per cent. and in the other not more than 30 or possibly 35 per cent. The quantity of energy used has nothing to do with the question. Under certain conditions the fact of the quantity increasing would be an excellent reason for raising the price. Take the case of a large dock fed during low tides by a river that is full in winter and somewhat dry in summer. To make up for leakage a certain amount of water is required, which, for example, may entail one hour's pumping in the winter and three hours' pumping in the summer. Such a dock might be a large customer of a power company for pumping, requiring, say, 3,000 H.P. of plant. This would mean that for certain times in each day, for one hour in the winter and for three hours in the summer, the power company would have to keep allocated to the dock company's requirements 3,000 H.P. of its buildings, plant and mains. It would sell per day 2,000 units in the winter and 6,000 units in the summer, or an average throughout the year of 4,000 units per day. The plant to deal with this work would certainly cost the power company £25 per horse-power, or £75,000. The company would have to earn on this amount 20 per cent. in order to cover working costs and depreciation, to allow a sufficient reserve and to pay a fair dividend. It would, therefore, have to charge the dock company about 2½d. per unit for its current. Unless, therefore, the dock company would pay such a price, which would not be likely, the power company would wisely refuse to supply it, although the sale would amount to 1½ million units per annum.

By this time the power company will have learnt that, given a good system and sound finance—"load-factor" is its finest asset, and it will endeavour to find some equitable system of charging, of which "load-factor" shall be the basis. It will find this difficult. If it is wise it will instruct "the caretaker"—its staff—to ponder over this question in their spare moments—if they have any—and endeavour to arrive at a satisfactory solution. If this desirable result can be attained, then the power company may look forward to an even more prosperous existence than it now can reckon on.

ELECTRICITY METERS.*

BY C. H. W. GERHARDI.

(*Continued from page 622.*)

The Scheeffer Meter.—The Scheeffer meter is an example of Canadian manufacture, being made by the Packard Electric Co. at St. Catherine's, Ontario, the agents being the Bastian Meter Co. The type G meter replaces what is claimed to be the first induction meter on the market, and when the modern meter is compared with its predecessor a good idea is obtained of the progress which has been made in the manufacture of meters. A model G meter of this make with its cover removed is seen in Fig. 23. An iron frame supports the motor, brake magnet, dials and jewel screw, the brake magnet being held by an adjustable clamp on the front, and the motor fixed by screws to the back of the frame. The general arrangement of the motor is seen in Fig. 24. The main coil M is placed between the poles of the shunt magnet S and has no iron core. Below the poles of the magnet is placed the disc with the yoke Y below it. The shunt current is taken first through the choking coil C, which has a nearly closed magnetic circuit, and then round the two poles of the shunt magnet.

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* From a forthcoming book to be published by "The Electrician" Printing and Publishing Co. All rights are reserved.

The compensation for inductive loads consists of a secondary winding on the shunt magnet, which is regulated by the resistance in its circuit. The low-load adjustment is effected by altering the position of a projecting piece of iron fixed by a screw to the frame below the disc on the right-hand side. Moving this adjusting piece down increases the speed. The meter should be adjusted on shunt only, until it does not creep in either direction. The disc is of aluminium, and is supported by a light brass tube; the latter rests on a highly-polished and hardened-steel ball, which takes the place of the pivot. The jewel and ball can be inspected or replaced without disturbing the calibration of the meter. The disc and spindle together weigh about 19 grammes. The terminals are in the main case, but the meter may be connected up without breaking the cover seal. The mains are inserted through vulcanised fibre bushes, one at each side of the meter near the bottom, the clamping screws being worked from underneath. A cover capable of being sealed is fixed over the screw heads. The shunt tee is taken to the small terminal on the right-hand side near the top, the fixing screw in this terminal requiring to be sealed by sealing-wax. This is rather a disadvantage, as two kinds of sealing appliances have to be used.

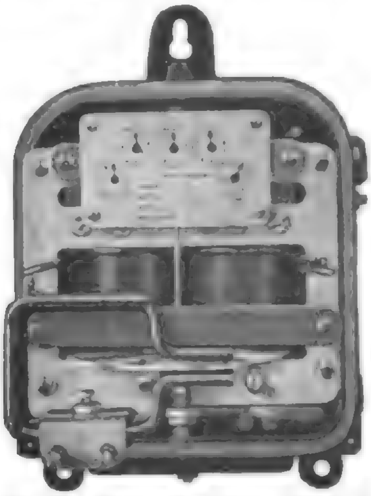

Fig. 23.—Scheeffer Meter—Model G.

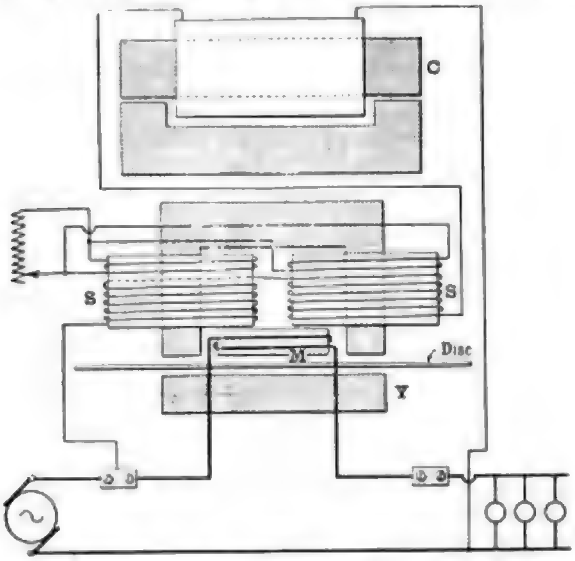

Fig. 24.—Scheeffer Motor.

The meter has a very straight curve, and does not appear to be affected by a dead short through a fuse of treble the capacity of the meter. The shunt current is low (0·02 ampere for a 200-volt 10-ampere meter), and the drop is also small (0·1 volt on the same meter).

Considering the smallness of the friction the full-load torque of 1·37gr.-cm. is fair.

The Stanley Meter.—So far as the author is aware the Stanley is the only meter in which the moving portion is entirely suspended magnetically. The Evershed meter[*] was partially suspended magnetically, but it was provided with a pivot and jewel. In the Stanley meter the rotating disc with its soft steel spindle (called the suspension core) to which the disc is rigidly secured are floated in air, and consequently the only mechanical friction is that due to the wheel train, and perhaps the rubbing contact between the bushes in the steel spindle and the taut wire which runs through them.

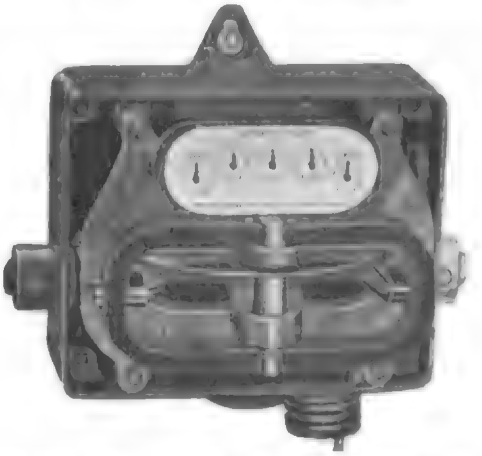

Fig. 25.—Stanley Meter: Front View of Supporting Frame Showing Brake Magnets, Dial, &c.

Fig. 25 illustrates the model G meter with the front part of the case removed, the registering dials, brass frame and brake magnets being visible. The two horse-shoe brake magnets butt up against common pole-pieces which are held rigidly in the brass frame, the object of this arrangement being to eliminate any chance of the length of the air-gap or distance between the poles taking place. The same arrangement is adopted in the case of the suspension magnet seen in position in Fig. 26, which also shows the dial train connection. A sectional view of the suspension system is given in Fig. 27. It consists of the permanent magnet Y, with its steel pole-pieces, A and B, and the suspension core. The upper end of this core is turned smaller and the lower end is flanged larger than the middle of the core; the pole-pieces are hollow, and the diameters of the hollows are larger than the diameters of the top and bottom of the core. Until the magnet is in position, the core rests on its flange in the cup in the lower pole-piece; the top of the core will then be just out of the hollow in the upper pole-piece. On placing the magnet in position the core is attracted and raised off the cup, and takes up a definite position between the two poles touching

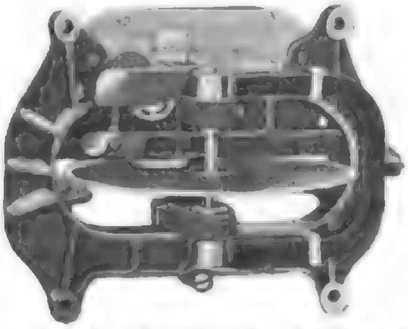

Fig. 26.—Back View of Supporting Frame Showing Suspension Magnet. Rotating Parts and Dial Train Connections.

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[*] See *Journal* I.E.E., Vol. XXIX., No. 146, p. 748; also *The Electrician* Vol. XLV., 1900, pp. 283, 328, 438, 513, 562.

neither. A fine steel wire is passed through the centre of the core and prevents a shock displacing it. It is stated that this wire does not touch the holes in the core through which it passes. It is a difficult matter to prove this, as the clearance between the wire and these holes is extremely small. Judging by results it seems probable that there is no rubbing contact here; thus the only mechanical friction in the meter is that due to the wheel train, and owing to the fine finish which this has, the friction must be very small and constant.

A diagram of the motor is given in Fig. 28, from which it will be seen that there are four shunt coils and two series coils and that the arrangement is symmetrical as regards the disc, half being above and half below. The series coils contain no iron core, so that the inductive drop is not great (it is about 0·35 volt for a 10-ampere meter). The shunt terminal on the left is to enable the shunt circuit to be disconnected from the main for testing purposes. R. R. are closed rings of copper forming shading coils, and are placed on the back half of each of the shunt pole-pieces. The vanes shade portions of the pole-pieces also, and by them the meter is stopped if it has any tendency to rotate on no load. These, together with the disc, cause the necessary lag in the shunt flux for accuracy on inductive load. The permanence of the magnetic suspension is the only doubtful point in this meter. The author's experience only extends to 18 months, during which time no trouble has been found either in the suspension or otherwise.

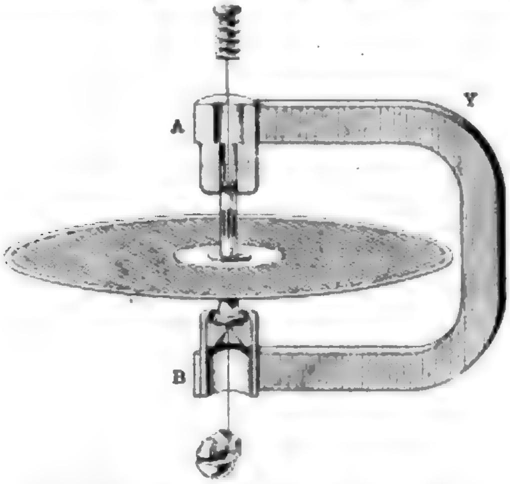


Fig. 27.—Suspension System of Stanley Meter.

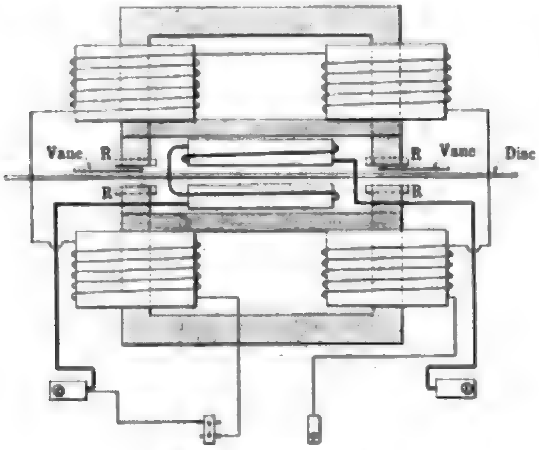


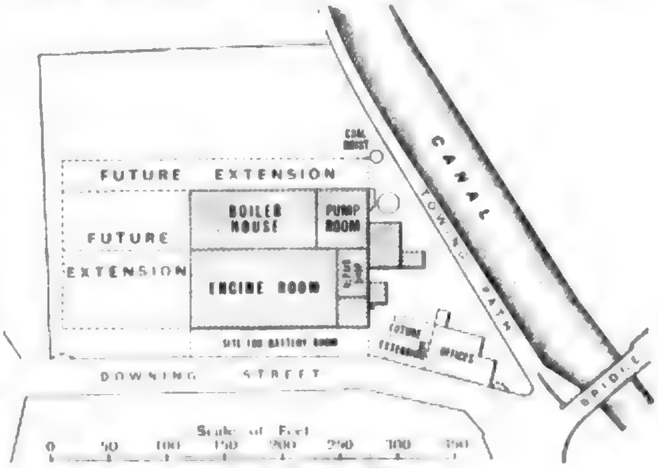
Fig. 28.—Stanley Motor.

The torque necessary to overcome friction practically vanishes, but by means of the vanes (Fig. 28), it is possible to cause a forward or backward creep; thus the friction due to the wheel train may be compensated for. When so compensated even, no amount of vibration causes a creep. The more the right-hand vane, or the less the left-hand one shades the pole, the greater the torque due to the shunt circuit becomes. The accuracy of the meter extends far below the single 8 c.p. lamp even in meters of large capacity. Notwithstanding the absence of friction, the meter has an extremely large torque for the induction motor type, it being 5·6gr.-cm. at full load. If, therefore, the magnetic suspension proved a failure—of which there is no indication at present—the meter would be exceptionally good if fitted with a jewel and pivot. The shunt current of 100-volt meters is about 0·08 amp., the shunt watts being about 1·3; thus an angle of about 80deg. is obtained between the shunt current and the impressed volts. The Stanley meter is made in America by the Stanley Instrument Co.

(To be continued.)

THE BIRMINGHAM AND MIDLAND TRAMWAYS.

Route.—These tramways, the total length of which is 11·8 route miles, start in the city of Birmingham close to the Municipal Buildings and extend along the Dudley-road as double track as far as Windmill-lane, Smethwick, whence they continue through Smethwick, Oldbury and Rowley Regis as a single line, with passing places, into Dudley. Inside Birmingham also, along Heath-street to the boundary of Smethwick, the line is single with passing places, and in Cranford-street, Smethwick, it is double. The new line, from Windmill-lane, in Smethwick, to the Harborne boundary is also double. At West Smethwick there is a branch line of single track, with passing places, into West Bromwich, and another into Oldbury through Bromford-lane, thus making a complete loop from Spon-lane to the Market square, Oldbury, through West Bromwich. These lines, together with those owned by the City of Birmingham Tramways Co., Dudley, Stourbridge & District Electric Traction Co., Wolverhampton District Tramways Co. and the South Staffordshire Tramways (Lessee) Co., are controlled by the Birmingham and Midland Tramways Joint committee, the total length of route under the management of this committee being 91¾ miles. All these companies are affiliated with the British Electric Traction Co.



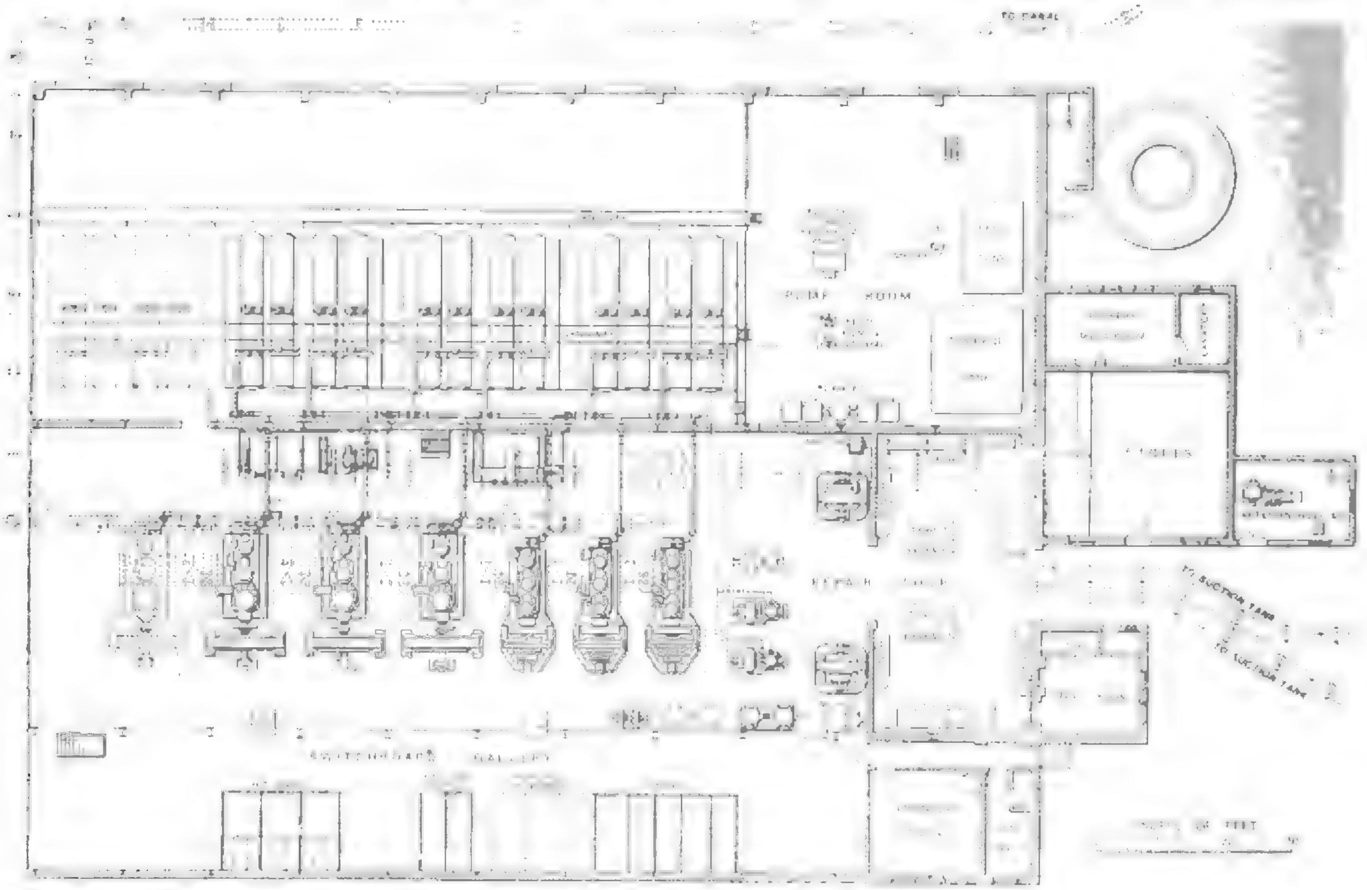
Block Plan of Works.

Permanent Way.—Inside the city the permanent way, equipped with 102lb. rails, has been laid to the specification of Mr. John Price, city electrical engineer, under the supervision of his assistant, Mr. T. Arnall. The two new lines, one in Cranford-street and the other in Bearwood-road and Waterloo-road, were laid with 96lb. rails, the contractor being Mr. George Law. All the other portions of the line, including turn-outs, &c., were relaid by the Tramways Company under the supervision of Mr. R. W. Cramp.

Car Depot.—The old steam car depot at West Smethwick has been added to and partly rebuilt to provide accommodation for an increased number of electrical cars, the site being sufficiently large to permit of a further extension of the buildings, which would make the holding capacity of the shed 100 cars.

Overhead Equipment.—Inside Birmingham bracket-arm construction, with taper poles made by Messrs. James Russell & Co., are used on each side of the road along the main line, with occasional spans, however, at very wide points, and centre poles at a point near the Free Library in Dudley-road. In Heath-street side poles on one side only are used along the track, except at loops and crossings, where poles and bracket arms are placed on both sides of the street. Outside the city, span wire is chiefly employed, with bracket arms in the narrower streets, where the steel poles are in three sections, and were supplied by Messrs. Spencer of Wednesbury. Inside the city No. 00 wire is used, and outside No. 0 B. & S. gauge. On account of the heavier traffic in the busy centre, from the municipal boundary buildings to Windmill-lane, the feeding points are a quarter of a mile apart; outside this area they are half a mile apart.

Cables.—Within the city these are to the joint specification of Mr. R. A. Chattock, city electrical engineer, and Mr. A. J. Lawson, engineer to the tramways, and were made and laid by the Callenders Cable & Construction Co. The low-tension are on the solid system, while the high tension cables carrying the supply from Smethwick to the sub-station at Springhill are three-core, paper-insulated, lead-covered cables drawn into Sykes conduits. It has been arranged between the company and the Corporation that, in the event of a supply not being required inside Birmingham from the tramways' generating station after the lapse of the tramways' lease in July, 1906, the high-tension cables should be withdrawn, and the low-tension cables, suitable for the tramway supply only, from the sub-station, are to remain. These cables were laid under the supervision of the city electrical engineer and his assistants. The cables outside Birmingham, both high and low tension, were made and laid by the British Insulated & Helsby Cables (Ltd.), Mr. Arkell being the representative of the cable manufacturers.



Plan of Power Station Showing General Arrangement of Plant, &c.

Cars.—The cars, of which some 60 are on order, are made by the Brush Electrical Engineering Co. at Loughborough, and 42 have already been delivered. Eighteen of these are fitted with standard Brush trucks and 22 with Lycett & Conaty radial trucks. The wheel base of the Brush trucks is 6ft. 6in., and of the radial trucks 8ft. 6in. The bodies are 16ft. long, and the total length between buffers is 28ft. The seating capacity is 22 inside and 26 outside. Twelve of the cars have been fitted with Bellamy top-deck covers made by Messrs. Dick, Kerr & Co., and on these cars Blackwell trolley bases are in use, but the open cars have been fitted with Brecknell, Munro & Roger's standards. On all cars Rowland's swivelling trolley heads, supplied by Messrs. Milnes, Voss & Co., are used. The life-guards are of the Brush trigger type, and to enable the guard to work efficiently folding steps are fitted to all cars. The equipment consists of Brush B1002 motors, rated at 33 B.H.P., and the controllers are of the B.T.-H. B18 type.

Power House.—For the supply of energy to the tramways, for the lighting of Smethwick, and for the supply to large works in that district and in Oldbury, a site for a generating station was secured on the canal bank, Downing-street, Smethwick, and sub-station sites at Oldbury and Springhill were selected for the company by their consulting engineer.

The buildings are constructed of steel and brickwork, the latter being of hand-picked local bricks, relieved with rubbed and gauged arches. The dimensions of the main building are as follows:—Engine room, 152ft. long by 45ft. wide, and 17ft. 6in. high. Boiler room, 152ft. long by 50ft. wide, and 40ft. high. The roof of the boiler-room and the width of the latter are only temporary, as the engineer's original design was for a building sufficiently wide to take two rows of boilers, with a central stokehold and coal storage on the floor above the pump room, from which the coal would be lowered by shoots into the hoppers on the chain-grate stokers below. This arrangement was abandoned on the score of economy, but will have to be reverted to in the event of any considerable demand for energy arising. The chimney shaft is of steel, 120ft. high, 11ft. in diameter, and stands on a concrete base 34ft. by 34ft. by 14ft. deep; it is lined with fire-brick up to 75ft.

There are also pump rooms, repair shops, engineers' offices, bath rooms, lavatories, workmen's mess rooms, stores, &c. The manager's and general offices are in a handsome detached building, and consist of entrance hall, ground floor and eight rooms, all equipped with modern conveniences. The whole of the building work has been substantially carried out by Messrs. Gowing & Ingram, contractors, of Birmingham, to plans and specifications prepared by Mr. M. H. Graham, architect, of Newcastle-on-Tyne. The same contractors carried out the builder's work in connection with the transformer sub-stations at Springhill, Birmingham, and at Oldbury, and these are also of plain hand-picked local bricks in cement mortar, but lined throughout with white and buff-coloured glazed bricks, with a dado border in chocolate

INTERIOR OF GENERATING STATION.

The steam-raising plant consists of five B. & W. water-tube boilers, each capable of evaporating 14,000lb. of water per hour. They are fitted with the same firm's chain-grate stokers and internal superheaters, the steam being superheated 150° F. The gear for working the stokers is driven by a 15 H.P. motor.

There are feed and storage tanks supplied from a well 180ft. deep by compressed-air lifts, the compressor being by the Worthington Pumping Engine Co., driven by a B.T.-H. motor. The feed-water purifying plant was supplied by the Harris Patent Feed Water Filter (Ltd.). Three feed pumps have been installed, two steam pumps being by J. & G. Weir (Ltd.), and the other a variable stroke motor-driven pump by Mather & Platt (Ltd.). There is an alternative supply from the South Staffordshire Water Co.'s mains.

Good slack coal is used as fuel, the price of which, delivered into the bunkers, is 6s. 3d. per ton.

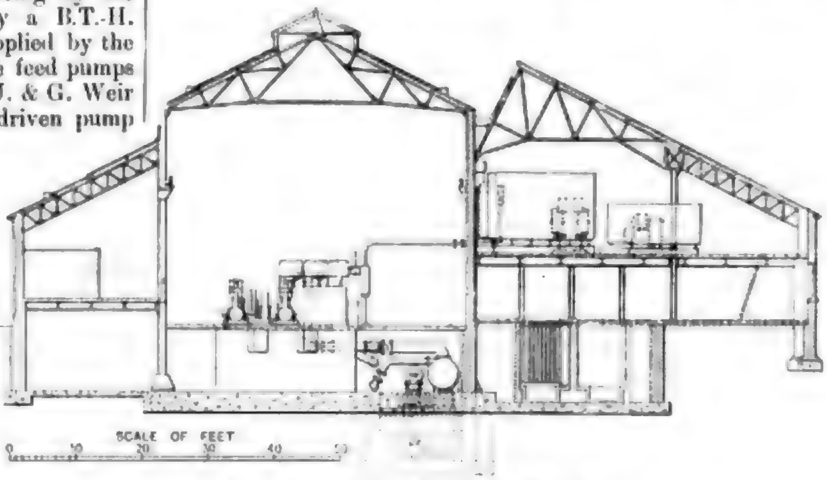
The steam and feed piping is of mild steel, supplied by Messrs. John Spencer, of Wednesbury, and was erected by the Tramways Company's staff; it is covered with blue asbestos supplied by the Cape Asbestos Co. The exhaust pipes are of cast iron, and are liberally fitted with expansion joints.

There are three 500kw. triple expansion, self-lubricating steam engines, running at a speed of 300 revs. per min., the diameter of the cylinders being 15½in., 23in, and 35in. respectively, with 15in. stroke. Three other engines are each of 300kw. capacity, three crank, compound, with one high pressure and two low-pressure cylinders, the dimensions of these being 16½in., 23in. and 23in. by 10in. stroke. All are fitted with governors of the inertia shaft type, guaranteed to control the speed within a variation of not more than 8½ per cent. from full-load to no-load. Engines and generators are specified to be capable of giving an overload of 25 per cent. for half-an hour, and 50 per cent. momentarily over and above the normal rating. The steam consumption per indicated horse-power-hour for the 500kw. sets, with 150lb. steam pressure, 100deg. superheat at the stop valve, and 26in. vacuum, was specified not to exceed 14¾lb. for the 500kw. output, 13¾lb. for 450kw., and 15lb. for 225kw.; the mechanical efficiencies of the engines under these conditions being respectively 91, 90 and 84 per cent. For the 300kw. sets the steam consumption per indicated horse-power hour, at the same pressure, vacuum and superheat as above stated, was specified not to exceed 15lb. at 300kw. output, or 16½lb. at 225kw., the mechanical efficiencies of the engine, under these conditions, being respectively 91 and 84. We understand that these conditions were satisfactorily met on test at the makers' works. These engines were built by the Brush Electrical Engineering Co. at Loughborough.

The alternators were supplied by the British Thomson-Houston Co. of Rugby, and are of the revolving-field type, each of 500kw. capacity, generating three-phase current at 25 ∾ and at 5,000 to 5,500 volts. The three 8-pole continuous-current generators are each of 300kw. nominal capacity, running at a speed of 375 revs. per min., and were made by the Brush Electrical Engineering Co. The steam exciter sets consist of two 30kw. engines coupled to direct current dynamos, and were supplied by the Brush Co., who also supplied the balancing sets for use on the three wire lighting system.

The condensing plant for the 500kw. engines is of the Weir circular type, having 3,600 sq. ft. of cooling surface, the air and circulating pumps being steam-driven. For the 300kw. engines a surface-condensing plant, having 2,260 sq. ft. of cooling surface, is supplied with motor-driven air and circulating pumps, the air pumps being of the Edwards pattern.

The switchboard is in two portions, arranged on a gallery extending the whole length of the building. The direct-current board is arranged to supply current to the tramways in the neighbourhood, and also to the three-wire electric lighting system for the town of Smethwick. It is fitted with B.T.-H. registering and Elliott's Weston type recording instruments, B.T.-H. circuit breakers, switches, &c., all of which are mounted on black slate panels. The E.H.T. board for dealing with the supply of alternating current to the sub-station is of the remote-control type, with B.T.-H. oil switches and circuit-breakers, wattmeters and measuring instruments. Kelvin indicating wattmeters are also provided. The switchboards were built by the Brush Electrical Engineering Co., at their works at Loughborough.



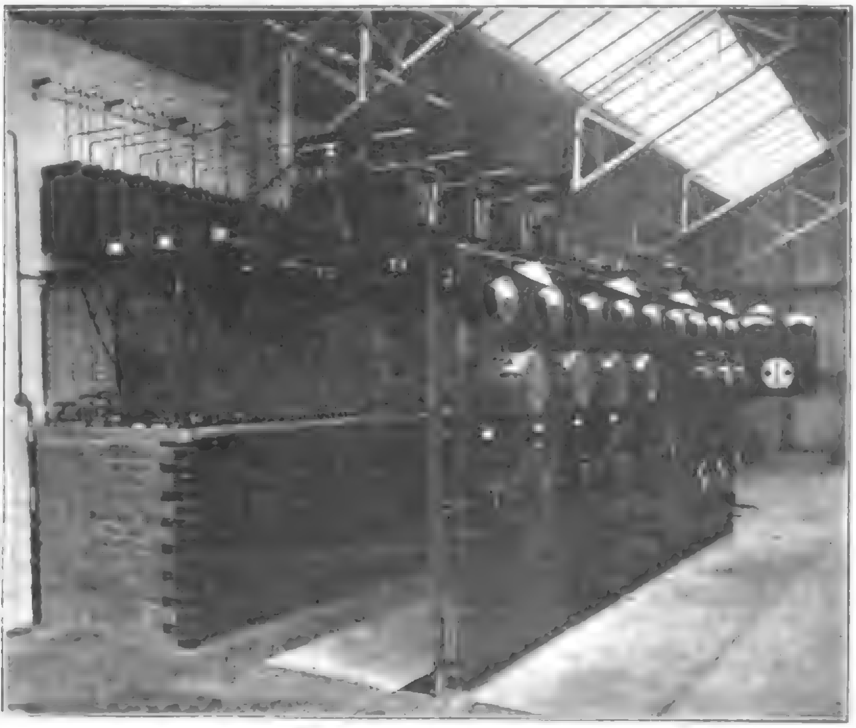
CROSS SECTION OF GENERATING STATION.

Sub-stations.—There are at present three transforming sub-stations—one at Springhill, Birmingham, to supply current to the tramways in the city district; one at Oldbury, for the Oldbury and Dudley sections; and a similar set of sub-station plant is erected in the power house at Smethwick for supplying either high and low-tension current in the Smethwick district for lighting and power purposes.

At Springhill sub-station there are three three-phase rotary converters, each of 200kw. capacity. The transformers are of the oil-cooled type, and are arranged in sets of three, each of 75kw. capacity for each rotary. The primary and secondary windings are wound for transformation from 5,500 to 340 volts, but various ratios may be obtained by connecting to intermediate taps on the primaries to compensate for drop on the feeders.

All the high-tension switch gear is of the oil-break remote control type, each switch being in a fireproof chamber. The main current entering the sub-station passes first through the high-tension feeder panels, then through the high-tension machine panels to the high-tension side of the transformers. The secondaries of the transformers are connected to a double throw-over switch, so that the rotary converter is started at half voltage; when the machine attains full speed the full voltage is put on to it by throwing over the switch.

From the continuous-current side of the rotary converter cables are carried on rack insulators in a subway under the machines to the direct current switchboard. The machine switchboard panels for the direct current side are fitted with wattmeters, ammeters and circuit breakers of the British Thomson-Houston magnetic blow-out type. The machine panels on the alternating-current side are each fitted with an ammeter and a power-factor indicator. The sub-station at Oldbury is of similar design, but is equipped with three rotary converters, each of 100kw. capacity. At the Smethwick Central Power Station there are also installed two 300kw. rotary converters, each with three 110kw. transformers, and equipped with a similar type of switch gear as at Springhill and Oldbury. There is also a small rotary converter sub-station at the West Smethwick car depot, for supplying current to the car shed, repair shops, &c.



View of H.-T. Switchboard.

All the plant and material for the sub-station equipment was supplied and erected by the British Thomson-Houston Co. (whom we have to thank for the photographs illustrating this article), Mr. J. T. H. Legge acting as their resident engineer.

The whole of this installation has been carried out to the plans and specifications, and under the supervision, of Mr. A. J. Lawson, the consulting engineer to the Birmingham & Midland Tramways (Ltd.), Mr. R. F. Browne was the resident electrical engineer for the company for all the electrical work, with Mr. A. Bocchi-Bianchi as his assistant. Mr. S. A. Mahood is the company's engineer in charge of the Smethwick power station, the sub-stations and the distributing system.

View of Sub-Station.

MASS ANALYSES OF MUNTZ'S METAL BY ELECTROLYSIS.*

BY JOHN G. A. RHODIN.

Towards the end of 1903 the author was asked by the Muntz's Metal Co. (Ltd.) to devise a method of accurately determining the copper contents of Muntz's metal at such a speed as to enable the management to utilise the results in the ordinary course of manufacture. The difficulties were many—viz., the large number of analyses required, the extreme accuracy necessary, the necessity of working during the night as well as during the day, and finally the *conditio sine qua non* that the results must be obtained within 12 hours of the time of casting. In the ordinary course of events 40 to 60 "heats" of metal are cast every 24 hours at the company's works. With regard to the accuracy the limits of useful copper contents are from 60·0 per cent. copper to 62 per cent., and within these limits there are four classes of metal behaving differently as to rolling temperature. Towards these limits the metal is extremely sensitive to over-heating in the one case and to under-heating in the other. A metal containing 62·0 per cent. of copper can be rolled at an elevated temperature; one containing 62·25 per cent would not stand the ordinary treatment at all. Hence we must have a mean probable error of not more than ± 0·1 per cent. On the other hand, metal with less than 60 per cent. of copper behaves towards sea water in a way which is highly undesirable. It is characterised by preferential dissolution of zinc, which occurs very rapidly.

In developing the electrolytic method of analysis I had an absolutely free hand, and I am greatly obliged to the directors of Muntz's Metal Co. (Ltd.) for putting no restriction in my way as to cost of plant, &c., which, as will be seen later on, was fairly considerable.

The Electrodes.—As I had to deal with unusual current densities I decided to increase both the anode and cathode surfaces to the utmost limit compatible with moderate weight. For this reason I chose a very fine platinum wire gauze as the material. The gauze was made from No. 36 B.W.G. hard platinum wire, 90 meshes to the inch. To support this delicate fabric a framework of stout platinum wire was designed in the case of the cathode. This framework also makes the current distribution even. Fig. 1 represents a pair of electrodes, *a* is a cathode and *b* an anode. The cathode is very much the same as an ordinary gauze cathode with the exception of the above-mentioned framework. The anode, however, differs from most constructions by having a cylindrical part of extensive surface which, when in use, is concentric with the cathode. The pole wire of the anode is fastened to the bottom ring at *c*. This way of connecting electrolytic conbinations serves two purposes. By having the two points of maximum P.D. at the upper and at the lower end of each of two concentric electrodes it may be assumed that the current distribution will be very even, as when such an arrangement is used the P.D. between any two radically opposed points in any horizontal section is theoretically and practically everywhere the same. Secondly, the arrangement offers no obstacle to the rapid removal of the cathode. I have, in fact, resorted to the plan employed for many years by the E.P.S. Co. in coupling accumulator plates. Thirty pairs of electrodes are at present in use in our laboratory, all being of this type. They were made by Messrs. Johnson & Matthey. Fig. 2 shows a couple of these electrodes in use. I always utilise as a containing vessel the same kind of beaker—viz., 500 cubic cm. Jena beakers. They are stouter and stronger than ordinary Bohemian glass beakers, besides being less affected by changes of temperature. The electrode holders are ordinary Classen stands, but modified. To force the operators to place the beakers neatly, and to avoid accidental short-circuits, the table is provided with turned wooden cups (*a*), which are firmly screwed down. The stands are also screwed down to avoid accidents, which might occur from the simple reason that no less than 25 pairs of electrodes are worked on a table 15ft. 6in. long. To cover the beakers, I use stout watch-glasses, provided with a radial slot. Ordinary watch-glasses treated in this way are too delicate and fragile, hence I have lately resorted to watch-glasses 4mm. thick. There is no disadvantage connected with this plan, as heating of the electrolyte is unnecessary.

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* From a Paper, entitled "Mass Analyses of Muntz's Metal by Electrolysis and some Notes on the Electrolytic Properties of this Alloy," read before the Faraday Society on Jan 30.

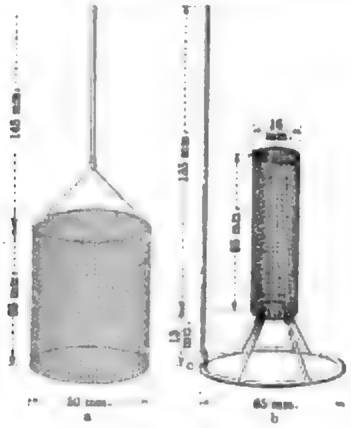

FIG. 1.

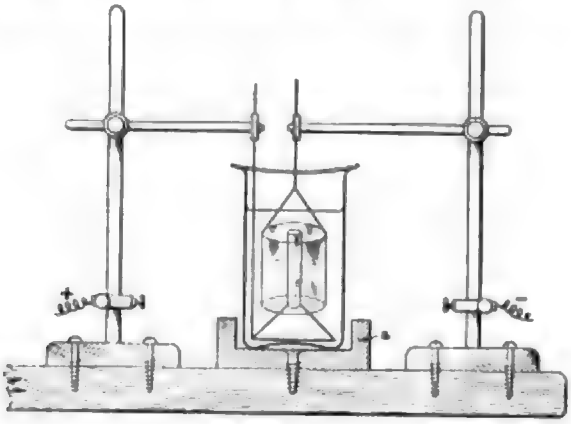

FIG. 2.

The Electrical Arrangements.—I have tried to arrange matters in conformity with the best accumulator practice. To accomplish this, use has been made of a fair number of cells, which are always charged in series and discharged in independent couples of two cells in series. The plant consists of six pairs of the Chloride Company's RP$_9$ cells in lead-lined wood boxes, each pair supplying current to five pairs of electrodes. Fig. 3 is a diagram of the connections of two sets of five pairs of electrodes, *a* and *c*. In each one of the secondary branches there is a resistance R_1, R_2, &c. These resistances can be shunted at S_1, S_2, S_3, &c. All the resistances are made from No. 20 nickelin wire, stretched on porcelain bobbins in front of the table. I might mention that the accumulators are charged from the light mains, and independently of the discharge, as may be seen from the scheme of connections.

Analysis of Muntz's Metal.—The process is the simplest one possible. One gramme of the alloy is dissolved in 20 cubic cm. nitric acid, 1·2 specific gravity, and the solution is heated on a sand bath till the red fumes disappear; 300 cubic cm. of distilled water are afterwards added, and the beaker is put in its place on the electrolytic table. The electrodes are put in, and electrolysis is proceeded with. Two current densities are employed—viz., 0·5 ampere or 2·0 amperes, for the electrodes as described. With the low current-density all the copper is deposited after 12 to 15 hours; this is confirmed by taking out a sample and testing it with H_2S water. The cathode is then taken off very swiftly, and it is immediately plunged into a large beaker containing distilled water. After washing it carefully, it is dipped into absolute alcohol and dried in a steam oven, and eventually it is cooled in the open air and weighed. The high current-density is obtained by shunting the resistances at S. The time necessary for complete deposition of the copper in this case *is only three hours, and the deposit obtained is perfectly adherent to the cathode.* In other respects the operations are similar. The theoretical loss, which must occur when the cathode is taken out in the manner described, was carefully investigated, and found to be of so small a magnitude as to be negligible. That the copper is fully deposited is patent from the fact that the remaining solution gives no reaction for copper with any known reagent. As a matter of fact, we may distinguish between three distinct phases of the reaction: (1) Copper deposition and ammoniacal reduction of nitric acid; (2) ammoniacal reduction *per se*; (3) deposition of zinc in some form or another. Phase 2 occupies a considerable time, and during that time the removal of the cathode takes place. It has very often been stated that the deposition of copper in the presence of zinc is incomplete, and many theoretical considerations would lend support to this statement. I think, however, that in the case under consideration, where the overlapping phase 2 occupies a long time, and is unaccompanied by *metal deposition*, a perfect separation is theoretically possible. That it is so practically is demonstrated by our daily work. Some metals do interfere with the accuracy of electrolytic copper determinations in nitric acid solutions, amongst others arsenic and nickel. When analysing arsenical copper I find that perfectly accurate results are obtained, if the arsenic be removed by means of metallic zinc in dilute nitric acid solutions before the electrolysis takes place. If this be omitted, the results are invariably high. Nickel will deposit with copper to some extent, especially if the alloy contains phosphorus, and in that case chemical separations must be resorted to as an initial step; but even then I prefer to weigh both copper and nickel as metallic deposits for the sake of accuracy.

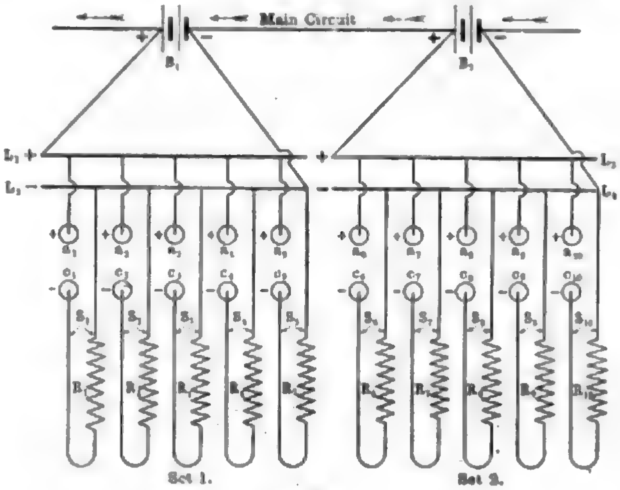

FIG. 3.

The usual run of work during 24 hours may be said to be as follows:—At 8:30 a.m. the two men, who do day work with 25 pairs of electrodes, find 25 analyses going. They test them, wash down the cover glasses, &c. At 9 a.m. one man takes out the cathodes, and the other one drills the morning's samples by means of a self-feeding American hand-drilling machine. He afterwards assists in taking in cathodes to be weighed by the first man. The weighing operations are finished by 10 a.m., and the results are immediately calculated on a Fuller's slide rule and entered in the firm's books. At 10:30 a.m. the analysis results are compared with the results of the rolling tests in the mill. Whenever there is a discrepancy orders are issued to hold the heat of metal back for analysis. In the meantime the cathodes are stripped by putting them altogether in a large accumulator box full of nitric acid. They are afterwards washed, ignited and weighed ready for the next samples. By proper scheming the fresh lot of samples is ready for electrolysis at noon, when another lot of samples arrives. These are drilled, weighed in and dissolved before the electrolysis of the morning's samples is at an end—viz., at 3:30 p.m. The cathodes are again washed, dried and weighed, and the results are again compared with the mill tests at 5 p.m., and orders issued for eventual re-sampling, &c. The noon samples have in the meantime been put *in situ*, the cathodes stripped and weighed, and the electrolysis can be started at 5:30 p.m., when the day men leave. As a general rule, only one man works during the night, taking off the noon samples and putting on those which arrive at 5:30, which he leaves with the low current to be taken off next morning at 8:30. The 5:30 samples and the noon samples are reported upon together in the morning. In this way 75 samples are handled in 24 hours, and the results are, on the average, only 12 hours behind the casters. Should an unusual pressure of work come on, we can manage 100 by putting one of the senior assistants to help the night man. Five more pairs of electrodes are worked on another table in connection with the more exhaustive metal analyses, which frequently occur.

As mentioned above, a number of re-analyses occur in our work. They are never done by analysing part of the original test-piece, but by drilling one of the "strips" represented by this test-piece and analysing the drillings. In this way the differences include, besides the inherent analysis errors, the error due to possible lack of uniformity of the metal. The differences are extremely small, only a fraction of 1 per cent.

In 100 consecutive repetitions, taken at random from the analysis book, the maximum difference was 0·29 per cent., the minimum difference ±0, and the average 0·1048 per cent. The probable difference or error is ±0·0706 per cent.

From this we may conclude that the mixing of the separate heats of brass is incredibly uniform, and that the electrolytic method yields most reliable results. There is, of course, a permanent error—viz., the results obtained are always too low to a very slight extent, probably <0·05 per cent. This is in our case an advantage, as no mistake is likely to occur in the rolling test when the copper percentages are too high, whereas mistakes are very common at the lower limit. I have known cases where a whole series of rolling tests passed low percentage metal into the mill, and vice versa, it frequently happens that perfectly good metal does not pass the rolling test.

We aim at producing metal containing from 60·50 to 61·50 per cent. of copper—the outside limits being respectively 60 and 62 per cent., and I may add that in June and July, 1904, for instance, the most desirable composition was obtained in over 80 per cent. of the cases, whereas the metal which had to be re-melted was less than 2 per cent. of the whole. This result is eminently satisfactory.

Muntz's metal was originally, and is now to a great extent, employed as sheathing for the protection of woodwork against the action of certain mollusca and algæ which breed in the sea. To be successful it must dissolve in sea water by electrolytic action to a sufficient extent to render the surface poisonous, but sufficiently slowly to make its use economical. The optimum must occur when the two constituents, copper and zinc, dissolve at exactly the same rates in which they occur in the alloy, during as great a part of the life of the plate as possible. By this means only the metal will remain of similar composition throughout its life, or the greater part thereof. Since the electric constants for most metals are only known approximately, it is not possible to compute accurately the best proportions of copper and zinc, but by a very good approximate calculation we arrive at the figures, 60·811 per cent. of copper and 39·189 per cent. of zinc. This agrees fully with practical experience. It has also been observed that for tropical waters, which contain less oxygen and more reducing organic matter, thus favouring the cuprous reaction, a higher percentage of copper than from 60·80 to 61·25 is necessary, whereas for temperate and Arctic waters a less rich alloy stands very well.

Prof. **HUNTINGTON** asked whether the author had considered the question of the best composition of Muntz's metal from the point of view of the constituents of the alloy, and of the critical points of the various combinations formed. He drew attention to the work of Mr. E. S. Shepherd on this subject, and showed the curves he had obtained in his study of the copper-zinc series. What determined whether the alloy would roll hot or not, appeared to be the presence of the compound Cu_2Zn.

Mr. **W. R. COOPER** thought there was some difficulty in the view that the dissolving action referred to by Mr. Rhodin was galvanic. If that were the case, he did not see how both metals could be affected.

Mr. **A. STEVENSON** referred to the question of the deposition of bright copper in the presence of colloids.

Mr. **RHODIN**, in reply, dealt in detail with the point raised by Mr. Stevenson, which he himself had first investigated in conjunction with Sir Joseph Swan. Replying to Prof. Huntington, he said that it was certain impurities which determined whether a Muntz alloy would roll hot. An alloy containing 70 per cent. copper could be rolled if these impurities were not present.

PATTERN MAKING.*

BY R. WATSON.

Twenty or thirty years ago pattern making and mill wrighting were considered joint branches of engineering, but gradually as competition and more complicated work came along, it was found that a man, to become thoroughly efficient, must devote his whole time to one branch. This subdivision has again taken place in the pattern shop of recent years. Iron pattern making has become quite a separate section. This includes the fitting up of iron patterns, turnover plates, and all stripping plates, &c., required for moulding machines. Again, where moulding machines are used men are kept on the special patterns that are required for them until they become quite experts at this class of work.

It is not the writer's intention to deal with these special kinds of patterns; each is important enough in itself to form a separate Paper, but to confine himself to his actual experience of wood patterns. It may be well to consider the material used in pattern making. Timber merchants have at various times advised several different kinds of wood, such as kauri pine, American white wood, teak and jarrah, &c., but experience has proved that they are not as suitable for pattern construction as Canadian pine and the mild straight-grained mahogany of Tabasco and Belize. Timber for standard patterns should be carefully selected, as there is a considerable variation in the quality of yellow pine. It is not unusual to find a shipment of pine altogether unsuitable for pattern making. It may be free from shakes and knots but has the defect of being hard in places, which is known to the pattern maker as being "strong." Timber of this kind has a great tendency to twist and warp, and if worked up into patterns proves costly in repairs, as it will not keep its shape so well as the milder quality. Yellow pine planks should be at least three years old. Weather-seasoned wood invariably works better than that artificially dried. Where large standard patterns are made it is advisable to have good stocks in hand of various thicknesses of a first quality; also a second quality, which may be used for temporary patterns, loam-boards, &c. Experience shows that this tends to great economy. It should be carefully stacked and stored so that it is kept out of the sun and rain, allowance being made for free passage of air between each plank.

The circular saw, band saw, planing machine, thickness planer, and lathes are indispensable tools. The hand trimmer might also be classed amongst them, for it considerably cheapens the production of patterns, especially of that class which are built up in segments. The introduction of pneumatic tools into the pattern shop is amongst the latest labour-saving devices. Portable drills and chipping hammers are finding a useful place on large work; they have this advantage, that they can be brought right on the work during the different stages of construction when it would be impossible to move the work to the different machines. Chipping hammers fitted with a gouge tool are very handy for removing surplus wood to form curved surfaces in patterns and core boxes, doing the work from four to six times faster than is possible with hand tools. Pneumatic drills almost dispense with the pattern maker's brace and bit and perform the work very rapidly and with considerably less labour to the man. In large pattern shops where standard patterns are made machines such as "The Moore" carving machine and "Wadkins" mechanical wood worker can be kept profitably employed in core-box making, recessing to different levels, and in the many different operations which are performed in the making of complicated patterns these can be done more accurately and quicker than by hand.

It is in the pattern shop that the engineer and draughtsman first see the actual thing which they have designed. Many views and sections may be given, but there still remain points which have to be left to the judgment of the pattern maker, such as the development of curves, rounded edges, fillets, &c., all of which go to make the symmetry of the whole. Upon receiving a drawing in the pattern shop, if the work is at all complicated, it is set out full size, but in some cases sections only that are required for the construction of the pattern and arrangement of cores. Machining allowances are shown. All the setting out is done to a contraction rule, so that any dimension which may be taken is the pattern size.

In some works the foreman or leading hand sets the work out. The writer prefers that each pattern maker should set out his own work, as by so doing he makes himself familiar with all the details.

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* Paper read before the Rugby Engineering Society on Jan. 5.

He is then in a position to discuss the construction of the pattern, method of moulding, and arrangement of cores. It is usual for the principal dimensions to be checked by the foreman. The first thing that has to be determined is the best way of moulding, and if it is likely to be a permanent or temporary pattern. The chief things that govern the moulding are the principal machined surfaces; these are placed in the bottom of the mould to ensure them being clean and free from defects. If it has to be machined all over, or top and bottom, extra machining should be allowed on the top side. This should be plainly marked on the pattern before being sent into the foundry by different coloured paint or written instructions. Another point to be settled is the readiest way in which the cores can be put in the mould. In some cases it is almost impossible to fulfil the foregoing conditions and to get the cores in the mould in such a manner that the moulder can make provision for getting the air or gases out of the cores.

Patterns should in all cases where possible be parted and dowelled together on the joint line of the mould, as in the case of a cylinder through the centre line of the circle, so that when the top part of the moulding box is lifted off, the portion of the pattern covered by it is taken with it. Then the moulder can loosen each part separately and see what he is doing in drawing the pattern from the mould. It is advisable to lift the pattern from the mould rather than the mould from the pattern. If the moulding box has to be lifted off, leaving the pattern behind, it often results in some portion of the mould breaking down, which sometimes costs a large amount of time to repair. Then it is not true to pattern and very often gives a badly shaped casting due to the patching up of the mould.

Loose pieces, such as bosses and facings, although objectionable, cannot in all cases be avoided. On permanent patterns these should be fixed on by a dovetail. On temporary patterns a screw or wire pin will do, providing the position of the piece is well scribed round on the body of the pattern. Where several pieces have to be loose near each other, it is as well to leave one large piece of the pattern loose containing them all, providing there is sufficient room in the mould to allow this being drawn in. Another method of getting over the difficulty of several loose pieces is to put them all together in a core. The objection to this is that in dry sand work it often leaves a mark on the casting if the core cannot be put in green and dried with the mould.

In constructing large patterns wide pieces of timber should be avoided because of the shrinkage and expansion. Frames made of narrow pieces and half lapped together at the corners can often be used with advantage. These are stronger and retain their shape better than large flat pieces. There is also a considerable saving of timber by this method. Patterns made of dry timber will expand when left in the mould for any length of time and contract when stored away. In boarding up large surfaces, open joints, say, ¼in. between each joint, should be left. All screw-holes should be bored larger than the diameter of the screw to allow free movement when the boards expand or contract. Where possible the grain of the wood should run in the direction that the pattern is going to be drawn from the mould. As little end grain as possible should be left exposed to the sand. If it cannot be avoided it should be placed so that it is the first portion of the pattern which leaves the mould when it is drawn out. If it is in the bottom of the mould the other way of the grain will shrink and leave the end grain projecting, which will pull a part of the mould up when the pattern is drawn out. This is often the cause of the moulder having to do a considerable amount of sleaking to the mould.

In large patterns, such as bedplates, &c., good provision should be made for rapping and lifting, as it adds considerably to the life of the pattern. In the joint or side of the pattern from which it is going to be lifted from the mould, stout timbers should be put in to receive rapping plates, connected to the bottom of the pattern by struts or stays. Lifting bolts or straps should go through the body of the pattern. In cases where bolts are used there should be a plate let in level with the bottom of the pattern and screwed to receive the bolt. Where this system is practised it is usual to have all lifting plates screwed one size, then one bolt will do service for several patterns. The screwed end of the bolt should be well tapered off to give it a lead into the bottom plate. The top end should have an eye at least 2in. in diameter, so that it will receive the hooks which are in general use around this class of work in the foundry. There is a certain amount of suction in lifting a pattern from the mould in addition to the weight of the pattern itself. Then there is the question of taking the pattern backwards and forwards to the pattern stores. If lifting irons can be relied upon, it is better to lift by them than by rope or chain slings, for these generally leave their mark on the pattern. In fact, heavy standard patterns are often more damaged in lifting about than in actual use in the foundry.

The question of taper is often a very debatable subject between the pattern maker and moulder. It is seldom the moulder complains of there being too much, but excess of taper often means more machinery than is necessary. There is no standard rule, each piece of work requires separate consideration. In most cases ⅛in. to the foot is found to be sufficient. On castings that have not to be machined it is customary to make the given dimensions half-way down the pattern, so that the pattern at the top of the mould is over the size and at the bottom under the size. If taper were shown on the drawings, on deep surfaces that have to lift vertically from the mould, it would save an amount of time in fitting brackets, &c., on what are supposed to be vertical faces. The brackets would then be designed to suit the taper. On the inside of ribs and brackets, where size is of little consequence, more than ⅛in. to the foot may given, providing it does not look unsightly or add much to the weight.

In complicated patterns sometimes pieces are left so that the moulder has to lift a part of the mould away before he can draw the pattern out, or, in other words, make a "drawback." This is an expensive method to the foundry. It can often be overcome by a core print being put on the pattern and a box made to suit. It incurs extra cost in making the pattern; still this fact should not be lost sight of, that it only has to be done once in the pattern shop, but every time a casting is made off the pattern in the foundry. If this extra cost is divided by the number of castings required, it will be readily seen that the "print and core box" is often the cheaper method to produce the casting; for this should be the aim of the combined efforts of both pattern maker and moulder. Where the core method is used great care must be taken that the piece which forms the part of the core matches the mould: if it is possible this piece should be worked on the pattern in its place, then taken off and put into the core box. This will ensure getting a good joint and only a very slight mark on the casting.

Prints that lift vertically should have more taper than other parts of the pattern. In no case should the taper be less than ⅛in. to the inch. The size of the core is the size of the print near the pattern. In prints where the core comes through the top moulding box for convenience of centring or releasing the core, &c., the size of the print is still kept the right size near the pattern, but tapered larger to give clearance for passing the core down, as shown in Fig. 1. No two prints on a pattern should be the same size, or nearly the same size, or probably the mould will be cored up wrong. In prints that mould horizontally the root should have a slight champher on it, as shown in Fig. 2, as the edge of the mould breaking down when the core is put in. If this is not done the moulder generally takes it off with his trowel each time he makes a mould.

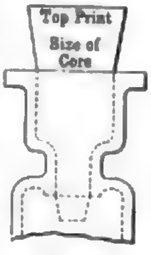

FIG. 1.

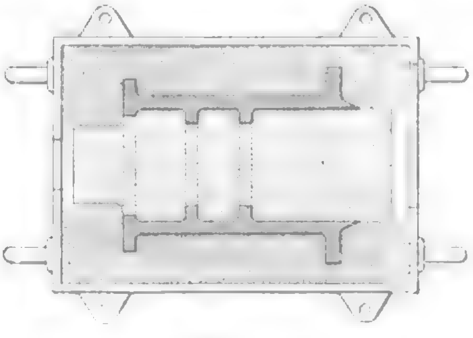

FIG. 2.

Cores are often more difficult than the outside of the pattern; it often takes considerable time to arrange them so that they may be put in the mould in the readiest possible way. Circular core boxes are generally dowelled together on the centre line for convenience of ramming up and getting the core out of the box. Intricate boxes often have to be made in several parts; where any doubt exists as to the best way of making it, the core maker should be consulted as to the handiest way for him to arrange for his core irons and vent passages. Large sized boxes should be made so that they can be taken to pieces, and the corners rabbeted together so as to ensure them being put together in the same place, and not trusting entirely to the screws going in the same holes. In boxes for standard work wood screws should not be used, as the constant taking them in and out wears the holes, and the core is made larger than required. Bolts should be used for screwing the boxes together with suitable shaped handles or wing nuts. These are more quickly released than wood screws and soon save the extra cost. In no case should the ordinary hexagon nut be used, as the time that should be saved is lost in hunting for a spanner of the right size.

In large cores allowance has to be made for the expansion of them in drying, $\frac{1}{16}$in. to the foot is found sufficient if the cores are dried at the usual rate. This point (which is not recognised by some pattern makers and moulders) is often the cause of considerable delay due to the time taking in rubbing the cores down to give the required thickness of metal. After the core has been dried the best test is to try and place it in the box in which it has been made. It is accounted for by the core iron expanding while the core is being dried, and pushing the sand out with it. The core iron contracts in cooling, but the sand on the outside of the iron is baked hard and does not move back with it.

Large cores should where possible be made the same way up as they are to be put into the mould, for convenience of getting at the iron to lift them by when fixing.

Where cores have to bore out to exact centres in relation to each other, as in the case of motor cylinders, where two or three boxes are in the same casting, these should be made in one core box tied together by continuous prints at both ends as shown in Fig. 3. This admits of a good stiff core iron which can readily be broken without any risk of breaking the casting. It is a quick method of coring up, as all the bore cores are put in at one operation, as well as keeping their centres exact, at the same time simplying the moulding of the pattern.

Where diaphragms, valve facings, &c., on the inside of the casting, have to be put in a particular position in relation to the outside of the casting, a key must be put on the core and its print. This should be put on the joint of the mould where it can be seen when coring up. It is often found useful to make the print on the pattern smaller than the required size of the core, so as to form a shoulder on the core, as shown in Fig. 2. The core can then be put up to the end of the mould, this will give it a definite position lengthways independent of the ends of the print, from which the moulder often finds it convenient to cut the sand away. This shoulder should be made in proportion to the size of the core, it must not be less than ⅜in., increasing up to $1\frac{1}{2}$in. in large cores. If it is made too small it will get a thick coat of blacking and do more harm than good. In small cores where great accuracy is required and where the metal is very thin the core should be made about $\frac{1}{32}$in. smaller in size than is required, to allow for blacking, and care must be taken that the cores fit their prints, for when once rubbing is commenced on the core no two castings will be identical. In this class of work the first casting that is made off a pattern should be cut up to see that all parts are of the required thickness.

Core boxes that are made to suit taper prints should be the exact size at the point where the casting commences, but should be slightly less than the top of the print, this will ensure them going in easily and tightening themselves when they are down in their right position. Core boards that are to be used for cores of which large quantities are likely to be required should have a thin sheet of iron on the striking edge, filed to the exact shape of the board, on the top side two strips of iron should be screwed on, giving the exact size of the prints into which the core is to fit, otherwise after a few cores have been made the board gets worn and often gives considerable trouble both to the moulder and machinist.

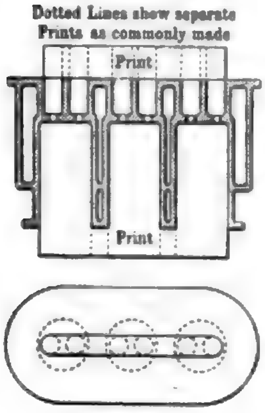

Fig. 3.

Large work, such as condensers, flywheels, pipes, &c., are usually swept up in loam, very little pattern making being required, as loam boards are used to make both the inside and outside, all projections having to be built in the mould. Work of this type is usually cast upon end. These do not contract the ordinary amount, $\frac{1}{200}$in. to the foot is found to be sufficient to allow in this class of work. Loam work as a rule takes more time in the foundry than when a pattern is used. No doubt it is the correct method to follow when two or three castings only are required, but when this amount is exceeded the cost of a light skeleton pattern, against the extra time each casting will take to make, should be considered. A case of this kind was given in the *American Foundry Journal* some time ago, where an American company had six sets of large engine castings to make, the first one or two of each of the larger pieces were struck up. Afterwards it was decided to make patterns and moulding boxes to suit. In finishing the remainder it was found to be both cheaper and quicker and the castings better to shape. This question is often settled by the tackle that exists in the foundry, for plates, binders, &c., required for loam work are expensive items. Another way of handling work of which only one or two castings are required is to make the outside in cores. This can often be done very economically, for one or two core-box shells with different internal fittings may be made to do duty for all the cores required. This method cuts the pattern making down to a minimum. In large work of this class especially, the pattern maker and moulder should try to avoid getting into set grooves of working, for the method has yet to be found that is economical and suitable for all work.

Light castings, such as covers, caps, cone pulleys, &c., may be made so that the core takes the place of the top moulding box and is self-centring, as shown in Fig. 4. This core must be at least $1\frac{1}{2}$in. thick and 1in. larger all round than the casting, so that it will bear sufficient weight being placed on it to withstand the lift while the mould is being poured. The print should have a large taper; this makes it simpler both for moulding and coring up. It is important in this method of work that the core fits its print, and that no blacking is put on that portion of the core which goes into the print. Patterns of this description, if they are circular, should be built up in segments, or framed up if square.

All circular work on standard patterns larger than about 10in. diameter should be built up in segments; it has the advantages of being stronger, does not shrink or expand, and retains its shape better than when cut out of the solid wood. The "trimming machines" now used in most pattern shops have cheapened this class of work. Built up work often can be made to leave its own core with advantage, and so save the time and material that would otherwise be spent in making a core box. The writer does not recommend building up flanges, &c., in less than three courses; in fact, two courses are very little better than when cut out of the solid. In pipes, cylinders, &c., "lagging up" is resorted to when the diameter of the work is large, partly to economise material and to secure a form which will be least affected by the distorting influence of shrinkage and expansion. Lags are usually made from 8in. to 5in. wide and the number that go to make up a diameter is determined by the size which can be cut most economically out of the width of a plank. In large diameters the rings on which the lags are fixed are built up in segments; this makes a very light but rigid pattern. This method of lagging up is not confined to circular work only, but is used on curves wherever a radial line can be fixed. There is often a difference of opinion as regards the right amount of contraction to allow on special large work, but the writer thinks that most people are fairly well agreed that for general castings 1 in 120 is found to give the most reliable results and most pattern-makers' rules are now made to this allowance. Steel and malleable iron of different makers often vary much in the contraction. In large size castings in these metals the safest way is to ask the founder what contraction should be allowed; on small work the following data can generally be relied upon:—General iron $\frac{1}{120}$; loam work cast vertically $\frac{1}{200}$; brass $\frac{1}{80}$; phosphor bronze $\frac{1}{100}$; steel $\frac{1}{48}$; aluminium $\frac{1}{71}$; malleable iron $\frac{1}{41}$; lead $\frac{1}{48}$.

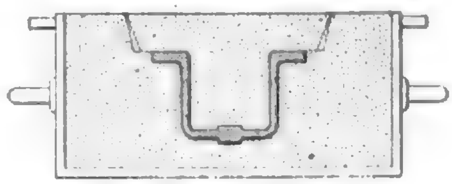

Fig. 4.

Painting and Varnishing of Patterns.—Various opinions are held by pattern makers on this subject, but all agree that patterns, except those of the most temporary kind, should be painted or varnished, as it preserves the pattern and fills up the grain of the wood, so that the sand does not cling to it when the pattern is being withdrawn from the mould. One good method that is practised by some of the larger firms is to paint "black" parts that are not to be machined, "yellow" parts that are machined, and "red" for prints and parts where the core cuts through the metal. In parted patterns the section is painted in the joint. This method enables the moulder to see at once what parts are going to be machined. It also shows him the arrangement of the cores and the thickness of metal, so that he can see where to cut the runner gates to the best advantage, without having to correspond the core boxes with the pattern; thus saving the time which would be taken in doing so. It also assists the pattern storekeeper in getting out the different core boxes belonging to a pattern without having to refer to his book or getting the tracing to see how many core boxes are required.

Upon finishing a pattern all centre lines should be cut in deeply with a scriber, this makes it much quicker to check the pattern, and also to make any alterations to it, as most of the principal dimensions are given from the centre lines.

Makers of different kinds of machinery have a system of marking their patterns best suited to their own class of work. Standard patterns generally have the marks cast on in raised letters or figures; this mark should also be stamped plainly on the pattern, core boxes, and all loose pieces that are used with it. A method that is now being employed for small patterns is to have the "pattern mark" stamped on a strip of aluminium by an automatic machine, this gives a fairly good mark on the casting if a little extra care is taken by the moulder.

In conclusion, it may be well to add that in making patterns they must not be considered as finished articles, but as means which are employed to produce castings. With this aim in view the work should be so distributed between the pattern shop and foundry that upon receipt of an order for castings it will result in their delivery with economical despatch.

The author wishes to thank Mr. C. Morehead for valuable help given in the preparation of this Paper.

FUEL ECONOMY IN STEAM POWER PLANTS.*

BY WILLIAM H. BOOTH AND JOHN B. C. KERSHAW, F.I.C.

(Continued from page 628).

Radiation and Air Leakage.—Loss of heat by radiation has long been recognised, and it will suffice here merely to indicate its reduction to a minimum by careful covering.

Loss by infiltration of air has only lately been generally recognised as a serious matter. It was possibly first pointed out as serious by one of the authors over 20 years ago, and was ridiculed as hair-splitting. It is serious as a direct loss, as a reducer of temperature head in the external flues and in the economiser, and as a reducer of draught by cooling and choking the chimney. Glazed brickwork—recommended by the authors many years ago—might often be better employed to case in boilers than to decorate engine rooms. In the absence of glazed brick, all boiler-casing walls should be of hard pressed brick in cement, or the walls should be thickly painted until air-proof, or covered in thin sheet metal all the way to the chimney. Heat insulation of pipes depends for its effect upon the entrapping of films of air by some poor-conducting cellular or laminated material. Animal wool is probably the best heat insulator could it withstand modern temperatures. Of the many coverings sold, any maker can produce figures of test which prove his particular material to be the best, if gauged per unit of thickness, or by price, or upon some other basis. All of them are better than bare pipes. Pipe flanges must be afforded equal protection with pipe bodies, and heat insulation is of sufficient importance to warrant careful attention.

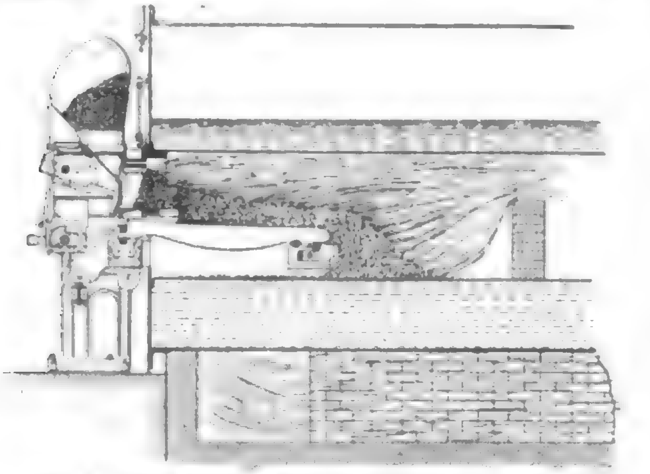

FIG. 4.—Vicars Stoker, with short grate and gas producer pit.

Stoking.—Few men can properly stoke a furnace so long as 6ft. The chief thing to aim at in stoking is even thickness, careful filling of hollow places, and complete covering of the bars, often so neglected at the front corners near the door. More steam can usually be made on the spreading than on the coking system; but in the spreading system either one side only should be fired at once, or one-half of the length, so that the excess of air through half the grate may mix hot with the gases from the other half. Bituminous coal does not burn, except as a gas, until about a third of its weight has been gasified. When stoked it chills the fire much more than would happen with so many cold stones, and the remarkable deadening of the fire is not due to this slight cause, for only about 11,000 heat units are employed in raising a charge of ⅓cwt. to 1,000 F. of temperature, or say ¾lb. of coal. The cooling is due chiefly to absorption of latent heat by the production of gas. A piece of coal is obviously carbon plus some solid variety or varieties of hydrocarbon unknown to the chemist, with a mean proximate empirical formula C_7H_5. Chemists only know the various heat distillates, and, as in all operations involving change of state from solid to liquid, and liquid to gaseous, the change of solid coal into gaseous compounds demands heat. In burning bituminous coal on a grate, much of the calorific capacity of the fuel is absorbed as latent heat by the newly-distilled gas, which renders it up again when burned later. Coke or anthracite, producing little or no gas, burns at or near the grate, and produces a clear bright fire. Bituminous coal cannot be thus burned. It must have time, and space, and temperature, and the least time and space are demanded when the temperature is highest.

Mechanical stoking cannot abolish these facts, nor can it possibly be a panacea for the smoke evil. Mechanical stoking does permit the use of inferior or rather smaller coal, and it tends to render more uniform the régime of the furnace. It does not render grate cleaning unnecessary, and it is not, therefore, a perfectly continuous process with the ordinary moving bars. In a coking stoker which feeds fuel to one end of a grate, the action as regards smoke production and burning is perfect, for the coked fuel tumbles into a pit behind the grate and burns out there as in a gas producer. The grate is short, and the coal never burns very thin upon the bars in such a stoker as the Vicars (Fig. 4) which aims to keep down air excess by this means. In the chain grate without a back pit, the fuel burns out on the grate, and large volumes of excess air get in at the back end. This renders economy impossible, unless means are taken to regulate the admission of air to different sections of the grate in accordance with the demands of the fuel. Air admission above the fire is regulated by grids in the furnace door. The opening for air may be 4 sq. in. per square foot of grate. Such grids are regulated by hand, or by clockwork or similar devices. In mechanical stoking the air supply gets in more or less incidentally through the fuel hopper and through casual openings, and often in far too large amounts at the rear of the grate.

Mechanical stoking does not eliminate the need for correct furnace forms, or for sufficient temperature and proper mixture of air and gas. All inventors and purveyors of furnace accessories, such as grate bars, air-admission devices, stokers, &c., appear to become possessed of one idea, and this they push for every case, overlooking the fact that the combustion of bituminous coal is a complex chemical process which can only be conducted where the chemical equivalents are present to combine, and the further essentials of combustion is ensured. Theoretically, perhaps little air beyond the chemical equivalent would be required were the furnace continued to so great a length that ultimately every molecule of combustible came into contact with its molecule of oxygen. This assumes a heat-conserving furnace.

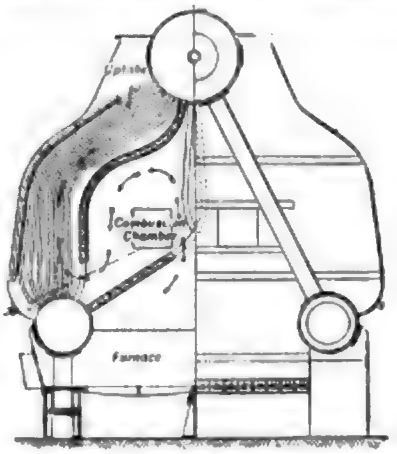

FIG. 5.—Weir Water-tube Boiler, with refractory furnace and combustion chamber.

Practical considerations render it necessary to reduce the extent of the furnace, and to add an excess of air, so as to ensure oxygen coming into contact with all the combustible elements of the fuel within the zone of sufficient temperature. It should be possible to do this with 25 to 33 per cent. of air in excess, and certainly with less than 50 per cent. excess. The flame of bituminous coal will be longer, as the heat is kept low, so that a suitable furnace has a cumulative effect. By conserving temperature flame is shortened, and by shortening flame the necessity for long-protected furnace surfaces is reduced. In Fig. 2 is a furnace which has been shown effectually to burn bituminous coal without smoke; but, so far as the authors are aware, this furnace has only been used with ordinary chain grates, and there is no ordinary chain grate that does not pass an unnecessary and grossly excessive volume of air. Until this furnace is tried with a less wasteful form of grate, no absolute opinion can be passed upon its proportions, though its principles are correct.

The manufacture of a maximum of carbonic acid gas per unit of fuel consumed, or rather per unit of air used, is what should be the aim of the stoker. High CO_2 means high furnace temperature, high heat transmission, small weight of waste gases, and general furnace economy. *Per se*, black smoke may not indicate serious waste of fuel; but it is evidence that the boiler surfaces are covered with non-conducting soot, and black smoke is an incentive to buy more costly coal of a less smoky order. The arrangement of Fig. 2 is smokeless under the conditions named.

Fig. 5, which shows the Weir water-tube boiler, is an example of the same principle, scarcely different in the way it is carried out. Coal is burned in the ʌ-shaped furnace, the walls on all four sides of which are of fire brick, and combustion is continued in a similarly protected chamber, and is perfect with ordinary hand-firing before the heated gases pass among the tubes. Fig. 6 shows the locomotive furnace similarly arranged to secure correct form.

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* Paper read before the Institution of Electrical Engineers, Jan. 12th.

The chain grate stoker is perfect as a self-cleaning contrivance, but admits excessive air. Hence the need of choking boxes, as employed by Mr. E. B. Coxe, Fig. 7. These difficulties with travelling grates are responsible for the sprinkling form of stoker, which, when in good order, keeps the grate evenly covered, as the coal tends to fill the hollow places. But the winnowing action of the draught carries off the dust to become a public nuisance. Such stokers require initially providing for, in the design of a chimney with a settling chamber to gather the dust. The economy of mechanical stokers lies in their ability to raise sufficient steam with cheaper coal than hand firing demands, and in the reduction of the stoking staff. But mechanical stokers will not be an economy unless their hoppers are filled mechanically, and they ought to be in charge of a skilled mechanic to look to upkeep and maintenance, and not be expected to run with unskilled attention.

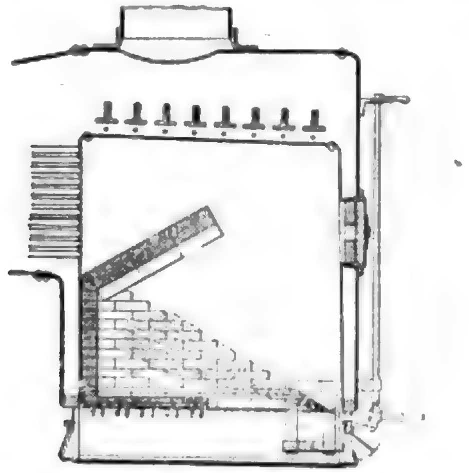


Fig. 6.—Locomotive Boiler, brick-lined for liquid fuel.

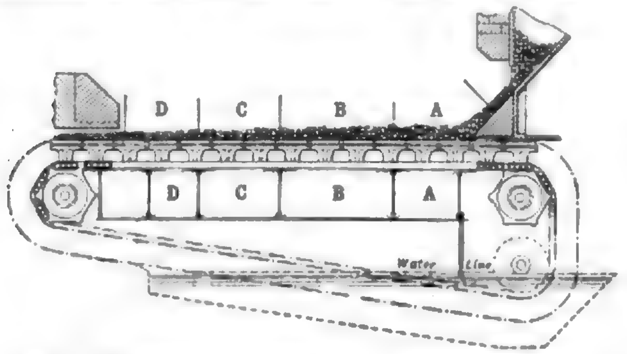


Fig. 7.—Chain Grate Stoker, with air-regulating chambers below.

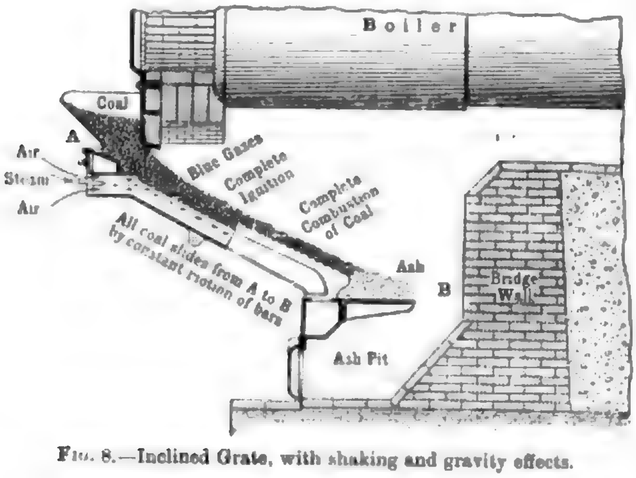

Boiler
Coal
A
Air
Steam
Air
Blue Gases
Complete Ignition
Complete Combustion of Coal
All coal slides from A to B by constant motion of bars
Ash
B
Bridge Wall
Ash Pit

Fig. 8.—Inclined Grate, with shaking and gravity effects.

The ideal mechanical stoker is of the inclined grate type, Fig. 8, in which the inevitable thinning of the fire of the coking furnace is made good by the aid of a moving grate assisted by gravity. In this type, only possible in its full extent with external furnaces, the fuel is helped to fill gaps and close the lower end of the fire by gravity, and at the foot of the inclined grate is some arrangement which enables ash and dirt to be removed. Rocking grates which profess to cut out the ash and clinker from the under side of the fuel bed are of doubtful use, for clinker is tough and adhesive when hot. It becomes brittle only when chilled, and users of such bars should be prepared at least to have each half of the grate workable independently. The system may then be used to clean a grate quickly, after the clinker has been chilled by removal of the fire to the other half of the grate.

Smoke Prevention.—This can often be managed by excessive air admission, for the reason, probably, that though air in excess has a chilling effect, its ample provision enables all the gases to burn before they have lost much temperature. But smoke cannot be prevented with economy unless sound conditions are present, as already detailed, and the crux of the whole matter is summed up in saying that a maximum percentage of CO_2 must be present in the furnace gases.

Could the furnace products be rejected at atmospheric temperature, an excess of air would be of no account. But the heating surfaces commercially available render it impossible to cool rejected gases below, say, 400° F. whatever the supply of air, and obviously the loss of heat is greater where air is used in excess. This point is emphasised because there is frequently a serious confusion of thought in relation to heat and temperature, and the weight of the gases possessed of such heat or temperature. Cold flue gases, unless of small weight per unit of fuel, do not represent economy, but excess of air. Some people think otherwise.

STEAM.

The object of burning fuel under steam boilers is to produce steam. Steam at atmospheric pressure contains about 967 units of latent heat and 160 units of sensible heat above feed temperature. Only by means of the latent heat can work be done. These facts make it of prime importance that when steam is used it should contain all possible latent heat. It should be steam, in fact, and not hot water. Steam loses heat from the moment it leaves the boiler. The surfaces which contain it must, therefore, be of minimum area. This involves pipes of minimum length and is one of the various reasons for avoiding ring mains, the fancied need for which is obviated by using good materials well put together for steam piping. Short pipes make it possible to carry a given weight of steam with less drop of pressure, or otherwise to carry the same steam at the same pressure fall through smaller pipes.

The loss of heat through pipes varies with the head of temperature. The weight of steam that will flow through a pipe varies with the pressure absolute very nearly. The pressure of steam rises faster than the temperature, and high-pressure steam (realised to be economical) will lose less heat than low-pressure steam, if the pipes are as much smaller as they should be for the high pressure. It is a mistake to employ steam pipes so large that there shall be no appreciable fall of pressure. Some fall, 3lb. to 5lb., per square inch may be allowed in long pipes, for there is a point where the saving due to high pressure will be lost by the extra radiation from the larger pipes. Wet steam travels with more friction than dry steam. Superheated steam, despite its greater head of temperature, loses heat less rapidly by contact than does wet steam; it flows with less friction and loses less at joints. Less of it is also required, and pipes may be smaller.

There is no thermo-dynamic gain from superheat. Steam leaves the boiler at boiler temperature; it starts expanding at boiler temperature. The work done on the piston during admission comes directly from the fire, or is done by expansion of saturated steam in the boiler. The superheater is merely an incident in the steam pipe. The sole function of superheat is to ensure that steam, saturated with heat, and at maximum density per cubic foot for its pressure, shall be present in the cylinder to work expansively when steam is cut off from the boiler. Superheat is thus intended to heat the cylinder as hot as the boiler, and, by avoiding the presence of water in the cylinder, to minimise the exchanges of heat between the cylinder metal and the steam. Superheated steam supplies heat directly to the cooled surfaces which require it. The jacket, on the other hand, endeavours to maintain the outside of the working liner of the cylinder as hot as the boiler, and, while it may do some good in certain cases, it is always liable to do little else than evaporate water of condensation during the exhaust period.

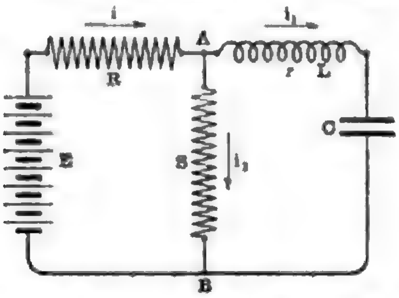
The steam engine, being a heat engine, it is obvious that the best working fluid is that which contains a maximum of heat in a unit of volume. This is what saturated steam does contain, and the object of superheat is to supply saturated steam to fill the cylinder at the time of cut off. Superheated steam is still often erroneously claimed to owe its superiority to the fact that less of it will fill a given space at a given pressure than is the case with saturated steam. This argument ignores the rapid drop of pressure which occurs when superheated steam expands. It ignores the fact that in a given bulk there is less heat and therefore less capacity for doing work. Therefore, while superheat is essential to economy, it is so only because it is the one means we possess of filling a cylinder with dry saturated steam.

(*To be concluded.*)

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Undamped Electric Oscillations.—S. Maisel attempts a better theory of the undamped electric oscillations occurring in Duddell's singing arc than the theories hitherto furnished by Duddel, Janet or Granquist. These latter postulated a "negative resistance" in order to account for the constant renewal of the energy of the undamped oscillations. This is, according to Maisel, not justified on the one hand, and insufficient on the other. For he has observed singing arcs in which dr/di was positive. He supposes a conductor, AB, which rigidly obeys Ohm's law, with the proviso that no current flows when the E.M.F. falls below a certain value, and that the restoration of the current requires a high E.M.F. This conductor is a simplified arc, and is better for theoretical purposes than the ordinary arc, about which we know as yet very little. In fact, the arc is only one of the things which can produce undamped oscillations. The author works out a complete mathematical theory of the phenomenon, and shows that the energy required to neutralise the damping is constantly supplied by the battery. In every phase of each oscillation there is damping, and it may be very strong. But the resulting discontinuity of the circuit enables the battery to cover the loss. This discontinuity surcharges the condenser *c* (see diagram). During charging, the condenser receives so much energy from the battery that during discharge the potential of the condenser falls much lower than it would in the case of a continuous current. If this potential is low enough, the vibrations go on indefinitely as long as the battery works.



[S. MAISEL, *Physikalische Zeitschrift*, Jan. 15, 1905.]

Electric Radiography.—V. Gabrichevski describes a curious combination of Lichtenberg figures and radiographs. He places a number of miscellaneous objects and a tube of radium preparation on an electrified ebonite plate, and removes them after about 10 or 15 minutes. He then powders the plate with the mixture of minium and flowers of sulphur, and obtains beautiful delineations of the objects, such as scissors, coins, pencils, matches or keys. The images are the sharper the nearer the objects are to the ebonite, but it is not essential that they should touch it. The radium tube may be among them or above them, or even on the other side of the ebonite. The plate is electrified negatively, and the images are red, and therefore negative. An image of the outline of the hand may be obtained through a thin ebonite plate. The image is neutral, and is surrounded by a yellow positive field. The phenomena may be explained by a consideration of the ionisation of the air by the radium preparation and a change in the distribution of the electricity on the plate produced by the presence of the other bodies, which are electrified by induction.

[V. GABRICHEVSKI, *Physikalische Zeitschrift*, January 15, 1905.]

Hertz's Grating in Optics.—F. Braun has succeeded in repeating Hertz's grating experiment in the region of the visible spectrum. In 1888 Hertz showed that electric waves, vertically impinging upon wire gratings in air, are divided into two components, those parallel to the wires being reflected, while those normal to the wires are freely transmitted. All attempts to reproduce this experiment with waves of the order of visible light have hitherto failed owing to the necessity of obtaining metallic gratings whose interval shall be smaller than half a wave-length. The furthest advance in that direction was made by Rubens and Nichols, who showed that infra-red rays of wave-length $24,000\mu\mu$ are reflected in the Hertzian manner by a grating of $5,000\mu\mu$ interval made with silver on glass. Now F. Braun has obtained the necessary fineness of interval by using Kundt's metallic "prisms" prepared by disintegrating a wire over glass. The best plan is to fasten a thin platinum wire on a glass plate with sealing wax at the ends. The electrodes are two weights with flat bottoms, which lie on the wire. A condenser of about 30,000cm. capacity, giving sparks 1cm. long, is charged by means of an influence machine, and discharged once through the wire, which is thereby disintegrated and deposited on the glass in two parallel strips, fringed with combs of metal ending in fine points. These combs furnish the grating required. Suitable regions are picked out by viewing the preparation between crossed Nicols and placing the strips at 45deg. Combs then appear bright on a dark ground, and disappear on turning the preparation through 45deg. This is Kundt's phenomenon. The portions thus picked out, when viewed with the polariser only, in diffused daylight, transmit less light when it is polarised in the plane of the strips than when polarised normal to the strips. In one position of the polariser the field appears jet black, while in a position at right angles to it the field appears a nutmeg brown. The author produces photographs showing this Hertz effect.

[F. BRAUN, *Annalen der Physik*, No. 1, 1905.]

Electrostatic Damping of Galvanometers.—A novel method of damping galvanometers is described by W. Einthoven. It is based upon the action of a condenser shunted on the galvanometer circuit. The formula showing the connection between the deflection *a* at time *t* and the constants of the condenser is the following

$$a = A(1 - e^{-\frac{t}{wc}})$$

where A is the permanent deflection, *c* the capacity, and *w* a resistance defined by the equation

$$w = \frac{W_g W_a}{W_g + W_a},$$

W_g being the resistance of the galvanometer and W_a that of the external circuit. The product $wc = T$ is the "time constant" of the galvanometer. If *w* is given in ohms and *c* in farads, T appears in seconds. By changing *w* and *c* the time constant may be made to acquire any desired value, and the damping may therefore be regulated at will. The author reproduces some curves showing the aperiodic nature of the deflections. In one curve, the final deflection is attained in 0·026 seconds with one microfarad, and the curve shows no trace of oscillations. The best type of galvanometer for this method of damping is the string galvanometer. With a quartz fibre tightly stretched it ought to be more sensitive than the oscillograph.

[W. EINTHOVEN, *Annalen der Physik*, No. 1, 1905.]

Magnetic Susceptibility of Liquids.—G. Meslin has endeavoured to introduce some order into the chaos of values assigned by various experimenters to the magnetic susceptibility of organic liquids by reducing them all to unit volume instead of unit weight. He has also determined some 30 values, which he tabulates in conjunction with those of Henrichsen, Quincke, Becquerel, Faraday and Plücker. The liquids are all diamagnetic, and their susceptibilities range from 0·475 for ethyl iodide to 0·908 for petroleum. Water, benzene and toluene stand in the middle at about 0·8.

[G. MESLIN, *Comptes Rendus*, January 23, 1905.]

A New Radium Mine.—Radium has hitherto only been found in connection with uranium ores. J. Danne has, however, discovered a new source of radium at Issy-l'Évêque, in the department of Saone-et-Loire, where it occurs associated with pyromorphite, and also to some extent with lead-bearing clays and pegmatite. Some of the ores show, without further preparation, a radio-activity several times that of uranium, but usually it is less. In any case, a ton of mineral would yield quantities of radium bromide of the order of 10 milligrammes, and MM. Armet de Lisle at Nogent-sur-Marne have taken in hand the exploitation of the mine. The wells in the neighbourhood are all radio-active.

[J. DANNE, *Comptes Rendus*, January 23, 1905.]

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"ELECTRICAL" FIRES.

Observant newspaper readers will, doubtless, have noticed that from time to time there is quite an epidemic of fires alleged to have arisen from electrical causes. Like all other technical matters dealt with by the lay press, these conclusions are frequently erroneous, and beyond the fact that the buildings in question happened to have been fitted with electric light, there is seldom any more evidence to go upon. In spite of this, however, the journals devoted to the gas industry seize upon these sensational paragraphs, and, only naturally, make the most of them. If it were not for the fact that "tu quoque" is a weak form of argument, the electrical journals could recriminate with the greatest of ease, as the daily occurrence of destructive fires and loss of human life due to the use of gas would provide abundant material. But fortunately there is no need whatever to resort to any such means, as the facts are so patent to the world at large. That some fires have been due to defective electric wiring cannot be denied, but even if all the newspaper reports were accurate, the number would be insignificant compared with the number of premises wired. We are able to state, for instance, that a ten-pound note would cover all that the Phœnix Fire Office has ever had to pay to meet claims for electrically-caused fires. One of our gas contemporaries asserts in its current issue that the insulation on electric light wires constitutes a source of grave danger, since it assists in spreading fire all over a building. It would be interesting to compare, in this respect, an installation of electric wires with a similar installation of gas piping in a burning house. There is little doubt as to which would prove the more easily extinguishable. Although this point is rather outside the issue, it is nevertheless well worth bearing in mind.

A matter of some importance to the electric wiring industry came before Mr. Justice RIDLEY and a special jury this week when Mr. LIONEL PHILLIPS sued Messrs. KINGSTON, MILLER & Co. for damages for the destruction of a marquee due to the defendants' alleged negligence. A full report of the action will be found in our Legal columns. It appears that the plaintiff had engaged the defendants to erect for him, at his house in Grosvenor square, a large marquee, in which an entertainment by distinguished artistes was to be given after a dinner party. The marquee was of the ordinary style and consisted principally of canvas. Like many other structures used for similar purposes, it was also adorned with muslin hangings, and the interior was illuminated with a large number of 5 c.p. electric lamps. These lamps were, of course, put up "for one night only," the looping-in system of wiring being employed with flexible cord. Everything appeared perfectly satisfactory, and immediately before the guests went in to dinner the hostess paid a visit to the marquee and desired to see the lamps switched on. This was done, and they were then switched off. Within a very short space of time, the exact length of which was in dispute by the parties to the action, an alarm of fire was raised, and in a few minutes the entire structure was destroyed, and the house itself was only saved with difficulty. Such, briefly, is the history of the unfortunate event which led up to the important legal action. Mr. PHILLIPS naturally felt rather aggrieved that his plans had been frustrated, and he commenced proceedings against the contractors for damages. In the course of the hearing some exceedingly interesting evidence was given by the expert witnesses, Col. CROMPTON and Mr. JAMES SWINBURNE appearing for the plaintiff, and Mr. W. M. MORDEY and Mr. A. H. DYKES for the defendants. However, the chief points to be decided by the jury were really only two in number. The first was as to the actual origin of the fire, it being maintained by the defendants that electricity had nothing whatever to do with it, but that a spark from a neighbouring chimney started the conflagration. The second point, in view of the evidence of the expert witnesses, was a good deal more difficult to decide: it involved the question as to whether the defendants had exercised due care or whether they had been negligent. It was argued that the looping-in system ought not to have been used in conjunction with flexible cord. The looping-in system has always been advocated by consulting engineers and others who are authorities on installation work, but certainly there is something to say against it when it is used in conjunction with small 200-volt candle fittings and "flex." There may admittedly have been danger of short-circuit owing to stray strands of conductor, but that such a short-circuit would cause a fire is unlikely in the case of circuits properly provided with fuses as these were. Not more than twenty 5 c.p. 200-volt lamps had been placed on each circuit, and the circuits were fused accordingly. Moreover, the fittings were all tested at the shops after they had been wired, and the installation was tested after completion. Bearing these circumstances in mind, it appears most unlikely that the fire was caused electrically or that the defendants did not display reasonable care in carrying out the installation. The only weak point in their case is the fact that they used flexible cord, when single strand or three strand conductor should have answered the purpose equally well, and would, in fact, have been less expensive.

With the finding of the jury, however, we are most emphatically in agreement, and we trust that the verdict will go a long way towards dispelling some of the absurd notions possessed by certain of the public, and fostered by opponents of the electrical industry, that there is danger in electric lighting. Unquestionably, it is the safest system of illumination known, either for temporary or for permanent work, and the case heard before Mr. Justice RIDLEY this week goes far towards supporting this claim.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Central Electric Stations: Their Design, Organisation, and Management. By C. H. WORDINGHAM. 2nd edition. (London: Charles Griffin & Co.) 24s.

Mr. Wordingham's book on electricity works may be considered partly as a text-book for the student and pupil, and partly as a technical treatise for the central station engineer. This combination might not appear desirable at first sight. For instance, it can be said with justice that the electrical engineer holding any position whatever in an electricity works will have little desire to read the succession of introductory chapters in the beginning of the book, and he will find that much of the practical information in other parts of the volume is unduly packed in with generalities and engineering truisms. On the other hand, the detailed and excellent examples of central station book-keeping will be thrown away on the younger readers, and in fact the system set forth in the latter chapters of the volume is only applicable in its entirety to the very largest electricity works. The middle chapters of the book contain pabulum for both the raw recruit and the veteran, more or less intermixed. Still, the scheme of catering for two or more distinct classes of reader in one book has distinct advantages in technical literature. Books on electrical engineering rapidly become out of date owing to continuous development in electrical science and theory and constant improvement in the methods of application. A book, although on a specific subject, may nevertheless be made interesting to a relatively large circle by this method, the sale of the book is accelerated, and a succession of editions enables the author to keep abreast with the march of progress.

Discussing the volume first as a text-book for students and pupils, we have no hesitation in recommending it for this purpose; it may well be placed among the standard books used at technical colleges, and no pupil at an electricity works should be without it. The main ideas under-running the design of an electricity supply system are clearly set forth, the interdependence of the various items of machinery and plant which form the whole is properly demonstrated, and general descriptions always precede the more detailed investigation with regard to the design of particular pieces of apparatus. In this respect the reader will occasionally meet with some surprises, and the student may even be led astray if he does not keep Euclid's ninth axiom well in mind. The author has, in fact, purposely refrained from devoting much space to subjects upon which there are already a sufficiency of good text-books and technical works of reference: thus as much attention is given to steam traps as to the construction of boilers; and while there are three large illustrations of Mr. Wordingham's "pillar distributor," no drawing is given to show the internal construction of an engine, dynamo, feed pump or condenser. The reader must have separate books on these in his library.

In general the author's advice may be taken as quite sound, but there are just one or two instances in which he lays down his opinion rather too dogmatically on points of current practice, forgetting to mention that there are other experts who hold contrary views. Taken as a whole, however, there is practically nothing in the book that may not be safely put before the student. Even the student's father is not neglected, and the author wisely urges him to give his son a good and liberal general education previous to the special training which is necessary. Mr. Wordingham even goes so far as to insist on the importance of writing good English, and the father with literary instincts will smile when he reads some of the examples which are unconsciously given of the result of neglect in this respect. The matter contained in the book is so good, however, that occasional lapses into prolixity and the frequent jarring of widely split infinitives may well be pardoned.

As we have already hinted, the engineer who desires to read this book as a technical treatise on electricity works will find it necessary to perform a certain amount of judicious skipping. But by the time he has skipped the first 20 pages, skimmed the 50 pages that follow, and dipped deeply into the succeeding 100 pages of this 500-page book he will be convinced that it should belong to his library. Yet it is the latter half of the book that will be the more useful to the full-blown central station engineer. The chapters on distributing networks and those dealing with organisation are worthy of special commendation. No author has attempted hitherto to deal so completely with the whole system of management of an electricity works. Every department is dealt with in its turn, and almost every detail is thought of. The specimen rulings for the books, and the collection of various printed forms for records of tests, log sheets, ticket indices, and so on, will be of the utmost value to every central station manager. They are, of course, based on the system employed by Mr. Wordingham when he managed the electricity department at Manchester, but, given the complete system for a large undertaking, it is no difficult matter to modify it to meet the conditions prevailing in a smaller town.

We sympathise with Mr. Wordingham's wish to abstain from travelling over ground already well explored and mapped out, but nevertheless we think that in some respects the chapters on power-house plant might be amplified. To describe all the patterns of engines and dynamos which are in use would be unnecessary, but a few more practical hints as to "their tricks and their manners" in central-station practice would be useful; for instance, a detailed discussion of the more usual causes of failure and their avoidance would not be out of place in a work of this character, written by an engineer for engineers. We should also like to see more on the design of switchboards; there is scope for a much fuller treatment of this part of the subject if properly illustrated with actual plans, sections and clear diagrams. Booster and balancer connections are also dealt with in too general a manner, and might well be accorded a chapter to themselves; and the chapter on street lighting should be of a more practical nature in view of the absence of a good book on the subject. We trust that the author will be able to adopt some of these suggestions in his next edition, which will shortly be needed if the book meets with the success it deserves.

HIGH VACUUM CONDENSERS.

In the first part of a Paper on "Condensing Arrangements in Central Stations," read by Mr. Jno. D. Bailie before the Leeds Local Section of the Institution of Electrical Engineers on January 19th, descriptions were given of various forms of condensing plant, already familiar to readers of *The Electrician*. In the second portion, however, a number of quite recent tests were quoted by the author to support his contention that in all but exceptional cases it is not difficult to maintain a vacuum of not less than 28in. The following is an abstract of the second part and of an appendix to it:—

One frequently hears that the maintenance of high vacua involves the use of abnormal quantities of cooling water and cooling surface, abnormally large capacity air pumps, prohibitive initial and working costs, &c. Such is not the case, however, for with properly designed condensing arrangements, and cooling water at a moderate temperature, there is no difficulty in maintaining a vacuum of 28in.

There are, of course, cases in which to condense at all is more or less impracticable, but these do not affect the question. The more perfect design and arrangement of modern condensers and pumps enable vacua of, say, 28in. of mercury to be obtained, with much the same allowance of cooling surface and cooling water as hitherto. The air contained in the exhaust steam and the injection water, and the vapour which is formed in the condenser, are frequently represented to be practically insurmountable obstacles to the attainment of high vacua, as, owing to the greater volume at the low pressure corresponding to high vacua, abnormally large air pumps would be required for their abstraction. A great deal may be done, however, by the use of properly designed air pumps. One well-known firm of condenser builders use with surface condensers a small auxiliary air pump, whose function is to deal only with the air and vapour, the main air pump dealing with the condensed steam. Probably the simplest and most efficient method at present in use for the purpose is the Parsons vacuum augmentor.*

The quantity of cooling water necessary depends, theoretically, chiefly on its initial temperature, on the temperature at which it is intended to leave the condenser, and upon the total heat of the steam to be condensed. If W = weight in pounds of cooling water required per pound of steam. T_1 = initial temperature of above, T_2 = final temperature of discharge mixture, and H = total heat of 1 lb. of exhaust steam. Then $W = (H - T_2)/(T_2 - T_1)$. For convenience H may be taken as 1,150 B.Th.U. For example: It is required to condense 20,000lb. of exhaust steam per hour with cooling water at 60°F., so as to give the cooling water and condensed steam mixture a discharge temperature of 92°F., or equivalent to, say, a 28½in. vacuum. Applying the formula: $W = (1{,}150 - 92)/(92 - 60) =$, say, 33lb., which for 20,000lb. of steam would equal 660,000lb., or 66,000 gallons per hour.

The foregoing applies, of course, to condensers in which the exhaust steam and the injection water are directly mingled; in the case of surface condensers, where a metallic surface is interposed between the exhaust steam and the cooling water, there cannot be such perfect transference of heat between the two, which means that the temperature of the ejection corresponding to a particular vacuum is considerably lower than the temperature of the discharge mixture from the jet type. This difference may be taken as something like 15°F., and applying this to the above formula we would have, deducting the 15°F. from the 92°F., $W = (1{,}150 - 77)/(77 - 60) = 63$lb., which for the 20,000lb. of exhaust steam comes to 1,260,000lb., or 126,000 gallons per hour.*

The above assumes that there is no air in the steam and water, but since there is, an allowance has to be made, depending on the efficiency of the apparatus for its extraction.

It is desirable to keep the exhaust-steam connections as short and as direct as possible. Extra length of exhaust pipe does not materially affect the vacuum, provided the area of the pipe be ample, and the joints thoroughly air-tight, but each bend involves loss. All valves should have full through-way, as any contraction is equivalent to reducing the area of passage at that point, and introduces friction. In some tests recently taken by Messrs. Korting at the Battersea Electricity Works there was found to be a drop of vacuum, from engine exhaust to condenser, of 1¼in. of mercury, of which 0·8in. was due to the non-return valve. The author understands that Messrs. Ledward & Beckett are now doing away with the non-return valve which is usually fitted between the engine exhaust and the condenser, and are instead fitting an arrangement on the discharge side of the ejector which answers the same purpose, without throttling the exhaust to the condenser. The flanges of exhaust pipes should be faced across in the lathe, and the author has found thin woodite rings to make an excellent joint; they are rather costly in the first instance, but keep tight, and are durable, so that they are probably as cheap as any other form in the long run. A light and satisfactory exhaust pipe may be made of riveted sheet steel, say, ⅛in. to ⅜in. thick, galvanised, and with flanges riveted on. All joints, whether of the pipe itself or of the flanges to the pipe, should be caulked.

The condenser tests recorded in Table I. have been compiled from official tests. The chief object in showing them is to draw attention to the small percentage of the total power generated used in driving the condenser pumps which, in all cases, are driven by electric motors. In the case of the Hulton colliery plant, an ejector condenser was used, and it will be seen that the percentage of power used by the motor-driven centrifugal circulating pump was somewhat high, owing chiefly to the large quantity of water passing, and to the considerable head against which the pump had to work. The vacuum at the condenser was good, considering the type of condenser and the temperature of the injection water. The other three cases cited include two with surface condensers and one with a two-pump jet, the motors being continuous current at Manchester and West Bromwich, and two-phase alternating at Neepsend. The tube areas of the surface condensers are on the basis of 1 sq. ft. per 10lb. of steam to be condensed, which is more or less usual practice. The vacuum maintained is higher in the case of West Bromwich, owing in part to the lower temperature of the injection water, and to the greater quantity circulated per pound of steam. The percentage of power used by the pumps is rather lower at West Bromwich on account of the smaller head against which the pumps work, and to the runners of the Neepsend pumps not being the most suitable for their duty, they are, in fact, now being changed. One of these new runners has been tried with the result that with the new impeller the pump is passing 14in. in depth of water over a V notch with an input to the motor of 47 amperes, as against 11½in. depth over the same notch with an input to the motor of 74 amperes with the original impeller.

In the case of Manchester, the vacuum is not so high as at West Bromwich and Neepsend, but this is more than accounted for by the high temperature of the injection water and by the barometer being slightly lower. There is a considerable head against the pumps, and, taking everything into consideration, the result is a very good one, though it could be greatly improved by the addition of a vacuum augmentor. It will be seen that in this case the condensing plant comprises a two-tank jet condenser with both dry and wet pumps.

Table II. shows a set of readings taken a few days before Christmas, 1904, at the Leeds tramways station, Crown Point, from a jet-condensing plant, comprising a single tank with wet and dry pumps on the same spear rod. The full load of the plant is 250kw., and it will be seen that at about 6 per cent. overload the vacuum is 28·4in. with the barometer 30·25in. It might be mentioned that the pump valves, which are of rubber, have not been examined or renewed for many months, and that the vacuum readings were taken by a mercury column, so may be relied upon.

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* Fully described in *The Electrician*, Vol. LIII., p. 225.

* A number of tests have been made, from which the difference between the temperatures of the condensed steam and injection water appears to be from 7°F. to 10°F.

Table III. contains some readings taken quite recently from the surface-condensing plants at the Derby electricity works. The tube surface allowed is 1 sq. ft. per 10lb. of exhaust steam to be condensed, and the air and circulating pumps are, in the case of each plant, driven by the one motor. The cooling water, with a load of 265kw. and a vacuum of 28·4in., was about 31,000 gallons per hour. The full-load of each set is 300kw.

At the Harrogate Electricity works, with a surface-condensing plant of approximately similar capacity to the last-mentioned, but with pumps driven from the engine shaft by gearing the vacuum at full-load at the official trials was 28·15in., the barometer standing at 29·97in., and the temperature of the injection water being 42·8°F.

The foregoing results would seem to support the author's contention that the maintenance of vacua of 28in. or more is neither impossible in practice nor costly.

Table IV. shows approximately the temperatures of the effluent corresponding to various vacua.

Table I.—*Condenser Tests.*

Station.	Hulton Colliery.	Neepsend Works.	West Bromwich.	Manchester.
Type of condenser..	Ledward ejector	Parsons surface	Parsons surface	Jet wet and dry pumps
Type of air pump ..	..	Parsons 3 thr'w c'mp'd	Parsons 3 throw c'mp'd	Parsons 3 throw c'mp'd
Type of circ. pump .	Gwynne centrifugal	Gwynne centrifugal	Gwynne centrifugal	Gwynne centrifugal
Pumps driven by ..	B.T.-H. motor	B.T.-H. motor	B.P. motor	E.C.C. motor
Cooling surface....	..	3,000 sq. ft.	1,000 sq. ft.	..
Temp. of cool'g water	67·6°F.	65·3°F.	51°F.	82°F.
Vacuum at cond'nser	26·17°Hg.	27·7°Hg.	28·2°Hg.	26·66°Hg.
Barometer	30·05°Hg.	29·9°Hg.	29·8°Hg.	29·5 Hg.
Cooling water per h'r	48,100 gals.	88,500 gals.	50,000 gals.	178,500 gals.
Steam cond's'd per hr	6,996lb.	20,580lb.	10,000lb.	35,700lb.
Cooling water per lb. of steam	68·75lb.	30lb.	50lb.	50lb. ?
Tot. power generated	314·4kw.	1,610kw.	446kw.	1,822·03kw.
Power used by pumps	22·5kw.	37·4kw.	9·17kw.	40kw.
% total power used by pumps	7·1 per cent.	2·3 per cent.	2·05 per cent.	2·2 per cent.
Head against circ. pump	47·5ft.	20ft.	15ft.	40ft.

Table II.—*Condenser Readings at Crown Point, Leeds.*

Barometer, 30·25in. Temperature of injection water, 46°F.

Load, kw.	110	154	220	235	265
Vacuum, in.	29·1	29·0	28·7	28·6	28·4

Table III.—*Condenser Tests at Derby.*

Plant.	Load.	Barometer.	Temp. inject.	Vacuum.
No. 1	265kw.	29·9in.	54°F.	28·4in.
" 2	250 "	30·1in.	56°F.	28·5in.
" 3	216 "	30·1in.	56°F.	28·7in.

Table IV.—*Relation (approximate) between Temperature of Effluent and Vacuum.*

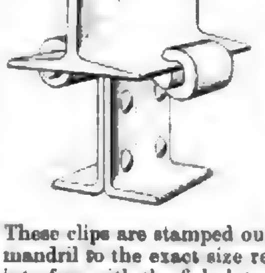
Temperature of effluent, °F...	161	152	140	133	125	114	110	102	92
Vacuum, in mercury	20	22	24	25	26	27	27·5	28	28·5

RECENT IMPROVEMENTS IN ELECTRIC LAMPS.

A very interesting Paper, entitled "Recent Developments in Electric Lighting," was read by Prof. H. T. Davidge before a crowded meeting of the Junior Institution of Engineers last Friday. Contrary to what might have been expected from the title, electric lamps only were touched upon by the speaker, but that in a very lucid manner. Some 12 different kinds of electric lamps, ranging from the familiar carbon filament lamp to the cathode ray bombardment device, were shown, partially working. After a brief theoretical introduction the author touched upon the question of photometry, mentioning in this connection Mr. Matthews' recent integrating photometer, which allows the mean spherical candle-power of any source of light to be obtained by one single reading. An illustrated description of this ingenious device will be found in Fleming's "Handbook for the Electrical Laboratory and Testing Room," Vol. II., p. 327. According to Prof. Davidge the average optical efficiencies of various lamps are as follows:—Incandescent lamp, 5 per cent.; arc lamp, 15 per cent.; vacuum tubes and mercury-vapour lamp, 33 per cent. Regarding the average consumption of electric energy per candle-power, it was mentioned that incandescent lamps consume from 2½ to 4½ watts per candle-power, enclosed arcs require from 2½ to 4 watts, the Nernst lamp consumes from 1½ to 2½ watts, while the corresponding figures for the open arc vary from 0·8 to 1½. Candles were credited with a temperature of 1,700°C., incandescent electric lamps 1,830°C., Nernst lamps 2,180°C., arc lamps 3,930°C. After these general remarks the lecturer explained successively the various classes of electric lamps. Commencing with the arc lamp, he dealt with the peculiarities of the open and enclosed arc lamps, and explained in detail how some of the recent types of "hot-wire" regulating mechanism work. Flame arc lamps were next discussed and figures were quoted to show their high efficiency. Turning then to the ordinary incandescent lamp, the author pointed out to what extent long life and economical service are dependent on the steadiness of the supply voltage. An osmium lamp was next shown working, and reference was made to the tantalum lamp, a full description of which appeared in *The Electrician* for January 27th, p. 589. Various types of Nernst lamps and glowers were next shown and explained, and Prof. Davidge mentioned *en passant* the reason why it is important to connect the ends of the Nernst filament to the proper polarities of the continuous-current supply. The reason is that the continuous current gradually shifts the material from one end of the filament to the other. The filament is, therefore, made taper from the very beginning, so that—assuming the Nernst glower to be connected to the proper polarities—the filament presently assumes a cylindrical form. After this has been attained the thinning takes place at that end which was previously the thicker one, and the process goes on until the glower breaks. It is obvious that, if wrongly connected up, the thin end of the taper will waste away and the glower will break prematurely. Vapour lamps were then shown and discussed, and the author concluded his discourse by showing in operation a cathode bombardment lamp and a "high-frequency" lamp. The latter consisted simply of a highly-exhausted glass tube. When brought near a high-frequency supply the tube began to glow, giving off a mild bluish light. The following gentlemen took part in the discussion: S. Cutler, jun. (in the chair), F. Fisher, P. Marshall, H. Thorne, A. W. Marshall, W. Alston, G. C. Allingham, R. Marshall, L. Rugg and W. Paterson. Mr. A. W. Marshall thought that iron resistances might with advantage be employed for ordinary incandescent lamps, as had already been suggested by Mr. J. Swinburne. Although these series resistances would absorb a certain amount of electric energy, they would, on the other hand, permit of greater fluctuations of the supply voltage, and this, again, would materially reduce the cost of plant. Mr. Alston mentioned that two continuous-current Nernst glowers of his, one connected up properly, the other wrongly, had already burned some 800 hours, both quite satisfactorily. Mr. Allingham drew attention to the fact, brought out by Prof. Davidge's figures, that enclosed arc lamps are not more economical than Nernst lamps, the latter having, therefore, a fair chance of replacing in many cases the more complicated and costly enclosed arc lamp. Nernst lamps were, however, not suited for private installations where the supply was alternating on account of the objectionable hum given off by the lamp.

A NEW RAIL ANCHOR.

A new rail anchor, patented by Messrs. Walker & Grant, is being put on the market by Messrs. Naylor Bros., of Golborne (Lancs.). This device, the leading features of which will be at once clear by reference to the accompanying illustration, is intended to meet the demand for an anchor which can be fixed without drilling the rail.



As will be seen from the illustration, the "Positive" anchor, as this device has been named, is formed of two rolled steel plates bent to the proper shape and riveted together. The "bulbs" along each top edge of the rail are formed to a slight taper to allow the clips to enter easily, which are then driven home by a hammer. These clips are stamped out of stout steel plate and pressed round a mandril to the exact size required. It is claimed that they do not interfere with the fishplates, bonds and tie-bars. The anchor may be made to suit any section of girder rail, any depth of concrete and may be of any length. For joint anchors a length of 18in. is recommended with two clips on each side, and for intermediate anchors a length of 6in. with one clip on each side.

OVERHEAD MAINS FOR ELECTRIC DISTRIBUTION.*

BY G. L. ADDENBROOKE.

The electric transmission of power on a large scale has been carried out chiefly in districts in Europe and America where abundant water power was available and the cost of coal was considerable; that is, in districts where, as we should expect, the economic margin was greatest. A great number of these transmissions consist of a long line of mains carrying the current to some point or area where distribution takes place. In the United Kingdom the problem will usually be rather different. In the first place, except in a few instances which I do not propose to deal with specifically, the source of power will be coal. Now coal is portable, and, notwithstanding what has been said by some people, it is my view that in nearly all cases it will pay better to locate the central station near to what may be called the "power centre of gravity" of the district to be served and bring the coal to it, rather than to place the central station at a greater distance from its work in order to save freight on coal.

It may be pointed out that progress is likely to accentuate the soundness of this argument, since improved methods of generating power, such as the use of gas engines necessitating less coal per kilowatt-hour output, will make the cost of carriage on the coal relatively less important, while the cost of carriage itself is more likely to decrease than to increase. Consequently, whenever we have a power station operated by steam or gas engines and using coal as its source of energy, as will be the case with nearly all the power-supply stations in this country, I think we may take it that such a station should be situated somewhere near the centre of the district it is intended to supply, except in special cases which we need not consider to-night. That it is cheaper to generate power from coal on a large scale and in a central station than when the same total amount of power is generated by scattered units has become almost an axiom. If transmission cost nothing it would be sufficient to set down such a central station in any suitable district, and within a moderate period—if it were not over-capitalised and were economically administered—its supply would displace all other sources of power in the district. But this is not the case practically; transmission costs money and involves losses, and consequently there arises the important engineering problem of how to make this capital cost and loss a minimum, seeing the smaller it is made the larger will be the field to the central generating station.

In supplying light the electrical engineer is dealing in a luxury and convenience, and the business is not altogether governed by ordinary commercial considerations. But in supplying electric energy for power purposes the whole question is purely one of economics and commercial desirability. No manufacturer will displace his present method of power supply unless he can see a distinct economic gain. Moreover, it will not usually be sufficient that the cost of central supply shall be equal to the cost of local generation: this will turn the scale in the case of extensions of old and for new works, but to displace existing means, some gain, including interest and depreciation on the capital to be expended, must usually be shown over the existing method. Moreover, it is desirable that the difference between local generation costs by existing methods and the power supply company's price should be such that manufacturers are tempted to change over fairly quickly and without waiting till plant breaks down or exceptional business demands additional power. On the other hand, during the early days of an enterprise, it is difficult to produce as cheaply as when a large demand has been created and matters have settled down to a routine.

For these reasons, therefore, and for many others which I will not attempt to enumerate, it is desirable, if electric power supply from central stations in this country is to make way rapidly, that the costs of generating the energy and the costs of distribution between the power house and the terminals of the consumers' motors should be kept as low as possible, and this apart from the general proposition that it is for the good of manufacturers first and the country generally afterwards that power in its most convenient form should be generally available over large areas at the lowest prices commercially compatible with a fair return on the capital needed.

The cheap production of power within the central station itself is a part of the question I do not propose to deal with directly in this Paper. I shall assume that everything is done in this way which experience and the state of our knowledge dictates. All that it is necessary to say here is that to secure good results the greater the amount of power which can be supplied from a given station the better, and also the better the load-factor the lower the average price which can be charged. It is also obviously important to get a good load on the station quickly after it is ready to start.

Now, in order to get a large load in a central station, to get such a load quickly and to obtain a good load-factor, unless the station is located in an exceptionally rich district, it should be in a position to invite customers from as large an area as possible, because it is not likely that manufacturers within range of the mains will change over the whole of the arrangements in their establishments to electric driving immediately; they will usually commence by adopting electric driving tentatively for some particular purpose, and gradually extend as they find it convenient and economical and can afford to make the change. Moreover, it is most desirable that power companies who have been granted, by the wisdom of Parliament, concessions over large areas should not be compelled to confine their operations during their earlier years to the richest corners of their districts, but should be in a position to afford a supply of energy over a wide area from the start. All this means that from the power companies' point of view, from the manufacturers' point of view, and from the public and national point of view, as soon as a power company is in a position to supply electric energy in an area it is desirable that it should have the largest mileage of mains radiating from its station which engineering and finance will permit, and should be in a position to take mains in any new direction required with the greatest facility and economy.

On the Continent and in America, outside considerable towns, electric transmission has almost universally been carried out by means of overhead mains—that is, by the most economical and simplest method which could be devised. Unfortunately, until recently in this country officialism and to some extent public sentiment have prevented the employment of this method on any scale, with results which appear to me the more deplorable the more I think of them; but within the last year it is pleasing to be able to record that more enlightened views have slowly begun to permeate official quarters, and a disposition has reluctantly been manifested to meet the necessities of the situation, so that applications for permission to erect overhead mains in suitable localities are likely to be favourably met in Whitehall. It is therefore possible to consider systems of transmission of this character in the United Kingdom and it becomes of practical importance to see how they compare with underground transmission, and what difference their employment may make in the policy and procedure of power companies.

For this purpose I have had prepared two Tables showing approximately the cost of overhead conductors and underground mains

Overhead Mains.—*Three-phase Cables. On the Basis of 1 per cent. Loss per Mile.*

Particulars of the conductors.			Carrying capacity in kilowatts at the following voltages.				Capital cost of line complete per mile, allowing 45 poles per mile at the following voltages.				Capital cost of line complete per kilowatt conveyed per mile at the following voltages.			
Size of cables.	Section of cables in sq. in.	Weight per mile in lbs.	6,000	8,000	10,000	12,000	6,000	8,000	10,000	12,000	6,000	8,000	10,000	12,000
3—7/18	3—0·01292	3 × 266	81	152	225	323	£211	£230	£245	£260	52/-	30/-	22/-	16/-
3—7/16	3—0·02299	3 × 468	143	254	400	545	259	275	290	305	36/3	21/8	14/6	11/3
3—7/14	3—0·03588	3 × 730	222	394	615	887	301	316	332	347	27/-	16/-	10/9	7/10
3—19/16	3—0·06247	3 × 1,270	382	650	1,060	1,526	402	418	433	448	21/-	12/4	8/2	5/10

Underground Mains.—*Three-phase Cables. On the Basis of 1 per cent. Loss per Mile.*

Particulars of the conductors.			Carrying capacity in kilowatts at the following voltages.				Cost of main complete laid and jointed at the following voltages.				Cost of line complete per kilowatt conveyed per mile at the following voltages.			
3—7/18	3—0·01292	3 × 266	81	152	225	323	£490	£540	£675	£800	120/-	71/-	60/-	49/6
3—7/16	3—0·02299	3 × 468	143	254	400	545	520	635	725	870	73/-	50/-	36/-	32/-
3—7/14	3—0·03588	3 × 730	222	394	615	887	545	660	772	950	49/-	34/-	25/-	21/-
3—19/16	3—0·06247	3 × 1,270	382	650	1,060	1,526	780	858	957	1,050	40/-	25/-	18/-	13/9

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* Paper on "The Value of Overhead Mains for Electric Distribution in the United Kingdom." Read before the Institution of Electrical Engineers last night.

by Goo

employed under similar conditions. The figures must be regarded as approximate, as so much depends in any given case on the amount of work to be done, the locality and other conditions, but still they are near enough for the present purpose. The costs in both cases are for high-class work, and this applies particularly to overhead work, as it is the experience of users both on the Continent and in America that to secure the best results such work must be solidly and carefully constructed and with due consideration of the requirements to be met; in fact, it would astonish many electricians in this country to find how much thought and care is being put into the construction of such lines abroad, into the manufacture and design of insulators, the arrangement of the conductors on the poles, the poles themselves and arms and their erection, lightning conductors, cradles, and all the other necessary details which go to make up a properly built overhead transmission line.

An inspection of these tables will show that at 6,000 volts between conductors on a three-phase system the cost of the overhead conductors is about half that for underground cables. If the voltage is increased, the cost of the overhead line only rises slightly while the cost of the cables increases more rapidly, so that at 10,000 volts the cost of underground is nearly three times the cost of overhead transmission. I may say that in the costs for the overhead transmission a fair sum is included for extra poles and networks when crossing roads or places to which the public have access.

In these tables the costs of overhead conductors have been calculated on the basis of a single set of conductors of the sizes mentioned on a pole, but when more power is wanted a second set of conductors can usually be added at the cost for copper, insulators, arms and erection only, whereas to lay a second cable will cost practically as large a sum as the first. Herein lies one of the great advantages of overhead distribution; the current can be taken to a works and a small-sized set of conductors put up to commence with at half the capital outlay required for laying a cable of similar section. If the use of electric energy should afterwards be discontinued for any reason, the poles and wires can be recovered and are still worth a great part of the original value, as they can be used elsewhere. If, as is probable, the use of current is extended, another set of larger conductors can easily and cheaply be erected. With a cable, if an underground main is discontinued it is worth nothing to take up. To lay a full section cable in the first instance means locking up a great deal of capital unremuneratively, possibly for some years; on the other hand, to lay a small cable first and a second larger one later is very expensive. In the first case—viz., with overhead conductors—the capital required will only be half that required in the second; and, moreover, a good proportion of it will remain in a liquid form. Thus by employing overhead conductors a power company is sinking a much smaller amount of capital in extending its mains widely during its early stages.

Besides the lower cost per mile of the distributing system with overhead mains, and which in many cases would make the difference whether a supply can be given profitably or not, it is important to observe also that if it will pay to carry the current a certain distance by underground mains, it will pay to carry the current nearly twice as far with overhead conductors; which means that a power station can economically supply current over about three times the area which would be possible with underground transmission at 6,000 volts, and if the pressure is increased the relative areas show a still greater difference. For this reason not only has a power station with overhead transmission a much larger area from which it can pick up customers and thus acquire a load quickly, but it will later on have a larger area to draw customers from, so that the advantages of additional size and concentration are also secured in a greater degree.

It is also important to bear in mind that overhead conductors are, comparatively speaking, free from the complicated phenomena known as resonance effects, which give a good deal of trouble on underground circuits and have been a cause of much anxiety.

Notwithstanding all these obvious advantages, the attitude of the high authorities of the Board of Trade has until recently been so adverse to the use of overhead conductors in this country as to amount to a practical prohibition, and this has led to a timidity amongst engineers in proposing their use and an impression amongst local authorities and the public that they are dangerous, unsightly and liable to faults. I therefore propose to devote attention to these points for a short time, as in the negotiations I have had with the Board of Trade it was on these grounds that I found most opposition and reluctance to move.

Overhead conductors are not now new. For nearly 20 years high-pressure overhead transmissions for series arc lighting have been used on an immense scale in America and elsewhere, and under conditions which would seem extraordinary to many English engineers. Such circuits, moreover, still continue to be used outside great towns. Again, it is now more than 12 years since multiphase transmissions at high pressures came into use, and they have since multiplied enormously outside this country. In Mr. Bell's book on "Power Transmission" there is a list of power transmission plants in America all at pressures above 10,000 volts, the list apparently being carried up to the year 1901. The horse-powers of these various transmissions aggregate 170,000 H.P., and as plants employing over 10,000 volts pressure must be in the minority, it is a fair deduction to make from this and other sources of information that at the present date there must be in America over 500,000 H.P. transmitted electrically by overhead conductors. Notwithstanding this we come across no long lists of accidents, we do not hear of any legislative prohibitions of this method of transmitting energy, there are no signs that overhead conductors are being given up; on the contrary, every week we hear of fresh projects, including such undertakings as the long-transmission lines in California and the running electrically of the whole of the railways in Switzerland, Norway and Sweden, the power for which would in most cases be almost entirely conveyed overhead.

I have also made inquiries amongst several of the leading firms on the Continent as to what accidents have come to their notice, and the invariable reply has been that so far as the general public was concerned they could not recall any, though they could usually mention one or two cases of accidents to employés, almost invariably, however, from transgressing simple rules as to not working on circuits with the pressure on. A little thought will show that with a properly-constructed route of overhead mains, with stout poles 40 to 50 yards apart, the chances of the mains falling are infinitesimal, far less than in the case of telegraph wires, which are much smaller in diameter and are run habitually in spans double the length and are strained up much more tightly in the case of tramway conductors. The most legitimate objection which can be taken to overhead transmissions is from the æsthetic point of view, but against this should be placed to their credit the fact that they would be the means of abolishing much smoke and dirt and heavy coal traffic on the roadways; they would render brighter, cleaner, and more cheerful numberless homes; and by bringing a convenience of town life into more open districts would be a powerful aid in the important object of repopulating the country which is at present so much to the fore.

One of the most desirable objects at the present time is the extension of tramways into the country and the construction of inter-urban tramways, in which so much has been done in the United States. Now, in that country the whole of the feeder work, an expensive item in tramway construction, is carried out by means of overhead mains. Abroad, overhead power-transmission mains freely traverse much of the finest scenery, and yet tourists and others do not find them overpoweringly objectionable. Overhead power mains are not more unsightly than heavy telephone or telegraph transmissions, which we already have with us on a large scale, and as they would more often traverse the open country they would be still less in evidence. A great deal can also be done to remove their obtrusiveness by simply painting the creosoted poles green or grey. Abroad, most of the poles are not creosoted, but when preserved at all are treated by another process. It is the deep dead black of the creosoted pole which attracts the eye and makes the ordinary telegraph pole an obtrusive object in a landscape. The adoption of any means by which the tone of the pole was brought as nearly as possible to that of its surroundings would make an immense difference in this respect.

We now come to the third objection to overhead transmissions—namely, that they are liable to faults. To meet this the best way is to appeal to facts. Overhead transmissions have been used on a large scale for many years in other countries, as alluded to above. Are such transmissions being given up? Do we hear that industries supplied with power in this way find the interruptions a serious source of loss? I can find no evidence to this effect, particularly where the mains are well erected, and it must be remembered that a great deal of overhead transmission is over very rough ground in hilly and mountainous districts where the chances of accident are the greatest. The fact that towns like Rome, Berne, Milan and Buffalo, to name only some which come into one's head at once, are and have been for several years dependent on electric energy supplied over distances of from 15 to 30 miles by overhead mains is clear proof of their reliability when well erected and looked after. It is a point in the favour of overhead transmissions that any fault which may occur can be so easily located and quickly remedied. The risks of wilful damage are much less than is supposed. There is a wholesome dread amongst people generally of electric shocks, and to do effective damage without personal risk requires an elaboration of means and an amount of knowledge which is possessed by few and can only be used with the most deliberate criminal intent. Any tendency in this direction is further restrained in several countries on the Continent by special provisions in the penal code.

The real danger of interference with overhead transmission is from lightning, which the pioneers of this class of work sometimes found exceedingly troublesome; but the question of lightning protection has received much study, and overhead transmissions are freely used now in countries where thunderstorms are so much more frequent than in this country that I do not think we need have any fear under this head in the United Kingdom when proper precautions are taken. Besides this, it must be recollected that practice and experience in those countries where overhead transmissions are used are continually producing improvements and developments, particularly in lightning protection and in the character and forms of insulators, and this progress will continue. There is no more question of finality here than in any other branch of engineering.

(To be concluded.)

CORRESPONDENCE.

PAPERS AND DISCUSSIONS AT THE INSTITUTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The editorial note in your last issue upon wasting time at the Institution deals with a subject of some importance. Efficiency is frequently discussed by members in relation to plant, but it is none the less important in regulating the meetings of the Institution, where it is often overlooked. This applies both to the reading of Papers and to discussions. There is nothing more wearisome and less profitable than the reading of a Paper verbatim. Those who are prepared to take part in the discussion will have already read the Paper, and those who have not read it will appreciate the contents for the moment just as well from an abstract as by the more lengthy procedure. The Council, as far as I am aware, aim at getting an author to give an abstract, but they by no means always succeed. In the case in point, however, Mr. Booth did give an abstract, occupying something like three-quarters of an hour, which was certainly ample, though in itself not excessive. But, in addition to this, his collaborator, Mr. Kershaw, at the next meeting, occupied the best part of another three-quarters of an hour in showing most elementary experiments on combustion which must have been familiar to everyone present—at least, to all who had any appreciation of the subject—and it would have been quite sufficient to indicate in a few words the principles involved. The final result was that nearly an hour and a half were spent by the authors in presenting the abstract of their Paper, and the discussion of a very important subject is thereby cut short. Authors do not seem to realise the importance of giving the speakers who follow them the best possible chance by themselves being brief. Many who are interested and well qualified to speak attend meetings at personal inconvenience, and when they find that discussion is made practically impossible they do not attend on a subsequent occasion, and their contribution is probably lost. Thus the meetings lose vitality.

The regulation of discussions is rather a delicate matter, and the presidential position is difficult. It is easy to criticise and by no means easy to effect reform. There is, however, no shadow of doubt that most people can say all they have to say that is worth hearing in 10 minutes. The 10 minutes rule would solve the whole difficulty, but, unfortunately, no president ever cares to enforce it. What is wanted is the equivalent of an American automatic pulpit. As a practical substitute I should like to suggest the use of a clockwork gong which could be set when a speaker rises and would sound at the end of 10 minutes. At the beginning of every discussion or meeting the president could announce that the 10 minutes rule would be automatically enforced in that way, and he would feel that the somewhat unpleasant duty was out of his hands. Of course there would always be exceptions, but in no case should a speaker continue for longer than 10 minutes without the opinion of the meeting being taken. In that way, very few speakers would exceed 10 minutes, and the later speakers would stand a fair chance with those who speak first, which is not the case at present.

I trust that the importance of the subject will be sufficient excuse for the length of this letter.—Yours, &c ,

Feb. 7. W. R. COOPER.

A NEW MOTOR RHEOSTAT.

In order to meet the more stringent regulations brought about by the use of higher working voltages now in vogue, the Sturtevant Engineering Co. have introduced a new type of motor-starting rheostat, which, it is said, possesses several advantages over the old types. These new rheostats, which have been given the name of "igranic," are made of incombustible material throughout, and no solder is used in making connections. On those rheostats which are designed for currents not exceeding 55 amperes, button contacts are employed, while renewable contacts, segmental in shape, are used for the larger sizes, but the smaller sizes may be thus equipped if desired. There are two patterns of fronts, one fitted with automatic no-volt release, and the other fitted with automatic no-volt release and overload cut-out (Fig. 1). Suitable terminals are provided for the main cables, and a terminal is also provided for taking the connection from the shunt, in the case of shunt-wound machines, to the no-volt release coil. The slate front of the rheostat is screwed to a cast-iron box and insulated from it by means of insulating washers and bushes. Fig. 2 shows the method of supporting the asbestos tubes upon which the resistance material is wound. Each end of a tube fits into a porcelain insulator, the latter being held in a specially-arranged perforated supporting strip, thus ensuring very high insulation between the resistance material and the metal box.

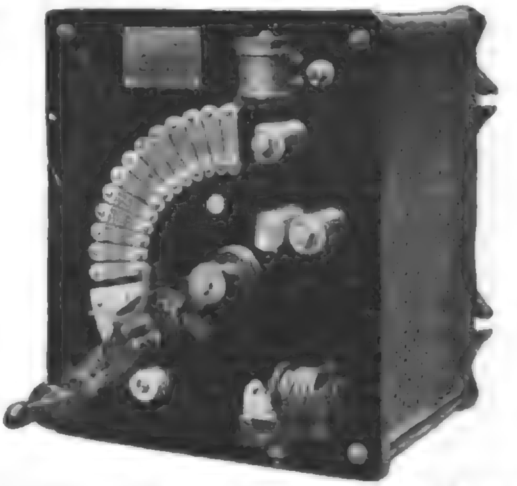


FIG. 1.—"IGRANIC" RHEOSTAT FITTED WITH NO-VOLT RELEASE AND OVERLOAD CUT-OUT.

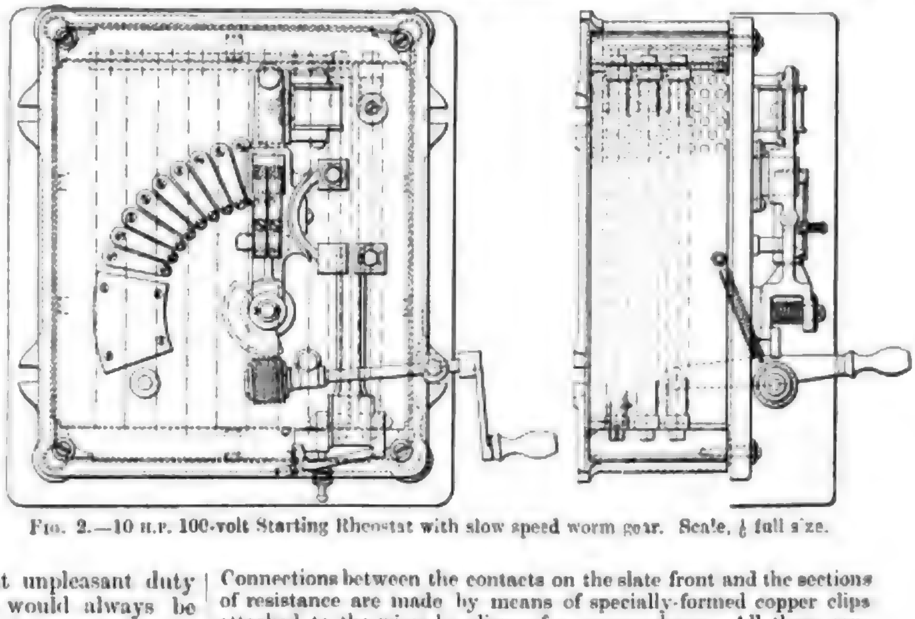


FIG. 2.—10 H.P. 100-volt Starting Rheostat with slow speed worm gear. Scale, $\frac{1}{6}$ full size.

Connections between the contacts on the slate front and the sections of resistance are made by means of specially-formed copper clips attached to the wires by pliers of a proper shape. All these connections are made on the side of the perforated supporting strip remote from the resistances themselves and are insulated entirely by air. They are perfectly rigid, and there is absolutely no chance whatever of a resistance section becoming short-circuited by wires touching accidentally. The top, bottom and sides of the cast-iron resistance box are covered by perforated sheet metal held in position by spring clips at the corners. It is therefore possible to open up and inspect the resistance box without removing a single screw and without requiring special tools.

PARLIAMENTARY INTELLIGENCE.

The Hammersmith, City & North-East London Railway Bill has been further considered, by the examiners of private bills, for proofs of compliance with standing orders, during the week. Non-compliance with standing orders has already been returned in connection with one or two sections of the bill, and consequently it will have to go before the Standing Orders Committee for a decision as to whether it shall be allowed to proceed. On the majority of the points considered this week, however, the promoters had complied with standing orders. In the bill, compulsory easements are taken under various properties and lands along the line of route, but several landowners petitioned that the notices did not include certain unbuilt-upon lands. The view held by the examiners was that if the notices were sufficiently clear for a person of average intelligence to be put upon his guard, then the promoters had complied with standing orders. In this case such a notice had been given and the objection must fail. Another point was that under the terms of the bill there were no powers to compel the promoters to use the scheduled lands for the purposes of the undertaking. If they so desired, it was argued, they could use the lands for the purpose of a building estate. This objection was also over-ruled.

The Great Northern, Piccadilly & Brompton Railway Bill (No. 2) has been reported as complying with standing orders.

The following petitions have been lodged :—Swansea Tramways and Improvements Co. against Swansea Corporation Bill ; Darwen Corporation against Bolton Corporation Bill ; Breconshire County Council and the Herefordshire County Council against the Birmingham Corporation Bill.

LEGAL INTELLIGENCE.

Phillips v. Kingston, Miller & Co.

Mr. Justice Ridley sitting with a special jury in the King's Bench Division on Monday heard an action by Mr. Lionel Phillips against Kingston, Miller & Co., contractors, Oxford-street, London, W., for damages for alleged negligence. Plaintiff contracted with the defendants to erect for him a temporary supper room at the back of his house in Grosvenor-square in July, 1903, when he was giving an entertainment at which Madame Melba and other artistes had been engaged. On the night of the entertainment the room was burnt down in consequence, as plaintiff alleged, of defendants' negligence.

Sir E. Clarke, K.C., Mr. Bankes, K.C., and Mr. Graham appeared for the plaintiff and Mr. Dickens, K.C., and Mr. G. Wallace, for the defendants.

Sir. E. CLARKE said the supper room was erected on the leads covering the lower part of the premises. The defendants handed over the construction of the room itself to Messrs. Simmons & Sons. All they did themselves was to supply materials for the supper. The supper room was a wooden structure covered and lined with canvas and hung with art muslin and lit by electricity. Just before half-past eight the lights were turned on for Mrs. Phillips to see the effect. Immediately afterwards there was an alarm of fire, and in 10 minutes the structure was destroyed and the house itself was only saved with difficulty.

The evidence of Mr. and Mrs. Phillips and Mr. Miller, manager of the defendant firm, taken by deposition, was read.

Mr. T. J. RORKE, of Rorke Bros., electrical engineers, said he had made an inspection after the fire. He found that there had been 155 lamps, of which 18 were full-sized, and there were four electric fans. There were altogether eight double-pole safety fuses 19 5 c.p lamps to each pair of fuses. The fact that there were a large number of lamps upon one circuit increased risk of fire. A recognised allowance was 10 lamps, and this should not have been exceeded. From samples which he took away he found that there were four conductors, each containing 70 strands brought into each miniature lampholder. In employing the looping system in such circumstances great care was necessary, as if one or more wires were left loose the holders being so small and the openings so close together a short-circuit was almost sure to be set up. The risk would have been enormously reduced by wiring the lamps two or three in series, and there would have been no difficulty in doing that. He should never have sanctioned an arrangement of hanging 200-volt lamps among muslin.

Cross-examined : The looping system was not dangerous in itself, but became so when miniature lampholders were used. If there had been 10 lamps instead of 20 to a circuit the fuse could have been smaller and would have gone with more certainty.

Further cross-examined, Witness said the looping system was adopted to save time. There would be some danger in a lamp with two wires instead of four, but to a less extent. The result of a short-circuit would be a flash from a miniature explosion, and the fuse would go usually instantaneously, but not always.

The rules of the Institution of Electrical Engineers say that you can have three amperes per circuit?—I point to the rules of the company supplying the place with electric light.

Do you disagree with the rules of the Institution?—Yes. When lamps are used among drapery.

Witness added that his theory was that there was a flash in one of the lampholders which communicated with the muslin, or it must have run back on the silk covering of the wires.

Re-examined : The system adopted in this case was one in which the risks were great, and the large number and the small size of the lamps increased the risk.

Col. CROMPTON, C.B., R.E., said he had made an examination after the fire. He should say that the fuses, though sufficient for a safe system, would be a source of danger and would not protect the system employed in this case. Fuses were no protection in the case of a short-circuit which occurred when two very small wires—No. 40's in this case—formed a bridge across the terminals of the lamp. He had himself prepared an installation similar to one of the circuits used in the present case. He had wired it as carefully as possible, but immediately he switched on a current of 200 volts there was an explosion in one lamp, and it set light to a piece of cotton wool 2in. away. He put in a new lamp and switched on again, when another lamp went in the same way. He repeated this a third time with the same result. The cause was that it was a moral impossibility to twist together 140 No. 40 wires and push them into the small hole in the socket without leaving one or two behind. A slight movement or oscillation of the lamp brought the loose ends into contact and caused an explosion. It was not possible to ensure safety in using this system with small lamps. The fact of the point of danger being under the cap was an additional objection. When there was drapery near incandescent lamps great additional precautions must be taken. It was for that reason that he was so strongly of opinion that the looping system should not be allowed in a case of this kind. The cap would afford no protection. It acted as a gun, projecting the flash in one direction, and rather further than if there was no cap.

Cross-examined : He had never heard of the looping system being used with very small lamps.

Do you suggest that it would be gross ignorance in an electrician of experience if he said the looping system could be safely used?—Yes. It should only be allowed, if at all, where there was no risk of danger in the case of a flash. The looping system used in connection with small lamps was not contemplated when the rules of the Institution of Electrical Engineers were drawn up. It was only introduced as a slipshod practice of wiremen two or three years ago.

A circuit was here handed up in which calico was twisted round conductors.

The WITNESS : I did not know it had calico twisted round the whole length. That is what caught fire. If that resembles exactly the circuit put up I have an additional reason for saying it was diabolically dangerous.

Would not the fault, if any, have shown itself during the previous tests?—No. It is entirely a matter of chance when the lamp goes. Tests are useless.

Re-examined : He did not think any fire insurance inspector would have passed this arrangement.

Expert evidence was also given by Mr. Jas. Swinburne.

For the defence evidence was given by SAMUEL WAITES, foreman in the employment of Messrs. Simmons Bros., who said the whole of the fittings were put together and tested in the shop for half an hour. There were six circuits of 20 5 c.p. lamps in the room, and there were, in addition, some eights on the staircase. There were in all 18 single-pole fuses. Witness went into the room with three assistants after the light had been turned on. One of the men said, "I smell something burning. Switch off." Witness immediately switched off, and looking up saw a black patch the size of the palm of his hand on the muslin. He had previously noticed that smoke was coming from the direction of the electric fan, which was working at the time. The man beat on the muslin with his hands, then all at once it burst into flames.

Re-examined : He had seen a fire in the harness room at tea time. He could not say where the smoke came from that was drawn into the room by the fan.

THOMAS BARRATT, examined, said he was working on the job when the company's inspector tested the work, after which the lights were going for about an hour on and off. Later on he smelt smoke, and saw some coming out of the fan. He saw some sparks. He did not notice any smell of burning rubber, but burnt rag or calico. That was about 10 minutes after Mrs. Phillips left. The black patch he saw was at least 18in. from the lamps.

Mr. A. H. DYKES, examined, said that the looping system came into existence before 1890. The object of that system was to have no joints. He had known the looping system used with these 5 c.p. lights. From his experience, if proper care was taken there was no danger in using the system used by the defendants. In nine cases out of ten the fuse would go at once if it went at all. Contact might be caused by vibration if the wires coming out of the holder were not properly secured, but in this case four wires had to go through the ebonite collet, and it was very unlikely that they would come out sufficiently to let the whole weight of the holder come on the wires. With a double set of wires, as in this case, the grip would be much tighter. His experience was that if a lamp was going to give trouble it gave it when the light was first turned on.

It is suggested that a spark might have come out of the head of the lamp itself? The insulating collet at the top of the holder is fairly well filled up, and I should imagine that the arcing inside would be confined long enough for the fuse to go before anything could come out.

It is suggested that you should have a fuse to every eight or 10 lamps? —The standard rules are those of the Institution of Electrical Engineers, which say nothing about the number of lamps, but that they should be divided up amongst three ampere circuits. He had heard nothing which induced him to believe that the fire was due to the electric light.

The JUDGE : What, in your opinion, caused the fire?—I think probably a spark from a chimney outside, because the first symptom of fire was noticed at a spot a foot or two above the nearest wire. Another circumstance was that a smell of burning was noticed some time before the scorching muslin was seen. Muslin scorched and turned black, but there was no smoke until it burst into flame. He thought there must have been something at the back causing smoke and scorching the muslin.

In cross examination witness's attention was directed to the rules of the Liverpool & London & Globe Insurance Co., advising wire guards to prevent lamp bulbs coming in contact with flimsy goods. He admitted that muslin arranged in contact with large lamps would be an element of danger which it would be negligence not to avoid. It was not difficult to push two wires of 70 strands each into small lamp-holders. He should not expect a workman to have any more trouble in wiring a lamp with 70 No. 40's than with 25.

Are you prepared to say this arrangement was as safe as if the lamps had been arranged in series?—I am.

Mr. W. M. MORDEY generally agreed with the last witness. He had examined drawings of the installation and samples of the materials and fittings. The workmanship and materials were good and the arrangements, in his opinion, were satisfactory. The system was a proper one for a contractor to have used and one that his firm had used by preference in work where there was a risk, such as theatre work. For decorative work he should have used miniature lamps. While the last witness was giving evidence he had connected up two ends, each containing 70 strands, and twisted them together, and there was plenty of room to go through the porcelain. It was quite slack in the hole. Nothing short of rough handling would cause contact between loose ends. There was evidence of quite unusual care in the way in which the work had been carried out. In his opinion the fire could not have been caused through the electrical fittings.

FREDERICK DODD, a tester for the Westminster Electric Supply Corpn., said he had tested the insulation and found everything correct.

Cross-examined: His work was only to see that there was proper insulation and no leakage. His company advised eight to ten lamps, but did not always get it. He had not tested the fans and was told nothing about them.

His LORDSHIP, having summed up, asked the jury to say if the fire was caused by the ignition of the electrical insulation, and, if so, was it brought about by want of care on the part of the defendants.

After an absence of about 10 minutes, the jury, without answering the questions specifically, returned a verdict for the defendants on both the claim and counter claim.

Judgment was entered accordingly.

Sheffield Corporation v. Wilson.

Last week a Divisional Court heard the appeal of Mr. A. Muir Wilson, a member of the Sheffield Corporation from the decision of the Sheffield Stipendiary Magistrate convicting him of having, while a passenger on one of the Corporation's tramcars, refused to deliver up his ticket when requested so to do. The facts of the case were given in our issue of July 22.

After hearing arguments, the LORD CHIEF JUSTICE, in giving judgment, said he could see no evidence that appellant had unlawfully refused to deliver up his ticket when requested to do so. The ticket was tendered by the conductor, but the appellant was so anxious not to touch the accursed thing that he let it fall on the floor. When he was asked for his ticket by the inspector the appellant pointed to it on the floor, and in these circumstances he could not hold that there had been an unlawful refusal to deliver it up. He would express no opinion with regard to the conditions which had been printed on the tickets. The other judges concurring, the appeal was allowed, and the summons dismissed, with costs.

Workmen's Compensation.

At Wandsworth (London) County Court last week, before the Hon Arthur Russell and a jury, a man named Gregory claimed from the W. R. Sykes Interlocking Signal Co. (Ltd.) £150 under the Employers' Liability Act for the loss of a finger. Plaintiff, a labourer aged 53, was in June last engaged with others in raising a hydraulic hammer, weighing between 5 and 6 tons, by means of a chain-block pulley, when one of the links formed a kink. Gregory was told to release the link, and was in the act of doing so when some other men pulled the chain and a portion of his right forefinger was smashed at the joint. Plaintiff was laid up for 17 weeks and received from defendant company 25s. a week. Since October he had performed lighter work at his old rate of wages (26s. 10d.) a week. Defendants pleaded that plaintiff was foreman of the job when the accident occurred and that there was no negligence on their part. The jury, however, awarded plaintiff £75, and judgment for this amount and costs was made.

At Salford County Court on Monday, before Judge Parry, a point arose as to whether a workman was entitled to compensation under the Workmen's Compensation Act if his injuries were directly due to an assault by a fellow-worker. In August last two men (Watson and Olive) employed by a firm of contractors in concreting one of the upper floors of a transit shed at the new Salford dock quarrelled, and Olive struck Watson. The latter was not seriously hurt, but fearing another blow he lifted his hands and stepped back, with the result that he fell over the edge of the floor a depth of 32ft. His leg was broken and he sustained serious internal injuries. He is now able to get about on crutches. For plaintiff it was contended that the accident was caused by plaintiff's feet catching in some "stirrups" and that it arose out of his employment. For respondents it was argued that the accident was due to the assault and not to anything connected with applicant's employment. It was a tortious act, and it had been held that in such a case it was not an accident.

His Honour said the accident was the result of an assault, and he had no doubt that the Legislature intended such a case to be covered by the Workmen's Compensation Act. In Armitage *v.* L. & Y. Railway Co., however, the Court of Appeal took a different view, and he must, therefore, decide in favour of the contractors.

In the King's Bench Division on Tuesday, before Mr. Justice Darling and a special jury, the father of a youth named Furlonger claimed damages from the London Electric Supply Corpn. under the Workmen's Compensation Act.

Mr. GERMAINE, K.C., for plaintiff, said his client was father of a youth who met his death in defendants' sub-station, in Blackfriars-road, London, where the youth was employed as cleaner. The sub-station was connected with the main station at Deptford, and it had the usual appliances for converting high-tension current (10,000 volts) to 2,000 volts, and then transmitting it to places where it was used. Such a current was sufficient to cause death to anyone coming in contact with it, and the greatest care was necessary to protect the people employed in the place from injury. There were a number of converters which the young man had to clean and dust every morning, and on March 4 last year, whilst he was so employed, he fell down and caught hold of a live wire. He was picked up insensible and taken to a hospital, where it was found necessary to amputate one arm and both legs. He died, and his parents now sought to recover damages on account of alleged negligence of defendants in not efficiently protecting the live wire. Plaintiff had applied to the defendants for compensation, and they offered to pay reasonable funeral expenses and medical attendance, if any, and compensation under the Workmen's Compensation Act if they were satisfied that he had left anyone dependent upon his earnings. Plaintiff's solicitor asked for £500 compensation, but, as no settlement had been arrived at, the present action was brought.

During the evidence (which went to show that the deceased only contributed to the parents the cost of his board), Mr. GERMAINE said it was impossible for him to prove damages, and he could not carry the case any further.

His LORDSHIP expressed the opinion that plaintiff had been very ill-advised to bring the action as he was unable to prove either negligence or special damage, as the deceased was only bringing into the house 8s. per week, out of which no profit could be made. Plaintiff's solicitor should have known better than to say that he considered £500 a moderate claim under the circumstances. If plaintiff would take his advice, he would see what he could arrange with the defendant company.

The case was withdrawn on this understanding.

At Dudley County Court last week, before Judge Howland Roberts, a tramcar conductor named Lowe sought to obtain from the Dudley, Stourbridge and District Electric Traction Co. compensation for injuries. Applicant was on April 5 engaged on a car that at the time of the accident was standing on one of the sidings of the market place. He was turning round the trolley-pole when, through the alleged carelessness of a motorman on another car, his left leg was crushed between two tramcars. The injured limb had to be amputated, the man being, therefore, totally disabled for his then employment. The question arose as to whether the accident occurred on a light railway (and so came within the provisions of the Workmen's Compensation Acts), or upon a tramway.

His HONOUR held that the sidings were used in connection with the light railway, but as there was no proof that the sidings were constructed under the Light Railway Order, the action must fail.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Three additional assistants competent to give instruction in the theory and practice of electric machine design, construction and testing, are wanted in the department of electrical engineering of the City and Guilds Technical College. Commencing salaries £200, £150 and £150 per annum respectively. Applications to Prof. Ayrton. See also an advertisement.

An assistant is also required for the mathematical department, who possesses sound knowledge of elementary mathematics and of the elements of the differential calculus and integral calculus. Salary £100 per annum. Applications to Prof. O. Henrici. See also advertisement.

An assistant is required in the civil and mechanical engineering department of the City and Guilds Central Technical College, Exhibition-road, London, S.W., who can teach mechanical drawing and mechanism. Salary £150 per annum. Applications to Prof. W. E. Dalby. See also advertisement.

Mr. T. B. Holliday, engineer and manager of the Brighton Corporation tramways, has tendered his resignation in consequence of his having accepted the position of manager of the Hastings Electric Tramways Co. For a number of years Mr. Holliday held a responsible position in the service of the Imperial Tramways Co., and supervised the laying of that company's permanent ways in London, Bristol, Stockton-on-Tees, Middlesbrough and other towns. He was previously for 11 years with the Melbourne Cable Tramways Co. and was appointed engineer and manager at Brighton in August 1900.

Bradford Electricity committee have appointed Mr. C. W. Salt, of Croydon, as second assistant engineer at £250 per annum. The other candidates in the short list were Messrs. J. R. Blaikie (Streatham), I. H. Birrell (Worcester) and R. N. Torpy (Wimbledon).

W. R. Nice, of Lancaster, has been appointed meter assistant at Hammersmith electricity works.

Mr. Ralph, of Stalybridge, has been appointed superintendent of the tramways at Leith during their conversion to electric traction.

Mr. Frederick Coutts, manager of Ayr Corporation tramways, has been appointed manager of the Paisley District Tramways Co., at a salary of £400 per annum.

Mr. W. H. Oxley, of Lincoln, has been appointed charge engineer at King's Lynn.

Dover Corporation last week appointed Mr. C. H. Lydall as station superintendent (in succession to Mr. T. McGill, resigned) at £150 per annum, rising by annual increments of £25 to £200.

Battersea (London).—The Lighting committee reported on Monday that the L. & S.W. Railway Co. had been in treaty for the supply of energy for lighting and power at the Nine Elms goods yard, and the directors had intimated their willingness to take supply and guarantee a consumption for five years of 200,000 units per annum, as per terms agreed upon. The company may at a later date require a much larger quantity to be supplied. The committee have asked the electrical engineer to prepare a scheme to include the supply of current to the whole of the extensive Nine Elms goods yard.

Beckenham.—The District Council are now considering the advisability of taking over the electricity works, which have been maintained by the British Insulated & Helsby Cables (Ltd.) for the past five years under lease.

The Council recently decided to charge 7d. per unit for electric current supplied for traction from 6 p.m. to 9 p.m. and 1½d. per unit for the remainder of the 24 hours.

Bermondsey (London).—The engineer to the Surrey Commercial Dock Co. recently inquired if the Council would supply current to the company's Acorn and Commercial yards, the former (up to 83 amperes) by end of February and for Commercial yard (up to 400 amperes) by mid April or earlier.

The electrical engineer (Mr. W. H. Vincent) said he could give supply at the dates named up to 83 amperes and 300 amperes respectively, and the cost of the extensions would be £264 and £142 respectively.

It was decided to supply current at rates quoted to the company in December.

The electrical engineer also reported having been in negotiation with the S.E. & C.R. Cos. regarding a special tariff for current to be used for lighting the staircases and areas of artizans' dwellings, and in consideration of current being consumed during all the hours of darkness the street lighting rate of 3d. per unit is to be charged

Bo'ness.—Electricity supply was inaugurated on Monday. The works have been erected and equipped by the National Electric Construction Co.

Callender's Works Hospital and Distress Fund.—We have before called attention to the excellent work that is being done by the Hospital and Distress Fund associated with Callender's Cable & Construction Co. From the second annual report, which is now before us, it is clear that the good work continues. As evidence of the necessity for this fund 176 letters for the various hospitals to which the fund has subscribed have been issued during the past year, 10 members of the fund have undergone operations at the hospitals, 74 letters for surgical appliances have been issued, and gratuities to the amount of £111. 5s. have been granted to members to tide over difficulties in which they have found themselves. Subscriptions of members amounted to £268. 5s. 2d. in the year, and beyond this Callender's Co. have contributed £50 as a donation, and about £26 in addition has been collected. £211 has been granted from the fund to various hospitals, the Surgical Aid Society, and to convalescent homes. The fund has thus in every way justified its existence, and must have proved a great boon to its members. It concludes its second year of existence with £174. 16s. 3d. in hand.

Catalogues for Southern Nigeria.—Mr. Frederick J. Hughes, H.M. Travelling Inspector of Telegraphs, Calabar, Southern Nigeria, will be pleased to receive from time to time catalogues from manufacturing and supply houses that may be considered likely to interest him.

Chelsea (London).—On Wednesday the Council discussed a letter from the Local Government Board with respect to the recent application for sanction to borrow £29,000 for public baths and for an independent electric lighting plant. The Board replied that while the scheme appeared to be generally satisfactory the Council would be well advised to consider whether it would not be more economical to purchase electric current required rather than provide their own generating plant.

Cheltenham.—An inquiry was held here last week into the application of the Council for permission to borrow £2,000 for the purchase of additional plant to supply electric current to the tramways. There was no opposition.

Coleraine.—Portstewart Sanitary and Waterworks committee recently asked the Rural Council to light the streets of Portstewart and to authorise the appointment of an electrical engineer to deal with the question. It was decided to defer consideration of the matter until a memorial in favour of electric lighting signed by three-fourths of the Portstewart ratepayers has been received.

Complimentary Dinner to Mr. James Paxman, J.P., C.B.—On Friday last the staff of Messrs. Davey, Paxman & Co., Colchester, gave a complimentary dinner to Mr. James Paxman, J.P., C.E., in the Masonic Hall, Colchester, to commemorate his term of office as High Sheriff of the County of Essex. In the afternoon a large party of guests were shown over the extensive works, covering an area of 18 acres, and fitted with most modern plant, machinery and tools for the manufacture of engines, boilers and other machines for which the firm have a well-earned reputation. The visitors were afforded an opportunity of inspecting an engine of 1,100 H.P., coupled direct to a 750kw. alternator running on test. These double-acting engines are a new departure in the firm's manufactures. There were also on show several engines of a similar type on order for Sheerness Dockyard, Paisley and Swindon Electricity Works, Cape Town, &c.

At the banquet in the evening the chair was occupied by the secretary of the company (Mr. W. Hedley King), and there were present, amongst many others, Sir William Preece, Sir Wm. Birt (director G.E. Railway), Mr. J. Wilson (engineer G.E. Railway), the Mayor of Colchester (Ald. E. J. Sanders, J.P.), the Mayor of Chelmsford (Councillor W. P. Gepp), Mr. W. Paxman, the Under Sheriff (Mr. C. B. O. Gepp), the majority of the aldermen and councillors of Colchester and the following members of the staff; Messrs. H. Allen, A. A. Arnold, A. Bailey, J. M. Bedwell, C. Brunning, A. P. Butcher, C. A. Cresswell, G. W. Doe, Stephen Eddy, H. Firmin, H. Fiske, J. Francis, R. Franklin (Chelmsford), H. Glass, W. Girling, F. W. Hall, T. H. Harrison (London), Geo. Haywood, B. L. K. Hazell, H. H. Hollaway, Stephen Ivey, Hermann Jahn, W. W. Judd, G. E. Lloyd, E. N. Mason, C. Mecklenberg, H. McCalmont, E. Millbourn, Geo. Phillips, H. G. Plane, M. G. Plane, F. H. Preece, A. Sawyer, Geo. Smith, J. T. Smith, Samuel Smith, Sidney Smith, and W. Turner. The Earl of Warwick regretted his inability to be present, owing to his leaving England the same day.

To the toast of "Engineering," proposed by Councillor A. Prior, J.P., Sir William Preece responded, and said that it was now 53 years since he entered the engineering profession, and 46 years since he became a member of the Institution of Civil Engineers. At that time the membership of the Civils was about 700; at the present day it was about 7,000. The application of electricity to practical work 53 years ago was very limited, but to-day the engineering industry had benefited largely by the immense development of electrical engineering. Mr. J. Wilson, who also responded, referred in high praise to his experience of the good work turned out by Messrs. Davey, Paxman & Co., of which he had had acquaintance for 25 years.

The Chairman then proposed the toast of the evening, and said that the staff desired to celebrate the honour conferred by the King on their chief as High Sheriff of Essex. Mr. Paxman (he said) was held in the very highest esteem by all who knew him, either socially or in business, and certainly the staff of Davey, Paxman & Co. were amongst those who appreciated the many good qualities of their chief. Representing the staff on this occasion, he could not speak too highly of the considerate manner with which Mr. Paxman treated the staff and all employés, every one of whom was proud to be associated with Mr. Paxman and with the undertaking over which he presided. The honour which had been conferred upon him by the King the staff regarded as a great tribute to Mr. Paxman's ability, which had been shown by the determination and energy which he had brought to bear upon the undertaking with which he had been so long associated. The present works were established nearly 40 years ago, and were an abiding testimony to the energy which Mr. Paxman had shown in bringing them to their present state of efficiency. In this country, in America, and in all parts of the world the name of Paxman in connection with engineering was well known, and the firm held a reputation second to none. Mr. Paxman had been twice mayor of Colchester, and was a good landlord and a benefactor to the town. They all wished their chief and friend very many years of happiness and the full enjoyment of good health to continue his labours. He wished to add that the staff and employés had the same high opinion of the High Sheriff's son, Mr. William Paxman.

The toast was drunk with great enthusiasm, and in reply Mr. Paxman thanked the chairman, the staff and employés, and the guests present for the kind reception he had received. He was extremely proud to be associated with the splendid staff the company had around them, always honourable, willing and able. It was obvious that without their co-operation, good workmanship and energy he could not have established and brought the firm of Davey, Paxman & Co. to its present high position. He regarded it as a great compliment to be asked to meet his staff on an occasion like this. He desired to pay a well-merited tribute to his son (Mr. William Paxman), whom he had every reason to know was much respected, and who had now taken over an active part in the control of the undertaking. With regard to the future of engineering, a recent visit to the United States had impressed upon him the necessity for continual alertness. The American success was largely due to the fact that the American man thoroughly believed in himself. He (Mr. Paxman) did not think we had much to learn from America in the building of large engines and boilers, but from a careful study of the American methods of business a great deal was to be learned.

The toast of the firm, proposed by Ald. H. Goody, J.P., was warmly received, and was responded to by Mr. William Paxman, Ald. Wilson Marriage and Mr. A. P. Butcher.

The High Sheriff then proposed the toast of the staff of the Standard Ironworks, and regretted there was no building in the town large enough to accommodate the whole of the staff and employés; but he would like them all to know how much he appreciated the good work they did, as was shown by the many prizes they had won at exhibitions and elsewhere in keen competition.

Sir William Burt expressed his pleasure at being present on the occasion to do honour to Mr. Paxman. Essex, he said, was renowned for its hospitality, and there was no better representative in the county than the present High Sheriff.

During the proceedings, which lasted to a late hour, the orchestral band of the Standard Ironworks (conducted by Mr. F. Snelling) rendered an excellent selection of music.

Customs Changes.—The Board of Trade have received from the High Commissioner for Canada bulletin No. 84 (1904) issued by the Canadian Department of Customs, from which it appears that among the articles subject to special duty (if sold at a reduced price for export) are the following:—

Electric travelling cranes, electric meters, electric motors, dynamos and generators, transformers, switchboards, insulated wires and cables, incandescent and arc lamps, porcelain insulators and cleats, lightning arresters, switches, cross-arms, cutouts, plugs, rosettes and wiring accessories, electric fuses for blasting purposes, wire rods, structural work (including heavy castings, and wire of all kinds, sizes and gauges).

Dublin.—At the meeting of the Corporation on Monday the report of the committee of the whole house recommending the Council to retain in its own control the electric lighting undertaking was considered, and, after a brief discussion, approved.

At the same meeting a letter from the Irish Local Government Board was read, notifying the receipt by the Board of the report of their chief engineering inspector (Mr. Cowan) on the recent inquiry into the application of the Corporation for sanction to a further loan for additional generating plant at the Pigeon House station. After reviewing the main features of the inquiry as reported by Mr. Cowan, the Board's communication concludes as follows:—

In view of the circumstances of the case, it appears to the Board that the Corporation were not yet in possession of clear and comprehensive information as to what was required to convert the Pigeon House scheme into a successful undertaking, and the Board consider that the Corporation should, without delay, investigate most carefully the question as to what additional capital expenditure was necessary to provide for a larger output for private consumption than had yet been estimated for by their engineer, and to enable them to fulfil their statutory obligation to extend the electric supply to Clontarf. Without very careful management it would be found impossible for some years, irrespective of the amount of capital expended, to prevent an annual loss in the working of the undertaking or to reduce the present average sale price of 4½d. per unit to the more moderate figures which are charged for electrical supply in other places.

With respect to the application for sanction to the loan of £21,000, the board saw no reason to question the wisdom of providing the additional 1,500kw. generating set, and they would be prepared at the proper time to sanction a loan for that purpose; but in the meantime they trusted that the Corporation would, without delay, apply themselves to the serious questions raised at the inquiry as to how the general scheme could be improved in order to prevent annual loss to the ratepayers, and as to the extension of an electric supply to Clontarf, which was mandatory on the Corporation under their Act of 1900.

Dudley.—Application has been made to the Board of Trade to appoint an arbitrator to determine the price to be paid by the Council for local tramways.

Eastbourne.—The Council have decided to give supply of electricity in Willingdon at the same charge as in Eastbourne.

Electrical Chess Club.—The chess club which was formed by the B. E. T. Associated Companies last year now numbers over 30 members, and has arranged to hold its weekly gatherings at Carr's Restaurant, Strand (adjoining Clement's Inn), on Thursday evenings. Chess players connected with the electrical industry are invited to communicate with the secretary, Mr. H. S. Parnell, Donington House, Norfolk-street, W.C.

Electrical Exports from America during 1904.—The value of exports of electrical machinery and material from the United States during 1904 amounted to $10,960,231, the largest amount on record. In 1903 the figure was $9,856,017, in 1902 $9,997,195, and in 1901 $7,452,783.

Electricity in Mining.—At the recent meeting of the Redhill (Westralia) Gold Mines (Ltd.) the chairman (Mr. St. John Winne) stated that when the company's new electric plant was installed (in about three months) the output would be materially increased, and would therefore greatly improve the prospects of the company.

Exhibition.—It is announced that the Cape Town Industrial Exhibition will remain open until Feb. 28.

Falmouth.—Plans of the proposed electricity works were approved by the Council on Tuesday.

Forthcoming Books.—The 1905 edition of "Garcke's Manual of Electrical Undertakings" will be published in a few days. Included in the contents will be found a number of special maps, and a full list of hon. members, members, associate members, and associates of the Institution of Electrical Engineers, besides a mass of statistical matter relating to the finance of electricity supply, &c.

Halifax.—The Corporation tramway extension from Sowerby Bridge to the Triangle was officially inspected on Tuesday, and will be opened for traffic to-day.

Halifax-Huddersfield Tramways.—A syndicate which proposes to construct a system of tramways to connect the Halifax and Huddersfield tramway systems, has obtained the sanction of Elland District Council to the scheme.

Hammersmith (London).—On Wednesday instructions were given for tenders to be invited for supplying cables required for the extensions to Wood-lane and Old Oak-road from firms who recently tendered for the cables to supply Olympia.

Horsforth.—The Yorkshire Electric Power Co. recently offered to supply electricity in bulk and the District Council have decided to make a canvass to ascertain the probable demand for current.

Ilkley.—The Council obtained a provisional order in 1901, and in reply to an inquiry from the Board of Trade announce that they are awaiting the erection of the Bingley station of the Yorkshire Electric Power Co. before deciding as to electricity supply.

Keighley.—Tenders are to be obtained for additional plant, estimated to cost £4,480, for the electricity works.

Labour Questions.—The Electrical Trades Union held a meeting last week at Acton (London) "to protest against the employment of cheap labour upon the electrification of the District and Underground Railways of London."

Mr. J. Macdonald [whose special qualifications for discussing the question did not transpire] said "the safety of the travelling public was endangered by the incompetent and unskilled men who were engaged in gangs under the control of hustling foremen who were themselves paid badly." [The speaker did not descend to figures to justify either statement.] In order (he continued) to prevent a disaster "which would certainly occur" steps should be taken to secure certified competent and well-paid men to do the work.

Mr. A. Ewer instanced cases where injury to life and property had happened "which were 'probably' due to badly-paid work" as follows:—Fire at Eton College, June, 1903; Liverpool Overhead Railway, Dec. 23, 1901 (train destroyed, station damaged and six persons burnt to death); Paris, Aug. 10, 1903 (85 persons burnt to death); also many other electrical fires before and since. He also asserted that recently a prominent electrical contractor had stated that it was criminal for a "workman" to put in bad electrical work under a floor above which persons had to sleep. If this was criminal (said Mr. Ewer), how much more so was it for bad work to be put into the trains which would carry thousands of the travelling public through the underground tunnels of London!

This is a truism, but Mr. Ewer should have gone a step further and have informed his hearers how such a remark applied in the particular case of the London Underground Railways. This he omitted to do.

Liverpool.—The tramways general manager (Mr. C. R. Bellamy) recently presented an interesting report upon the subject of halfpenny fares.

Mr. Bellamy urges that if a universal penny fare were introduced in Liverpool, there would be serious risk of the majority of the citizens claiming either that they were being improperly charged a large proportion of the cost of carrying the long-distance passengers, or that they should be carried at a proportionate rate for shorter distances. If halfpenny stages could be limited to ½ mile, there might be some argument in favour of their introduction, but it seemed clear, as a result of carefully observing the operation of those stages in Glasgow and Sheffield, that the ever-growing demand for the approximation of the halfpenny stage in point of length to that of the penny stage, as in London, would be irresistible. A census had been taken of the distance travelled by each passenger on a typical route over a fairly representative period. It was found that of the 91 per cent. of penny passengers, 30 per cent. rode less than 1 mile, and 30 per cent. less than 1½ miles. Of the latter, it was fair to assume that with 1 mile stages at least half the passengers in that group would take advantage of them by walking to the mile limit. It might therefore be reasonably calculated that under such stages 45 per cent. of the present penny passengers would pay halfpenny fares. On the present revenue of the tramways department that would mean a reduction of £95,000 per annum. To provide for that loss at least 45,000,000 additional halfpenny passengers would be necessary against the 9¼ millions which it is assumed would be obtained. There would, therefore, be a deficit of nearly 36,000,000 passengers, representing a loss in revenue of £75,000. To put the case most favourably for halfpenny fares, and assuming that in Liverpool the traffic figures would rise to those of Glasgow, there would be an increase of 23,000 000 passengers, which would leave a deficit of 22,000,000 passengers, representing a loss of revenue of £45,800, which would further be increased by about 20 per cent. in the operating charges due to the increased number of passengers, amounting to £68,000, and seeing that the service would also require to be increased by 20 per cent., involving the addition of 80 cars, there would be a further capital expenditure required of £44,000, which would increase interest and sinking fund charge to the extent of £2,640. Whether the addition of 20 per cent. in the cars running over the already congested lines in the centre of the city could be safely provided for was an open question, and the committee might at once be involved in the problem of providing central lines. Having regard to all these considerations, the general manager is strongly of opinion that the introduction of such halfpenny stages would seriously jeopardise the commercial stability of the undertaking. With regard to workmen's fares, Mr. Bellamy submits that Liverpool has adopted a general fare which is below the statutory fare of a halfpenny per mile fixed for workmen, and he is against any change. He concludes by asking the Tramways committee to consider whether it would not be a wise policy to refrain for a time from experimental concessions which it would be difficult to recall, and which might prove disastrous to the tramway enterprise.

London County Council.—At Tuesday's meeting it was agreed to loan Hampstead £4,335 for electric lighting purposes.

Tramways.—The total receipts of the Council's tramways from April 1 to Jan. 28 were £550,061, against £427,754 in the corresponding period, the length of tramway being 47½ miles, against 39¾ miles.

Mr. Hubbard called attention to the fact that the Chatham & Dover Railway had taken off workmen's trains, and asked if the committee would consider the question of the purchase of the South Suburban Tramways Co. and also if more trams could not be put on.

Sir M. Beachcroft asked if the committee had considered whether motor cars could be used upon the present tramway lines.

Mr. Dolman asked if the committee had considered the fact that the South Suburban Tramways Co. were applying to Parliament to electrify their lines.

Mr. Baker said he was afaid their power in the neighbourhood of Loughborough would not enable them to put on more trams at present. If any proposal came from the South Suburban Tramways Co. the committee would consider it. They had looked to see if any practical motor car could be utilised, but they were assured at the present moment that it was impossible to put on a heavy tramcar run by auto-motor or any other motor without entirely reconstructing the lines.

Macclesfield.—The question of a public supply of electricity, which has been so often before the Council, has assumed definite shape. The application of Messrs. Foote & Milne for a provisional order appears to have brought matters to a crisis, and the Board of Trade has, we understand, now given definite intimation that the Council's 1901 order will be revoked unless some genuine steps are taken to carry its provisions into effect. It was therefore decided at a meeting of the Council last week to proceed with a scheme forthwith. Subsequently the Electricity committee met and decided to invite Mr. J. H. Woodward (Messrs. Preece & Cardew) to meet the committee to discuss arrangements for preparing a scheme.

Marylebone (London).—The Board of Trade have fixed Dec. 22 last as the date for the commencement of the St. Marylebone Electric Lighting Order, 1901.

Motor 'Buses as Railway Feeders.—Nottingham Tramways committee recommend the Corporation to oppose the Midland Railway Co.'s bill in Parliament, objection being taken to the clause which would authorise the company "to use in connection with or in extension of their railway system or otherwise in any district to which their said system affords access, omnibuses, coaches, cars and other road vehicles to be drawn or moved by animal power or electrical or any mechanical power, to enter into agreements with any company or person for the supply or working of such omnibuses," &c., as the committee consider that the clause would enable the company to compete with the municipal tramway undertaking.

Parliamentary.—Notice is given by the Midland Electric Corpn. for Power Distribution (Ltd.) of intention to apply for leave to introduce a bill seeking authority to supply electrical energy in bulk in Stourbridge; to enter into agreements with the Stourbridge Urban District Council, or with other companies, for the supply of electrical energy in bulk by or to such Council or companies; to confirm agreements for supply of current to railway or tramway companies; to revive or extend the time limited in which the Stourbridge District Council are required by their 1899 order to lay mains and supply current; to alter, amend and extend provisions of the Midland Electric Power Distribution and Lighting Orders, 1898 and 1899, and the District Council's order of 1899, &c.

Perth.—The burgh surveyor and the water manager have been instructed to prepare estimates for the removal of the water and gas mains out of the track of the projected electric tramways in order to save future expense and inconvenience.

St. Helens.—The Council have granted the following increases of salaries: Mr. F. Dickinson, works superintendent, from £150 to £160 per annum; Mr. C. White, mains superintendent, from £150 to £160; Mr. J. W. Warr, traction and motor superintendent, from £120 to £140; Mr. R. M. Maine, station engineer, from £120 to £180; Mr. R. Roby and Mr. J. Croston, shift engineers, from 38s. 6d. to 40s. per week.

Siberian Telegraphs.—So many misleading statements have been made concerning telegraphs in the Far East of late, that it was hardly to be expected that the land lines through Siberia would escape the attention of the canardist. A statement was circulated this week that the Russian Government had taken over the control of the Siberian telegraphs. There was no truth whatever in this statement, as telegrams from various points on the Siberian lines and from Manchuria, China, &c., have been received with regularity throughout the period of hostilities, and as late as Wednesday certainly no alteration had occurred. This statement regarding Siberian telegraphs is on a par with a report circulated a few days back concerning the cutting of the cable at Labuan, and with indiscriminate charges against the telegraph companies equally devoid of foundation.

Single-phase Motors at Burton.—Recently the Burton-upon-Trent Electricity and Tramways department have had a number of applications for the supply of electrical energy for motors, and the most important of these are:—

71 H.P. in motors for a timber mill to replace existing steam-driven plant. These are two 30 H.P. Siemens-Schukert motors, one 10 H.P. and one 1 H.P. Fuller-Wenstrom motors for driving circular saws, planing machines, &c.

A 4 H.P. Langdon-Davies motor for driving a hoist has lately been installed in large stores, and the economy is such that they will extend this to some 26 H.P. altogether, the motors driving two hoists, a passenger lift, bread and cake making machines and cooling fans.

A 7½ H.P. motor for driving refrigerating compressing plant at butcher's premises.

In a building workshop a 5 H.P. motor, driving circular saw, and a 7½ H.P. for mortar mill have been installed. This will probably include a further 5 H.P. for a planing machine.

The total horse-power connected with the applications in hand amount to 271 H.P. We are informed that the electrical exhibition held last summer led to a large increase in the number of applications for motors. The connections in motors 15 months ago only amounted to 60 H.P. The total equivalent in 8 c.p. lamps for all lamps, motors, &c., connected with the applications in hand shows an increase in the past twelve months of 35 per cent.

South Africa.—The "British and South African Export Gazette" states that the Cape Electric Tramways (Ltd.) have a bill before the colonial Parliament to authorise extensions to Woodstock and Maitland.

The £115,000 which Pretoria Corporation are to pay in 5 per cent. bonds for the Pretoria Electric Lighting Co.'s undertaking works out at £1. 2s. for each £1 share. The charge for current has been reduced to 1s. per unit for lighting and 5d. and 6d. for power.

Potchefstroom Consumers' Electric Light and Power Co. have accepted the Town Council's offer of £6,000 for the company's undertaking. Considerable extensions are contemplated.

Ladysmith (Natal) Corporation are recommended by the Streets and Public Works committee to accept the offer of Mr. J. Addison, of Kimberley, to erect and maintain electricity works, the Council reserving the right to purchase at the end of seven years at a valuation plus 15 per cent., or at the end of a further 10 years plus 5 per cent. It is proposed to fix the maximum charge for current for lighting at 1s. 6d. per unit, and for power at 25 per cent. less, and to approve steam or oil engine driving at the works and overhead transmission at 200 volts.

It is expected that Boksburg electricity works will be operating by April next. Three-wire direct current distribution is to be adopted, with a pressure of 500 volts across the outers and of 250 at consumers' terminals. The maximum charge to private consumers will be 1s. per unit. The concessionaires (Messrs. E. H. Gellender & Co.) have ordered Davey-Paxman boilers, Belliss & Morcom engines and General Electric dynamos.

It is probable that electric light and power plant will shortly be installed at the Giant Mines of Rhodesia.

Cape Colony postal department recently issued a second invitation, through local agents, for tenders for the supply of 6,004yds. of 408-pair and 4,454 yards of 204-pair dry-core lead-covered telephone cable, 3,000lb. gal. steel suspension wire (No. 11), and 14,000 raw-hide cable suspenders. It is stated that no offers were received in response to the first invitation.

The "Financial News" says the first large electric hoist adopted for the Rand has been ordered by Messrs. Wernher, Beit & Co. and the Consolidated Goldfields of South Africa. Electricity, compressed air and steam have been repeatedly tried for hauling from great depths and on the lower inclines of the Rand mines, and it is assumed that the placing of this order is the first definite step in favour of electricity. The three-phase generating plant will be of 900 H.P. and the hoisting motor of 500 H.P. The winder will be placed at a depth of 1,100ft. and will haul on a 1,700ft. incline.

Stafford.—The Town Council decided on Wednesday to let out electric motors on hire, acting as agents for a manufacturing firm.

Sunderland.—The Tramway committee have been authorised to appeal to the Quarter Sessions against the assessment of the tramway undertaking by the Assessment committee. The Finance committee have been instructed to borrow £15,000 for electric lighting extensions.

Telephone Development.—The National Telephone Co. have issued a statement showing that the relative increase in the number of stations or working instruments for the year ended Dec. 31 is as follows:—Glasgow: Corporation increase 1,504, National 5,209. Portsmouth: Corporation increase 558, National 981. Swansea: National increase 702, Corporation 488. The grand totals are:—Glasgow: National 17,227, Corporation 12,186. Swansea: National 2,548, municipal 1,067. The National stations at Glasgow are equal to nearly the total number of municipal instruments in the United Kingdom (17,810).

Warrington.—The following increases of salary have been granted:—Mr. F. V. L. Mathias, chief electrical engineer, from £250 to £300 per annum; Mr. F. W. Purse, chief assistant engineer, from £156 to £169; Mr. J. Telfer, tramways manager, from £120 to £140; Mr. W. E. Rogers, mains engineer, from £130 to £143.

Westminster.—A writ has been issued against the City Council by the Westminster Electric Supply Corpn. for the return of £1,637. 16s. 4d. alleged to have been overcharged for reinstating streets disturbed by trench work in 1901 and 1902, and such further sum as may be adjudged to have been overcharged in respect of a charge of 10 per cent. on the amount expended on reinstatement for supervision of such reinstatement work. The Council are defending the action.

Willesden.—It was resolved on Tuesday to purchase for £850 land adjoining the power station in Taylor's-lane. An agreement for the purchase from All Souls' College of a site for electricity works at Neasden was approved.

The following statement of account was rendered by the North Metropolitan Electric Power Supply Co. for current supplied during last quarter:—Public lighting, 75,378 units at 0·73d. (£229. 5s. 5d.); power, 24,138 units at 0·9d. (£90. 10s. 4d.); general supply, 289,781 units at 1·22d. (£1,476. 1s.).

Worcester.—The report of the electricity department for 1904 states that there is a deficiency of £1,220. 16s. 8d. on the year's accounts.

A deficiency of £670 was anticipated by the late Mr. Sutherland, but owing to an exceptionally bad supply of water power that figure has been exceeded by £550. 16s. 8d. The deputy electrical engineer (Mr. Birrell) states that since the starting of the Powick station there had never been such little assistance obtained from water power as in last year's working. In February they were subject to a flood for 26 days, and the turbines were of no use whatever. In May the supply of water commenced to fail, and from June 2 to Dec. 21 they were subject to continual drought. The run of water power alone did not average 7½ hours per day, and then only on the lightest load possible; and for six months they were obliged to use steam, even for the night load, which consisted of street lighting only. When the Powick day load could not be run by water power that station was shut down, and the supply taken up by the Hylton-road station, this being more economical than steaming at Powick for so small a load, the steam at Hylton-road being obtained from the same boiler as the traction plant. The units generated last year by water power were 110,744 less than in 1903, and the coal bill for Powick alone rose from £1,859 in 1903 to £1,960 in 1904, and as 85,000 units more were generated in 1903 than in 1904 by steam and water power combined at the station, they had an increased coal bill of £100 to generate 85,000 units less. There was also a reduced revenue of £337 from the waterworks motors, which had been brought about by the great lack of water power, as they had supplied them with 40,310 units less than in 1903. The works costs increased £1,849. 13s. 7d., the reason being that they had sold 246,181 units more than in 1903, but the increase in cost was out of proportion to the increase in units, since the cost per unit had gone up 0·092d. That was due to a larger percentage of the alternating units having been generated by steam, either at Powick or Hylton-road. They had connected 38 new customers and disconnected five, the increase in lamps connected being 2,468, several consumers having made considerable extensions to their installations. The works costs of Hylton-road station show a satisfactory decrease of 0·45d. per unit, and a much better result would have been obtained with a full year's supply of current to the Traction Co., the tramways not starting their service until Feb. 6, and then only on a portion of their routes.

Conversazione.—Messrs. Anderson & Munro, electrical engineers, of Glasgow, held their annual conversazione at the Masonic Chambers, Glasgow, on Friday last, when there were more than 150 ladies and gentlemen present. It was stated that 1904 was the most successful of the 65 years of the firm's existence.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The directors of the *Great Western Railway Co.* invite tenders for supply, delivery and erection of plant at their electricity generating station at Park Royal and proposed sub stations and distribution centres, including high tension three-phase direct-current switchboards and battery boosters at Park Royal; three-phase static transformers and high and low-tension switchboards at various sub-stations and lighting distribution centres; and high and low-tension, three-phase direct-current switchboards at Royal Oak, Shepherd's Bush and Old Oak in sub-stations (*a*) three-phase switchboards, (*b*) direct-current switchboards, and (*c*) six motor-driven boosters in connection with storage batteries at Royal Oak and Shepherd's Bush sub-stations). Specifications, &c., after 14th inst., of the consulting engineers (Messrs. Kennedy & Jenkin), 17, Victoria-street, London, S.W. Tenders (addressed to the secretary, Great Western Railway, Paddington Station, London, W.) will be received up to March 13. An advertisement contains further particulars.

Stoke Newington (London) Council invite tenders for supply, delivery and erection of sub-station plant and mains, including transformers, three-phase motor generators, boosters, &c., extra h.t. and three-wire l.t. switchboards, storage battery and l.t. distribution mains. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Talbot & Stevenson), 26, Victoria-street, London, S.W., and copies obtained of the borough surveyor (Mr. W. F. Loveday), Town Hall, Milton-road, Stoke Newington, N., after Feb. 6. Tenders (addressed Electric Lighting committee) to the Town Hall by 4 p.m. March 8. See also an advertisement.

Wimbledon District Council invite tenders for supply of stores during the year ending March 31, 1906, including engine-room stores, cables, joint boxes and jointing materials, transformers, meters, oils, incandescent electric lamps, carbons and accessories, and iron castings. Forms of tender and specifications from the chief electrical engineer (Mr. H. Tomlinson Lee), Durnsford-road, Wimbledon. Tenders (addressed Chairman of General Purposes committee) to the clerk (Mr. R. H. S. Butterworth), 12, Queen's-road, Wimbledon, before noon, March 4. See also an advertisement elsewhere.

Islington (London) Council invite tenders for electrical and engineers' stores for one year from April 1, 1905, including meters, time switches, earthenware pipes, carbons, incandescent lamps, terminal boxes, arc lamp globes, oils and lubricants, waste, &c., belting, rubber and asbestos and engineers' sundries, &c. Forms of tender, &c., at the Town Hall, Upper-street, after Feb. 13. Tenders by noon of Feb. 23. See also an advertisement.

East Ham Town Council invite tenders for the supply and delivery of five double-deck roof-covered tramcars, complete with electrical equipment. Forms of tender, &c., from the borough electrical engineer (Mr. W. C. Ullman, Nelson-street, East Ham). Tenders, addressed to chairman of Electric Lighting and Tramways committee by noon Feb. 21. See also advertisement.

Salford Electricity committee invite tenders for supply of 1,800yds. of 0·45 sq. in. and 1,200yds. of 1·2 sq. in. lead-covered and paper-insulated cable, and 1,760yds. of 7/16 high-tension concentric cable. Specifications from the borough electrical engineer (Mr. C. D. Taite), Frederick-road, Pendleton. Tenders (addressed to chairman of committee) to the town clerk (Mr. L. C. Evans), Town Hall, Salford, by 18th inst. See also advertisement.

Salford Corporation also invite tenders by Feb. 18 for the supply of stores for the electricity department for the year to March 31, 1906.

Sunderland Corporation invite tenders for four 250kw. synchronous three-phase motor-generators. Specifications, &c., from the borough electrical engineer (Mr. J. F. C. Snell, M.Inst.C.E.), Town Hall, Sunderland. Tenders (addressed to chairman of the Electricity and Lighting committee) to the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon Feb. 24. See also advertisement.

Rathmines and Rathgar Urban District Council invite tenders for supply of electricity stores for the 12 months ending March 31, 1906, including arc-lamp carbons, cables, &c., general stores and coal (about 2,000 tons). Further particulars are given in an advertisement. Tenders, on official forms, to the clerk to the Council (Mr. F. P. Fawcett), Town Hall, Rathmines, Co. Dublin, by 20th inst.

South Shields Corporation invite tenders by March 13 for a marine type boiler, two engines and two 550kw. direct-current generators, a traction switchboard, and electric tramcars complete with Brill trucks.

Tenders are wanted by 10 a.m. of 14th inst. for fire alarms, telephones, &c., for the County Borough Asylum, *Newport*, Mon. Plans, &c., at office of Mr. A. J. Wood, 22, Surrey-street, London, W.C., and borough engineer's office, Newport.

Manchester Electricity committee invite tenders for supply and erection at Dickinson-street station and sub-stations of (*a*) motor generators and (*b*) five-wire balancers. Tenders to chairman by 10 a.m. 21st inst.

Manchester Tramways committee invite tenders for supply and erection of a main switchboard, auxiliary distribution boards, &c., for their car-repairing works. Tenders to chairman by 10 a.m. 14th inst.

Battersea (London) Council invite tenders by noon 27th inst., for stores for 12 months, including electricity meters, arc lamp carbons, surface joint boxes, oil and coal.

Tenders are required by 11 a.m. of 18th inst. for supply of stores, including electrical supplies, lamps, &c., to *Sheffield* tramways department.

Dublin Corporation invite tenders for supply of arc-lamp carbons. Tenders to town clerk, Mr. Hy. Campbell, by Feb. 28.

Swindon Corporation invite tenders by 21st inst. for supply and erection of switch panels, &c.

Bury (Lancs.) Electricity committee invite tenders for a 500kw. direct-current high-speed generating set. Tenders by noon Feb. 14.

Tenders are invited for the construction and erection of 15 electric cranes at the port of *Ghent*, Belgium. Adjudication of these tenders will take place on Feb. 20. Tenders (registered) to the College Echevinal de la Ville de Gand with a preliminary deposit of 3,000fr. (£120). A limited number of specifications can be obtained from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

Tenders are invited for a concession for an electric tramway between Calle de Barquillo and the Plaza de Olavide, *Madrid*. Tenders will be adjudicated on April 8. Full particulars concerning this matter are published in the "Madrid Gazette" of Feb. 2, but local representation is necessary before tenders will be entertained by the authorities.

TENDERS RECEIVED AND ACCEPTED.

The Paterson Engineering Co. inform us that they have recently supplied Paterson feed-water purifiers as follows:—

To Babcock & Wilcox, for H.M. Dockyards, Pembroke, and for Gosport and Fareham Tramways; to Belliss & Morcom, for their Ledsam-street Works; to Danks & Co., for H.M. Dockyards, Chatham; to the Electric Construction Co., for H.M. Dockyards, Gibraltar; to the Mirrlees Watson Co., for Partick electricity works; to Crompton & Co., for Ultadunga station, Calcutta; to the Earl of Rosslyn's Collieries Co.; to Sharp & Sons, Dartford; and to Busbridge & Co., Kent, &c.

Davis-Perrett Limited, 13, Fenchurch-avenue, E.C., have received an order from the Dublin United Tramway Co. for one of their electrical grease-separating plants capable of purifying 4,000 gallons of greasy water per hour. The same company has also recently installed a large plant at the South London Electric Supply Corpn.'s works, Loughborough Junction, to deal with 8,000 gallons of greasy water per hour.

The Metropolitan Asylums Board received 20 tenders for the installation of electric fire alarms at the Northern Hospital, and the lowest, that of Jackson Bros., was accepted at £210. 10s. The highest tender was £650. The estimate of the engineer-in chief was £340.

Orders for three-phase and single-phase transformers have been received by Ferranti Limited from the Midland Electric Corporation for Power Distribution (10 boosters), from Eccles Corporation, from Bloemfontein (Natal) Corporation, &c.

Stockport Council have accepted the tender of the British Insulated & Helsby Cables (Ltd.) for the supply of cables at £223. 15s., and that of Walter Scott (Ltd.) for tram rails (at £5. 12s. 6d. per ton), fishplates and tie bars.

Battersea (London) Council have accepted the following tenders:

C. A. Parsons & Co., one 750kw. turbo-generator, £4,680.
Green & Sons, fuel economiser (consisting of 256 tubes), £491. 17s.
General Electric Co., six double-tariff meters.

Ferranti Limited, Hollinwood, Lancs., have received an order from Islington (London) Borough Council for seven 30kw. single-phase transformers.

Epsom Lighting committee have accepted the tender of Wm. Cory & Son for the supply of coal (Nixon's Navigation washed nuts) at 19s. 6d. per ton for the ensuing 12 months.

Warrington Council have accepted the tender of Milnes, Voss & Co. for four top covers for tramcars and new trolley poles at £80 each.

Accrington Council have accepted the tender of Stephenson & Sons for wiring the Market and Wesley clocks.

Camberwell (London) Guardians have accepted the tender of Wells & Co. for an electric lighting installation at the new workhouse.

Horsham Council have accepted the tender of H. Lindfield & Sons for extensions to the electricity works at £350.

Salford Council have accepted the tender of Mr. Bertram Thomas for four reverse-current circuit breakers at £17. 10s. each.

Rochdale Corporation have accepted the tender of the British Thomson-Houston Co. for a high-tension switchboard.

BUSINESS NOTICES.

The London Electrical Fittings Co. (Ltd.), of Hampstead-road, N.W., have been appointed sole agents for the London district of the Wandsworth Electrical Mfg. Co.

Messrs. Edwd. Frowine and Hy. Resell, trading as the New Electric Novelties Co. at 20, Paper-street, London, E.C., have dissolved partnership. Debts by Mr. Frowine.

The General Contracts Co. (Ltd.), of 102, Charing Cross-road, London (makers of the "Strut" switch), have, in consequence of increasing business, removed their offices and showroom to their factory premises at 62, Rosebery-avenue, Clerkenwell, London, E.C.

Messrs. S. N. Wolff & Co., of Wevelinghoven, near Dusseldorf, write informing us that from April 1 next their works and offices will be removed to Beuel-Bonn, almost adjoining Bonn station, on the Rhine.

Messrs. C. S. Rolls & Co. have removed their head offices and showrooms to 14 and 15, Conduit-street, London, W.

BANKRUPTCIES, LIQUIDATIONS, &c.

Hugh Evans Arkwright and Rosina Maria Collins (trading as Collins Bros.), electricians, &c., 85, Electric-parade, Blackheath, London, S.E., have been adjudicated bankrupt.

A first and final dividend of 8s. 6d. will be payable at the office of Mr. D. Sibbald, 23, St. James'-street, Derby, in the failure of Benjamin Geo. Hodges, electrical engineer, 21, St. Luke's-street, Derby.

Claims against the British Autovolt Co. (Ltd.) must be sent by March 16 to Mr. St. J. Winne, 7, Laurence Pountney-hill, London, E.C.

The liquidators (Messrs. E. Bradshaw & E. Johnson), of the Warrington & District Electric Light & Power Co. (Ltd.), have been released.

A meeting will be held on March 9 at 5, Fenwick-street, Liverpool, to receive an account of the winding up of the British Electric Works Co. (Ltd.).

Stores Sale.—Messrs. Horne & Co., Storey's Gate, Westminster, London, S.W., will sell by public auction at the Royal Arsenal, Woolwich, on Thursday, Feb. 23 (by order of the Secretary of State for War), at 11 a.m., a quantity of obsolete and unserviceable stores, including electric cable, brass, copper, German silver, zinc and other metals, lead and founders' skimmings, broken crucibles, &c., three horizontal engines, 20 turning lathes, tools, &c. The lots may be viewed at the Arsenal from 10 to 1 and from 2 to 4:30 on Monday, Tuesday and Wednesday previous to and on the morning of sale. Catalogues at the War Office, Pall-mall; at the Ordnance Office, Tower; and at the Ordnance Office, Royal Arsenal, Woolwich. See also advertisement.

Plant, &c., for Sale.—Messrs. White Bros., engineers, High-street, Stratford, London, E., have some electric lighting plant for sale, including a pair of Ruston-Proctor compound horizontal engines, Crompton dynamo, loco-type boiler, portable Marshall engine, &c. See also advertisement.

Messrs. Pearce, Brownsmith & Co., 7, Wilson-street, Finsbury, London, E.C., have for sale a quantity of new cotton-covered electric wire.

Business for Sale.—A well-established mechanical and electrical engineering business is for sale by private treaty by Messrs. C. Baker & Co., 89, Bennett's-hill, Birmingham. See advertisement.

Premises to Let.—Mr. A. Monk, 555, Holloway-road, London, N., has to let a factory, 80ft. by 31ft., meeting London County Council requirements, with or without boiler, &c.

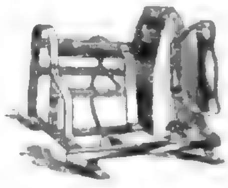
A ground floor, area 2,700 super. ft., equipped with electric power, and suitable for general engineering, is to let. Applications to Messrs. Marshall & Co., Campbell Works, Stoke Newington, London, N. See advertisement.

Messrs. Stimson & Son, 8, Moorgate-street, E.C. and 2, New Kent-road, S.E., London, have extensive factory premises (close to Vauxhall and Nine Elms, with frontage to the main road) to let. See advertisement.

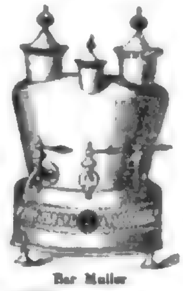
Legal Notice.—Notice is given in an advertisement that creditors and other persons having claims against the estate of the late Major-General Charles Edmund Webber, C.B., R.E., late of 17, Egerton-gardens, London, S.W., must send particulars of their claims to the solicitors for the Executors (Messrs. Long & Gardiner), 8, Lincoln's Inn-fields, London, W.C., by March 18.

Electrical Exhibition.—As previously announced, the County of London Electric Supply Co. intend to hold an electrical exhibition at Nos. 118-122, Holborn, London, E.C., from March 20 to April 5 inclusive. The exhibition will be divided into two sections: (*a*) Lighting and Heating, (*b*) Power, and special attention will be given to the latter section. In view of the large number of applications already received, exhibitors desiring space should apply at once to the secretary, Mr. H. B. Renwick, Moorgate-court, Moorgate-place, London, E.C. See also an advertisement.

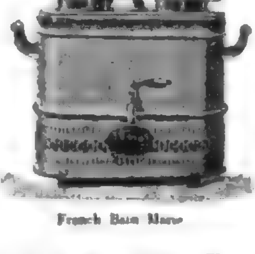
Catalogues, &c.—The Electric Heating Co., 8, Holborn-place, London, W.C., have ready a new list of electric heaters and cookers to meet all requirements. There is a useful assortment of portable heaters, counter urns, &c., fish fryers, domestic and trade utensils, apparatus for hot air and Turkish baths, &c. Some of these items are shown in the accompanying illustrations.



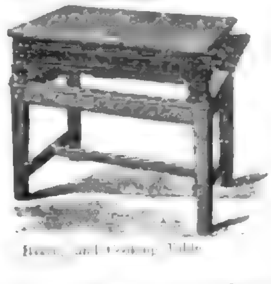
Automatic Flat Iron Stand



Bar Muller



French Bain Marie

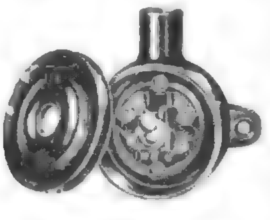


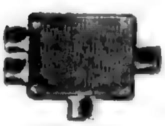
[illegible] and Cooking Table

The General Electric Co. have ready a new conduit list, and, in view of the interest which is being taken in the subject, we may call attention to an example or two of this company's make of an article which is coming into more general use every day. The General Electric Co.'s "Union" steel conduit is manufactured at Witton, and particular attention is directed in the catalogue to the company's elaboration of the "Papristeel" conduits. Paper-insulated tubes have been manufactured for some years, and it is claimed that a satisfactory lining for these conduit fittings has been found by the use of a mineral compound spread evenly over the interior of the fittings before enamelling. For purposes of economy, unscrewed patent Papristeel tubing and insulated fittings are provided for by the "Union" patent earthing nipple, an improvement on the soft metal nipple for a similar purpose which was introduced by the firm some years ago. For these nipples an alloy similar to type metal is used, as it is necessary that they should preserve their conducting properties indefinitely. If preferred, the conduits can be screwed in the ordinary way for watertight installations. Several sizes of plain steel boxes are also listed which can be adapted to any number of ways in any direction by either drilling clearing holes in the boxes and using back nuts for clamping the tubes or by tapping the holes and using the patent nipples above mentioned. In the latter case the tube would not be screwed where it enters the nipple. The company have made arrangements for drilling their customers' boxes at the London works in Union-street, S.E. There is also described and illustrated in this list an infinite variety of conduit accessory parts, including solid drawn ofall kinds of galvanised tubes. Kennedy's patent bending machine also is shown, in which all kinds of tubes can be bent to any required angle without heating. The accompanying illustration shows various items of the "Union" conduit, &c.

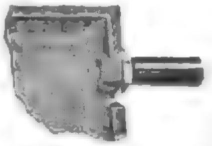
B.—Bush Fixed in Position.

A.—Construction of "Union" Bush.


"Union" Flush Switch for Sealed Wiring.


Union Branch-off Box.

"Union" Inspection Tee Piece.


Tapped Hole & Earthing Nipple Device.

"Union" Watertight Fitting.

Double-pole knife switches in cast-iron cases for pressures up to 550 volts are described in a circular list issued by Ernest F. Moy (Ltd.), Camden Town, London, N.W.

A new list of arc lamps is issued by Mr. G. Braulik, of Upper Thames-street, London. E.C.

Motor Vehicle Exhibition at Olympia.—An exhibition of motor vehicles of every type opens at Olympia (adjoining Addison-road Station, London) to-day (Feb. 10) and remains open till the 18th. The exhibition promises to be the most important of the kind yet held in this country, the opportunities for testing the speed and other points of the vehicles being a special feature of the show. The dimensions of the huge buildings at Addison-road afford a better opportunity for these tests than any other covered building in London, and it is anticipated that the fullest advantage will be taken of these facilities. All the leading makers of motor vehicles are to be represented, some of them on a very large scale. The particulars yet available are too meagre for an extended notice, but we have received sufficient particulars to justify the anticipation that the exhibition will prove of unusual interest. Amongst the exhibits will be that of Messrs. S. Smith & Son (9, Strand, London, W.C.), who, at Stand 195, will make the largest display of motor speed indicators, distance measures and motor watches ever made in connection with the automobile industry. Amongst these exhibits will be found an English mile recorder, which is the latest innovation of this class of apparatus. The "Milometer" is attachable to the outside cap of the wheel, and is a very simple piece of mechanism.

"Imperial Directory of Electric Lighting and Electric Traction Works."—This is the title that has now been given to the annual directory edited by Mr. C. S. Vesey Brown, and published by Messrs. Hazell, Watson & Viney, London, price 12s. 6d. net. The directory is divided into two main divisions, the first concerning Great Britain and Ireland and the second dealing with the colonies and the continents of Africa, America, Australasia and Europe. There is also a section dealing with India and the British Colonies, and in regard to this section a claim is made that "this is the first book to chronicle the electrical industry in the British Colonies." This statement is, of course, made under a misapprehension. There is evidence of much industrious compilation in Mr. Vesey Brown's book, the get-up of which is all that can be desired. We think there is danger that the electrical industry will be overdone with annuals, but this is rather for the editors and publishers of such publications to decide than ourselves.

Imports.—The following are the official values of the imports of electrical machinery, material and apparatus into this country during January:—Electrical machinery, £762 (an increase of £9 compared with January, 1904); telegraph cables and apparatus, £5,918 (increase, £2,164); other electrical goods, £76,896 (increase, £1,722).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Feb. 1 to 7, with the ports of destination:—

Africa—Cape Town, £754 (including £101 telegraph material); Chinde, £10; Durban, £687; Port Elizabeth, £225; Sekondi, £14 (telegraph material). *Argentina*—Buenos Ayres, £1,016 (including £450 telegraph apparatus and material); Rosario, £2,288. *Australasia*—Adelaide, £8; Auckland, £53; Brisbane, £912; Fremantle, £280; Launceston, £340; Lyttelton, £102; Melbourne, £614 (including £59 telegraph material); Otago, £19; Perth, £71; Sydney, £1,721; Wellington, £576. *Brazil*—Pernambuco, £820. *British Guiana*—Demerara, £45. *Canada*, £50. *Ceylon*—Colombo, £110. *Channel Islands*, £6. *China*—Canton, £99; Shanghai, £80; Tientsin, £154 (telegraph material); Wei-hai-Wei, £256 (telegraph cable). *Colombia*—Santos, £101. *Egypt*—Alexandria, £35; Port Said, £300. *Germany*—Hamburg, £246. *Gibraltar*—£19. *Holland*—Amsterdam, £89; Rotterdam, £141. *Hong Kong*, £799. *India*—Bombay, £199 (including £180 telegraph material); Calcutta, £1,972. *Japan*—Kobe, £17; Hiogo, £11; Tokyo, £100; Yokohama, £5,076. *Malta*, £25. *Norway*—Christiania, £118 (telegraph material). *Portugal*—Lisbon, £82 (telegraph apparatus). *Straits Settlements*—Penang, £117; Singapore, £138 (including £65 telegraph material). *U.S.A.*—Boston, £500; New York, £34 (telegraph material). *West Indies*—Trinidad, £200. Total, £21,592, against £22,114 in the corresponding week last year (Feb. 3 to 9).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

December 12, 1904.

27,013 J. H. Parsons and H. R. Waddington. Leicester. Electric automatic stopping device for textile fabric machines.
27,028 T. T. Dewhirst and B. Biggs. Flexible continuous covering for ploughway of electric conduit system and apparatus therefor.
27,033 C. M. Dorman, R. A. Smith and H. G. Baggs. Salford. Electromagnetic releasing mechanism for switches and cutouts.
27,060 B. C. Kenyon. Controlling devices for electric motors.
27,082 Dollond & Co. and T. Crawford. Electric counting apparatus.
27,083 B.T.-H. Co. (G.E. Co., U.S.). Control of electric motors and apparatus therefor.
27,084 B.T.-H. Co. (G.E. Co., U.S.). Controlling mechanisms for self-propelled vehicles.
27,095 C. A. Randall. Telephony.*
27,096 C. D. Abel. Electrical fire alarms. (Siemens & Halske Act. Ges., Germany.*
27,100 Mavor & Coulson and H. A. Mavor. Electric motor apparatus.

December 13, 1904.

27,114 A. C. Virgin. Bristol. Operating gear for points on electric tramways.*
27,115 L. Andrews. Manchester. Reverse current circuit breakers and indicators for alternating currents.
27,135 H. Heap, J. Bailey, T. Brierley, R. Billington, A. Richardson, J. Haydock and T. S. Jones. Manchester. Ears for overhead trolley wires.
27,168 M. J. E. Tilney. Automatically regulating voltage with varying loads.
27,186 F. W. Sorg. Conductors.*

27,199 Siemens Brothers & Co. Accelerating the excitation of electrical machines. (Siemens Schuckertwerke G.m.b.H. Germany.)*
27,201 E. Wilson. Electrostatic wattmeters and watt-hour meters.
27,209 J. H. Hallberg. Electrical distribution for railways and operating same.*
27,211 B.T. H. Co. (G. E. Co., U.S.). Protection of electric distribution systems.

December 14, 1904.

27,217 J. Esser. Germany. Telegraphic transmitters and receivers. (Date applied for May 2, 1904, date of application in Germany.)*
27,239 E. T. Whitelow and G. H. Scholes. Manchester. Signalling the approach or proximity of ships to previously-determined positions and operating submarine mines.
27,245 C. D. Lucas. Mercury vapour lamps.
27,246 Siemens Brothers & Co. and E. A. Holmes. Electrical measuring instruments.*
27,260 A. J. Betteridge. Birmingham. Apparatus for electrode deposition.
27,297 G. Giobel. Lighting and extinguishing gas lamps by electricity.*

December 15, 1904.

27,310 C. E. Abell. Birmingham. Glow lamps.
27,317 T. D. Jackson. Stockton-on-Tees. Reflectors.
27,348 G. Eason. Switches.*
27,352 Otis Elevator Co. (Otis Elevator Co., U.S.). Electric controlling apparatus.
27,376 H. Fairfield. Thermometers adapted as fire alarms.
27,399 W. Hamilton and Ferranti Limited. Electricity meters.
27,400 and 27,401 B.T.-H. Co. (G.E. Co., U.S.). Electric motor control systems.
27,402 and 27,403 B.T.-H. Co. (G.E. Co., U.S.). Maximum current indicating devices.

December 16, 1904.

27,424 M. Walker. Manchester. Magnetising iron by an alternate current and improvements in dynamo-electric machines.
27,434 C. Brown, F. Olai and Brown & Barlow. Birmingham. Switches.
27,437 G. M. Zingel, W. Wolf and A. Reiner. Arc lamps.
27,443 A. Eckstein and A. E. Arnold. Manchester. Arc lamps and carbons.
27,444 A. Eckstein and A. J. D. Krause. Manchester. Switches.
27,449 W. Fairweather (C. H. Huff, U.S.). Electrostatic separation.*
27,456 F. Lutz. Electromagnetic ignition device for explosive engines.
27,475 W. R. Comings. Switches.
27,479 N. P. Andrew and T. M. M. Johns. Inverted arc lamps.
27,520 G. H. Oatway. Fire-alarms.
27,537 H. I. Wood. Vapour electric apparatus. (Date applied for, Dec. 17, 1903, date of application in U.S.)*
27,538 C. P. Steinmetz. Transforming electric current. (Date applied for, Dec. 17, 1903, date of application in U.S.)*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

24,516 Armstrong and Orling. Receiving and recording apparatus.

1904.

818 B.T.-H. Co. (Sporborg, Carter and Cubitt). Electric railway systems.
1,081 Nathan and Newland. Telephone for partially deaf persons.
1,106 Francis. Incandescent illuminating apparatus.
1,484 B.T.-H. Co. (G.E. Co., U.S.). Controlling electric motors.
1,513 Escare. Shade carrier holder.
3,449 Campiche. Electric clocks.
3,564 Thomas and Tomcox. Connections and couplings for wires, &c.
4,587 Smith. Construction of switch.
4,772 and 4,773 B.T.-H. Co. (G.E. Co., U.S.). Controlling alternating-current motors.
4,991 Boult (Macquaire). Sparking plugs for explosion engines.
5,113 Marconi's Wireless Telegraph Co. and Gray. Transmitters for wireless telegraphy.
5,146 Armistead. Preventing or lessening sparking at brushes.
5,147 Talbot and Mundey. Switches for igniting circuits of multiple cylinder explosion motors.
5,298 Davies. Fuses and fuse boxes.
5,308 Pedersen. Electric contact devices.
5,688 Johnson (Badische Anilin & Soda Fabrik). Apparatus for producing reactions in gases by electricity.
5,860 Hirst and Collings. Electric lampholder.
6,035 Tyers. Clips for fixing pipes, cables, &c.
6,402 B.T.-H. Co. (G.E. Co., U.S.). Insulating compositions.
6,425 Banks. Electric candle fittings.
6,433 London Electric Supply Corpn. and Partridge. Switches.
6,535 Sharp. Saddle for carrying cables.
6,600 Cleminson Electric Lamp Attachment (Ltd.) and King. Cement for electric lamps.
6,682 Smith and Lewis. Sparking plugs and the like.
6,747 Marsh and Marsh. Universal joint for electric light fittings.
6,806 Sutton and Gregson. Manufacture of conduits.
7,056 Ashcroft. Production of metals by electrolysis.
7,304 Gaiffe. Electric light baths.
7,489 Gaiffe. X-ray apparatus.
8,262 Port. Telephones for use in dictating correspondence.
9,831 James (Northern Electric Co.). Regulation of electric circuits for the production of constant current or potential or both.
9,859 Centner. Obtaining magnetic fields having rectilinear reciprocating motion.
10,119 Regnart. Adapting "electric candles" to sconces.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Tools for Engineers and Wood-workers: including Modern Instruments of Measurement." By Joseph Horner. (London: Crosby Lockwood & Son.) 9s.

"'N'-Rays: A Collection of Papers communicated to the Academy of Sciences." By R. Blondlot; translated by J. Garcin. (Longmans, Green & Co.) 3s. 6d.

"Proceedings of the Royal Society of Edinburgh." Vol. XXV., No. 5. (London: Williams & Norgate.) 4s.

"Causeries sur Le Radium et les Nouvelles Radiations." By G. Claude. (Paris: Ch. Dunod.) 3fr.

"Jahrbuch der Elektrochemie." 1903. Edited by Dr. Heinrich Danneel. (Halle-a-S.: Wilhelm Knapp.) 26m.

"Die Formelzeichen." By Olof Linders. (Leipzig: Jah & Schunke.) 5m.

COMPANIES' MEETINGS AND REPORTS.

Metropolitan Electric Supply Co. (Ltd.)

An extraordinary meeting was held on Tuesday, under the presidency of Mr. Harrison Cripps, for the purpose of considering resolutions—(1) for approving a bill to confer further powers on the Company with respect to electrical energy, to provide for the rearrangement of the capital of the Company and for other purposes, and (2) for approving a bill to authorise agreements between the Company and the Acton Urban District Council with respect to the supply of electrical energy by the Company to the District Council and to confer further powers on the Company.

The SECRETARY (Mr. E. Cunliffe Owen, C.M.G.) having read the notice calling the meeting.

The CHAIRMAN said: With regard to the two bills we have met to discuss (one our Various Powers Bill and the other our Acton Bill) I may explain to you that lying on the west of us at Willesden there is a very considerable area, including Uxbridge, Southall, Staines and other places. At the present moment electricity in that portion of Middlesex is in its infancy, and considering that at Willesden we shall very soon have a considerable amount of plant set free which is now engaged in supplying Marylebone, we think it is very desirable, as far as possible, to find employment for it, and we are applying for powers to supply certain of those districts. In some of them the district authority hold the provisional order; in others the orders are held by local companies. What we propose to do is to offer and, with their consent, to give them a bulk supply, so that they may be enabled to provide their customers cheaper than they can from their own small stations. We are, therefore, not entering on any scheme of rivalry or competition. Another provision in the bill is to include the north-west corner of Paddington in our Paddington Order. When we had our original provisional order that corner was part of the Chelsea district, but it has now been transferred to Paddington, and we can supply it by obtaining the authority of Parliament. I dare say some of you may have seen that there is a bill coming before Parliament called the Administrative County of London Bill, applying for powers this year to supply—I hardly know what; but to supply, as far as we can make out, the whole of London, practically the whole of West Middlesex, a good part of Kent and a good part of Surrey. Whether it goes beyond that I cannot say. But this is a company that professes to require an enormous amount of capital, and we feel—and feel very strongly—that the present companies in London, who between them have invested many millions of capital, are not only in a position, but are willing and anxious, to supply every scrap of power wanted in their districts, and not only to supply it when certain stations are built, but to-morrow. Anyone coming to us, for instance, for a supply to-morrow can have it. All the London companies feel that they are in the same position—perfectly capable of supplying everything required; but we are at present under the disadvantage that we cannot without the sanction of Parliament help each other. We conceive that as the power supply increases, it will be very desirable that the companies should have the power to supply into each other's stations, so that a deficiency at one time in one area might be supplied by the excess of power in another; and in our bill we seek powers to enable us to supply, not to individual consumers in anyone else's area—no rivalry of that kind—but to other already existing undertakings with their wish and sanction. I think that with that condition of things the London companies would be in a position to supply any possible amount of power which might be required at present or in the future. There is another provision in the bill, and in regard to this we are in rather a curious position. We are enabled at the present moment to supply any railway or tramway company, or any canal that runs through our district, but the moment the train, the tram, or the barge—or whatever it is—has got outside our district, there is some doubt, owing to a recent decision in the Court of Chancery, whether we can really supply such consumers. Such a restriction would absolutely prevent any company from giving any supply at all for locomotion. So far as railway, tramway and canal companies are concerned, we want it to be made clear that, when once they get their supply from us, they can do what they like with it. Another provision of the bill relates to finance. The Directors, as foreshadowed at the meeting last year, had an idea that it was desirable to reduce the ordinary share capital of the Company from £1,000,000 to £750,000 by returning the difference to the ordinary shareholders, it appearing to us to be undesirable to have a quarter of a million of our money locked up, not in the business, but in some 3¼ or 3½ per cent. securities as we have now. But to get the reduction of capital it is necessary to get the consent of Parliament, and to do this we require the consent of all the existing interests, especially that of the debenture holders. We give the debenture-holders every facility for looking into our accounts, and show them that after this reduction of capital they will have at least three or four times the amount of security they had when they lent us their money. We, therefore, ask you to pass the financial clauses of the bill as if we were going to carry them through, because we cannot take them out at present without coming into conflict with the Standing Orders, but we shall withdraw them unless the debenture-holders alter their present attitude. As regards our Acton Bill, Acton lies, as you know, handy to Willesden, and after very friendly negotiations with the Acton Borough Council they have agreed to take a bulk supply from us. The terms and everything else have been fixed. We had always supposed that owing to Willesden station being partly situated in Acton, there would be nothing to prevent the Acton Borough Council from taking their supply direct from our works at Willesden, but owing to a judgment in the Court of Chancery last autumn some doubt has been thrown on the point. We therefore ask Parliament in our second bill for powers to enable us to supply in bulk to the urban authority in Acton on terms mutually agreed upon.

The resolutions were then put to the meeting and carried unanimously, and were subsequently approved at a meeting of the ordinary shareholders. A vote of thanks to the chairman and directors terminated the proceedings.

Anglo-American Telegraph Co. (Ltd.)

The ordinary general meeting took place on Friday last, under the presidency of Mr. FRANCIS A. BEVAN.

The SECRETARY (Mr. T. H. Wells) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said: Before moving the adoption of the report, I have to congratulate the shareholders that there has been a considerable increase in the traffic during the past half-year, compared with the corresponding half of 1903, the traffic receipts being £183,570 against £174,850, an increase of £8,720; but, unfortunately, as a set-off against these increased receipts, our revenue from the steamship "Minia" has been only £2,000, compared with nearly £12,400 in the corresponding half of 1903, which more than wipes out our traffic increase. The result altogether is that, taking account of the increased working expenses (£561), there is a diminution in the balance available for dividends. This total is £108,194. 1s. 11d., against £109,629. An interim dividend has already been paid on both preferred and ordinary stocks, absorbing £43,750, and the directors now propose to pay dividends which will require £61,250, leaving £3,194. 1s. 11d. to be carried forward. The figures for the whole year will be interesting to the shareholders. The gross pool traffic for the first half of 1904 was £255,650, against £284,830 for the same period of 1903, a decrease of £29,000 for the first half of the year. In the second half the receipts were £296,740, compared with £279,890, an increase of £16,000. On the whole year we received only £552,390, against £564,720, a decrease of nearly £13,000 on the year. The shareholders might think that this decrease was due to some want of vigilance on the part of the directors and the staff, but they might rest assured that this was not the case. A few days previously he (the chairman) had invited Mr. J. C. Lamb, the head of the Telegraph department of the Post Office, to see the working of the company's stock traffic, and Mr. Lamb was pleased to express his astonishment at the way our staff was working. This was a compliment for the staff of the very highest value. Turning to the accounts, the chairman said there was one item in the balance-sheet which had never previously appeared—the pensions account (£3,400), due to the resolution of the shareholders to establish a pension fund and to set aside £2,000 to that fund which had previously been put to the renewal fund. With regard to the renewal fund, some of the shareholders might have been disappointed to find that, instead of there being an increase in that fund during the past year, there had been a decrease of £13,000, and of something over £19,000 in the half-year under review. Out of that fund the repairs of the steamship "Minia," amounting to £13,680. 18s. 1d., had been paid, making the total sum spent on the "Minia" during the year £27,680 18s. 1d. This expenditure had become absolutely necessary, and they had now practically a new ship, which had only cost them about £28,000. The only alternative would have been to sell the "Minia" and to purchase a new ship, which would have cost them £80,000. Cable repairs had cost £26,778. 14s., consisting mainly of three items. One of these was the break near Valencia. The particular cable was one patented by Capt. Trott and Mr. Hamilton, and was laid many years ago, as it was considered to be well worth trying, the principal point about it being that there was no iron wiring, and it was supposed at the time that it would be much more easily handled, being so much lighter. But in course of time the directors found that the cable could not be lifted at all. The moment they began to deal with it it went to pieces; so they came to the conclusion that it would be better to cut out the Hamilton-Trott cable and put in good cable. That had cost them £14,000. There had also been a break on the other side of the Atlantic, which cost something like £6,000 in cable, and the other item of expense was the hire of the c.s. "Seine" from the Telegraph Construction & Maintenance Co. owing to the "Minia" being under repair. They might assume that these three items of expenditure were not likely to recur. With regard to the renewal fund he would like to tell the shareholders what the directors' understanding was as to this fund. When the fund reaches £1,000,000 they would cease to charge anything more to revenue and only credit the fund with the interest on investments; but should there be an accident or a breakdown of the cable, the cost of the repair of which would bring the fund below £1,000,000, then they would again have to debit revenue until the amount was made up to £1,000,000, but not to a greater extent than £20,000 in any one year, or of £10,000 in a half-year, unless some great or unforeseen catastrophe should occur—such as their requiring to lay a new cable. There was another question to which he must refer—the French law suit. What he had to say regarding that matter was not very encouraging. The final judgment of the Court of Rouen was given as far back as July, 1901. Appeals to the Court of Cassation were lodged shortly afterwards, and these appeals were still unheard. Since their last general meeting a strongly-worded communication had been addressed to the company's legal advisers in Paris, in which it was pointed out that the delay amounted to a scandalous denial of justice. They had had a decree in their favour, but the answer received from Paris was that the cause of the continuous delay in bringing on the case in the Court of Cassation had been the great political disturbances connected with the Dreyfus case and the religious congregations in France. Their litigation had been going on for nearly 20 years, but they could only continue to wait and hope for a speedy end of the matter. With regard to the future, their receipts for the first month of the new year had been decidedly satisfactory, and if they could only go on in the way they had commenced, without any excessive expenditure in repairs, he hoped the preferred stockholders would get their dividend of 6 per cent., and that something would be left for the deferred. He concluded by moving the adoption of the report and accounts, and the declarations of the dividends as recommended by the directors.

The DEPUTY CHAIRMAN (Sir Gerald FitzGerald, K.C.M.G.) seconded the resolution.

Mr. THORPE: In the event of our getting a final decision in our favour in the French Courts, shall we get the money?

Mr. RIDDLESBURGH: As a deferred shareholder, I would like to ask whether it would not be possible to sell some of the gilt-edged securities we have and invest the money in our own preferred stock. We should then get a much better dividend. If it is against the articles of association to do this, cannot these articles be altered?

Mr. BAGGALLAY: In regard to our investments, would it not be possible to make these produce a little more interest with practically the same security? We have £900,000 in securities which are practically realisable at any moment, but could we no get a larger interest in perfectly safe investments?

Mr. EDMUNDS: I should like to ask the chairman whether there is anything in connection with wireless telegraphy that affects us at all, or is likely to do so.

The CHAIRMAN, in reply, said he could not answer the shareholder's question as to the position of affairs if the company received a favourable verdict in the French Court. With regard to the investment of any portion of their reserve in their own preferred stock, he believed the law was absolutely against their doing so; nor was the suggestion a good one from a business point of view. With regard to their investing in securities which would bring them in a larger interest, to some extent this had been already done. As to wireless telegraphy, he could say with confidence that it would not affect them in the slightest degree. The directors were watching its progress carefully, and, so far as they could see, it was more likely to do them good than harm. Up to the present the Marconi Company only sent long-distance messages from this side, so that if they sent a message which required an answer this answer must come over the Atlantic cables. With regard to the suggested wireless telegraph rates, these did not alarm the directors. The minimums of 6s. 6d., 24s. 6d. and 36s. 6d. per message of 12 words for wireless messages were not likely to harm the company.

The report and accounts were then carried.

The retiring auditors having been re-appointed, a hearty vote of thanks to the chairman and directors and the staff for their admirable conduct of the business of the company was carried unanimously. The Chairman and Mr. J. H. Carson (the manager) having replied, the proceedings terminated.

CENTRAL ELECTRIC SUPPLY CO. (LTD.)—The report of the directors for 1904 states that energy has been supplied to the St. James and Pall Mall Co. and to the Wesminster Corpn. to the extent of 6,214,873 units. The increase of output has materially affected the costs of production, and for the past year the company have been able to considerably reduce the charge for supply. A bill for an extension of the company's powers will be dealt with in the ensuing session. Further debenture stock amounting to £48,014 has been issued during the year, and the premium (after deducting expenses) has been carried to credit of capital reserve. After making a full allowance for sinking fund and depreciation the net balance for 1904 is £604. 10s. 1d., which, with balance from 1903 (£4,402. 19s. 11d.), makes £5,007. 10s. The directors propose to pay a dividend at the rate of 5 per cent. on the ordinary shares for the year, which will require £5,000, leaving £7. 10s. to be carried forward.

CENTRAL LONDON RAILWAY CO.—At the meeting on Wednesday the Chairman (Sir Henry Oakley) said the company were endeavouring to keep their undertaking up to the latest date, but at the moment they had no serious expenditure in contemplation. They had increased the number of their passengers during the half-year, and they had earned an increase of about £1,000 in receipts. "Workmen" represented £12,000 out of their total of £169,000. The expenses for the half-year had been reduced by £1,425. They had run less miles, and had carried 131,000 more people, the increased receipts being £2,471. Since the line had been open they had carried 191,230,000 people without injury to any one of them, no accident had occurred that had damaged a passenger, and the board, in considering the matter, felt that that result was the best certificate that could be given for the system adopted and the care, skill and attention shown by the manager and staff in carrying out the work. In the morning and evening, when the times of pressure were greatest, they could run, and did run, 31 trains an hour, at intervals of two minutes, from end to end of the line without a hitch or difficulty; and again, at night, between 4:30 and 6:30, the same speed in working had occurred. They were earning more per train-mile now than formerly. Leaving out the first year, they had increased from 4s. 10d. to 5s. 5d. per mile. The expenses were slightly up, but not in proportion. They were able to pay dividends on all their stocks and to carry forward £52,000. In regard to the connection between their railway and the Charing Cross, Euston & Hampstead and Baker Street & Waterloo Railways, they had suggested to the parties representing the companies how desirable it would be in the interests of both that an underground connection should be made, so that through booking should take place. He had no doubt, taking into consideration the enlightened and intelligent way the promoters of those schemes were desirous to serve the public, that they too would readily recognise the value of the proposal and fall in with it. That would be an additional source of traffic for their line.

GREAT NORTHERN & CITY RAILWAY CO.—The chairman (the Earl of Lauderdale) at the meeting on Monday said the gross amount earned during the past half-year was £36,509, against £19,354 for the previous four and a-half months, an average per week of £1,404, against £967, an increase of over 45 per cent., while their present weekly traffics were about £1,600 per week. The average number of passengers for January of the current year was 256,904 per week, a steady increase. The maximum number of cars in operation was 54 out of a total of 58. There had been no accidents to the passengers or to any member of the staff. The temperature of their tunnels was very good, remaining nearly uniform. The matter of working expenses was in the hands of the contractors, who were responsible for a further period of two years. Since their last meeting they had entered into a supplemental agreement with the contractors, by which the latter undertook to work the line at 60 per cent. of the gross earnings for the first year and at 50 per cent. for the second and third years. In regard to the extension to Lothbury, they had already spent what had been requisite on preliminaries to admit of the carrying out of the extension later on without the working arrangements at Moorgate-street being disturbed or the traffic there being interfered with, but the state of the money market, as well as other reasons, held out no immediate prospect of their being able to raise the capital, except at a heavy discount. The directors thought the prudent course was to feel their way further before embarking on the completion of this project.

GREAT NORTHERN, PICCADILLY & BROMPTON RAILWAY CO.—The report for the half-year ended Dec. 31 states that the capital expenditure during the period was £644,897, and the estimate for the current half-year £750,000. The progress of the works has been satisfactory. The rent due from the Underground Electric Railways Co. of London permits of a dividend at the rate of 4 per cent. per annum, which the directors recommend.

LANCASHIRE & YORKSHIRE RAILWAY CO.—In moving the adoption of the annual report on Wednesday, Sir G. Armytage referred to the electrification of the Liverpool and Southport line, and said that during the half-year they had been gradually completing the service. He could not tell yet the exact cost in comparison with steam working, but reliable accounts were being kept which would enable this to be done in due course. The increase in the traffic had far exceeded their most sanguine expectations.

LONDON & SOUTH-WESTERN RAILWAY CO.—At the meeting yesterday Sir Charles Scotter said that in the course of a few weeks they would be experimenting with electric traction on the South-Western Railway. He believed that within, probably, three months' time the railway belonging to the company between Putney Bridge and Wimbledon would be worked by electricity, and also up to Richmond. The railway motor cars had been much developed, and road motor omnibuses were provided as feeders to the railway. These latter had not been very satisfactory up to the present, because he did not think that they had succeeded in getting the proper omnibuses. Automatic signalling was a new development, and they found it worked very well on their system.

LONDON CHATHAM & DOVER RAILWAY CO.—Sir E. Leigh Pemberton, K.C.B. at the meeting on Friday said there was a serious decrease in passengers and traffic, and among the causes of this decrease was the ever-increasing competition of electric tramways in the metropolitan area. Tramway competition was a subject for much more serious consideration, as its tendency was to increase rather than diminish. Seeing that the traffic in and about London had a tendency to decrease to a disconcerting extent, while further in the country it had the opposite tendency, the directors, instead of sitting down and bemoaning their loss, deemed it wiser to make some effort to develop districts further afield, where the tramway competition could not be felt; and many additional trains had been put on with that object. With regard to the loss on the metropolitan section of the railway, they would have noticed that the Brighton Company had, by agreement with the managing committee, decided to conduct experiments with electric traction between Battersea and Peckham Rye. Those experiments would be watched with the very greatest attention, and should they be successful, as they had reason to hope they would, they might before long see steam locomotives abolished in favour of electric trains on the metropolitan section of their railway, which formed a physical junction with the Metropolitan Railway (now being converted for electric traction), and when that was done, passing, as the railway did, through densely crowded districts, they might hope not only to make up the lost headway, but convert that portion of the undertaking into one of the good paying parts of the company's system.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—The directors' report for the year ended Sept. 30, 1904, states that the net profit for the year is £12,681. 5s. 3d., against £10,607. 7s. 8d. for the previous year. The business of the company is making satisfactory progress all over the world, and with the stations for trans-Atlantic telegraphy in operation a new era in the company's affairs may be anticipated. The directors consider that, as a result of Mr. Marconi's experiments, the company is now in possession of all the data necessary for the equipment of stations for good commercial working between England and the continent of America, and a new station embodying the latest improvements equipped on a commercial scale is already nearly completed in Canada. The question of a site for a new station in Great Britain is still under consideration; the greater part of the machinery has, however, already been ordered, and it is expected that a station similar to that nearly completed in Canada will be equipped in the United Kingdom a few months after the site has been finally selected. It may be stated that a single pair of stations is capable of working at a speed of from 30 to 35 words a minute; a pair of the company's stations now operating commercially show an average working speed of 24 words a minute, calculated from one hour's working on six successive days. With a reduced rate of 6d. per word for trans-Atlantic messages, it might be reasonably assumed that a pair of wireless stations would be kept very fully employed. Reckoning, however, that the total number of words transmitted in a year would be at the rate of only 15 words a minute for 10 hours a day for 300 days, it is estimated that two wireless stations should earn, after deducting land charges, about £56,000 per annum. The stations already equipped at Poldhu, Cornwall, and Cape Cod, Massachusetts, are being regularly employed for transmission of messages to ships fitted with long-distance receiving apparatus at any point on the Atlantic, and by the results of the working of these stations during the last seven months the directors are confirmed in their belief that the new stations will afford a satisfactory service between England and the continent of America. The agreement entered into with the Postmaster-General last August came into operation on Jan. 1 for the collection at all the post offices throughout the United Kingdom of messages (and the rates in respect of those messages) to be transmitted through the company's shore stations to ships at sea. The company has continued to receive from the Admiralty during the past year substantial orders, including instruments for receiving messages at long distances. Certain ships equipped with this apparatus have recently been in communication with England by wireless telegraphy throughout the whole of the voyage from Gibraltar. Four stations have been equipped during the year on the St Lawrence with our apparatus, and a new contract has been entered into with the Canadian Government by our associated Canadian company representing extensions of the organisation of wireless telegraph stations already established to the order of the Canadian Government. Five stations have been equipped at fishing centres along the Labrador coast. When the other stations contemplated have been erected in Canada, the chain of stations will offer to the Newfoundland Government direct wireless communication between the Labrador coast and Canada. The stations for a wireless telegraph service between Italy and Montenegro, referred to in last year's report as in contemplation, have been equipped, and are now in operation daily for commercial purposes for the transmission of messages of the public between Italy and Montenegro, the wireless connection forming part of the regular telegraph service of the Italian Government. The Italian Government has made certain favourable modifications in the contract entered into for the equipment of a high power station at Coltano, near Pisa, for communication with the other high-power stations of the company, and a number of new stations for naval work have also been completed. Communication across the Straits of Messina has been effected by the Marconi wireless system to the order of the Sicilian railways. The purchase of our wireless telegraph stations, utilised for the transmission of Press messages between England and Amsterdam, is under consideration by the Post Office. The Chilian Government having voted a sum of money for carrying out practical demonstrations of the utility of the Marconi system for Chili, men and material for the purpose were despatched last July. A Chilian man-of-war was placed at our disposal. The demonstrations were successful, and the Government is now discussing with our company the practical application of our system in Chili. A contract has been entered into for the establishment and maintenance of wireless telegraph communication between certain of the Channel Islands. A proposal to the Powers was, it is understood, made by Germany for a further conference in August of last year, and, when that date was found inconvenient, for a meeting in October. Certain of the Powers were unable to attend the conference on the dates proposed, and it is now understood that it is likely to take place in April. The directors feel that the company has, in the contracts which it has secured, protection against decisions of the conference injurious to the international service which has been organised. Reference is made in the report to the arrangements with the London "Daily Telegraph" for a wireless meteorological service, and it is notified that the Government Meteorological Office in London is now in communication with the company with the view to similar arrangements being made. The report continues:—The works have been fully occupied during the whole of last year, the machinery going night and day by double shifts of workmen. Orders in hand and in prospect are beyond the capacity of the existing works, and the directors are taking steps to provide new works. The international organisation of ship-and-shore stations for sea telegraphy has been very extensively extended. [Here follows a list of steamers equipped with the Marconi system.] After the close of the financial year (concludes the report) the company made an offer of 30,000 shares to members at par. This issue was guaranteed by a group in which six of your directors were interested, directly or indirectly, the consideration being to take up a further 30,000 shares at 27s. 6d. each, and with their assistance the whole of the 30,000 shares offered were placed.

METROPOLITAN DISTRICT RAILWAY.—Mr. R. W. Perks, M.P., at the meeting yesterday, said he thought that meeting was the last occasion they would meet together with the line working under steam. Before they met in July next the whole of the main line and branches would be working by electricity. The delay which had arisen in the running by electricity was due to the contractors for rolling stock. Continental companies had orders for 280 cars, and 140 were being made in this country, but in both cases the makers were considerably behind in the delivery. The trains were now being delivered by the English companies. The board were hurrying on the contractors. The generating station at Chelsea was practically ready for working, the cables were laid, and they now only awaited the cars. Mr. Perks announced that he was resigning his position as chairman of the company, but he would remain as deputy-chairman. The new chairman would be Mr. Charles Yerkes.

NORTH-EASTERN RAILWAY CO.—The half yearly report to December states that against decreases of £42,366 and £15,406 under the heads of locomotive power and traffic expenses respectively must be taken the expenditure of £42,525 on the working of the electric trains. The steam train mileage was 13,894,289, a decrease of 675,232, but the electric trains ran 588,786 miles. During the half-year the company carried on the Newcastle and Tynemouth suburban lines, now worked by electricity, 675,000 more passengers between stations on those branches than in the corresponding half of 1903. The directors consider that the results of substituting electricity for steam in working the passenger traffic on these lines have so far been satisfactory as regards receipts and expenses.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The directors' report for year ended Dec. 31 states that supply has been distributed from the Carnaby-street and Mason's-yard stations on a total of 278,889 8 c.p. lamps, an increase of 24,121 for the year; 6,488,589 units were generated at the stations and 2,088,347 were purchased from the Central Electric Supply Co. The price charged on the supply of the Central Company has been considerably reduced, so that it has not been necessary to draw upon the contingency fund. The Central Company has recently declared a dividend of 5 per cent. on the ordinary shares, in respect of which a sum of £2,500 will in due course be payable to this company. The net profits applicable to dividend 1904 were £36,146. 12s. 4d., making with balance from 1903 (£2,744. 16s. 11d.) £38,891. 9s. 3d. The interim dividends absorbed £13,500, leaving £25,391. 9s. 3d. to be dealt with. The directors now propose to pay the balance preference dividends and a dividend on the ordinary shares of 7s. 6d. per share and a bonus of 2s. per share, making a total distribution of 14½ per cent. for the year, leaving £2,891. 9s. 3d. to be carried forward.

SOUTH STAFFORDSHIRE MOND GAS (POWER & LIGHTING) CO.—The report for 1904 states that the central station has been practically completed, and substantial progress has been made in the laying of the trunk mains, which are also very nearly completed through Bilston to Wolverhampton, and through Wednesbury to Walsall. The gas plant was started at the end of December.

TYNESIDE TRAMWAYS AND TRAMROADS CO.—At the meeting on Monday the chairman (Lord Armstrong) said the past year had seen the termination of the struggle for running powers over the Corporation tramways, which they had secured, the completion of their line to Gosforth Park racecourse, and the opening of the North-Eastern Railway Co.'s electrified system. The agreement between Newcastle Corporation and themselves had been put into partial effect. During the last four months of the year interchange of traffic had been carried out on two of the three routes covered by the agreement. The delay in giving through traffic facilities on the third route arose through certain difficulties which the Corporation were experiencing. While the benefit resulting to the public was unquestionable, it seemed a pity that the cost of bringing it about should have been so great. During April, before the running powers were in operation, the number of passengers in Wallsend travelling to or from the junction between the two systems was 28,627, whereas the equivalent figure in September, after through traffic had been introduced, was over 66,000. As the consumption of current was the only item which increased through the additional passengers carried, and as their company obtained from the Corporation four-fifths of the receipts which the Corporation cars earned on that section of the line, it would be seen that the agreement would far more than justify both the capital cost of securing it and the burden which the efforts in this direction had laid on this year's revenue. Since September the running expenses had been steadily falling, and as a result of a reduction in rating and the price of current, the total expenses were now below 5½d. per car-mile. In the published returns there were only two other tramway companies which showed a lower cost. A dividend was declared out of the profits for the half-year at the rate of 2 per cent per annum. At an extraordinary meeting consent was given to the promotion of a bill in Parliament to enable the company to issue a portion of their capital as preference shares.

WATERLOO & CITY RAILWAY CO.—At the meeting yesterday the chairman (Sir C. Scotter) said that they were now able to pay 3¼ per cent., against 3 per cent. for the half-year ended December, 1903. The improvement had been brought about not only by increased receipts but also by decreased expenditure. They were proposing that the company should supply electric current for lighting Waterloo Station, and whatever margin of profit there was in connection with that work would be so much to the good of their company. After providing for 3 per cent. on the ordinary and borrowed capital, there was an excess of £694, of which this company was entitled to two-thirds under the working agreement and the South-Western Co. to one third. Adding this amount to the balance of £421 brought from last half-year, the directors were enabled to pay the extra ¼ per cent. of dividend. With the thousands of trains run during the half-year there had been practically no accident of any kind or description, and the delays had been only a few minutes in the whole of the half-year. Since the commencement of the working of the railway the number of passengers carried had been 30,000,000 (including season ticket holders), and this vast number had been carried without accident of any kind.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

BOHM LENS LAMP CO. (LTD.) (83,466.)—Reg. Feb. 3, capital £4,000 in £1 shares (200 deferred), to acquire business carried on as Bohm Lens Lamp Co., to adopt an agreement with F. J. Pullen and E. C. Funnell, and to carry on the business of lamp manufacturers, glass blowers, electricians, suppliers of electricity, &c. First directors, F. J. Pullen (chairman), E. C. Funnell, F. Heywood and E. Bohm. Reg. office, 101, Great Russell-street, London, W.C.

DOWELL SYND. (LTD.) (83,401.)—Reg. Jan. 30, capital £500 in £1 shares, to adopt an agreement with C. A. Vandervell and W. H. W. Proctor, and to carry on the business of manufacturers of and dealers in electric, hydraulic and steam machinery and appliances, electrical and mechanical engineers, metal workers, machinists, &c. First directors, H. P. Smith, R. C. McC. Poulter and E. W. Hann.

DURHAM COLLIERIES ELECTRIC POWER CO. (LTD.) (83,421.)—Reg. Jan. 31, capital £125,000 in £1 shares (100,000 6 per cent. cumulative preference), to adopt certain agreements with the Sunderland Electric Tramways (Ltd.), the Electric Conversion Synd. (Ltd.), the Lambton Collieries (Ltd.) and the Hetton Coal Co. (Ltd.), for the supply of electricity, and to carry on the business of suppliers of electricity to any persons and public or private bodies, electrical and mechanical engineers, producers, accumulators and storers of electricity and gas, &c. First directors, Sir Douglas Fox, J. S. Bergheim and H. R. Hogg.

ELECTRIC POWER DEVELOPMENT CO. (LTD.) A company with this title has been registered with a capital of £50,000 in £100 shares for the purpose of promoting a bill in Parliament "to consolidate the sources of electricity supply in Greater London, and afford facilities to borough councils and electric lighting companies to purchase current wholesale at prices varying from ½d. to 1½d. per unit." The bill provides for a share capital of £5,000,000, with borrowing powers to one third of that amount. The names of the supporters of the bill include:—Lord Armstrong, D.C.L., Right Hon. Sir G. D. Taubman-Goldie, P.C., Sir Andrew Noble, K.C.B., Sir James Joicey, Bart., M.P., Sir Lindsay Wood, Bart., J.P., Dr. R. Spence Watson, and Messrs. J. H. Armstrong, James Falconer, Leonard Cunliffe, J. H. B. Noble, Francis Priestman, Henry Peile, Samuel Insull, E. Kraftmeier, John Annan, G. F. McCorquodale, P. Wigham-Richardson, A. F. Yarrow, Arthur Paget, James Couper, B. A. Firth, Douglas Vickers, C. Eric Hambro, M.P., and John Cowan.

LOWDEN ELECTRIC LAMP CO. (LTD.) (83,470.)—Reg. Feb. 3, capital £3,000 in £1 shares, to acquire and take over as a going concern the business carried on at Watford, Herts., as the Lowden Electric Lamp Works. Reg. office, Granville House, Arundel-street, London, W.C.

STATUTORY RETURN.

ENGINEERING INSTRUMENTS LIMITED (formerly Schattner Electricity Meter Co., Ltd.)—Return to Jan. 4 gives capital as £50,000 in 37,500 ordinary and 12,500 deferred shares of £1 each, of which 15,000 ordinary and 12,500 deferred shares have been taken up. 15s. per share has been called up on the ordinary and £11,250 has been received. 12,500 deferred shares are considered as fully paid. No mortgages or charges.

MORTGAGES AND CHARGES.

CHELMSFORD ELECTRIC LIGHTING CO. (LTD.)—A memorandum of satisfaction in full of a debenture stock trust deed dated Dec. 21, 1903 securing not more than £20,000, has been filed.

HAVANA ELECTRICITY CO. (LTD.) Trust deed dated Jan. 19, 1905, to secure £150,000 debentures, created same date, has been registered. Property charged, certain bonds of Cia de Electricidad de Cuba for $1,500,000 U.S. gold, and company's undertaking and other assets, present and future. Trustees, H. Rüffer and Major W. E. E. Gordon, M.P.

NORTHWICH ELECTRIC SUPPLY CO. (LTD.)—Trust deed dated Jan. 12, 1905, to secure £11,000 has been registered. Property charged, company's freehold and leasehold lands and hereditaments, undertaking and property. Trustees, Brunner, Mond & Co.

TYPEWRITING TELEGRAPH CORPN. (LTD.)—Issue on Jan. 25 of £640 debentures, part of series created Nov. 14, 1904, to secure £3,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

WORCESTER ELECTRIC TRACTION CO. (LTD.)—An acknowledgement of indebtedness under seal dated Jan. 27, 1905, creating £10,000 further debenture stock, making with £10,000 already created a total of £20,000, and being supplemental to deed dated Oct. 22, 1903, securing £10,000 of such debenture stock, registered. The company takes power to issue further debenture stock ranking pari passu up to half issued capital. Property charged, company's assets, present and future. Trustees, Electric and General Investment Co.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—The gross receipts for 1904 amount to £259,799 15s., the working and general expenses and renewals to £168,798. 18s. 2d., net revenue £91,000. 16s. 10d. After allowing for debenture interest (£11,415. 14s. 10d.), the preference dividend £19,020 16s. 8d. and interim dividend at the rate of 8½ per cent. per annum (less tax) for the half year to June 30 (£20,231. 15s. 5d.), it is proposed to pay a final dividend at the rate of 9½ per cent. per annum and to place £17,769 19s. 11d. to reserve. The receipts from the tramways department show an increase of £3,441 over the previous year's takings.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Feb. 4	1,093	+ 20	36	49,915	+ 5,797
Airdrie	Jan. 27	192	...	4	772	...
Ayr Corporation	Feb. 4	175	− 10	38	11,782	+ 583
Barnsley	Jan 27	143	− 1	4	840	+ 13
Barrow	" 27	169	...	4	647	...
Bath Electric Trams, Ltd.	Feb. 1	511	+ 45	5	2,650	+ 156
Bexley District Council	...	...	...	...	...	...
Birkenhead	" 5	1,030	− 7	...	...	...
Birmingham Corporation	" 4	354	...	5	17,578	...
*Birmingham & Mid.	Jan. 27	1,559	+ 98	4	6,085	− 450
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	Feb. 2	298	+ 9	44	44,984	+ 6,087
Blackpool and Fleetwood	" 4	206	− 11	5	850	− 110
Blackp'l, St. Anne's & Lytham	...	...	...	...	...	...
Bolton Corporation	" 5	1,063	+ 46	45	81,959	+ 764
Bournemouth Corporation	" 1	840	− 9	‡44	47,782	+ 2,153
Bradford Corporation	" 4	3,784	+ 884	44	195,797	+ 28,[illegible]06
Brighton Corporation	" 5	724	+ 88	44	41,168	+ 3,606
Brisbane Tramways	...	...	...	...	...	...
Bristol Trams & Carriage.	" 3	4,493	+ 100	26	166,177	+ 2,247
Buenos Ayres & Belgrano	...	...	...	...	...	...
Burnley Corporation	" 4	1,077	+ 191	18	5,315	+ 3,480
Burton Corporation	" 5	2[illegible]5	− 1	¶44	11,136	...
Calcutta Tramways Co.	" 4	r3,467	+ r2,105	5	r210,415	+ r27,744
Camborne-Redruth	" 6	99	+ 1	14	13,416	− 107
Cardiff Corporation	" 4	1,8[illegible]0	− 87	44	89,959	+ 2,084
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	" 4	7,072	+ 78	5	56,674	+ 677
Chatham & Dist. Lt. Rys.	" 2	582	+ 64	5	2,668	+ 189
*City of Birm'gh'm Tram Co.	Jan. 27	5,087	− 81	4	19,5[illegible]3	+ 119
City & South London Rly.	Feb. 5	2,9[illegible]5	− 334	6	18,503	− 783
Colchester Corporation	" 2	148	...	1	148	...
Cork Electric Trams Co.	" 2	406	+ 8	5	1,907	− 64
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	Jan. 27	390	− 43	4	1,076	− 69
Dover Corporation	Feb. 4	164	...	45	9,881	− 129
Dublin & Lucan Railway	" 3	96	− 3	5	457	+ 6
Dublin Southern District	" 3	770	+ 94	} 5	21,481	+ 100
Dublin United	" 3	3,679	− 96			
Dudley—Stourbridge	Jan. 27	693	− 25	4	2,636	− 60
Dundee Corporation	Feb. 1	606	+ 1	¶16	31,865	+ 135
East Ham Council	" 4	627	+ 50	44	31,317	+ 1,086
Gateshead & Dist. Trams	Jan. 27	840	− 14	4	3,259	+ 48
Glasgow Corporation	Feb. 4	13,996	+ 156	†36	517,109	+ 24,204
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	Jan. 27	175	− 19	4	687	− 69
Gt. Northern & City Rly.	Feb. 4	1,608	...	6	7,115	...
Greenock & Port Glasgow	Jan. 27	445	− 12	4	1,907	+ 193
**Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	" 27	210	− 17	4	8[illegible]9	− 21
Huddersfield	Feb. 4	1,284	+ 180	44	53,915	+ 3,161
Hull Corporation	" 4	2,036	+ 53	44	96,579	+ 10,919
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	" 1	163	− 18	18	1,954	− 316
Ipswich Corporation	" 4	329	+ 18	44	20,723	—
Isle of Thanet Co.	" 4	227	+ 112	19	5,[illegible]29	+ 9
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	Jan. 27	92	− 5	4	164	− 4
Kirkcaldy Corporation	Feb. 1	183	+ 7	...	...	...
Lanarkshire Trams Co.	" 2	588	+ 26	5	3,127	+ 119
Leeds Corporation	" 4	5,860	+ 1,561	46	257,463	+ 14,267
*Leicester Corporation	" 4	1,734	...	5	8,475	...
Liverpool Corporation	Jan. 28	9,160	+ 216	4	32,041	+ 908
Liverpool Overhead Rly.	Feb. 5	1,447	− 45	6	8,777	− 497
*London County Council	Jan. 28	14,048	+ 3,200	‡48	560,060	+ 172,806
Lowestoft	Feb. 4	123	+ 2	5	6[illegible]8	...
Maidstone Corporation	" 2	90	...	30	3,957	...
Manchester Corporation	" 4	11,589	+ 806	44	536,452	+ 25,523
Mersey Railway	" 4	1,510	+ 136	5	8,107	+ 540
Merthyr	Jan. 27	182	− 4	4	633	− 60
*Metropolitan Elec. Trams	" 27	1,873	+ 88	4	7,145	+ 2,039
Middleton	" 27	243	+ 10	4	940	+ 64
Nelson Corporation	Feb. 4	111	+ 11	45	5,547	+ 1,841
Newcastle-on-Tyne Corp.	" 4	3,661	+ 78	5	17,644	+ 198
Newport (Mon.)	" 4	501	+ 61	16	9,193	+ 1,838
Oldham, Ashton & Hyde	Jan. 27	463	− 20	4	1,791	−
Oldham Corporation	Feb. 5	1,393	+ 316	45	56,270	+ 3,769
Perth (W. A.) Elec. Trams	" 3	1,599	+ 170	5	7,424	+ 160
Peterborough	Jan. 27	93	− 11	4	371	− 26
Poole and District	" 27	186	− 6	4	602	− 28
Portsmouth Corporation	...	...	...	...	...	...
Potteries	" 27	1,539	− 86	4	6,007	+ 183
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	" 27	36	− 1	4	177	+ 15
Salford Corporation	Feb. 6	3,809	+ 131	44	160,280	+ 3,752
Sheerness	Jan. 26	50	+ 10	4	1[illegible]8	+ 30
Sheffield Corporation	Feb. 5	4,445	+ 213	‡45	200,480	+ 5,885
Southampton Corporation	...	...	...	...	...	...
Southend Corporation	" 1	222	+ 33	44	15,490	+ 1,589
Southport Tramways	Jan. 27	195	− 21	4	817	− 81
S. Staffordshire Trams.	" 27	601	− 144	4	2,332	− 254
Stockport Corporation	Feb. 3	4[illegible]5	+ 73	44	24,9[illegible]0	+ 5,317
Sunderland Corporation	" 5	1,120	+ 40	44	55,885	+ 1,468
Swansea Trams	Jan. 27	441	− 24	4	1,6[illegible]9	− 19
Taunton Trams	" 27	35	− 9	4	150	− 22
*Tynemouth and District	" 27	165	− 30	4	635	− 122
Tyneside Trams Co.	Feb. 1	824	+ 45	5	1,471	+ 151
Wallasey District Council	" 4	647	+ 64	‡44	32,916	+ 2,190
Walsall	" 4	418	...	5	2,187	...
Warrington Corporation	" 2	208	+ 51	44	14,105	+ 849
West Ham Corporation	" 2	1,[illegible]52	...	49	47,[illegible]4	...
Weston-super-Mare	Jan. 25	26	+ 3	4	99	+ 24
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	" 27	338	− 8	4	1,283	+ 24
Worcester	" 27	231	+ 135	4	918	+ 623
Wrexham	" 27	58	− 14	4	817	− 34
Yorkshire Woollen District	" 27	5[illegible]2	+ 37	4	1,964	+ 136

(a) These comparisons are with the corresponding period last year. † Minus 3 days ‡ Minus 2 days. § Plus 2 days. ¶ Plus 5 days. ** Fortnight. * Partly electrical.

CITY NOTES.

MEMORANDA (Feb. 9).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 28[illegible]d. per oz. Consols 89¼—89½ for money, 89½—89¾ for account; 2½ per cent. annuities 87¾—88¼. Consols Pay Day, March 1. Stocks and Shares Continuation Day, Feb. 22; Ticket Day, Feb. 23; Pay Days, Feb. 10 and 24; Mining Share Carry-over Days, Feb. 21 and March 10.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—The directors recommend, subject to audit, a dividend on the ordinary shares at the rate at 7½ per cent. per annum for the half-year to Dec. 31, making 6 per cent. for year, carrying forward about £1,170.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—The directors recommend a dividend on the ordinary shares at the rate of 10 per cent. per annum for the half-year ended Dec. 31, and a bonus of 2 per cent. for the year, making (with interim dividend) 12 per cent. for 1904.

RAND CENTRAL ELECTRIC WORKS (LTD.)—The result of working for January was 775,000 units generated, yielding a gross revenue of £7,300, compared with 776,940 units and £7,450 for the corresponding period of last year.

SOUTH LONDON ELECTRIC SUPPLY CORPN. (LTD.)—Subject to final audit, the directors recommend a dividend on the ordinary shares at the rate of 4 per cent. for the past year.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO. (LTD.)—The preference share transfer register will be closed from 15th to 28th inst.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Feb. 15 a special settling day in £135,000 4½ per cent. first mortgage debenture stock of the *Bath Electric Tramways Co. (Ltd.)*, and Feb. 16 a special settling day in 415,598 $100 common shares and 359,382 $100 preferred shares of the *Commercial Cable Co.*, and have ordered the first-mentioned stock as well as £200,000 4½ per cent. redeemable first debenture stock of the *Birmingham & Midland Tramways (Ltd.)* to be quoted in the Official List. The Committee have been asked to appoint a special settling day in and to grant a quotation to a further issue of 30,016 £1 fully-paid shares of *Marconi's Wireless Telegraph Co. (Ltd.)*, and to allow 248,000 £5 fully-paid shares and £174,000 4 per cent. debenture stock of the *City of Buenos Ayres Tramways Co. (1904) (Ltd.)* to be quoted in lieu of the shares and debenture stock of the *City of Buenos Ayres Tramways Co. (Ltd.)*.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—The directors recommend a dividend of 10 per cent. (£1. 4s. per share), in addition to 5 per cent already paid, making 15 per cent. for 1904.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., Feb. 8.	Rate per Cent. Yielded.*	Dividend Due.	Business, Week to Feb. 8. Highest.	Business, Week to Feb. 8. Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
	2/0	Anglo-Argentine Ord. Shares	8[illegible]–8[illegible]	2 9 7	Ap, Oc	[illegible]	[illegible]
	[illegible]	Do. 5% Cum. Pref.	[illegible]	4 5 1	—	[illegible]	[illegible]
St.	6%	Do. Permanent 6% Deb. Stock	140 —143	4 3 11	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 —105	4 15 3	—	105	..
	6%	Barcelona Tramways Ord.	11¼—11¾	2 9 0	—	12[illegible]	11¾
	5/0	Do. 5% Cum. Pref.	[illegible]—10	5 0 0	—	[illegible]	[illegible]
	4½%	Do. 4½% Deb. Stock (red.)	96 —100	4 10 0	—	..	..
100	5%	Do. 5 per Cent. Debs.	99 —102	4 18 1	..	..	..
	..	Brisbane Electric Trams. Invest Ord.	1¼—1¾	..	..	..	..
5	[illegible]	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 6	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Ctfs	94 —98	4 11 10	..	..	..
St.	6%	British Columbia Elec. Rlwy Def. Ord.	100 —103	5 16 6	—	[illegible]	103½
St.	5%	Do. Pref. Ord. Stock	100 —103	4 17 2	—	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 —10½	4 10 11	..	..	..
	4½%	Do. 4½ per Cent. 1st Mort. Dbs	[illegible]	4 6 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	97 —100	4 10 0	..	..	..
5	1/6	Buenos Ayres and Belgrano Ord.	3¾— 4¼	5 10 8	—	4¼	4
5	5/0	Do. 6 per Cent. "A" Cm. Pref	[illegible]—6	5 0 0	—	..	..
5	3/0	Do. "B"	5¾—[illegible]	5 6 8	—	..	..
St.	5%	Do. 5 per Cent. Debs.	106 —108	4 12 7	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov Certs.	102 —105	4 15 3	—	[illegible]	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	94 —97	5 3 1	..	..	..
5	3 0	Calcutta Tramways	[illegible]	5 11 4	—	6	[illegible]
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —108	4 3 4	—	107	..
1	1/6	Cape Electric Tram Shares	1¾—1[illegible]	3 14 0	—	1[illegible]	1[illegible]
St.	5%	Colombo Trams & Ltg. 5% 1st Mt Deb. (red)	102 —104	4 18 1	..	102½	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	101 —103	4 17 3	Ja, Jul	..	..
100	5%	Montreal St. Ry. St'g 5% Mort Debs. (1908)	101 —104	4 16 2	—	..	..
100	4½%	† Do. Sterling 4½% Debs. (1922)	102 —104	4 6 7	..	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	102 —106	4 15 3	..	..	..
		ELECTRICITY SUPPLY.					
5	8/0	Calcutta Electric Supply Ord.	[illegible]	3 16 11	..	9	[illegible]
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	96 —[illegible]	5 0 11	..	..	..
10	..	Havana Electricity Co. Shares	9¾—10¼	—	—	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	[illegible]—1¼	..	—	..	..
1	..	Rand Electric	1 —1¼	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	100 —102	4 8 9	Ap, Oc	..	..

*In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., Feb. 8.	Rate per Cent. Yield.	Dividend Due.	Business, Week to Feb. 8. Highest.	Business, Week to Feb. 8. Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
1	..	Bath Elec. Trams Pref. Ord.	½–¾	..	..	..	..
1	1/- and.	Do. 5% Cum. Pref.	⅞–1⅛	4 14 1	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19–20	4 0 0	Feb, Aug	..	..
10	6%	Do. Cum. Pref. (fully paid)	10–10½	5 18 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	103–105	3 16 0	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	9–9½	6 6 0	..	10⅛	9⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–11¾	5 2 0	Feb, Aug	11¾	11⅝
St.	5%	Do. 5 per Cent. Perpetual Debs	120–122	4 2 0	—	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	97–99	4 10 11	—	..	..
St.	4%	Central London Ordinary Stock	91–92	4 6 6	June, Dec	93	92
St.	4%	Do. 4 per Cent. Pref. Stock	101–103	3 17 9	—	102½	..
St.	4%	Do. Deferred Stock	85–87	4 12 0	—	..	..
100	4%	Do. 4 per Cent. Debs.	109–111	3 12 0	—	109	108
5	2/6	City of Birmingham Trams 5% Cm. Prf.	5¼–5½	4 17 6	—	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	101–104	3 17 8	..	103½	103
St.	2½%	City and South London Rly. Con. Ord.	46½–47½	4 9 6	Feb, Aug	47½	46½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122–126	4 0 3	Feb, Aug	..	..
St.	5%	Do. (1896)	119–122	4 2 0	..	—	..
St.	5%	Do. (1901)	117–120	4 3 4	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106–108	3 14 1	May, Nov	..	..
10	6/0	†Dublin United Trams. (1896) Ltd., Ord.	13–14	4 5 8	..	..	..
10	6/0	† Do. 6 per Cent. Pref.	16½–16¾	3 12 9	—	..	..
10	2/0½	Gt. Northern & City Rly. Prf. Ord. (4%)	4½–4¾	4 8 10	—	4¾	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8½–8¾	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19–20	4 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	15–15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	111½–112½	4 0 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½–3¾	6 13 4	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90–93	4 6 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3⅛–3⅜	3 11 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref	10–10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99–101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10⅝–10⅞	4 14 0	..	10⅞	10¾
St.	4%	Do. 4% 1st Mort. Deb. Stock	104–106	3 15 6	..	105½	104½
St.	..	Mersey Con. Ord. Stock	4–7	..	..	5	..
St.	..	Do. 3 per Cent. Perp. Pref.	10–13	..	—	..	..
1	..	Metropolitan Electric Trams Def	¼–½	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	1–1⅛	4 17 0	—	1	..
St.	4½%	Do. 4½% Deb. Stock	104–106	4 5 0	..	105	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1–1½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	8–9	5 11 2	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	9¼–9¾	5 6 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99–102	4 8 3	—	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	—	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London	98–99	5 2 0	..	98½	97½
St.	3%	Waterloo and City Ord.	91–93	3 4 6	June, Dec	92	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99–102	4 0 0	Jan, July	..	..
10	..	Amazon Telegraph	1–1½	..	Jn, Dec ..	..	..
St.	12/6	Anglo-American	58–60	4 11 8	F,My,Ag,N	61½	59
St.	25/0	Do. Preferred	105–107	6 3 0	F,My,Ag,N	106	105
St.	2/0	Do. Deferred	11½–12½	..	F,My,Ag,N	13	11½
100	8%	Commercial Cable Capital Stock	170–190	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95–97	4 2 6	Jn,Ap,Jy,O	96½	94½
10	5/0	Cuba Submarine Ord.	6¾–7¼	5 5 0	Feb, Aug	7¼	..
10	10/0	Do. Preference 10 per Cent.	16½–17½	5 14 3	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	3¼–3¾	5 11 9	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7¾–8¼	6 1 2	April Oct	8¼	..
50	4½%	Do. 4½ per Cent. Deb.	100%–102%	4 10 0	Jan, July	..	..
20	8/0	Direct United States Cable	11½–11¾	5 6 6	Ja,Ap,Jy,O	11⅝	10⅞
100	4½%	Direct West India Cable 4½% Rg. Db.(rd.)	99–101	4 9 1	Jn, Dec ..	..	..
St.	26/0	Eastern Ordinary	135–138	5 1 5	Ja,Ap,Jy,O	137½	136
St.	17/6	Do. 3½ per Cent. Pref. Stock	87–89	3 18 8	Ja,Ap,Jy,O	88½	87
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105–107	3 14 9	May, Nov	107	105½
10	2/6	Eastern Extension	13½–14	5 0 0	Ja,Ap,Jy,O	13¾	13½
St.	4%	‡ Do. 4 per Cent. Deb. Stock	104–106	3 15 7	Feb, Aug	..	..
100	4%	†Eastern & S. African 4% Mrt. Deb. 1900	99–101	3 19 2	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%–102%	3 18 5	May, Nov	..	..
10	5/0	Great Northern (of Copenhagen)	37–37½	4 15 8	Jan, July	35½	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	99–101	4 9 1	June, Dec	..	..
25	12/6	Indo-European	65–67	4 9 5	May, Nov	66½	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs.(rd.)	97–100	4 0 0	June, Dec	..	—
10	4/0	West African Telegraph Shares	7¼–7¾	5 5 2	—	..	..
2½	..	West Coast of America	⅞–1⅛	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	99–101	3 19 2	Jan, July	..	..
10	..	West India and Panama	¾–1	..	May, Nov	1	¾
10	7/0	Do. 6 1st Pref. ex 7 on acct. of arrears	7¾–8	8 8 6	May, Nov	7¾	7½
10	..	Do. 6 per Cent. 2nd Pref.	6¾–7½	..	May, Nov	7¼	..
100	6%	* Do. 6 per Cent. Debs.	101–103	4 17 1	Jan, July	..	..
10	2/0	Western Telegraph	13½–14	5 0 0	Mr,Jn,O,D	13⅞	13½
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101–103	4 17 1	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	100½–103½	3 18 0	—	102½	102
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid,	6¼–6¾	5 9 10	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	1⅛–1⅜	2 11 9	..	..	..
St.	6%	National Co. Pref. Stock	105½–106½	5 9 7	..	106½	105½
St.	5%	Do. Def. Stock	107–109	4 11 9	..	109	106½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13–14	4 5 5	Feb, Aug	13½	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12–13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 6 per Cent. Non-Cum. 3rd Pref.	6½–6¾	4 10 11	Feb, Aug	6¾	6½
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	86–88	3 11 5	June, Dec	86½	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102½–103½	3 16 10	..	103	102½
..	24/0	Do. Do. Prov. Certs. all paid	10½–10¾	3 17 3	..	..	..
1	0/7½	Oriental	1⅛–1⅜	5 7 3	April, Oct	1¼	—
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼–1⅜	4 16 0	..	1¼	..
St.	20/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	100–103	..	..	..	..
5	3/0	United River Plate	6½–7¼	5 10 4	July......	7¼	7
5	2/6	Do. 6 per Cent. Cum. Pref.	5–5½	4 17 9	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	105–107	4 13 5	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	6/0	Elec. & Gen. Investment 5% Cum. Pref.	4¾–5½	5 17 1	—	..	..
10	2/0	†Globe Telegraph and Trust	10½–10¾	5 6 9	Ja Ap Jy O	10⅝	10½
10	6/0	† Do. 6 per Cent. Pref.	16½–16¾	4 4 11	Ja Ap Jy O	16¾	16½
100	6%	Submarine Cables Trust (Cert.)	121–126	4 16 9	April, Oct	..	..

Share.	Last Dividend.	Name.	Price Wed., Feb. 8.	Rate per Cent. Yield.	Dividend Due.	Business, Week to Feb. 8. Highest.	Business, Week to Feb. 8. Lowest.
		ELECTRICITY SUPPLY.		£ s. d.			
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12–12½	6 8 0	..	12½	12¼
10	4/6	Do. 4½ per Cent. Cum. Pref	9½–10	4 10 0	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11–12	5 0 0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104–106	4 4 10	—	..	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5½–5¾	3 9 7	..	..	..
St.	4½%	Do. Do. 1st Debs	101–104	4 7 0	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½–11	4 10 11	..	10¾	..
5	3/6	Do. 7 per Cent. Pref.	10½–10¾	3 5 1	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105–108	3 14 1	..	..	..
5	4/6	Charing Cross & Strand Electric Sup.	8¼–8½	4 11 6	Feb, Aug	8⅜	8¼
5	2/3	Do. 4½ per Cent. Pref.	5½–5¾	3 16 3	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	102–104	3 16 11	..	103	102¼
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾–5	4 4 9	—	5	..
5	2/3	Do. Do. (1903)	4¾–5	4 4 9	..	4⅞	5
5	2/6	Chelsea Electric Supply Ord.	6¾–7¼	4 0 8	March ..	7⅛	6¾
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108–110	4 1 10	Jn, Dec ..	..	..
10	8/0	City of London Electric Lighting Ord.	12–12½	6 0 0	Feb, Aug	12½	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13½–14	4 5 9	Jan, July	13¾	13½
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123–126	3 19 4	Jn, Dec ..	—	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102–104	4 6 7	..	..	..
10	4/0	County of London Elec. Supply Ord.	9–9½	4 4 2	..	9¼	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12–12½	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	108–111	4 1 1	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	102–104	4 6 7	..	103½	102½
5	2/0	Folkestone Electricity Supply Co. Ord.	4½–5	4 11 9	..	..	..
St.	4½%	† Do. 4½ 1st Deb. Stock (red.)	102–104	4 6 7	—	..	—
5	3/0	Hove Electric Lighting Ord.	7½–8	3 6 3	..	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	100–103	4 8 9	..	101½	..
5	5/0	Kensington & Knightsbridge Ord	13–13½	4 8 11	..	..	..
5	6%	Do. 6 per Cent. 1st Pref	6½–7	4 6 9	Jan, July	—	—
St.	4%	Kensingtn. & Knghtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102–104	3 17 3	—	..	..
5	..	London Electric Supply Ord.	2½–3	..	—	2¾	..
5	3/0	Do. 6 per Cent. Pref.	5½–5¾	5 2 2	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96–98	4 1 8	Mr,Jn,S,D	..	..
10	9/0	Metropolitan Electric Sup. Ord.	18–18½	5 0 0	April, Oct	18	17¾
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅞–6⅛	3 19 0	Jan. July	6⅛	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	113–116	3 18 3	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96–98	3 11 3	..	..	—
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	94–97	4 12 11	..	..	—
10	9%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	12¼–12¾	5 15 8	Feb, Aug	..	..
5	8%	Newcastle Elec. Supply Ord.	8–8½	4 19 3	Feb, Aug	..	..
5	5%	Do. 5 per Cent. Non-Cum. Pref.	6¼–6½	3 19 2	Feb, Aug	..	..
1	..	Northern Counties Elec. Sup. 17/- paid	15/9–16/9	3 6 0	Mar, Sep	..	..
10	6/0	Notting Hill Electric Ord.	14½–15½	4 0 0	March....	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	102–104	3 17 0	..	103	..
5	2/6	Oxford Electric Ord.	6½–6¾	5 2 2	March ..	6⅛	..
St.	4%	Do. 4% Deb. Stock	95–100	4 0 0	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	13½–14½	5 0 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	8½–9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98–100	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3½–3¾	5 3 1	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85–87	4 12 0	—	..	..
5	2/0	South London Electric Supply Ord.	4½–4¾	2 4 11	—	4½	4¼
1	..	South Metrop'n Elec. Lt. & Power Ord.	¾–1	..	—	..	..
1	0/8½	Do. 7% Cum. Pref.	1⅛–1⅜	4 10 9	—	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	107–110	4 2 3	—	..	..
5	2/6	Urban Electric Supply Ord.	5–5½	4 17 6	..	5⅛	..
5	2/6	Do. 5% Cum. Pref.	5¼–5½	4 16 3	..	5¼	5⅛
St.	..	Do. 4½% 1st Mort. Deb.	106–107	—	..	106½	..
5	6/6	Westminster Electric Supply Ord.	15–15½	5 0 0	Mar, Sept	15¼	15⅛
5	2/6	Do. 5 per Cent. Cum. Pref.	6¼–6½	3 18 5	—	6½	6¼
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 6% Cum. Pref.	⅞–1	5 0 0	..	..	..
1	6d.	Aron Elec. Meter 6% Cum. Pref.	⅞–1⅛	..	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6¼–6¾	4 19 2	July, Feb	..	..
5	3/0	† Do. 6 per Cent. Pref.	5–5½	5 3 5	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101–104	4 6 6	—	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101–103	4 10 6	—	..	..
5	3/0	British Westinghouse 6% Pref.	5⅛–5⅜	..	—	5¼	5⅛
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	86–88	4 11 0	..	85	..
2	..	Brush Electrical Engineering	¾–1	..	March ..	⅞	..
2	2/6½	Do. 6 per Cent. Pref. Non-Cum.	1½–1¾	8 0 0	Mar, Sept	1⅝	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	95–98	4 14 6	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	75–78	5 11 6	Jan, July	76½	..
5	5/0	Callender's Cable Con. Ord.	9½–10	6 5 0	Jan, July	9¾	9⅝
5	2/6	Do. 5 per Cent. Cum. Pref.	5½–5¾	4 10 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	105–107	4 4 0	Nov, May	..	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	2–2¼	4 9 5	..	..	..
St.	4½%	† Do. 4½% 1st Mort. Deb. (red.)	91–96	4 13 9	..	..	..
1	0/4½	Chadburn's (Ship) Telegraph Ord.	¾–1¼	8 17 0	..	..	..
2	1/0	Crompton and Co. (Nos. 1 to 64,000)	2⅛–2⅜	3 0 3	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	93–95	5 2 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	8–8½	5 17 5	Sept	..	..
5	5/0	Do. 6% Cum. Pref.	4¾–5	5 0 0	Sept	4¾	..
St.	4½%	Do. 4½% Deb. Stock	105–107	4 4 0	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅛–¼	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1–1¼	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77–82	4 17 8	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79–84	6 0 0	..	..	..
5	3/6	Edmundson's Elec. Corp. Ord.	6¼–6½	5 12 0	H'lf-yearly	6⅜	6¼
5	3/0	Do. 6 per Cent. Cum. Pref.	6–6½	4 16 0	—	6¼	6⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106–108	4 3 3	..	106½	106¼
2	1/-	Electric Construction Co.	1½–1¾	6 3 0	July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	1¾–1⅞	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97–99	4 0 10	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90–95	5 5 3	—	..	—
10	5/0	General Electric (1900) 5% Cum. Pref.	9½–10	5 0 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91–96	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	10½–11½	4 8 8	Feb, Aug	11	..
5	2/3	Do. 4½ per Cent. Pref.	5½–5¾	3 18 9	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	110–112	4 0 10	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	15–16	6 5 0	Feb, Aug	15⅛	—
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99–102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 6 per Cent. Cum. Pref.	11–11½	4 7 0	Mar, Sept	..	..
12	17/6	Telegraph Construction & Mainten'ce.	34–37	5 2 2	Mar, July	35½	34
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101½–102½	3 17 3	Jan, July	..	..
5	—	Willans and Robinson Ord.	1½–1¾	..	Apr, Oct	1¾	1½
5	—	Do. 6 per Cent. Cum. Pref.	3–4	—	Apr, Oct	3	3
	6%	Do. 6 per Cent. 1st Mort. Debs.	76–79	6 1 3	May Nov	..	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

IN our issue of last week we made some general criticisms upon the motor 'bus "boom," with special regard to the effects upon the safety and amenities of the streets of such a service as would adequately replace the existing tramway service in South London. In this issue will be found an article dealing especially with the commercial aspects of the discussion. The results may be thus summarised:—The working cost of a motor omnibus, including repairs, is from 11½d. to 1s. per car-mile and its carrying capacity 34 passengers. The working cost of an electric tramcar is from 5d. to 6d. per car-mile and its carrying capacity from 50 to 70 passengers. The much greater margin between working expenses and earning power is far more than sufficient to cover the disbursements put upon the tramway owner for capital charges, track maintenance, paving maintenance, and rates, wherever anything approaching a frequent service is demanded.

◆

A CONCRETE proof of the correctness of this statement is afforded by the fact that many an electric tramway lives and pays a dividend on lower earnings per car-mile than the sheer working expenses of the motor 'bus. In fact, it is an axiom of tramway management that when the takings reach 1s. per car-mile this is an indication of insufficient service of cars.

◆

A POINT not often appreciated is that, whilst a large part of the cost of omnibus traffic is defrayed by the ratepayers in the shape of road construction and repairs, the tramway pays for and maintains its own track, the paved surface between the rails and for 18in. outside them, and also that it pays rates upon its track. The tramway is thus a ratepayer, even when it belongs to a local authority. It is the 'bus service that is rate supported—not the tramway.

◆

THE simple comparison between the working costs and carrying capacity of horsed omnibus and tramway undertakings brings out clearly enough the immense advantages of the iron road with animal propelling power, and all the conditions give mechanical propulsion a greater advantage upon the rails. The cost of power also gives the electric car a great pull over any self-contained vehicle. No means exist or are in sight of any method of supplying power to vehicles, that can approach the modest figures afforded by the modern large and highly economical generating station and distributing system. From every point of view, the electrically-driven tramway is superior as a device of commercial engineering to the independent vehicle wherever large carrying capacity is needed.

◆

THE Paper by Signor SEMENZA, which we publish in this issue, will be read with interest in view of the discussion on overhead mains that is to take place at the Institution of Electrical Engineers next week. Unlike Mr. ADDENBROOKE'S Paper, it deals with some practical points in the construction of overhead cable lines, which should not be overlooked by designers. The Brembo type of construction has apparently much in its favour, both in view of the disposition of the wires and of the "elastic" support for them, but possibly there is also something to say in favour of the more usual methods. We trust that the discussion of such questions as these will not be ruled out of order at the next Institution meeting, although the Paper under consideration does not deal with the actual construction of overhead lines, but is almost confined to general principles.

◆

WE are also able to supplement Mr. ADDENBROOKE'S Paper by an outline of the policy that the Board of Trade will adopt in the matter of overhead work. The draft regulations, published in our issue of August 26, 1904, have been considerably modified in this respect, and the 12 rules as to overhead lines will be replaced by a short clause stating that such lines may not be erected except in accordance with plans approved by the Board of Trade, and subject to such regulations as the Board may prescribe. These regulations will be prepared at the outset to meet each particular case, and they will not be more stringent than either the German rules (published in our issue of January 27th last), or the Swiss rules given in the Appendix to Mr. ADDENBROOKE's Paper. In all probability similar procedure will be followed as in the Railway Department of the Board of Trade: Plans and a written description of the system to be deposited with the Board by the undertakers, the plans of the route being on a 6in. map and the plans of the poles, insulators, &c., on a reasonable scale, say ½in. or 1in to the foot. These plans and descriptions to receive the Board's provisional approval if satisfactory. On completion of the line, an inspection to be made, and in some cases inspection of the route before and during erection if deemed necessary. The regulations would then be made after the final inspection, as in the case of the working regulations for tramways.

We commence this week an interesting Paper on electric light and power cables read at the last meeting of the Manchester Section of the Institution of Electrical Engineers. The authors of the Paper are connected with a firm of cable manufacturers, and frankly recommend the material supplied by this firm in preference to that in which other makers have specialised. This does not constitute the sole interesting part of the Paper, however, although conformity to standard estimates of human nature is always interesting. The portions of the Paper that will be read with the greatest profit are those relating to the tests of the various substances employed in cable manufacture. As the authors truly remark in the first part of the Paper (which we publish this week) the buyer of rubber cables has to place himself largely in the hands of the seller. This statement is preceded, however, by a devout expression of opinion that, were it not for the high cost of this class of cable, it would never have been superseded. On this point we must disagree with the authors. Rubber cables have been superseded for outdoor work because they did not stand the test of time. The insulating material after a few years' use underwent a chemical change, lost its mechanical properties, and ceased to be waterproof. Rubber insulation was used more than any other in the early days of electric lighting, but lead-covered cables were not only employed for extensions but also largely to replace the original rubber cables. The authors now give valuable hints to assist the buyer in choosing his cable, and he will doubtless find these of the greatest utility in ordering cable for internal work and for special positions outside. In spite of the progress made by this firm of manufacturers, however, in discovering the causes of decay in indiarubber and the methods of avoiding them, we cannot recommend the readoption of this class of insulation for underground work: the risk is too great. The second and third part of the Paper will deal mainly with vulcanised bitumen and paper-insulated cables.

After a long period of depression, the London Electric Supply Corporation has at last been successful in paying a dividend on its ordinary shares. Three per cent. is a small profit for an Electricity Supply Company, especially in view of the fact that the original capital of the company has been reduced, but it is more than would have been expected a few years ago, when only after prolonged careful nursing on the part of the Managing Director, Mr. R. STEWART BAIN, and economies by the engineering staff, the undertaking paid a dividend on its preference shares. The improvement this year must, however, be attributed largely to good luck, although we are far from suggesting that good management has not contributed to it. The good luck has been the closing of a contract with the London County Council by which steam is being supplied for running temporary generating plant for the south London tramways until the Council's own generating station has been completed. This steam is sold to the Council at a price of 1·65d. per unit of electrical energy measured at the switchboard, and, taking into consideration the high load-factor and the fact that the distribution costs are saved, the price is one which must bring considerable profit to the company. In the Directors' report, which we publish elsewhere in this issue, the sale of steam is embodied in the item "number of units sold," and it evidently accounts for the greater part of the increase from 4,102,099 to 10,531,785 units. We think that the temporary nature of the increase in business should have been made clear in the report before us, in which no mention is made of the special circumstances that have increased the company's output, for the shareholders should be advised that this feature and the attendant increase in the profits will not be continued for more than another year or so unless the company largely increases the number of its ordinary consumers. Doubtless, however, Mr. BAIN will make a statement with regard to this at the annual general meeting next Thursday.

Although complaint has been made in some quarters that the programme contained in the King's speech to Parliament on Tuesday is too long, we trust that some measures that have not been mentioned in it will nevertheless be introduced by the Government during the present session. The only proposal in the speech which has any interest for the electrical profession is the establishment of a Ministry of Commerce, and little permanent good will have been accomplished if only the recommendations of the Committee appointed in 1903 to consider the reconstruction of the Board of Trade are acted upon. Something much more radical than the mere changing of titles and the increase of salaries is needed in order that the industrial and commercial development of this country may receive the effective aid it so sorely lacks. We once more express the hope that reforms will be introduced into the legislation governing the electric supply and traction industries. The Supply of Electricity Bill ought this year to be passed into law, and one can only regret that, after the large amount of time devoted, during the past two sessions, to getting the Bill into shape, the whole thing has to be started afresh, and all the unsuccessful applications for modifications in the Bill will be gone through once more. Thus, unless the Bill is introduced at an early stage, there will again be the possibility that shortness of time will determine its fate. The electric traction industry should certainly also be relieved of some of the anomalies at present hampering it.

◆

THE annual general meeting of the Physical Society took place on Friday last week, when the Council's and Treasurer's reports were presented, and the new president, Prof. POYNTING, succeeded Dr. GLAZEBROOK in the chair. The reports showed that the average attendance during the past year worked out at 43, about 10 per cent. of the membership, which is, we believe, a slight improvement on the preceding session. The fact that the attendance has been rather greater at evening than at afternoon meetings indicates that the introduction of evening meetings has been a step in the right direction. Friday's gathering was, however, smaller than ought to have been on such an occasion. Prof. POYNTING'S presidential address took the form of a résumé of recent progress in radiation theory, and dealt especially with a phase of the subject with which he has lately been busy—namely, the mechanical effects exhibited at the incidence of radiation on surfaces of reflecting, refracting and absorbing matter. His treatment of this fearsome topic was lucid in the extreme, and came as a revelation to many of his hearers. The new simplicity arose from the conception of momentum localised in a beam of light—a principle so promising that we are sure to hear more of it in the near future. A report of the meeting appears on another page.

◆

A DRAFT agreement between the Postmaster-General and the National Telephone Co., presumably relating to the purchase of the company's telephone system by the Government, has been drawn up, and it will be considered by the House of Commons before ratification, as promised by the Postmaster-General last session. Up to the time of going to press we have been unable to obtain a copy of this agreement, but in all probability it will be issued by the Government printers to-day (Friday), and we hope, therefore, to publish the heads of it in our next issue.

◆

Royal Society.—Among the Papers down for reading yesterday were the following:—"Polarised Röntgen Radiation," by Dr. C. G. Barkla (communicated by Prof. J. J. Thomson, F.R.S.); "The Effects of Momentary Stresses in Metals," by Prof. B. Hopkinson (communicated by Prof. J. A. Ewing, F.R.S.).

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne—Pinheiros	**Aug. 18, 1902**	—
Beissi-Issa (Yemen)—Camaran	**Oct. 22, 1902**	—
Tarifa—Tangier	**Jan. 18, 1904**	—
Cayenne—Paramaribo	July 13, 1904	—
Cap Haytien—Puerto Plata	Dec. 27, 1904	Dec. 29, 1904
Marmaritza-Rhodes	Jan. 30, 1905	—
Jamaica—Colon	Jan. 10, 1905	—
Martinique—Paramaribo	Feb. 14, 1905	—

Application of Electricity to Mines.—A Paper on this subject was read before the Birmingham Local Section of the Institution of Electrical Engineers by Mr. A. C. Anderson on Wednesday. In the course of the Paper the author expressed his regret that the new mining rules restricted the voltage of motors and transformers up to 75 H.P. capacity to 650 volts, while in Germany, for instance, voltages above 2,000 volts were in actual use.

Elektrotechnischer Verein.—The report presented at the general meeting of this association on January 24th states that the number of members at the end of 1904 amounted to 2,741, of which 1,232 live in Prussia, 380 in other parts of Germany, 325 in Austria-Hungary and 804 in all other foreign countries. The receipts during 1904 were some £7,310, the expenditure being about £2,875. In comparison with this, it may be noted that the membership of the Institution of Electrical Engineers on August 31, 1904, was 5,410, made up of six honorary members, 136 foreign members, 965 members, 1,435 associate members, 1,761 associates and 1,107 students.

Telegraph Posts and Open Spaces.—In connection with the deputation which recently waited upon the Postmaster-General, urging that steps should be taken to prevent the disfigurement of commons and places of natural beauty by the erection of lines of unsightly telegraph posts and wires (*The Electrician*, January 27, p. 571), Lord Stanley has addressed a letter to Mr. Shaw Lefevre concerning the Epping Forest case, which was mentioned. Lord Stanley hopes that he does not propose to press this case any further, although it appears very difficult to find an alternative route. He trusts, however, that he will receive full support in asking for the moderate and reasonable extension of his present powers as regards private property which he proposes to do this session.

Opening of the Bo'ness Electric Supply Works.—The electricity works which have been erected at Bo'ness by the National Electric Construction Co., under an agreement with the Burgh Commissioners, were opened last week. A provisional order was obtained by the Burgh Commissioners in 1903, and Messrs. Burstall & Monkhouse were retained in connection with the scheme. A three-wire continuous-current system at 230 volts was eventually adopted. The generating station contains two Heenan & Froude boilers, two Peache-Lancashire Dynamo Co. generating sets, a battery of 256 Chloride cells, having a capacity of 400 ampere-hours at 10 hours, and a Lancashire Dynamo Co. balancer-booster set. The capacity of the generating plant is 200kw. Mr. J. M. McGown is the resident engineer. The Burgh Commissioners have borrowed £25,000 for the scheme, and the company pay the capital charges upon this sum. Over nine miles of B. I. & H. cables have been laid in Sykes troughing, and there will eventually be 12 arc lamps besides Nernsts and incandescents for street lighting. The works have been placed near the centre of the town quite close to the docks. At present a tariff of 5d. per unit for lighting and 2d. per unit for power is in force. The contract with the company for running the works allows the local authority the option of purchase at 10, 14, 17, or 20 years.

Obituary.—It is with deep regret that we announce the death of Edward Hemphill Mullin, an American technical journalist, who succumbed to an attack of heart failure consequent upon influenza. Mr. Mullin was born at Castlederg, County Tyrone, Ireland, in 1859, and took honours in 1881 at Queen's College, Belfast, afterwards studying physics and medicine in London. Later on he adopted the career of journalist, and was associated with the late Chas. A. Dana on the New York *Sun*. This led to his appointment as editor of the New York *Evening Sun*, and, for a time, he also had charge of the technical reporting on the New York *Times*. In 1898, Mr. Mullin's services were secured by the General Electric Co. of America, and as head of the company's publicity department he won universal esteem. He was a member of the council of the American Institute of Electrical Engineers at the time of his death, and was well known to most professional and technical men of any standing in America. During the year just past he had charge of all the travelling plans and facilities in connection with the visits of foreign societies at the invitation of the American Institute. He accompanied the special train to St. Louis, and will, therefore, probably be familiar to many of our readers. Before the British Institution of Electrical Engineers left for home the members showed their appreciation of Mr. Mullin's services by presenting him and his wife with a handsome silver service.

Railway Companies and Motor 'Buses.—A conference was held at the Westminster Palace Hotel on Monday consisting of representatives of municipal tramway authorities throughout the United Kingdom. Representatives of 22 municipal tramway authorities were present, including five delegates from Manchester, by whom the conference was brought together. The object was to protest against the clauses which several railway companies have introduced into their bills this year, enabling them to provide motor omnibuses in connection with their railway systems. The use of motor 'buses by railway companies without any restrictions was strongly condemned, and the opinion was expressed that the only conditions upon which they should be allowed was that they should be used solely for carrying traffic to and from the companies' railway stations, and that the vehicles should be licensed by the local authority in whose district they were used. A resolution was unanimously carried to this effect. The Tramways and Light Railways Association also laid before the conference a series of proposals for the amendment of the Tramway and Light Railway Acts. Among these were an alteration in the constitution of the powers of the Light Railway Commissioners, and also that the Light Railways Commissioners should have authority to grant compulsory running powers over tramways and light railways. Some reference to this matter was made by the Hon. Arthur Stanley at the annual meeting of the Tramways and Light Railways Association (reported in another column), and a meeting of the Association and the Municipal Corporations Association is to be held concerning it. The question of rear lights was also dealt with, and the Bill of the Cyclists' Touring Club and the Automobile Club, providing that every vehicle on the public highway shall carry a white light in front and a red light behind, which could be seen at a distance of 50 yds., is to be given the support of the conference.

Wireless Telegraphy in the United States.—The *Electrical World* of New York states that on January 27th the United States Cabinet discussed the subject of Government supervision of wireless telegraphy. The matter was brought up at a Cabinet meeting about a year ago, and a special board, appointed for the purpose of investigating it fully, made a report to the President. The Administration's views have been embodied in a bill drafted by the Commissioner of Navigation, assisted by Capt. Seabury, of the navy, and others. The bill provides that no person or corporation shall use any apparatus for wireless telegraphy in the United States or upon any American vessel unless he be licensed by the Secretary of Commerce and Labour. Persons exchanging messages or signals between points situated in the same State or on behalf of the American Government are to be exempt from this requirement. The official licence is to provide that the President of the United States in time of war or public peril may close any wireless telegraph station, or authorise its use by the Government. The President receives power to establish regulations which shall prevent interference between the naval and military wireless telegraph stations and private or commercial stations. Each licensed station is to be required to answer calls and signals from any other licensed station and to receive all such messages or signals offered for transmission to a neighbouring station, the rate to be that customarily required for such service. This requirement is to be observed regardless of the system used, on pain of revocation of the licence. Operation of any apparatus for wireless telegraphy on a foreign ship, while that ship is in American waters, shall be in accordance with the regulations prescribed by law. Government stations are prohibited from competing for commercial messages with licensed wireless stations.

Coming of Age of the Junior Institution of Engineers.—The coming of age of the Junior Institution of Engineers was celebrated at a dinner at the Hotel Cecil last Saturday, when close upon 200 members and guests met. Mr. W. H. Lindley, the President of the Institution, occupied the chair. After the loyal toasts had been honoured, Prof. W. E. Ayrton, in a humorous speech, proposed "Legislation and Engineering," this toast being acknowledged in the same strain by Mr. J. Swinburne and Mr. J. H. Balfour Browne, K.C. The latter pointed out that Parliament, although opposed at times to views advanced by scientific men and engineers, had generally given way in the long run. Engineers, on the other hand, owed a great debt to Parliament, without which the very existence of extensive engineering undertakings would be well-nigh impossible, while the growth of others would be impeded by many difficulties which could only be cleared away by legislature. "The City and Port of London" was proposed in a powerful speech by the president, who took his hearers back to the days of the old Hanseatic towns, which used at one time to own wharves in this city, but had sold them since, as they possessed extensive wharves of their own, built by eminent engineers. The tonnage dealt with annually in these German ports was increasing by leaps and bounds, and it behoved English engineers and statesmen to be on the alert. In the absence of Mr. W. H. Grenfell, M.P., the foregoing toast was acknowledged by the Ven. Archdeacon Sinclair, D.D., who expressed his belief in the future of motor cars, especially for agricultural districts, and hoped that the extensive tunnelling in connection with future underground railways would not damage that splendid edifice, St. Paul's Cathedral. Mr. P. J. Waldram next proposed "Municipal Engineering Progress" in terms more flattering to the engineers than to the municipal authorities. This toast was acknowledged by the president, who defended the municipal councillors with some ability. "Applied Science" was proposed in a humorous speech by Prof. J. A. Ewing, F.R.S., and was responded to by Dr. R. T. Glazebrook, F.R.S. "The Senior Institutions" was toasted by Mr. S. H. Wells, Wh.Sc., and acknowledged by Mr. Charles Hawksley, who mentioned that the Institution of Civil Engineers, at their coming of age, had only half the number of members of the Junior Institution of Engineers at the present day, and by Mr. A. Siemens, who pointed out that the real parental institution was the Society of Arts, founded in the latter half of the 18th century. In proposing "The Junior Institution of Engineers," Lord Reay, G.C.S.I., referred in complimentary terms to the integrity and ability of engineers, amongst whom it was impossible for "quacks" to thrive. The musical programme between the speeches included several violin solos, exquisitely rendered by Mr. T. E. Gatehouse.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

SATURDAY, February 18th.

Glasgow Technical College Scientific Society.

7.30 p.m. Meeting at 38, Bath-street. Paper to be read: "High Speed Tool Steels from the Users' Point of View," by E. H. Robertson.

MONDAY, February 20th.

Society of Arts.

8 p.m. Cantor Lecture II.: "Internal Combustion Engines," by Dugald Clerk.

TUESDAY, February 21st.

Institution of Electrical Engineers: Manchester Local Section.

7.30 p.m. Meeting at Owens College. Paper to be read: "Manchester Tramways Power Supply," by S. L. Pearce and H. C. Gunton.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. Time permitting, the following Paper will be read: "Surface Condensing Plants and the Value of the Vacuum Produced," by R. W. Allen.

THURSDAY, February 23rd.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting. Paper to be discussed: "The Value of Overhead Mains for Electric Distribution in the United Kingdom," by G. L. Addenbrooke.

Tramways and Light Railways Association.

8 p.m. Meeting at the Society of Arts, John-street, Adelphi, London. Paper to be read: "The Waterloo & City Railway," by Herbert Jones.

FRIDAY, February 24th.

Physical Society.

5 p.m. Ordinary Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda:—(1) "On the Curvature Method of Teaching Geometrical Optics," by Dr. C. V. Drysdale; (2) "Exhibition of Dr. Meisling's Colour Patch Apparatus," by R. J. Sowter; (3) "A Method of Illustrating the Laws of the Simple Pendulum and an Exhibition of String Models of Optical Systems," by J. Schofield.

Institution of Electrical Engineers: Manchester Students' Section.

7.30 p.m. Meeting at the Manchester School of Technology. Paper to be read: "Metallography," by Mr. Buttenshaw.

Rugby Engineering Society.

8 p.m. Meeting in the Benn Buildings, High-street, Rugby. Mr. J. T. Milton will commence a course of three lectures on "The Minute Structure of Metals."

Electro-Harmonic Society.

8 p.m. Concert (ladies' night) at the Holborn Restaurant (King's Hall).

TRAMWAYS v. MOTOR 'BUSES.

BY HENRY M. SAYERS.

The *Daily Mail* has lately proclaimed with characteristic emphasis that tramways are obsolete, and the tens of millions spent upon them wasted money. Truth and emphasis are not always directly proportional, and a slight examination of the facts behind the sensational pronouncement of the doom of the tramway will show that they do not support the conclusions come to, and as far as they go have no bearing upon the continued use of tramways.

Tramways are designed to reduce the tractive effort required to propel vehicles upon a road surface, and consequently to increase the carrying capacity of the highway and reduce the cost of vehicular traffic. The efficiency of tramways in reducing the cost of transport is substantially independent of the means of propulsion employed. Whether man power, horse power, steam or petrol, it is the merest commonplace of transport economy that a pair of rails increases hauling capacity and reduces cost. If the petrol 'bus is the economical vehicle suggested, the logical result will be, not the abolition of the tramway, but the advent of the petrol tramcar. The advantages of the tramway and its efficiency in reducing the cost of passenger transport are indicated by comparing the costs of omnibus and tramway traffic using the same motive power—viz., the horse. It seems to have escaped the memory of the *Daily Mail's* expert that there ever were horse tramways, and that in many cases they drove 'buses entirely off the road.

In London we still have horsed tramways, and the accounts of the omnibus and tramway companies afford excellent examples for comparison. Such a comparison for a recent half-year between the two largest companies gives the following figures:—

Traffic Statistics.

	'Bus Co.		Tramway Co.
Vehicles in service (daily average)	1,391	....	520
Vehicle-miles run	16,272,202	....	7,318,017
Passengers carried	106,116,283	....	70,701,915
Horses in stock	17,060	....	6,380
Horses per vehicle	12·26	....	12·27
Vehicle-miles per horse	954	....	1,147
Passengers per horse	6,220	....	11,082

So that, as regards the number of passengers carried, five horses on tramways will do the work of nine on 'buses.

The operating costs naturally show this advantage in money terms. Thus:—

Costs, Horsing and Vehicle Maintenance.

	'Bus Co.		Tramway Co.
Horsing costs per vehicle-mile	3·79d.	....	2·40d.
Horse renewals per vehicle-mile......	0·62d.	....	0·48d.
Vehicle maintenance per vehicle-mile	0·525d.	....	0·235d.
	4·935d.	....	3·205d.
Traffic expenses per vehicle-mile	2·82d.	....	2·164d.
Rates and taxes	0·103d.	....	0·678d.
Grand total per vehicle-mile	7·858d.	....	6·047d.

Taken out at per passenger the totals are

'Bus.		Tramway.
1·202	....	0·628

The costs given complete the working expenses for the 'bus, but the tramway company has to pay in addition the rent of its track and the maintenance of the paving.

	Per vehicle-mile.		Per passenger.
Rent of track	0·917	....	0·095
Road maintenance	0·581	....	0·060

And adding these to the other figures, the total comparison stands thus:

	'Bus.		Tramway.
Per vehicle-mile	7·858	....	7·545
Per passenger	1·202	....	0·783

So that the tramway costs per passenger carried are only 65 per cent. of the omnibus costs, and as the tramway fares per passenger are 74 per cent. of the omnibus fares, the net receipts on the tramway are proportionately higher than on the omnibus lines.

The advantage being distinctly with the tramway operating with horses, it hardly needs arguing that self-propelled vehicles will show greater advantages from running on rails. No more efficient transmission of tractive effort than by the steel tyre on a steel rail is at present known.

The smaller power needed and the reduced wear on the vehicles is only one side of the economy due to the rail. The other side is that of road maintenance. Now, the omnibus proprietor pays nothing towards either the capital cost or the maintenance of the roads. The ratepayer bears most of this burden, so that in reckoning up the working expenses of a motor or any other omnibus the contribution from the rates must not be disregarded. On the other hand, the tramway undertaker pays rates on the track, and also bears the maintenance of the road surface between and for a certain distance outside the rails. Hence we arrive at the curious fact that it is not the tramway, whether municipal or company owned, that is the rate-aided enterprise, but the omnibus service. On the busiest thoroughfares it is probable that the omnibuses cost the ratepayers at least £3,000 per mile per annum. This is not the occasion for an argument upon the equity of the rating and road maintenance charges put upon tramways by the existing law, but in considering the question of tramways versus omnibuses as an economic whole, it must not be forgotten that the tramway fares cover maintenance of the tramway rails, part of the road surface used by other vehicles, and also a direct contribution to the rates; whereas omnibus fares cover no road maintenance and only a very small rate contribution.

The main argument against the tramway is, of course, the large capital expenditure involved in laying the track, and providing the electrical equipment; expenditure which it is assumed is entirely avoided by the substitution of the motor omnibus. It will be quite apparent, however, that the tramway track is well worth its cost, that is, that the reduction of working expenses more than covers the capital charges and maintenance involved, provided that sufficient use is made of it. There is some minimum traffic below which the saving in working expenses does not cover the capital charges. For an electric tramway with overhead equipment it is a common rough axiom that unless the traffic justifies a 15 minute service the line will not pay.

If a tramway can be constructed and equipped with petrol tramcars at a saving of capital, and no increase in working expenses, compared with electrical equipment, some less frequent service will justify its construction, but at some point the capital charges will swamp the saving and the omnibus will find its sphere.

The available information about the working expenses of petrol omnibuses is scanty and imperfect. In default of anything better, that published as based on Messrs. Tillings' experience of three months' use is worth examination. The figures given (*Daily Mail*, February 4, 1905) are these:—

Average earnings per week..................................	£42
Miles covered per day	115
Profit on one year's working	£850
Carrying capacity..................................	34

There is nothing to show how the "profit on one year's working" is arrived at, but putting the figures into the usual form for comparison gives the following, assuming seven days per week:—

Earnings per mile run	12·52d.
Working expenses per mile run	10·52d. = 84 per cent.
Net earnings per mile run..................	2·00d. = 16 per cent.

Whether "working expenses" include any repairs is left in doubt, but it is at least probable that there is some maker's guarantee covering the first few months of use. Reasoning from analogy it does not seem unfair to suggest that if a horse omnibus costs 0·525d. per mile run for maintenance, a petrol omnibus, costing about six times the money, will need at least 1·5d. per mile run for this purpose, which will leave very little divisible profit for the owners. Even this may be an improvement upon horse-worked 'buses, with which working expenses and maintenance frequently exceed 90 per cent. of the receipts, but it does not augur any serious and sudden damage to tramway traffic.

The working expenses per car-mile on large electric tramway systems rarely exceed 6d., and many cases can be found where the costs are materially lower.

The largest item in working expenses is the wages of the car crew. The omnibus cannot run at a lower wages rate than the tramcar; it may even be found advisable to pay the driver somewhat more than the usual wages to secure the skill and attention needed to get the best service out of petrol engines.

As the carrying capacity of the omnibus is only half that of a bogey tramcar it is seriously handicapped by the necessarily higher proportionate wage expenses.

If, power for power, the petrol vehicle were to cost less than the electric car, the petrol car would undoubtedly take its place upon the rails. But it is highly improbable that petrol can get anywhere near the present cost of electrical energy. The total cost of production and distribution to the car, including all capital and maintenance charges, varies between 1½d. and 2d. per Board of Trade unit, according to local circumstances, and on a good road this is the power cost for one car-mile.

At the present cost of petrol no such figure seems probable when the low load-factor of the engine, due to frequent stopping and starting, and great range of power needed is taken into account. Nor does there appear to be any probability that repairs and maintenance charges can be got down to the figures of electric practice.

It has been freely stated by advocates of the motor omnibus that it can give a quicker service than the tramcar. This advantage, so far as it exists in fact, is purely artificial and temporary. There is, probably, not an electric tramcar in London that cannot run at 20 miles an hour on the level, and it is not difficult to find some travelling at that speed frequently enough not far outside the 4-mile radius. The permitted speed of the tramcar is certain to increase as its safety becomes demonstrated and other traffic gets accustomed to it. Whether a really frequent service of motor omnibuses at speeds of 14 to 20 miles per hour can be safely operated in busy thoroughfares remains to be proved. It is at least conceivable that though one such vehicle every 10 minutes gets along safely, three or four per minute would create difficulties in some central London streets. Driving to the common danger is an offence at any speed with any vehicle, and skidding on a greasy road may have very awkward consequences. Hence there is no reason to fear that motor 'buses will show any permanent speed superiority over the electric tramcar.

The motor omnibus will doubtless prove a valuable addition to our means of locomotion. It will accelerate the abolition of the horse from our cities, and thereby diminish mud and other kinds of dirt. It will perform many services supplementary to the tramways, tubes and subways that will form the chief arteries of traffic; but there will have to be very large changes before it can supersede any of those facilities.

ELECTRICAL EQUIPMENT OF THE LONDON, BRIGHTON & SOUTH COAST RAILWAY.

We are now able to give a few more particulars of the scheme for the electrical equipment of the suburban lines of the London, Brighton & South Coast Railway than were published in our issue of December 23rd last and in the supplement Table given with our issue of February 3rd. The specifications have now been issued by the consulting engineer, Mr. Philip Dawson, and eight firms have been invited to tender. These are Messrs. Dick, Kerr & Co., the British Thomson-Houston Co., the British Westinghouse Company, Siemens Brothers & Co., the Allgemeine Elektricitäts Gesellschaft, Brown, Boveri & Co., Messrs. Ganz & Co. and the Lahmeyer Company. The Oerlikon Company were also asked to tender, but have not accepted the invitation.

Although Mr. Dawson has himself worked out a complete and detailed scheme for the electrical equipment of the whole of the vast network of suburban lines belonging to the Company—a task upon which he has spent two years—and has embodied the result of his labours in a voluminous report to the Company and a large collection of drawings and designs, the contractors are left considerable latitude, results rather than details having been specified. The general features of the overhead equipment are necessarily fixed, however, and this will consist of a single overhead wire of 0·5 sq. in. section for each line of rails, fed at about ½-mile intervals with single-phase alternating current at 6,000 volts and 25 ~. A suspended centre conductor has to be employed, owing to the large number of lines running abreast in the greater part of the route, which place out of consideration any side-conductor system such as that which has been worked out by the Oerlikon Company or the one used by Messrs. Siemens & Halske in the Berlin-Zossen trials. The rails will be bonded not to one another but to a return conductor, which it may be presumed will have to be concentric with the feeders to the overhead line, in order to diminish impedance as much as possible.

At the outset a 5 mile length of line will be equipped from Battersea Park to Peckham Rye, with four intermediate stations, but it is not improbable that in a few months' time extensions to Victoria on the one hand and London Bridge on the other will be decided upon, making the whole length of route 11 miles, and representing 25 miles of single track. Tenderers are to assume an average speed of about 22 miles an hour with 20-second stops at the stations and two minutes at termini, and a unit train of two motor cars and one trailer, each seating 60 passengers, and they are to guarantee to keep within certain limits as regards the heating of the motors. There will be four motors per car, each rated at 250 H.P., and connected to the axles by single reduction gear. A multiple unit of control is insisted upon, with no train cable carrying the main current from car to car.

As is usually the case with railway contracts, the general conditions appended to the tender are rigid. One clause which may be mentioned, however, specifies that should the Company desire to extend the system not more than 18 months after it has started, the contractors are to be ready to extend the contract to a further portion or all of the Company's suburban lines if desired. This is significant of a desire to progress with the "electrification" once it is started.

It should be added that the Board of Trade is taking considerable interest in the experiment, and has thrown noobstacles in its way; in fact Mr. Dawson informs us that he has profited by their assistance and advice.

Up to the present it has not been decided whether the Company will generate its own power or buy it from one or more of the companies supplying in the districts through which the line passes. As it will require some 500 amperes at 6,000 volts to start a train, it is evident that large generating units will be needed.

LIVERPOOL CORPORATION ELECTRICITY SUPPLY ACCOUNTS.

The electricity supply accounts of the Liverpool Corporation for the year ended December 31, 1904, show an increased sale of 3,318,561 units over and above that for the previous 12 months. Altogether, nearly 29½ millions of units were sold during the year, 19 millions of which were taken by the trams, 10 millions by private consumers and the remainder by public lighting. The actual maximum supply demanded was 14,093kw., as against 12,600kw. in 1903, and the number of consumers has also increased from 5,084 to 5,639. As a result of the larger number of consumers the connections to mains, equivalent to 8 c.p. lamps, have gone up from 525,812 to 583,430. To meet this large increment of consumers and connections no additional generating plant has been installed, however, and the figure therefore remains at 24,470kw. The price charged for lighting, 3½d. and 3d. per unit, and the number of public lamps, which is equivalent to 1,469 8 c.p. lamps, have also remained unaltered. For motive power 2d. to 1½d. is charged, for public lighting 2d., and for traction 1·12d. per unit, with an addition at the rate of 5 per cent. for each 1s. per ton paid for coal in excess of 6s. per ton.

The total works costs of generating and distributing 29,333,623 units sold during the year, excluding "management charges," &c., was £69,945. 6s. 9d. This works out to

0·573d. per unit. For the previous year the corresponding figure was 0·679d. The following Table gives the various items, and also the management charges, interest, redemption fund, &c. :—

	Year ended Dec. 31, '03.	Year ended Dec. 31, '04.
Units sold to consumers	8,697,474	10,069,856
" " for public lighting	274,837	284,684
" " for traction	17,042,751	18,979,138
Total units sold	**26,015,062**	**29,333,633**
GENERATING COSTS.	Per unit sold	Per unit sold
Coal (including unloading)	0·345d.	0·295d.
Oil, waste, water and stores	0·063d.	0·043d.
Wages at generating stations	0·147d.	0·123d.
Repairs and maintenance	0·084d.	0·073d.
	0·639d.	0·534d.
DISTRIBUTING COSTS.		
Wages	0·013d.	0·014d.
Repairs and maintenance	0·027d.	0·025d.
	0·040d.	0·039d.
Total works costs	**0·679d.**	**0·573d.**
MANAGEMENT CHARGES, &c.		
Rents, rates and taxes	0·118d.	0·135d.
Contribution to City Fund	0·018d.	0·016d.
Salaries, stationery and establishment charges	0·082d.	0·077d.
	0·218d.	0·228d.
Total costs, *excldg. interest and redemption fund*	**0·897d.**	**0·801d.**
Sundry charges, insurance, &c.	0·015d.	0·016d.
Interest	0·396d.	0·439d.
Sinking fund	0·308d.	0·314d.
Total costs, *incldg. interest and redemption fund*	**1·616d.**	**1·570d.**

The load-factor increased from 23·5 in 1903 to 23·7 in 1904. The total works costs for 1904 were £69,915. To this must be added £16,432 for rents, rates and takes, £11,456 for management charges, £1,967 for special charges and £114 written off for bad debts. Thus there is a total expenditure so far of £99,914, and as the revenue from all sources amounts to £236,404, there remains a balance of £136,490. This balance is disposed of as follows: Interest £53,618, sinking fund £38,362, reserve fund £16,286, renewal fund £11,290, contribution to general rate £16,934.

The following is an analysis of the capital expenditure up to December 31, 1904, showing the expenditure on the various items per kilowatt installed in the generating station, and the percentage which each item represents on the whole capital expenditure :—

Account.	Total Dec. 31, 1904. £	s.	d.	£ per k.w.	% of total.
Purchase money paid to Liverpool Electric Supply Co.	400,000	0	0	16·34	23·27
Additional capital spent by Co. but not included in share capital	36,474	3	11	1·49	2·12
Lands	7,624	15	10	0·31	0·44
Buildings	215,234	14	0	8·79	12·52
Machinery	419,416	7	8	17·15	24·40
Accumulators	8,583	9	11	0·35	0·50
Mains	500,510	5	6	20·16	29·12
Meters	26,282	10	10	1·08	1·53
Electrical instruments	5,556	18	0	0·23	0·33
Cost of provisional order, creation of stock, transfer of undertaking, &c.	50,949	7	6	2·08	2·97
Purchase money paid to the Garston & District Co.	48,080	3	6	1·96	2·80
	1,718,712	16	8	70·24	100

In the following table are given the amounts which were set aside last year for interest, &c., and the percentage relations which they bear to the capital expenditure :—

	£	s.	d.	Per cent. of capital expenditure.
Interest	£53,618	8	8	3·12
Sinking fund	38,362	1	9	2·23
Reserve "	16,285	18	8	0·95
Renewal "	11,289	12	11	0·66
Contribution to general rate	16,934	9	5	0·98

THE MOTOR CAR EXHIBITION.

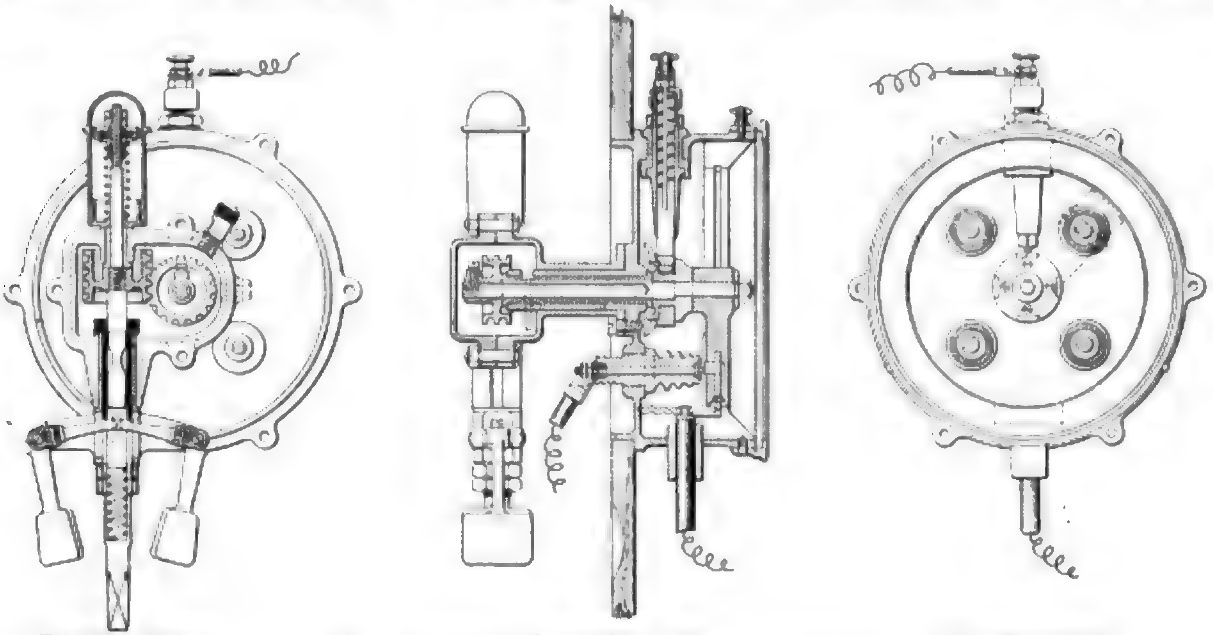
The motor car exhibition at Olympia, which will close tomorrow (Saturday), is certainly the finest which has ever been held in this country, and certain experts hold that it even eclipses anything of the kind held in the world. From the numbers of visitors its success cannot be doubted, and it is said that the value of the exhibits is nearly three-quarters of a million sterling. Unfortunately, however, the electrical features of interest are very few, and it does not appear that electric vehicles are making the progress that is wished for them. It is quite certain that electric broughams and landaulets have established themselves firmly for town work, for people who can afford them, but the field is necessarily very restricted, and the number of manufacturers does not increase at any very startling rate.

The finest exhibit of such carriages at Olympia is undoubtedly that of the Electromobile Co., who show a brougham, a landaulet, an ambulance waggon, a chassis of the latest type and a petrol landaulet fitted with a 15 H.P. Napier engine. Several important improvements have been introduced on the standard chassis. The front wheels have been set forward 6in., giving a slightly longer wheel-base, and the rigid front spring hangers have been replaced by half-springs. The rear suspension has also been improved by the addition of a transverse spring which supports the weight of the body, and to which the side springs are attached in the usual manner. A new form of circuit-breaker has been introduced; this is fitted with a carbon break, and prevents the breaking of the circuit on the controller. In practice this has been found to be very efficacious, eliminating all trouble from burnt contacts. This chassis is fitted with a safety device, which renders it impossible for the running plug to be inserted except when the controller is on the zero or neutral position by means of a lever which is always in front of the socket when the controller is on any running position. The socket is fixed in a conspicuous position in the front of the car, so that a casual glance will show whether the plug is in position or not. All the company's carriages are now fitted with an efficient mileage recorder. The counter, which can be locked, is fitted to the chassis in a conspicuous position at the rear. It is driven by means of bevel gear and flexible shaft direct from the gearing.

The electric ambulance van shown is mounted upon one of the company's normal chassis. It is fitted with two full-length stretchers, one above the other, which slide into the van from behind. A wide passage for the attendant runs down the right-hand side of the van. The carriage is lighted and warmed by electricity, and is completely fitted with all necessary appliances for first aid. The driver's seat is covered as a protection from weather, and telephone communication is provided between the driver and the attendant. The van is intended entirely for city use. A distance of 25 miles can be covered on a single charge of the battery, and an exhausted battery can be exchanged for a fully charged one in two minutes. In the brougham there is an ingenious little indicator worked by separate storage cells. Instead of communicating with the driver by means of a speaking tube, the occupant of the carriage has merely to press a button corresponding to the direction to be indicated, and the order appears in red in front of the driver's feet. No fewer than 10 different signals can thus be conveyed.

Messrs. W. and F. Thorn exhibit a Silvertown landaulet and a standard chassis. There are two motors, each of 2½ H.P., fitted one on each axle, and thus a four-wheel drive is obtained, giving great smoothness in running and freedom from skidding on greasy roads. The motors are made totally enclosed so as to be perfectly damp and dust proof, and are fitted with automatic chain lubrication. They are capable of working at 50 per cent. overload for a considerable time, and for a short time at double their ordinary load, without any injury, and are so arranged that should either motor get damaged the carriage can be run on the other alone. The framework of the Silvertown chassis is made from one piece of channel steel, to which all the parts are securely fastened. The spring brackets are forged from the solid metal, and the springs are designed so as to give comfort in travelling over rough roads, and are at the same time stiff enough to prevent undue movement of the carriage. The axles are made of nickel steel and are turned all over. Spur gearing is used for transmitting power from the motors to the wheels. A small pinion on the armature shaft drives a large gear wheel, which is firmly fixed to the outside of the balance gear box, the whole arrangement being enclosed in a steel gear case, making an efficient and silent drive. The controller is of strong mechanical design, and all the contact surfaces are large enough to carry the current required by the motors without heating. Wrought copper contact brushes are carefully fitted to the drum of the controller to ensure a good bearing surface. A prominent feature of the Silvertown controller, which is not found in several other types, is that the current is never broken on the drum, but always automatically by a quick-break chopper switch, thus preventing burning of the segments, and the consequent bad contacts and heating troubles. The same switch, which is fitted with a carbon break, is also independently operated by the brake pedal before any braking effect can take place, and is held open by a cam when the brake-pedal is released, till the controller handle is brought back to the neutral position. The cam is then released and the switch closed again as the controller handle is moved to the notch required. There are eight forward positions, five brake, and five reverse, all of which are controlled by one handle, placed under the steering wheel. The first four steps in the eight forward positions are intended primarily as starting positions, but can also be used for slow-speed traffic work, the first position, for instance, giving a speed of about 1½ miles per hour, and the remaining four positions give running speeds of about 7, 10, 12 and 15 miles per hour respectively. Internal expanding metal-to-metal double-acting brakes are fitted. The phosphor-bronze brake-shoes work on the inside of a steel drum, rigidly fixed to the hub of each rear wheel, and are well protected against wet and dirt. These brakes will hold the carriage from running backward or forward, and are sufficiently powerful to hold the car on the steepest gradient. All parts of the brake-gear are made adjustable, and a notched lever is fitted to hold the brake-pedal in any desired position. By bringing the controller handle to one of the brake positions an electric brake is put in action, by which the carriage can be made to descend any long hill at different speeds, according to the position of the handle. A strong sprag is fitted, and is worked from the driver's seat. The steering gear, combined with the bevel wheels for actuating the controller drum, is contained in a phosphor-bronze case, which is made dirt-proof, and is securely fixed to the frame of the car. The steering is of the irreversible type, and the connecting rod is provided with cushion springs and adjustable ball joints to take up any shocks from the road. All parts are made adjustable, and the radius rods are made out of solid forgings securely fixed to the pivot axles. The wheels run on ball bearings of special design, which are dust-proof and oil retaining. By taking off the hub cap and screwing off the octagonal nut the wheel is free to be slipped off the axle. Each car is fitted with 44 E.P.S. cells on ebonite trays contained in teak boxes. One charge is sufficient to propel the vehicle about 35 miles on good level roads. The general appearance of the Silvertown cars is excellent, and they are designed on sound engineering principles. The chassis are built by the India Rubber, Gutta Percha and Telegraph Works, and the electrical equipments are also supplied by the same firm. Messrs. W. and F. Thorn are responsible for the construction of the car bodies.

Probably no exhibit in the exhibition receives more attention than that of the Brotherhood-Crocker Motors Limited. This firm is a new recruit to the motor car industry, and it must be confessed that the work which they turn out augurs well for their future success. Every part of their cars is made in this country, and the name of Peter Brotherhood is a sufficient guarantee of excellent workmanship. This well-known firm of engine builders is responsible for the manufacture of the engines fitted to the Brotherhood cars. With the mechanical design of these petrol cars we have little to do, but the ingenious devices employed in connection with the ignition gear are deserving of special attention. Low-tension current is supplied from accumulators to the primary of a "cartridge" coil and trembler which is in series with four metallic segments mounted on an insulating ring on a half time shaft. The function of these segments is merely to effect economy in consumption of current by allowing the primary circuit to be closed, in the aggregate, during the half of each revolution only. In a circular glass-covered dial are mounted four terminals, each corresponding to a sparking plug, and this dial is mounted on the dashboard so as to be always visible to the driver. On the end of the shaft carrying the low-tension segments mentioned above, is a revolving ebonite arm, on the underside of which is fixed a short strip of brass. Embedded in the ebonite rim of the dial is a brass ring and one high-tension lead is connected to this. Thus the path of the high tension current is from the coil to the brass ring, whence it jumps a very small air-gap to the brass strip on the revolving arm, and from there across another very small air-gap to the top of the terminal. Then it is taken, by means of a high-tension lead, to the sparking plug itself, and back to the other terminal of the coil. By this arrangement the driver is able to see at a glance whether proper sparking is taking place in all or any of the cylinders. Above each cylinder is fixed a small switch, by means of which any plug



Transverse section. Longitudinal section. Front elevation.

Fig. 1.—Brotherhood-Crocker Ignition Gear. (½ full size.)

may be cut out of circuit if desired and the spark caused to pass from the switch blade to a 'bus bar. This prevents damage to the insulation of the coil if a plug is disconnected when the engine is running. One great disadvantage of ordinary ignition devices is the primitive arrangement for advancing or retarding the sparking. It frequently happens that the driver forgets to retard the sparking on stopping the engine, and the result is that there is considerable danger of back-firing when starting again. In the Brotherhood car this difficulty is overcome by the agency of a centrifugal governor which automatically advances or retards the sparking according to the speed of the engine. Referring to the illustration, it will be seen that the vertical spindle, which is driven off the half-time shaft, is fitted with a worm geared to the shaft carrying the ebonite distributor arm. This vertical spindle is also capable of vertical movement effected by the centrifugal governor, and the method of operation is thus so obvious as to need no further explanation. Brotherhood cars are now being made, with four cylinders, up to 40 H.P., and it is the intention of the company to devote special attention to the manufacture of cars of high power, such as are required for omnibuses, &c.

Messrs. Willans & Robinson show some excellent specimens of castings produced by a special process which eliminates all blow holes, &c. Certainly the sections of cast-iron cylinders and other parts display a degree of homogeneity which we have seldom seen before. Moreover, Messrs. Willans & Robinson inform us that their process enables them to produce large numbers of castings from the same pattern without a single failure. The process is a secret one, but it is understood that special attention is paid to the mixture of the metal. The same firm also make a speciality of bearings which are not cast from any particular metal, but the process may be applied, it is said, with equal success to any alloy. Troubles due to the segregation of the different constituents are avoided, and a practically complete equality of the structure of the mass of the bearing is obtained. The result is that there is an equal distribution of the load over the wearing surface of the bearing, which increases its durability and anti frictional properties to a considerable extent. Phosphor bronze cast in the ordinary way and having an ultimate tensile strength of 13·4 tons per square inch, when cast by the new process has an ultimate tensile strength of 19·7 tons per square inch. The respective figures for gun metal are 12·1 and 19·0 ; and for yellow brass 7·5 and 16·0 Lately, however, some yellow brass cast by this method has shown a tensile strength of nearly 20 tons.

Some new speed and distance recorders are shown by Messrs. S. Smith & Son. Their "milometer" is a small instrument about 3in. in diameter covered with a thick lens. It is simply attached to the outside of the cap of the wheel, in which position the mileage run is easily read. The register extends from 1 to 10,000 miles. Messrs. Smith & Son also show one of their new speed indicators with a supplementary "tell-tale" hand. By this device it is possible to ascertain the highest speed attained during any period, but the indicating hand may be reset at its original position at any time by pressing a button at the top of the case. It is claimed that the indicator will be of considerable utility in rebutting police evidence.

Of accessories, in the form of accumulators, ignition devices, &c., probably the best exhibit is that of Messrs. Peto & Radford. This firm shows one or two new forms of sparking plugs in which the spark jumps from an inner to an outer ring instead of between two points. One feature of novelty is an aluminium rectifier for charging accumulators from an alternating-current source of supply. This consists of four small cells holding about 4 pints each working on the Nodon principle. As it is now becoming customary to equip petrol cars with low-tension magneto ignition Messrs. Peto & Radford are showing a number of magneto generators which are supplied in combination with an induction coil and accumulators, the latter to be used in starting the car.

Although the number of variable speed gears which have been devised is legion, that shown by Messrs. Johnson & Phillips, which passes under the name of the "Newman" gear possesses points of great ingenuity. Usually, a motor car is fitted with gearing which gives three or four changes of speed, but the Newman gear gives any speed from zero to maximum.

On the end of the constant speed shaft a crank or eccentric of variable throw is fixed, and the throw of this eccentric can be varied at will by suitable mechanism. The centre is shown by the small circle at A (Fig. 2), and when the constant speed shaft is in rotation, the point A revolves in the dotted circle shown passing through A. Connected to the variable eccentric A are four arms or connecting rods, whose centre lines are shown by the lines B_1, B_2, B_3, B_4, which are connected on their outer ends to studs C_1, C_2, C_3, C_4, each stud being fixed in the clutches D_1, D_2, D_3, D_4. These clutches are of the roller type, *i.e.*, they drive in only one direction, and release when turned in the opposite direction. Each clutch D_1, D_2, D_3, D_4, turns on a stud or pin E_1, E_2, E_3, E_4, which is fixed into the back of the casing surrounding the gearing. The clutches are surrounded by rings F_1, F_2, F_3, F_4, having gear teeth formed on them. These four gear rings all gear with one common pinion G in the centre, this pinion being fixed on the end of the variable speed shaft. It must be understood that the eccentric A is not directly connected in any way to the pinion G, the constant speed shaft being supposed to stand up out of the plane of the diagram, there being a space between the eccentric A and the pinion G. Now if the eccentric is supposed to revolve, it will be seen that the clutches are moved backwards and forwards at each revolution of the eccentric through an angle depending on the throw of the

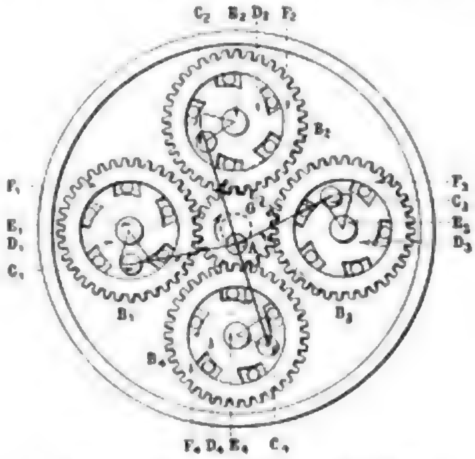


FIG. 2.—NEWMAN VARIABLE SPEED GEAR.

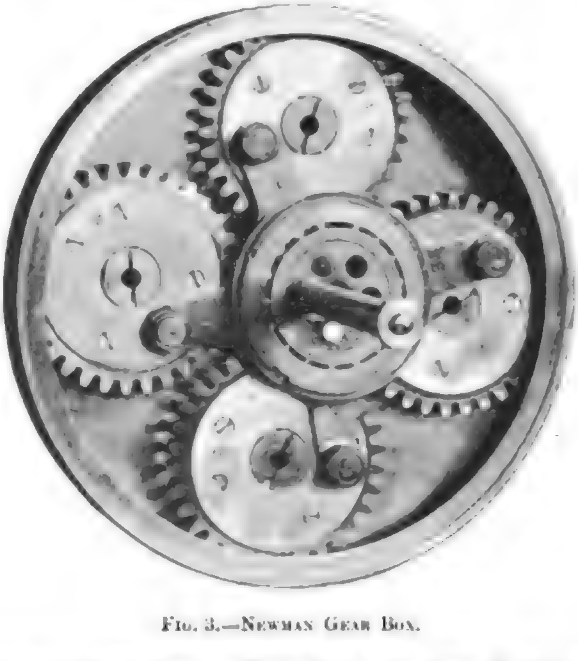


FIG. 3.—NEWMAN GEAR BOX.

eccentric. The greater the throw of the eccentric the greater will be the angle, while if the throw is reduced to zero, *i.e.*, if the centre of the eccentric is made to coincide with the centre of the constant speed shaft, the clutches will be at rest. As each clutch moves backwards and forwards it drives its gear ring through a certain distance and then releases, but it must be observed that before it has released, the next clutch has taken up the driving, and that therefore the motion of the pinion and variable speed shaft is continuous, and its speed depends on the angle through which the clutch oscillates, this angle being controlled by the throw of the eccentric. With zero throw the variable speed shaft is at rest, but it begins to move as soon as the eccentric is given a slight throw and attains a maximum speed with the maximum throw of the eccentric.

THE SELECTION OF ELECTRIC CABLES.*

BY L. B. ATKINSON AND C. J. BEAVER.

The specification of any standard conductor should state the effective sectional area of the whole conductor—*i.e.*, the area of a solid wire having the same coductivity, and the number of wires in the strand, or alternatively, as is common in the case of small conductors, the gauge number, or diameter in mils of the wire, and the number of wires in the strand. It should further define the minimum conductivity allowable. In the case of tinned wires it should also state the percentage permissible departure from the standard of conductivity produced by the tinning.

Every engineer specifies that conductors shall be of electrolytic copper of 100 per cent. Matthiessen's standard, but in few cases, especially with smaller ones bought commercially, is this tested, and there are copper conductors in the market of not more than 80 per cent. (Matthiessen's standard) conductivity, and these are accepted and used for house wiring and other purposes without discovery. It cannot be claimed that such wire is bought by the manufacturer as high-conductivity copper, as there is no difficulty in obtaining electrolytic copper of from 99 to 102 per cent. conductivity. But it must always be remembered that the necessary fixed outlay in producing a cable is large, and it is only by variations of small percentages that profit or loss in cable making arises: hence a difference of about 3½ per cent. in the price of the copper is appreciable in the case of a large turnover. It is quite arguable that the margins of carrying capacity, insisted upon by fire insurances and supply companies' rules, are so great that such cables are quite sufficient for all requirements; but if they are, the rules should be altered, or rigid tests should be made to ensure that all tenders are really on a similar basis.

The efficiency of the tinning process also has an effect on the conductivity of wires; the detrimental effects of imperfections in the preparation of the wire, and incorrect temperature of the tinning bath, &c., are of course more marked on small than on large wires. Cases have been known in practice where imperfect conditions in the tinning process have resulted in a variation of as much as 12 per cent. in the conductivity of 20 S.W.G. wire.

RUBBER CABLES.

Rubber insulated cables were the first, and in the early days of heavy electrical engineering, the only cables used, and their use today is still very large for all purposes where high insulation and easy fixing and manipulation are primary considerations. Indeed, except for their cost, they probably would never have been superseded. Speaking generally, there is hardly any article of general commerce in which the buyer places himself so largely in the hands of the seller, as he does in the matter of india-rubber; and although large buyers often have facilities for analysis of goods, there are difficulties in the analysis of india-rubber articles which are hardly paralleled in other general analytical work, and to correctly interpret results, and to appreciate the vital points to cable manufacture, it is essential that the analyst should not only be, to some extent, a specialist in rubber, but should also have knowledge of the manufacture of cables, and of the various electrical phenomena which affect the life and efficiency of cables.

In rubber cables the copper conductors should always be tinned, although in certain classes of flexible and special wires plain copper wires are used, and cotton lappings are interposed between the conductor and the rubber. The proportion of such wires used nowadays is, however, almost negligible. Oxidation is the form of deterioration to which rubber is most liable; and to a greater extent with pure than with vulcanised rubber. Now the chief office of the pure rubber layer in a vulcanised rubber cable is to prevent the sulphur in the compound rubber attacking the conductor. It has, of course, a high dielectric strength, but for this alone it would be unnecessary to use absolutely pure rubber. It is a chemical fact that copper is a powerful carrier of oxygen, and that it will readily part with its oxygen to a substance which has a great affinity for it. It is unnecessary here to refer further to this oxygen carrying property beyond pointing out that similar reactions occur in the boiling (*i.e.*, oxidation) of oils for varnishes and other purposes, the oxygen carriers (commonly known as "driers") being such oxidising agents as lead oxide, borate of manganese, &c. It may also be mentioned that, within the last few years, the rapid deterioration of the rubber in certain waterproof garments has been traced by the late Dr. C. O. Weber to the use of copper salts in the manufacture of the cloth before proofing.

It will thus be seen that we have (for certain electrical reasons) in close proximity in a rubber cable two substances, rubber and copper, which for chemical reasons should be kept apart. The coating of tin on the wire acts as the necessary separating medium, and in face of the facts noted above, it is obvious that its efficient application is of the greatest importance. Until recently specifications hardly referred to this matter at all. Those of certain Government departments simply specified that the tin must be free from lead, and that the conductors must be clean after vulcanising. This did not meet the case completely, and apparently it was found that clean conductors immediately after vulcanising did not necessarily mean efficient tinning, a fact well known to cable makers. Then a storage period between the first and second official inspection, varying from one to three months, was specified, which, though attaining a greater degree of safety, is a cumbersome way of arriving at the desired end. There is now a marked tendency to ensure reasonable efficiency and uniformity by striking at the root of the matter, and specifying a definite test of the tin coating. The standard test, which is known as Glover's Test, is now being used by the largest makers of tinned wire in this country and abroad, and was devised by one of us in 1897, and has been in daily use for the past seven years. Appendix I. describes the test in detail.

"Pure rubber" should consist of absolutely pure rubber, without admixture of any kind. Pure hard fine Para rubber sheet is chiefly prepared by what is known as the "spreading method," in which the requisite mechanical and other properties are attained by "ageing" (hanging in dark rooms at a certain temperature) for several months. It is obvious that such pure rubber must be expensive. With raw rubber in the neighbourhood of 5s. 3d. per pound the cost to the cable maker will be about 8s. 6d. per pound. Though at the present time rubber strip, purporting to be pure Para, is being offered at 5s. 9d. per pound. There is, therefore, little occasion for surprise to find that in foreign cables, and in cables made by firms with little or no reputation to support, the pure rubber, as above described, is substituted by a lower grade rubber, in which the requisite elasticity and mechanical properties are obtained by vulcanising by what is known as the "cold cure" method. This consists of treating the surface with chloride of sulphur in carbon bisulphide. Apart from the fact that this rubber contains sulphur, contrary to the essentials of its functions in the cable, it nearly always contains traces of hydrochloric acid as an after result of the chemical treatment. The danger of using such rubber hardly needs emphasis, but the temptation to the small maker lies in the fact that it can be produced at something like 40 per cent. less cost than pure Para strip made by the best method.

In some cases of cheap cables the pure rubber may be found to contain a proportion of "rubber substitute," which usually consists of oxidised or vulcanised oil, sometimes with an addition of wax. Such adulteration is not only fraudulent, but almost as harmful as the low grade chemically treated rubber referred to above. Where no attempt is made to adulterate, it is sometimes found that makers attempt to imitate the hard non-adhesive surface of correctly "aged" strip by coating with a film of soapy composition. Wires coated with such rubber will blacken before vulcanising if traces of free alkali are present.

Even in pure rubber strip, made solely from fine Para rubber, appreciable differences in the tendency to oxidise may be noticed. Fig. 1 illustrates the rate of oxidation of varions makes of pure rubber strip, the curves showing the results of ageing tests which were carried out byexposing weighed quantities of the finely divided pure rubber to the atmosphere continuously at a temperature of 210° F. Precautions were taken to expel all traces of residual solvent and surface moisture before the actual experiments were commenced. It will be seen that sample No. 4. oxidised most rapidly, and after 80 hours' exposure the finely divided particles were sufficiently oxidised to form a magma.

The same thing occurred with sample No. 2 at 70 hours, while samples 1 and 3 remained almost unaltered at 120 and 130 hours respectively. It was found that the proportion of rubber resins in the various samples bore a well-defined ratio to the rate of oxidation observed.

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* "Some Points on the Selection of Electric Cables," read before the Manchester Local Section of the Institution of Electrical Engineers on Jan. 31. Slightly abridged.

Compound or vulcanising rubbers are usually applied in two layers, that next the pure rubber being usually drab in colour and the outer grey. It is not necessary here to consider why they are so applied or coloured, as technical reasons and the conservative ideas of makers and users both have some bearing on the matter. They should have for their basis hard fine Para rubber, and should be vulcanised with a minimum proportion of pure sulphur and mixed with mineral matter only to the extent required for the particular grade of cable which it is intended to produce. The addition of rubber substitute should never be allowed, and the expression "containing no organic matter other than rubber" is in some specifications intended to prohibit such materials.

In few cases are analyses made to check this important matter, and even when the specification is framed to bar substitutes large contracts are frequently placed without reference to anything of the kind, and the first-class firm has to be passed and orders given to, possibly, a foreign competitor, who does not scruple to put in his "mixings" 5 per cent., 10 per cent., or even more of a material costing anything from 4d. to 1s. per pound, in place of the hard fine Para costing from 6s. to 7s. 6d. per pound, according to the state of the market. Such substitutes are invariably prejudicial to the life of rubber cables or any other rubber goods. They increase the liability to oxidation, because they only form mechanical mixtures, and neither combine chemically nor cohere physically; in fact, they subdivide the particles of rubber when ground up with it, and this means imperfect results as regards durability, from mechanical and from electrical points of view. The Admiralty moist heat test of 320 F. for four hours was designed to indicate roughly the presence of this class of adulterant, the substitute becoming partially saponified by the steam. Though only a rough test, it has answered its purpose fairly well.

Specifications frequently state the permissible percentage of mineral loading matter, or conversely the minimum proportion of Para rubber; but it will be readily seen that, in spite of specifications, the due performance of them is difficult of verification. Consider as an example a specification issued not long ago for high and low-tension cables, involving some thousands of pounds; and note, notwithstanding its apparent exactitude, the loopholes that existed for variation therefrom. The specification, as regards materials, ran as follows:—

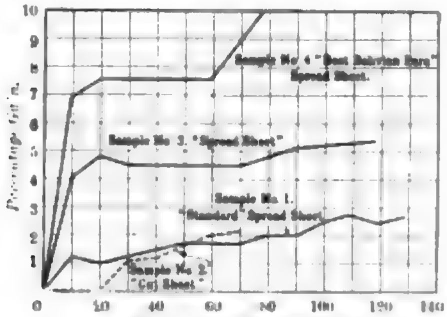

FIG. 1.—DIAGRAM SHOWING RATE OF OXIDATION OF VARIOUS PURE SHEET RUBBERS.

Low-tension Cables.—Conductors to be of high-conductivity copper well tinned. The insulation to consist of pure and vulcanised rubber, the latter to contain not less than (X) per cent. pure Para rubber, and the insulation to be not less than 1,250 megohms per mile.

The specification for extra-high-tension cables was worded in a similar manner, with the difference that the insulation resistance was not specified. The contract for these cables was sent abroad, British prices being far higher than those of foreign competitors. Analysis of samples of the dielectric supplied under the contract showed distinctly the reason of the discrepancies in the tenders.

The pure rubbers contained "rubber substitutes," and the proportion of them varied from 18 per cent. in the best to 40 per cent. in the worst sample. There were also indications that even the pure rubber which was present was not fine Para, which those who drafted the specification no doubt wanted. One sample of so-called pure rubber contained over 1 per cent. of sulphur. The vulcanised compound rubbers also contained rubber substitutes varying in quantity from 5 per cent. in the best to 15 per cent. in the worst, and although the results showed that the makers had kept within 5 per cent. of the letter of the specification as regards the proportion of rubber to be used, there were signs that a rubber inferior to fine Para had been used, though no doubt the expression "Pure Para" in the specification was intended to mean "Fine Para," and not a rubber at little more than half the price (in the raw state). From the analytical results it was plain to the authors that the specified insulation resistance could not have been obtained on some of the larger sizes of cable. It was ultimately found that difficulties in this direction had been evaded by the makers of those cables by taking the galvanometer readings after three minutes' electrification, instead of after one minute, which, in the absence of anything stated to the contrary, is the accepted standard, and the difference in test at these two intervals would correspond with an approximate difference of insulation resistance in such cables in the ratio of 1 to 3.

The specifications issued by engineers for extra high-tension rubber cables usually state the proportion of Para rubber which the vulcanised rubber shall contain, the pressure test to which the cable shall be subjected in water (usually two to three times the working pressure), the insulation resistance per mile and sometimes the radial thickness of the dielectric. Much greater care is necessary in making extra-high-tension cables than in ordinary low-tension cables, because the working conditions have a tendency to create effects (such as electrolytic dissociation in the dielectric and static discharge from the outer coverings of the cable and the consequent ozonising effect) which are almost negligible at ordinary low-tension pressures. The former depends to a very great extent on the treatment of the rubber and the selection and preparation of the loading materials which are used in conjunction with it. The latter may be avoided to a very great extent by metallic braiding or lead covering. Otherwise there is always risk of a static discharge occurring from the usual fibrous outer coverings at local places, which afford convenient paths for the same, which may cause local oxidation of the rubber and ultimately a breakdown.

Before leaving the subject of rubber cables it may not be out of place to consider briefly the essential features of fire-resisting coverings, as these are usually applied to rubber cables for the simple reason that rubber cables are chiefly used in situations where measures for the prevention of fires are most required. It will be obvious, however, that they may be just as efficiently applied to other types of insulation, such as V.B. or G.P., where the volatilisation of the combustible constituents would cause fire to spread rapidly.

Dielectrics having these three materials as a basis are more or less inflammable, though the degree of inflammability may be reduced by admixture with non-volatile substances, such as mineral powders. But this, if taken to excess, for the purpose of reducing the natural inflammability of the material used as a basis, is detrimental to the insulating properties. Hence the fire-resisting properties cannot practically be secured through any modification of the dielectric, and must be attained by special treatment of the tapes, braidings or lappings which form the usual mechanical protection to such cables. These fibrous materials may be chemically treated, so as to be absolutely incapable of supporting flame, and this treatment (under the process devised by one of us, used by Messrs. W. T. Glover & Co.), is preferable, and for the sake of efficiency applied to the yarns or fabrics before applying them to the cable. Tanned jute is found to be the most suitable fibrous material for this purpose (though cotton, hemp or flax may be used), and has at the same time the advantage of being mechanically strong, and therefore not liable (as abestos is) to succumb to vibration or rough handling.

During and after the process of lapping, braiding, &c., a suitable fire-resisting compound is served on to the coverings. It is obvious that any degree of fire-proofness can be attained in the cable by adding to the number of braidings or lappings. In practice, these are proportioned to the volume of inflammable material (*i.e.*, dielectric proper) in the cable, to the size of cable and to the particular class of work for which the cable is intended.

Imagine such a cable to be subject to the heat of a fierce flame externally for a prolonged period. After a lapse of time, dependent on the proportion of fire-resisting coverings to volatilisable materials (dielectric), the latter becomes softened by the heat, and ultimately decomposes and assumes the gaseous state. When the gases thus formed have accumulated sufficient pressure inside the cable they force their way through the fire-resisting coverings and burn on the exterior of the cable. But when the cause of the volatilisation is taken away (*i.e.*, the external flame), the flame on the cable quickly disappears, and does not spread along the cable, as would be the case if the ordinary preservative compounds were used.

In the same way, if the source of heat applied to the cable is internal (an arc due to a breakdown of the dielectric, for instance), volatilisation will proceed at the point of breakdown so long as the arc is kept up, but the resultant flame will disappear almost immediately the arc is stopped, because there is nothing on which the flame can feed.

Moreover, the flame due to the combustion of the volatilisation products is not hot enough to ignite any adjacent cable having similar coverings, so that in every way the fire-resisting coverings tend to keep flame arising from any cause purely local. It may be noted here that even the ideal dielectric above mentioned could do little more than this, because it could not prevent an arc occurring if the cable suffered mechanical damage.

Cables of this type have found a wide range of application for electric railway work, as well as for colliery, switchboard, generating station, house, factory, church, theatre and public building wiring.

(*To be continued.*)

THE ELECTRIC LIGHTING OF MACHINE TOOLS.

Ever since the introduction of lighting by electricity the problem of applying the light to machine tools, drawing-boards and similar purposes has been well to the fore. Naturally, early attempts were made to apply electric lamps to folding brackets, but none of them were successful. The weight of the lamp and its lamp-holder caused trouble with the swivel joints, and there were troubles with the flexible conductors.

To light a workshop generally with arc lamps is insufficient. Workmen are dealing with articles of black iron to which they have to impart forms having dimensions limited to a very small fraction of an inch. They have to bore out dark castings and work into shady corners, and general illumination is insufficient.

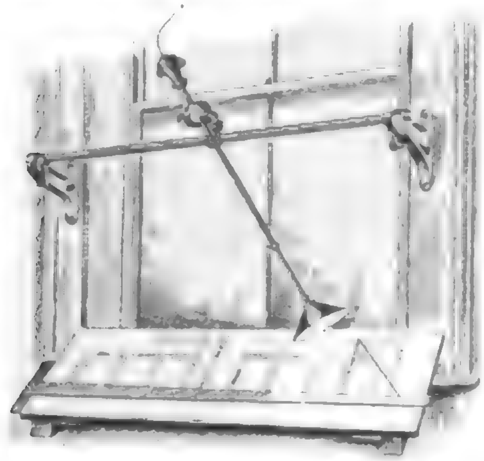

FIG. 1.—ADJUSTABLE DRAWING BOARD FITTING.

Mr. Henry Lea, of the Birmingham firm of Henry Lea & Son (consulting engineers), has been experimenting for some time in his private workshop with various devices for properly lighting his lathe, vice and carpenter's bench, and has now brought out an invention which possesses several advantages. It consists of a tubular arm (Fig. 1.) suspended from a large ball sunk deeply into a circular opening in a horizontal plate, the arm being therefore capable of motion in any direction to an angle of about 45deg. with the perpendicular, the motion being limited by the diameter of the lower edge of the hole in the plate. An extension of the arm above the ball has a weight fixed upon it which balances the weight of the lower portion of the arm. Hence the arm will stay in any position in which it may be placed. A short telescopic tube slides in and out of the lower end of the arm, and has a light spring frictional attachment to prevent its descent by gravitation. To the lower end of the telescopic tube a lamp-holder with lamp and cardboard shade are attached sometimes directly and sometimes by means of a hinged arm (Figs. 2 and 3). In Fig. 1 the two side brackets and the horizontal tube are merely the means adopted in the particular case shown for carrying the fitting itself in front of a window, and do not form part of the fitting. There is, of course, a great variety of ways in which the fitting can be supported to meet the requirements of the object to be lighted and the conditions of its surroundings.

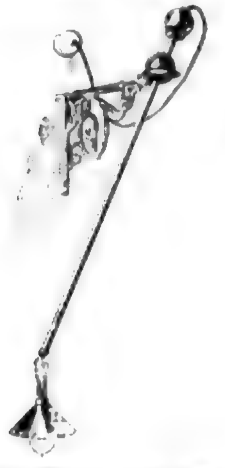

FIG. 2.—FITTING WITH HINGED ARM.

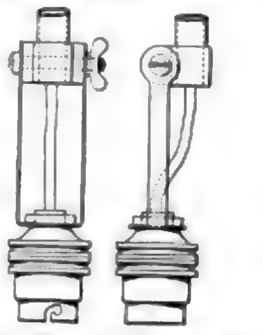

FIG. 3.—DETAIL OF HINGED ARM, ONE-THIRD FULL SIZE.

There is enough friction between the ball and the plate to neutralise the varying leverage of the telescopic tube. The electric conductor, consisting of a length of braided workshop "flex," passes upwards through both tubes and is connected by a bold bend to a wall socket above the fitting. As the conductor slides in and out of the tube it simply forms a more or less bold bend. The fittings are at present made in four sizes, having total ranges of motion as follows:—

No. 1	9ft. 3in.	No. 3	5ft. 6in.
No. 2	8ft. 0in.	No. 4	3ft. 0in.

That is to say, the lamp can be placed at any spot within a horizontal circle of the diameter stated, and it will remain in that position without tightening up any set screw, wing nut, or other locking device. One of these fittings, No. 1 size, has been in use for some time over a lathe at the Birmingham University. We understand that it has given the greatest satisfaction, and that the machine shop, pattern shop, and drawing office of the new University buildings will be fitted throughout with such fittings. The battens which support the countershaft form convenient fixtures for carrying the plates in which the balls rest.

The fittings are made by Messrs. Player and Mitchell, of Cambridge-street, Birmingham.

MODERN OVERHEAD TRANSMISSION LINES.[*]

BY G. SEMENZA.

The problem of the construction of an Overhead Power Transmission Line can be stated in exact engineering terms as follows:—To support on insulators a certain number of wires so as to obtain the necessary stability of the installation with the minimum cost in capital and yearly maintenance. The construction of the transmission line demands a careful study of the topography of the track, the permissible dip of the wires, their tensions, and lastly, the strength of the supports. The forces acting on the various parts of a line are, its weight, the wind pressure on wires and poles, and the weight of snow and ice it may have to carry. When the diameter and coefficient of elasticity of the wire are known, it is easy to determine the form of the catenary from the two extreme conditions, first, when under maximum stress due to weight of snow and wind pressure at the lowest winter temperature, and, second, when at the highest summer temperature. The first condition gives the maximum possible tension of the wire, and the second the greatest dip of the catenary. From the latter figure, the height of the points of suspension can be determined, so that the middle point of the catenary may be never less than a safe distance above the surface of the ground.

When the track is a straight line with equal spans, the longitudinal tensions on any support balance each other, and they have then only to resist the weight of the wire and the wind pressure. For corner posts, the two tensions give an unbalanced resultant in their own plane, and, further, when two spans are unequal, there is an unbalanced longitudinal tension. Thus it is easily possible to calculate the vertical and horizontal tensions which each wire transmits to the support, and knowing the height of the wires, all the elements are to hand for the design of the supports and the foundations. The wind pressure on the post itself is small enough to be neglected.

Assuming that the amount of copper in the line has been determined from Kelvin's law of maximum economy, the following are the chief points in the erection of the line that demand attention. First of all, there is the choice of the route, and it is at once obvious that, if possible, this ought to be a straight line. For one reason, with the same percentage drop, the section of copper varies as the square of the length of the line, and if it is set out in a curve necessitating a 20 per cent. increase in length over the distance "as the crow flies," the weight of copper would be increased by 44 per cent. Then, instead of plain light poles, heavy angle supports would be necessary, and these not only represent a greater capital expense, but constitute points of weakness, as the insulators and the members of the built-up post would be subjected to much higher stresses. It will always pay then, even when expropriation and wayleaves cost considerably more, to select a straight-line route.

The arrangement of lines on the supports is controlled by electrical and mechanical considerations, as the possible contacts between adjoining wires when subjected to oscillations caused by wind must be guarded against. With continuous current, the matter is quite simple, as there are no electromagnetic restrictions on the distance apart of the wires or their arrangement, and for this reason very high pressures may be used without any precautions except giving plenty of clearance. With polyphase currents, on the other hand, there must be a symmetrical arrangement of the conductors, and a compromise must be made between the mechanical and electrical exigencies. For three-phase lines, the figure of symmetry is an equilateral triangle, but it may be disposed in space in various ways; for instance, with one side vertical or one side horizontal. Although electrically they are equivalent, there is a marked difference in the mechanical result between the two methods, as is shown in Fig. 1 (A and B). This illustrates a section taken at the middle of the span, and the projections of the three catenaries on a vertical plane. The dimensions are in millimetres. Only the wires and insulators are shown in the diagram, the poles being omitted. With the action of the wind the wires will oscillate so that the lowest points will describe circles having as centres the projections of the supporting insulators. It will be easily seen from observation that the arc of the circle through which the wires have to travel in case A for neighbouring wires to come in contact is much smaller than in B. The maximum angle through which the plane of the catenary can be displaced is determinable in each case, and in the arrangement B, much larger dips, and therefore much larger spans, can be used with impunity than in A, and thus it is in every way superior.

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[*] Paper read before the Assoz. Elettro. Ital. Abridged translation by John R. Dick.

In considering wind pressure, the maximum is taken to be 280kg. per square metre, and the effective surface of the wire as its length multiplied by half the diameter. Recent experiments have shown, however, that this formula gives too high a result; but one more nearly in accord with the observed values is obtained by using the empirical formula $P = 8{\cdot}10^{-5}dv^2$, where d is the diameter in centimetres and v the wind velocity in metres per second, and P is given in kilogrammes per centimetre length. Where double lines are employed, as is usually necessary in important schemes to diminish risk of breakdowns and facilitate repairs, care must be taken to avoid having two wires in the same horizontal plane, as they might touch when oscillating under heavy wind pressure (Fig. 2).

The length of the spans is not, however, controlled alone by the nearness to which the wires may approach under wind pressure. It is a very common argument to say that when the line is subjected to great stresses due to snow or wind, long spans are inadvisable, but this is hardly true, as by using a sufficient dip the limit of elasticity of the copper need not be exceeded. By increasing the spans the number of insulators is diminished. However well the insulators may be designed they are the real points of weakness in the line, as should even one out of 10,000 break it may give rise to considerable damage.

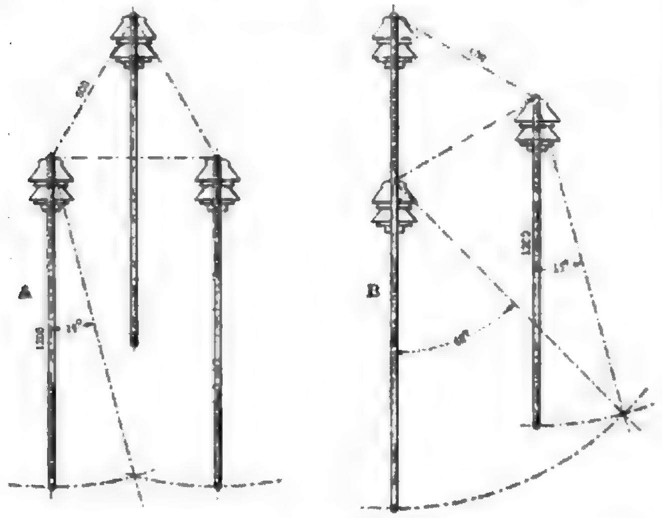

FIG. 1.

The economic aspect of the problem can be realised by remembering that the increase of span diminishes the number of supports, but increases their height and the stresses to which they are subjected, and therefore their weight. The most suitable span is, therefore, the one which requires the smallest weight of material per mile, and it can be only ascertained by successive approximations. Long spans, besides improving the line electrically, require less expense for expropriation or wayleaves, as these costs are usually proportional to the number of supports.

The materials employed in the construction of the posts are wood, iron and to a small degree reinforced concrete. Iron permits of long spans, because it can be readily designed to take the resulting stresses. It is, however, necessary in such cases to provide a specially heavy foundation. An economic consideration which renders iron preferable is that, as it is more durable, its depreciation may be allowed for on a 80 years' basis, whereas with wood the period is not more than eight or ten years. The annual cost of maintenance of iron poles—being only that of painting—is considerably less than for wood. Regarding the increase of insulation said to be due to a wooden pole, this is quite unimportant, and in rainy weather is probably not more than $\frac{1}{3000}$ that of the insulator. Although with the use of iron a short-circuit is almost certain when an insulator breaks, there is with wooden poles the peculiar phenomenon of slow combustion of the wood without the insulator being actually perforated. Mixed supports of iron and of wood partake of all the defects of the latter, such as the absence of sufficient strength and the difficulty of making a permanent joint to the iron base on account of the wood warping.

The original designs of metallic supports were excessively heavy, as the calculations were made on the hypothesis of all the wires on one side breaking, but experience proves that this condition is almost impossible to occur. Any cause sufficient to break the whole bunch of wires would certainly overturn the post itself. The calculation was also based on the supposition that the post was perfectly rigid, so that the breaking of all the wires on one side permitted the full unbalanced horizontal tension to come on the post, but this is found not to be the case, as the post instantly deflects and reduces the tension of the wires. If this is borne in mind, and if also the simultaneous breaking of only two wires on one side is allowed for, then the weight can be greatly reduced. The posts of the present Paderno transmission line with 60 metres spans were actually calculated on this basis.

Quite recently a very great improvement has been introduced in the construction of metallic supports by making them elastic. The first instance of this was in the transmission line of the Brombo scheme. The idea of this design originated from the following considerations:—In a straight track, and with equal spans, the only force acting on the supports apart from the weight of the wire is the transverse wind pressure. It is, therefore, unnecessary to make them withstand a longitudinal stress, and they need only be designed for a transverse stress. As is seen from Fig. 3, they consist of two parallel uprights of channel iron about 2 metres apart, trussed together with angle irons. Should the wires ever get broken, the supports by their elasticity will bend in the longitudinal direction, and this deflection will instantly diminish the tension. In the highly improbable case of the breakage of all the wires in one span, it is found that the first support beyond the break will deflect considerably, but as this deflection diminishes the length of each successive span, and, therefore, the tension of the wires, the second support will be deflected, but to a less extent. The further supports will also deflect, but always to a lesser degree, and by calculation it is found that should the tension be entirely removed from one side the resulting stress would not exceed half that on a rigid support. Thus we arrive at the apparent paradox that the weakness of the support is a factor of its resistance to breaking.

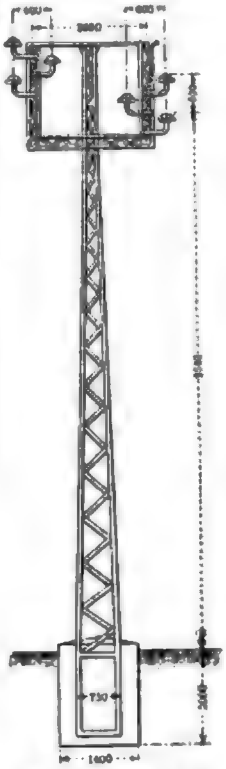

FIG. 2.—SUPPORT FOR DOUBLE LINE.

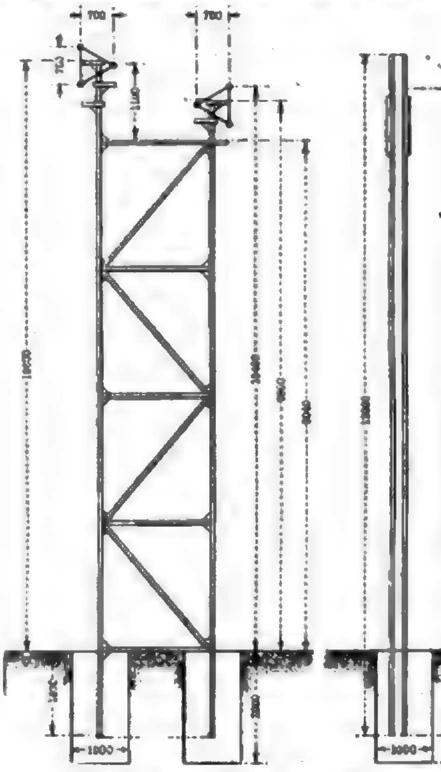

FIG. 3.—ELASTIC IRON POSTS CARRYING DOUBLE LINE.

Regarding the relative cost of making the line with wood or iron supports, it must be borne in mind that the comparatively small number of the latter compensates for the greater cost and the heavier foundations. Thus a line carrying six wires of 8mm. diameter each would only cost £216 per mile, with elastic iron posts 15 to the mile, as against £201 for wooden poles 57 to the mile. With the longer life of the former the annual amount for depreciation would be very much smaller; thus the construction is really cheaper.

With reference to the general argument, it will be apparent that too much importance cannot be attached to the choice of insulators. It is a great and unjustifiable error to select those on the basis of price alone. The value of the insulators is not a great item in the total cost of the line, and a shilling more spent on each one will give an enormously increased safety in working.

PHYSICAL SOCIETY.

At the annual general meeting of the Physical Society, held on February 10th, Dr. R. T. Glazebrook, F.R.S., President, in the chair.

The report of the council was read by the secretary.

Since the last annual general meeting 13 science meetings of the society have been held. Of these 11 were held at the Royal College of Science; one, that on November 25th, was held at the Finsbury Technical College, and one, on December 9th, at the Central Technical College, South Kensington. The average attendance at the meetings has been 43, the number being somewhat larger at the evening than at the afternoon meetings. Additional interest has been given to the meetings by the increase in the number of experiments shown to illustrate the Papers.

The number of Fellows on now the roll is 425, an increase of seven over the number last year. Fourteen new Fellows have been elected. There have been four resignations, and the society has to mourn the loss by death of one honorary Fellow, Prof. Villari, and three Fellows—namely, Prof. J. D. Everett, W. T. Goolden and Dr. Lawson.

The council have co-operated with the Institution of Electrical Engineers in bringing "Science Abstracts" up to date. This has entailed a rather heavy expenditure, which, however, the council felt was fully justified by the importance of the work. The council are glad to be able to report that the publication has now been brought up to date, and in future the society will be liable only for the usual annual contribution. The agreement with the Institution referred to in the last report has not yet been executed, owing to difficulties in making an agreement exactly on the lines which were proposed. Some alterations in detail have therefore been made, and a three years' agreement will shortly be executed, dating from the beginning of the present year.

During the year the President signed on behalf of the council a petition in support of a bill for the metric system.

The report of the treasurer for the year 1904 was read by the secretary.

Additional expenditure was incurred last year amounting to £115 in bringing "Science Abstracts" up to date, which has the effect of reducing the balance in the bank as compared with that at the beginning of the year. But the income from subscriptions has increased, so that the reduction of the balance is less than the extraordinary expenditure. The value of some of the securities has declined, but others have risen, so that on the whole the position of the society remains almost unchanged.

The following officers and council were elected for the ensuing year:—

President.—Prof. J. H. Poynting, D.Sc., F.R.S.

Vice-Presidents.—Those who have filled the office of President, together with C. Chree, D.Sc., F.R.S., H. M. Elder, M.A., Prof. J. A. Fleming, M.A., D.Sc., F.R.S., J. Swinburne.

Secretaries.—W. Watson, D.Sc., F.R.S. and W. R. Cooper, M.A.

Foreign Secretary.—Prof. S. P. Thompson, D.Sc., F.R.S.

Treasurer.—Prof. H. L. Callendar, M.A., F.R.S.

Librarian.—W. Watson, D.Sc., F.R.S.

Other Members of Council.—T. H. Blakesley, M.A., C. V. Boys, F.R.S., A. Campbell, B.A., Prof. W. Cassie, M.A., W. B. Croft, M.A., W. Duddell, W. A. Price, M.A., S. Skinner, M.A., Prof. F. T. Trouton, Sc.D., F.R.S., Prof. S. A. F. White, M.A.

Prof. POYNTING then took the chair and delivered an address on

"Radiation Pressure."

A hundred years ago, when the corpuscular theory held almost universal sway, it would have been easier to explain the pressure of light than it is to-day, when it is certain that light is a form of wave-motion. The means at the disposal of early experimenters were inadequate to detect so small a quantity; but if the 18th century philosophers had been able to carry out the experiments of Lebedew and of Nichols and Hull, and had they further known of the emission of corpuscles revealed to us by the cathode stream and by radioactive bodies, there can be little doubt that Young and Fresnel would have had much greater difficulty in dethroning the corpuscular theory and setting up the wave theory in its place. The existence of pressure due to waves, though held by Euler, seems to have dropped out of sight until Maxwell, in 1872, predicted its existence as a consequence of his electromagnetic theory of light. The first suggestion that it is a general property of waves is probably due to Mr. S. T. Preston, who in 1876 pointed out the analogy of the energy carrying power of a beam of light with the mechanical carriage by belting, and calculated the pressure exerted on the surface of the sun by the issuing radiation. It seems possible that in all cases of energy transfer, momentum, in the direction of transfer, is also passed on and that there is, therefore, a back pressure on the source. Though there is as yet no general and direct dynamical theorem accounting for radiation pressure, Prof. Larmor has given a simple indirect mode of proving the existence of the pressure which applies to all waves in which the average energy density for a given amplitude is inversely as the square of the wave-length. He has shown that when a train of waves is incident normally on a perfectly reflecting surface, the pressure on the surface is equal to $E(1+2u/U)$, where $E/2$ is the energy density just outside the reflector in the incident train, U is the wave-velocity, and u the velocity of the reflector, supposed small in comparison with U. In a similar manner it can be shown that there is a pressure on the source, increased when the source is moving forward, decreased when it is receding. It is essential, however, that we should be able to move the reflecting surface without disturbing the medium except by reflecting the waves. Though Larmor's proof is quite convincing, it is interesting to realise the way in which the pressure is produced in the different types of wave motion. In the case of electromagnetic waves, Maxwell's original mode of treatment is the simplest. A train of waves is regarded as a system of electric and magnetic tubes transverse to the direction of propagation, each kind pressing out sideways, that is, in the direction of propagation. They press against the source from which they issue, against each other as they travel, and against any surface on which they fall. In sound waves there is a node at the reflecting surface. If the variation of pressure from the undisturbed value were exactly proportional to the displacement of a parallel layer near the surface, and if the displacement were exactly harmonic, then the average pressure would be equal to the normal undisturbed value. But consider a layer of air quite close to the surface. If it moves up a distance, y, towards the surface, the pressure is increased. If it moves an equal distance, y, away from the surface, the pressure is decreased, but to a slightly smaller extent. The excess of pressure during the compression half is greater than its defect during the extension half, and the net result is an average excess of pressure on the reflecting surface. Lord Rayleigh, using Boyle's Law has shown that this average excess should be equal to the average density of the energy just outside the reflecting surface. In the case of transverse waves in an elastic solid, it can be shown that there is a small pressure perpendicular to the planes of shear, that is, in the direction of propagation, and that this small pressure is just equal to the energy density of the waves. The experimental verification of the pressure of elastic solid waves has not yet been accomplished, but the pressure due to sound waves has been demonstrated by Altberg, working in Lebedew's laboratory at Moscow, the pressure obtained sometimes rising to as much as 0·24 dynes per square centimetre. By means of a telephone manometer it was found, that through a large range the pressure exerted on a surface was proportional to the intensity of the sound.

Both theory and experiment justify the conclusion that when a source is pouring out waves, it is pouring out with them forward momentum which is manifested in the back pressure against the source and in the forward pressure when the waves reach an opposing surface, and which, in the meanwhile, must be regarded as travelling with the train. It was shown that this idea of momentum in a wave-train enables us to see the nature of the action of a beam of light on a surface where it is reflected, absorbed or refracted without any further appeal to the theory of the wave motion of which we suppose the light to consist. In the case of total reflection there is a normal force upon the surface, in the case of total absorption there is a force normal to the surface and a tangential force parallel to the surface; while in the case of total refraction there is a normal force which may be regarded as a pull upon the surface or a pressure from within. In any real refraction there will be reflection as well, but with unpolarised light, in the case of glass, a calculation shows that the refraction pull is always greater than the reflection push, even at grazing incidence. An experiment, made by the President in conjunction with Dr. Barlow, was described to serve as an illustration of the idea of a beam of light being regarded as a stream of momentum. A rectangular block of glass was suspended by a quartz fibre so that the long axis of the block was horizontal. It was hung in an exhausted case with glass windows, and a horizontal beam of light was directed on to one end of the block so that it entered centrally and emerged centrally from the other end after two internal reflections. Thus a stream of momentum was shifted parallel to itself, or in this particular case a counter-clockwise couple acted on the beam. By suitable means the clockwise couple on the block, due to the pressures at the two internal reflections, was distinctly observed and approximately measured. The result obtained was of the same order as that deduced from the measurement of the energy of the beam by means of a blackened silver disc.

The extreme minuteness of these light forces appears to put them beyond consideration in terrestrial affairs, but in the Solar system, where they have freer play, and vast times to work in, their effects may mount up into importance. On the larger bodies the force of the light of the sun is small compared with the gravitational attraction, but as the ratio of the radiation pressure to the gravitation pull varies inversely as the radius if the density is constant, the pressure will balance the pull on a spherical absorbing particle of the density of the earth if its diameter is about $\frac{1}{[illegible]}$ in. The possible effects of radiation pressure may be illustrated without going to such fineness as this. In the case of a particle of the density of the earth, and [illegible] in. in diameter, going round the sun at the earth's distance, there are two effects due to the sun's radiation.

In the first place, the radiation push is [illegible]th of the gravitation pull, and the result is equivalent to a diminution in the sun's mass. In the second place, the radiation absorbed by the particle and given out again on all sides is crushed up in front as the particle moves forward and is opened out behind. There is thus a slightly greater pressure on the advancing hemisphere than on the receding one, and this appears as a small resisting force in the direction of motion. Through this the particle tends to move in a decreasing orbit, spiralling in towards the sun. As there is good reason to believe that some comets at least are composed of clouds of dust, there is hope that some of their eccentricities may be explained by the existence of radiation pressure. If the particles of a dust cloud circling round the sun are of different sizes or densities, the radiation accelerations on them will differ. The larger particles will be less affected than the smaller, will travel faster round a given orbit, and will draw more slowly in towards the sun. Thus a comet of particles of mixed sizes will gradually be degraded into a diffused trail lengthening and broadening, the finer dust on the inner and the coarser on the outer edge. If a planet, while still radiating much energy on its own account, captures and attaches to itself, as a satellite, a cometary cloud of dust in which there are several different grades, with gaps in the scale of size, it may be possible that in course of time the radiation-pressure effects will form the different grades into different rings surrounding the planet. Such may possibly be the origin of the rings of Saturn.

CONDUIT TRAMWAYS IN NEW YORK AND LONDON.

Mr. J. Allen Baker, chairman of the Highways Committee of the London County Council, has just issued the following memorandum, in which he makes some interesting detailed comparisons between the conduit tramway systems of New York and London:—

In compliance with the request of the committee, I have pleasure in submitting the following particulars with regard to the working of the conduit system of tramways in the City of New York. No other system of mechanical traction is now allowed on Manhattan Island (New York proper), but the overhead system still prevails in Brooklyn and the outlying districts north of Manhattan, and also in Jersey City. Both the cable and the trolley lines within the city have been converted to electric conduit, and also many of the "cross town" horse lines. The original cost of constructing the Broadway cable lines was £100,000 per mile of single track. A considerable number of horse lines still exist, but many of these are now under reconstruction.

Originally there were over 40 independent street car companies in New York, but now the entire system is operated by "The New York City Street Railway Co.," which has absorbed "The Metropolitan Street Railway Co.," "The Third Avenue Co.," and the other smaller companies.

The lines traverse the most densely populated districts, and the traffic and earnings exceed those of any other street railways in the world. The first conduit line, 3 miles in length, was laid in Lennox-avenue in 1894, and it proved so efficient, reliable and economical in operation, that the extension of the electric conduit system was decided on, not only for all new lines, but also in place of the cable system, in comparison with which it showed an economy in operation of at least 5 cents per car-mile. No printed report is published by the company, but the chief engineer, Mr. M. G. Starrett, very kindly furnished me with particulars of the working of the lines during the last financial year. Some of these, in comparison with corresponding figures on the Council's South London conduit lines, will, I think, be of interest to the Committee.

In all there are now 210 miles (counted as single track) of conduit lines in New York, compared with the 185 miles of tramways (also counted as single track) in the County of London, of which 156 miles are owned by the Council, while 29 miles still remain to be purchased, the last falling in in 1911.

A universal 5 cent fare (2½d.) is charged, but as the transfer system prevails (entitling a passenger by the payment of one fare to a continuous ride over two or more lines) so large a proportion of passengers take advantage of it that the average fare per journey is reduced to 3¼ cents, or very slightly more than 1½d. A single fare under this system may be made available for a distance of 15 miles. The Council's highest fare is 3d., for a distance of 6½ miles, and the lowest ½d., for a maximum ride of about a mile, the average distance for a ½d. fare being two-thirds of a mile. Moreover, a system of workmen's tickets peculiar to London is in force, the charge being 1d. per single journey for any distance, and 2d. for a return journey, the return ticket being available on the same day. This privilege is very extensively used. The average fare on the Council's tramways is, for these reasons, thus only about 0·93d.

In New York the average speed on all the lines is 10 miles per hour, the great amount of traffic on Lower Broadway and many of the "down town" cross lines tending to bring down the average. For those streets even a less speed is attained than is possible in the case of the busiest thoroughfares traversed by the Council's electric lines, whereas on the more open "up town" streets a higher speed is attained than is permitted by the Board of Trade in London. The average of 10 miles in New York compares with an average of about 8 miles in London.

On the Broadway, Fourth Avenue, and some other lines a headway of 15 to 20 seconds is maintained for several hours in the busy part of the day. Both of the lines specially mentioned are intersected in the city by very busy lateral thoroughfares, and pass, for some portion of their route, through streets so narrow that vehicles standing by the kerb have to be passed with great care. The result is that a large number of accidents occur, especially collisions with vehicles, and the amount and nature of the claims on account of accidents are greater, in proportion to population and mileage, than is the case in London.

The following figures with regard to the earning power, &c., of the New York lines are important:—

The average earning power per car-mile is from 33 to 34 cents, or 1s. 4½d. to 1s. 5d. (dollar at 4s. 2d.).

The operating cost (including maintenance, repairs, renewals, accidents, &c.) per car-mile is from 14 to 15 cents, or 7d. to 7½d., making a net profit per car-mile of about 19 cents, or 9½d.

The New York City Street Railway Co. has about 3,000 cars in use, all single deck, but many of these are open or "summer" cars. An average of 1,600 cars were in daily operation during the year under review, and 52,014,109 car-miles were run; this mileage, for the 210 miles of track in use, at 19 cents, gives a profit for the year of $9,882,680 (say £2,058,892), an average of £9,804 per mile of single line.

The cost of construction of the New York conduit lines averaged from $100,000 to $125,000 per mile of single track; this cost, including all the conduit work, tracks, earthenware ducts for the feeder cables (but not the feeder cables themselves), works out at an average of about £22,500 per mile, as compared with £13,800 per mile of single line, the average cost in the case of the South London conduit construction, plus £1,000 extra for the earthenware feeder-cable ducts, making £14,800, as compared with £22,500 in New York.

The cost per single mile of the feeder cables used on the New York system is about $16,000 (that is practically £3,200 per mile of single track, as compared with £1,500 in London).

The power stations and sub-stations, together with their equipment, cost per mile of conduit line installed, about $29,000 (that is about £5,800, as compared with the estimated cost for London of about £5,850). This comparison is indicated in the Table included later in this report.

The cost of cleaning the conduit averages $500 per mile of single track (say £100), compared with £134 per mile included in the estimates for the Council's tramways for the current year; 160 men are employed for conduit cleaning in New York on the 210 miles of track.

Scrapers are used to carry away the dirt in the conduits between the manholes, and no caked mud is allowed to accumulate at the bottom of the conduit. The insulation holes are placed 15ft. apart, and through these the cleaners clean out the conduit daily as well as through the manholes, or sumps, which are placed 100ft. apart. One of the greatest difficulties experienced in New York is the maintenance of the service during the severe winter weather, when snow may accumulate and ice freeze at the bottom of the conduit. Further, in times of very severe frost, an occasional difficulty has been experienced in straight-track work, the track rails being forced inwards, and in their turn forcing the slot rails inwards, and so decreasing the width of the slot opening along which the plough passes. These are difficulties which are not likely to occur in London. Mr. Starrett expressed the opinion that the climatic conditions of London are much more favourable than those of New York for the operation of conduit tramways. Notwithstanding these special difficulties, the "trouble" items on the conduit lines are considered to be no greater (if as great) as on the trolley lines outside the city limits, while the operating expenses, including maintenance, repairs and renewals, when the greater life of the conduit work is taken into account, is considered to be in favour of the conduit system.

In New York the day's work of motor-men and conductors consists of 10 hours' labour out of 12 consecutive hours. The motor-men receive a minimum wage of $2.10 and a maximum wage of $2.50 per day for a full day's work. For the first year $2.10 (8s. 8d.); for the second year $2.25 (9s. 4d.); for the third year $2.35 (9s. 9d.); and for the fourth and fifth, and after the fifth year, $2.50 per day (10s. 4d.). The rates of pay of the conductors are as follow:—First year $2 (8s. 3d.); second year $2.10 (8s. 8d.); third year $2.20 (9s. 1d.); and after the fifth year $2·35 (9s. 9d.). Conduit cleaners are paid $1.75 (7s. 2d.) for 10 hours' work. Car cleaners receive from $1.50 to $1.75 (6s. 2d. to 7s. 2d.) for a day of 10 hours, according to their work and length of service; they are supposed to work seven days per week, but in practice every man is off duty on alternate Sundays.

The greatest care is exercised in the selection of the motor-men, as the safe and economical working of the system depends on their skill and efficiency. Every applicant has to pass a severe examination, including tests for eyesight, hearing and colour blindness. After an examination for this purpose he enters the "school," and upon the certificate of the "instructor" he is first placed upon streets having the least traffic until he is considered competent to take charge of a car on a more crowded street. Of the men who pass the physical examination, only about 40 per cent. finally qualify as first-class men. Neither the motor men nor conductors are permitted to sit while on duty on the cars. This is also the rule in all the large American and Canadian cities. It is not considered possible for the motor man to operate electric cars with safety in town traffic unless he is in a standing position.

It will thus be seen that the constructional costs in New York are about 50 per cent. higher than in the case of the Council's tramways, this being probably accounted for by the facts (i.) that some portions of the conduits had to be excavated through solid rock, (ii.) that an extended and more expensive form of yoke is used than in London, (iii.) that all labour and materials are dearer in New York than in London and (iv.) that the pipe obstructions are greater than those met with in the reconstruction of the Council's lines.

The construction of all the New York conduit lines has been carried out by the operating company itself, without the intervention of a contractor.

Table of Comparison between the New York and London County Council Conduit System.

—	New York. 210 miles (single track).	London. 54 miles (single track).
Average gross earnings per car-mile	1s. 4½d.	1s.
Average operating cost per car-mile, including repairs, renewals and reconstruction, maintenance, accidents, &c.	7½d.	Estimate without renewals. 7d.
Average cost per track-mile for conduit cleaning per annum	£100	Estimate for current year. £134
Average cost of constructing conduit line per car-mile of single track, including cable ducts but not cables	£20,000 to £25,000	£14,800
Average cost of feeder cables per mile of single track	£3,200	£1,500
Cost of power station and sub station per mile of single track	£5,800	£5,850[*]
Average speed at which cars run	10 miles an hour	8 miles an hour
Hours of motormen and conductors	10 hours' labour (in 12 consecutive hours)	10 hours' labour (in 12½ hours average)
Pay of motormen per day.	8s. 8d. to 10s. 4d.	4s. 9d. to 6s. 3d. (74 per cent. at 6s. 3d.)
Pay of conductors, do.....	8s. 3d. to 9s. 9d.	4s. 9d. to 6s. 3d.) 65 per cent. at 6s. 3d.)
Pay of conduit cleaners, do.	7s. 2d.	5s. 4d.
Pay of car cleaners per week	£2. 3s. 5d. to £2. 10s. 6d.	£1. 5s. to £1. 7s. 6d.

It will be noted that under the head of "cost of operation" in New York the figure of 7½d. per car-mile includes all renewals and reconstruction of lines, rolling stock, &c., and no sum has therefore to be set aside for this purpose. On the Council's lines the present estimates (with labour 50 per cent. lower than New York) show an operating cost from the Greenwich station of 7d. per car-mile, and it is also proposed to set aside a further 1d. per car-mile as a "renewal reserve fund."

The average life of "special work" is given for New York at five years, and that of straight track 10 years, while the traffic on the lines is much heavier than in London. The average estimated life of "special work" and straight tracks on the L.C.C. lines is fixed at an average of seven years.

Among the important advantages in a city like New York of the conduit over the trolley are considered to be (1) the greater sightliness, (2) the absence of danger from live wires in the streets, (3) immunity from danger of electrolysis to water and gas mains owing to insulated conductor bars in the conduit instead of rail returns as in the case of the trolley system, (4) greater durability of construction, the conductors and insulators in the tube lasting probably 30 years, as compared with three or four years for overhead wires; (5) no loss of currents by bad contacts, greasy rails or imperfect bonding of rails, and, consequently, no disturbance to observatories where magnetic observations are carried on. Similar advantages will no doubt be experienced in London as are found by experience to obtain in New York.

The comparisons with the New York "cost of operation" and "life of plant," &c., are of more value to London than the earnings, the average fare being so much higher in New York than in London and other special circumstances as above indicated operating. At the same time, it shows with what remarkable economy a complete conduit system in a large city like New York can be operated, and indicates that a slight readjustment of the Council's present fares, or the stages now given for a ½d. or 1d. fare, would add materially to the earning power of the lines.

TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

The Annual General Meeting of the Tramways and Light Railways Association was held on Friday, February 10th, at the Society of Arts, the chief business being the presentation of the report of the Council for 1904, and the election of a President and some new Members of Council. Mr. C. A. Baker (the retiring President) took the chair, and in the course of a short speech mentioned the fact that there had been an addition to the membership during the year of 32 members. The report, which is short, gives the names of these new members, a list of the papers read during the session, and the names of the nominations for the new Council. The latter are as follows:—Hon. Arthur Stanley, M.P. (President), Lord Vaux of Harrowden, H. England, J. B. Hamilton, J. H. Rider, and Stephen Sellon. The report was unanimously adopted and the Council nominations agreed to. Mr. Baker then introduced the Hon. Arthur Stanley, who took the Presidential chair.

The new President said he presumed he had to thank his connection with the South Lancashire Electric Tramways Co. for the honour which had been conferred upon him. Referring to the difficulties which tramway companies experienced with local authorities, he said he was pleased to notice that this was fast dying out, and as an example mentioned one particular local authority on the line of route of the South Lancashire Company. This body had persistently refused to give any facilities whatever to the company until they had been practically forced to do so. After the trams had been running a short time, however, a member of that Council waited upon him and informed him that had it been known what a benefit tramways would confer upon them no opposition would ever have been offered. He only wished they had come to this state of mind earlier, as it would have saved the tramway company many thousands of pounds. Tramway companies did not exist solely for the purpose of being fleeced, and they were not to be looked upon as a company which was to supply all sorts of things free of charge which any particular local authority required.

With regard to motor 'buses, a good deal was now being heard about these, but he could only say that if anybody found a cheaper mode of traction than a metal wheel on a metal rail, that would displace the tramways, but this was certainly not found in the motor 'bus. Would it not be possible for the tramway associations to co-ordinate and co-operate their forces so as to present a united front to all opposition. The individual societies now existing could remain, but there should be appointed one central body which could speak with authority and to which all appeals should be made. As a matter of fact this ought to be the function of the Tramways and Light Railways Association, but apparently it was not so.

Referring to the Tramways Exhibition at the Agricultural Hall this summer, Mr. Stanley mentioned that it was hoped to have a joint convention of tramway authorities during the Exhibition, and in September it was proposed to hold a convention of tramway managers. A meeting had also been arranged, and would probably take place very shortly, with the Association of Municipal Corporations, the object being to present a joint representation to the Government with a view to doing away with some of the obsolete regulations and some of the anomalies which existed at present in connection with the tramway industry. After suggesting a number of points which might well be discussed during the forthcoming meetings of the Society, the speaker drew attention to the question of rear lights on vehicles. It was a peculiar state of things, he said, when all fast-going vehicles were compelled to have rear lights whilst the slow-going traffic was not so compelled. Could not the Automobile Club and the Tramways and Light Railways Association combine in this movement?

A hearty vote of thanks having been accorded to the retiring President (Mr. C. A. Baker), the proceedings terminated.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

New Type of Atmospheric Ions.—P. Langevin has discovered a type of slow-moving ions whose existence in the atmosphere has hitherto been unsuspected. He used Ebert's method of conducting air through a cylindrical condenser and measuring the currents passing through the condenser with various E.M.Fs. and various velocities of the blast. He obtained only two different mobilities. One was the well-known mobility amounting to 1·5cm. for a gradient of 1 volt per centimetre. The other mobility was 4,000 or 5,000 times less than this, and corresponds to that found by Townsend in freshly-prepared gases, or that found by Bloch for the ions of phosphorus. Ebert's instrument as usually constructed fails to indicate these ions, which, however, may convey 50 times more electricity than the usual ones.

[P. Langevin, *Comptes Rendus*, January 23, 1905.]

Theory of Electrolysis.—L. Kahlenberg criticises the electrolytic dissociation theory as developed by van't Hoff and Arrhenius, and maintains that in spite of its present popularity it cannot by any means be considered as well established. He contends that the facts presented by Arrhenius in his original article are not sufficient to serve as a basis for the assumption of electrolytic dissociation in solutions, and that while isolated facts may here and there be interpreted by means of the dissociation theory, the bulk of experimental evidence gathered since 1887 speaks strongly against the theory. All data of freezing points and boiling points of solutions on the one hand, and of molecular conductivities on the other, show that there is no such relation between them as the theory of electrolytic dissociation requires. The hypothesis of Arrhenius cannot be harmonised with the facts of thermal chemistry, nor with the law of mass action, and this constitutes a strong argument against the hypothesis. But the hypothesis appears at its worst in the case of non-aqueous solutions, such as those in liquid ammonia, liquid sulphur dioxide, and liquid hydrocyanic acid. The most absurd application of the dissociation hypothesis is to substances that are not solutions at all, such as fused salts, pure solvents and gases. Since these may be regarded as solutions 100 per cent strong, one cannot apply a theory which admittedly only holds strictly for infinitely dilute solutions.

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[*] This figure is based upon obtaining power from the Greenwich generating station, and with 1,000 cars in operation over 200 miles of single track.

[L. KAHLENBERG, *Philosophical Magazine*, February, 1905.]

Zeeman Effect.—If light traverses parallel to the lines of force very attenuated sodium vapour placed in a magnetic field, the plane of polarisation is rotated in the positive direction for all periods lying outside the components of the doublet, but in the negative direction, and very strongly, for periods intermediate between those of the components. If light traverses the vapour normally to the field, there is double refraction, as predicted by Voigt from theory. When placed in a magnetic field, all isotropic bodies should show this double refraction, but to a measurable degree only in the neighbourhood of the absorption lines. The experimental work carried out by Voigt and Wiechert in confirmation of this result has now been extended by Zeeman and Geest, who worked with sodium vapour so dilute that, in a strong magnetic field, there were seen the four absorption lines corresponding to the components of the quartet into which the line D_1 is split by the magnetic field. The manner in which the double refraction depended upon the period could be predicted from Voigt's theory, which has been brilliantly confirmed by the results. Plane-polarised light, under an azimuth of 45deg. to the vertical, was made to fall on a Babinet compensator with horizontal edges. The light then traversed a second Nicol crossed. An image of the system of parallel interference bands was thrown on the slit of the spectroscope. The light was finally analysed by means of a large Rowland grating mounted for parallel light. On putting the field on, the bands became distorted, the vertical displacements being proportional to the difference of phase between vibrations respectively parallel and normal to the field. The authors succeeded in observing the polarisation between the quartet of line D_1, and even in the extremely narrow spaces separating the sextet of line D_2. In every case the phases were in entire agreement with the theory.

[ZEEMAN and GEEST, *Proceedings of the Royal Academy of Amsterdam*, December 24, 1904.]

Cathode Fall at Hot Carbon.—J. A. Cunningham published two years ago some determinations of the cathode fall at a platinum wire grating heated by an electric current. But he found that platinum became soft, and finally fused just at a critically interesting stage in the transformations of the discharge. He therefore turned to carbon as the most infusible material. This required the exclusion of oxygen from the gas employed. The curves of current and cathode fall show a remarkable general resemblance to those characteristic of all conduction through gases, such as that produced by ultra violet light striking a metal immersed in the gas, where the saturation current is first attained. On further increasing the difference of potential, a greater conductivity is produced as the result of the ionising collisions of the negative ions. But this is just the stage which is ordinarily regarded as initiating the luminous discharge. This is evidently the region of rapidly increasing ionisation by collision, though such ionisation must have been going on even during the prevalence of the comparatively "saturated" current corresponding to the normal cathode fall, and in the case of low temperatures even before it. The author inclines to the opinion that the second diminution of the value of dV/dC marks the point at which the positive ions also begin to produce fresh ions by collision.

[J. A. CUNNINGHAM, *Philosophical Magazine*, February, 1905.]

Secondary Radium Rays.—J. A. McClelland has discovered an interesting relation between the position of a metallic plate exposed to radium rays and the amount of secondary radiation projected in various directions. The secondary rays are not merely produced at the surface of the plate struck by the primary rays. They come from all parts of a layer of considerable depth, the depth depending upon the substance of which the plate is composed. Superposed on an effect of the nature of reflection we have other effects. The law of reflection being fulfilled, there is more secondary radiation near the normal, which is to be expected, as then the radiation coming from some depth in the plate has a smaller thickness to penetrate. The author investigated only those rays which are capable of penetrating tinfoil and a few centimetres of air. That the secondary radiation is not merely a surface effect was conclusively proved by reflecting the primary rays from a single sheet of tinfoil 0·013mm. thick, measuring the secondary radiation, and then doubling the sheet and adding more sheets. The intensity of the secondary radiation being 13 with one sheet, it was 24 with two sheets, 44·5 with four sheets, and 60·5 with eight sheets. This shows that the secondary rays were at least as penetrative as the primary rays.

[J. A. MCCLELLAND, *Philosophical Magazine*, February, 1905.]

Electron Theory of Metallic Conduction.—The work of Riecke, Drude and J. J. Thomson has shown that the conductivity of metals for electricity and heat, the thermo-electric currents, the Thomson effect, the Hall effect and phenomena connected with these may be explained on the hypothesis that a metal contains a very large number of free electrons and that these, taking part in the heat motion of the body, move about with a speed depending upon the temperature. H. A. Lorentz has attacked this problem by a new mathematical method. He assumes that the metal contains but one kind of free electrons, having all the same charge e and the same mass m, and that at a given temperature the mean kinetic energy of an electron is equal to that of a molecule of a gas. He considers the forces acting upon an electron in a cylindrical bar of metal, a sort of generalised wire. This force may be due to an electric field, or, in the case of non-homogeneous metals to molecular attraction. He then calculates, by the statistical method of Maxwell and Boltzmann, the drift of electrons through a partition across the bar, and also the drift of energy through it—*i.e.*, the difference between the energy passing the partition in the positive direction and at passing it in the negative direction. For the former he obtains the formula—

$$V = \frac{2}{3}\pi l\left[\frac{1}{h^2}\left(2hAX - \frac{dA}{dX}\right) + 2\frac{A}{h^3}\frac{dh}{dx}\right];$$

and for the latter

$$W = \frac{2}{3}\pi m l\left[\frac{1}{h^3}\left(2hAX - \frac{dA}{dx}\right) + 3\frac{A}{h^4}\frac{dh}{dx}\right],$$

where $A = N\left(\frac{h^3}{\pi^3}\right)^{\frac{1}{2}}$ and $h = \frac{3m}{4\alpha T}$. The author applies these fundamental equations to a number of phenomena. For the electric conductivity he deduces the value

$$\sigma = \sqrt{\frac{2}{3\pi}}\,\frac{lNe^2u}{\alpha T},$$

and for the ratio of the thermal to the electric conductivity

$$\frac{k}{\sigma} = \frac{8}{9}\left(\frac{\alpha}{e}\right)^2 T,$$

which is independent of the nature of the metal. The formulæ obtained by this new method differ from Drude's formulæ only in the numerical coefficients.

[H. A. LORENTZ, *Proceedings of the Royal Academy of Amsterdam*, December 24, 1904.]

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THE INSTITUTION OF ELECTRICAL ENGINEERS.

Although the membership of the Institution of Electrical Engineers is steadily increasing, there is no doubt that during the present session the average attendance at the meetings has diminished. Papers and discussions are listened to with apathy or not listened to at all, and subsequent conversation in the tea room is usually devoted to matters far away from the subject which has previously been debated. In fact, it is evident that a large proportion of the members come on Thursday evenings rather for the opportunity of discussing topics of current interest with their fellow engineers after the meetings than to hear the proceedings in the lecture theatre. We feel that we are expressing the opinion of a number of London members in calling attention to the general unsuitability of the Papers submitted at the meetings and the absence of a proper sense of proportion in the regulation of the discussions. The present session is half over, and there has only been one evening's discussion approaching to the former standard at the Institution, and this did not attract as large an audience as it deserved on account of the mismanagement of the proceedings which occupied the time of the previous meeting. We have had four Papers. The first dealt with an obscure point in dynamo design and was illustrated by some fascinating and delicate experiments in hydro-dynamics ; it attracted a large concourse of spectators in view of the announcement that the discussion would be opened with a cinematograph display. Following on this came a Paper on the theory of magnetic testing, excellent in its way but suitable rather for the Physical Society than for the Institution of Electrical Engineers. We do not wish to reflect any discredit on the authors of these Papers, nor even to suggest that the authors were wrong in submitting them to the Institution ; but we do wish it to be understood that the Council should have avoided opening the session with two Papers which could interest but a small section of the members. The brief discussion they elicited is sufficient proof of the correctness of this view. We should all of us have been pleased to see Prof. HELE SHAW's ingenious experiments and Prof. SILVANUS THOMPSON's cinematograph demonstration during the first or last half-hour of one of the meetings, but the bulk of the Paper might, with advantage have been published in the journal without being read at a meeting. The same applies to Mr. SEARLE's contribution. The third Paper was on a well-worn subject—the combination of Dust Destructors and Electricity Works—and but a small proportion of the London members of the Institution came to hear the discussion on it, although an interesting Paper on boiler-house economies was to be presented on the same evening. We alluded, a fortnight ago, to the ridiculous waste of time at the next meeting, and last week a valuable half-hour was again thrown away, by the President allowing Mr. ADDENBROOKE to read his Paper instead of letting it be taken as read.

When the Traction, Light and Power Distribution Sub-Committee invited Mr. ADDENBROOKE to write a Paper on the subject of overhead mains, they must surely have meant that they would like a Paper on the construction of overhead mains. Instead of this it appears that they received from Mr. ADDENBROOKE, a year ago, a Paper—the greater part of which might equally well have been written six years ago—devoted to pointing out the reasons, well known to every electrical engineer, why overhead mains would be economical, and why they are desirable when the circumstances are propitious. Two parts of the Paper were of value—viz., a Table comparing the cost of erecting overhead and underground mains, and an Appendix giving an abstract of the regulations in force in foreign countries. These portions were perforce omitted in reading the Paper aloud—a treatment which might with advantage have been extended to the remainder. We trust that the discussion next week will not be confined to the topics suggested in the Paper itself, for the sins of the Board of Trade and Local Authorities in the past with regard to overhead mains may be taken for granted; on the other hand, a discussion on the details of overhead construction for electric light and power lines will be welcome. Doubtless those who have had actual experience in this class of work will be invited to express their opinions.

It is hard to believe that the Institution of Electrical Engineers is so insufficiently provided with Papers for the session that the necessity has arisen to protract the proceedings unduly. If this is the case, may we suggest that some members of the Council might themselves step into the breach, or that some of the best local section Papers should be read at the London meetings. For instance, the Paper on cable construction, recently read at Manchester and commenced in this week's issue of *The Electrician*, has more practical value, both intrinsically and as a basis for discussion, than any one of the four Papers read in London this session. On the other hand, if, as we have reason to believe, there is a plethora of Papers, the policy that is being pursued at present should be amended.

FUEL ECONOMY IN STEAM POWER PLANTS.*

BY WILLIAM H. BOOTH AND JOHN B. C. KERSHAW, F.I.C.

(Concluded from page 670).

To produce superheated steam has proved more difficult than might be anticipated, owing to the variable conditions of the furnace. To prevent superheater tubes burning away, steam is often made to rush through them at a high frictional velocity, whereby, its pressure being reduced 12lb., 15lb. and even 25lb., much of the gain of superheating is sacrificed. In separately fired superheaters no tube will stand a temperature above, say, 1,400°F. Few will stand more than 1,000°F. to 1,200°F. But a furnace worked with any regard for fuel economy has a temperature of waste gases of 2,500°F. or 3,000°F. All separately fired superheaters that do not possess a system of water control and temperature reduction, are made safe against the high furnace temperature by an enormous inlet of cold air through the grate or door, or through special air openings. As the superheater must inevitably reject its gases at, say, 700°F., the surplus air is all rejected at that high temperature, and a large proportion of the advantage of superheat is lost. The separately fired superheater should abstract the surplus furnace heat in a rational manner, and this is best done by means of a shield of water between the furnace and the superheater. The advantage of the water protection shield in advance of the superheater tubes is that the feed-water for all the boilers of the set may be passed through the tubes and raised to the boiler temperature. The advantages of thermal storage are thus secured, for these are chiefly confined to the high rate of evaporation at which a boiler can be forced when fed with fully heated feed-water. Not only is priming reduced or prevented, but the whole working of the boiler is rendered more efficient.

To secure superheat economically, it is first necessary that the steam way through the superheater tubes should have an area equivalent to 25 to 50 per cent. in excess of the boiler steam-pipe. The ordinary small-tube superheater, if given so much equivalent area, would not then cause the serious loss of pressure it now causes, but it would burn away more rapidly than it now does. In Germany, where, probably, small-tube superheaters have a larger allowance of area, this burning out does occur rapidly, but it is said to pay to burn out tubes rather than to sacrifice so much pressure. There is no need to do either where water control of superheat is adopted, as proved by six years of steady work without deterioration. But a first class water-controlled superheater, though it may last indefinitely, will cost double or treble as much as an ordinary uncontrolled superheater. In return for this, it will supply feed through the water-control pipes at full boiler temperature, thus increasing the efficiency of the boiler considerably as well as the output.

In the manufacture of steam fit to be used in an engine, economy demands its production in distinct stages. The water, duly purified, is first raised to the temperature of condensation by the exhaust steam. This may be, say, 100°F. It is next raised to a temperature of, say, 250, 300deg. or upwards, by means of the residual heat of the waste gases. If still below boiler temperature the feed water may be raised to that temperature by the water-control apparatus of the superheater, and in separately fired superheaters by the water screen which protects the superheater pipes from too direct fire action. The boiler then comes into action and adds heat to the feed water. All this heat ought to become latent. None of it ought to go towards raising feed temperature. Indeed, in the absence of the last-named stage of feed heating a live steam heater should form this stage.

The boiler should produce steam which contains the maximum possible amount of heat per cubic foot, and is capable of performing work in the smallest possible cylinder. Unfortunately for economy cylinders are made of material which exchanges heat with the steam, particularly if wet, and, despite all precautions, steam enters the cylinder loaded with water and cannot lose heat without liquefaction taking place. If superheated its water contents are evaporated and its volume is increased. It can travel faster because its molecular kinetic energy is greater. It loses nothing at drains, and though it loses temperature it does not become wet so long as any superheat continues. It furnishes heat to the interior walls of the cylinder and reduces those exchanges of heat which increase steam consumption by 20 to 50 per cent. Little or no superheat need remain at the point of cut off, and there is then contained in the cylinder the greatest amount of heat possible at the given pressure. For the first cylinder of a compound engine steam should be superheated. The superheating of the steam between the cylinders is a matter of dispute. It ought to be economical, and, if it fails to be so, the cause is perhaps connected with the absence of drainage of the receiver. Engineers who have intermediate receivers capable of re-heating would perform a service if they would make commercial tests under the two conditions during a series of alternate weeks.

Superheating should therefore be considered as one of the final stages of dry steam production, the actual final stage being the cooling of the steam to saturation temperature by means of the heat-absorptive effect of the cylinder walls. Superheating is necessary to economy because cylinders are not adiabatic. With superheated steam, cylinders are nearer to adiabatic conditions. The economy from a given expenditure upon superheaters is to be found by suitably equating first cost charges, cost of stoppages to renew tubes and maintenance generally with the economy of fuel that superheat will secure. There are only two classes of superheaters, the cheap apparatus without control and the apparatus with water control, of which class there is only one representative. Comparison would be therefore out of place by the authors.

THE WASTE GASES.

The temperature and chemical composition of the waste gases passing from every large boiler plant ought to be regularly ascertained, the work being carried out by a man specially trained in technical gas analysis. The absence of smoke is no guarantee that combustion is being carried out in an economical manner, and only by constant testing of the exit gases can one be certain that the fuel is being burnt without undue excess of air. The significance of air excess becomes manifest when one considers the following figures:—

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*Paper read before the Institution of Electrical Engineers, Jan. 12th.

With gases containing only 4 per cent. of CO_2 and a chimney temperature of 400 F., 4,380 B.Th. units are lost for every pound of fuel burnt, *i.e.*, 32·4 per cent. of the total heat value of the fuel. It may be objected that this percentage of CO_2 is much lower than that present in the flue gases of electricity works, but the authors believe that this percentage is not exceeded in many works where no special attention has yet been given to this question and where no CO_2 testing apparatus has yet been installed. In nearly every case where automatic or other CO_2 testing apparatus has been purchased and used the authors know that all the earlier tests have been under 5 per cent. of CO_2, proving that under the every-day conditions of work obtaining in these plants unduly large volumes of air were being admitted. Where no economiser is installed the loss of heating power is even greater, for the gases then pass to the chimney at a temperature of from 600° F. to 700° F., and the heat losses rise to 6,570 and 7,665 B.Th. units, or to between 48 and 56 per cent. of the total heat value of the fuel.

Taking now the case where the boiler plant is under scientific control, and by constant testing the percentage of CO_2 in the exit gases has been raised to 12 per cent., the loss of heat with chimney gases at 400 F. is reduced to 1,540 B.Th. units, or to 11·4 per cent. of the total heat value of the fuel. In the one case, only between 44 and 68 per cent. of the heat can possibly be utilised, while in the other 88·5 per cent. of the thermal value of the fuel may be converted into useful work—either in the boilers or in the feed-water apparatus. Engineers would therefore be wise to give most careful attention to this question of excess air supply to the boiler furnaces, and to make proper provision for the constant sampling and testing of the exit gases.

Having drawn attention to the great importance of this subject, the authors do not propose to describe all the various apparatus and methods to be used in sampling and testing the exit gases. A few general remarks on the subject may, however, prove of value as a guide to practice in this matter. The examination of the exit gases should cover the following points:—(1) Colour and appearance, (2) draught and temperature, (3) chemical composition. Daily tests should be made for these on each boiler of the plant, and in the main flue and at the base of the chimney. To facilitate this work, special sampling and observation holes must be constructed at the various required points in the brickwork of flues and boiler settings by use of 30in. lengths of wrought-iron pipe, 1¾in. inside diameter. The pipes should have a flange screwed on the top, and should be set in the brickwork with cement. When not in use for testing purposes, they must be closed with an iron bolt or with cotton waste. When new boilers are installed, these sampling holes should be left when setting the boiler.

Iron pipes are not to be recommended for sampling flue gases, since such pipes corrode and become choked. Many low tests of CO_2 are, in the author's opinion, due to the use of iron pipes for sampling purposes. 3ft. lengths of hard potash glass tubing ¾in. in external diameter should be employed. This glass stands a very high temperature without softening or fusing, and does not combine with oxygen at a red heat.

These glass sampling tubes must be removed from the flues when not in use for sampling purposes, and cleaned with a tube brush from adhering dust and soot. Fixed filters for retaining soot and dust are also bad in practice, since, if small, they speedily get stopped up, and, if large, they hold a large volume of gas and prevent the tested sample from being truly representative. They also increase the dangers of air-leakage, and are to be condemned on that account. Lengthy lines of iron connecting pipes are also not to be recommended. The sample of gas from boiler flues ought in fact to be collected as near as possible to the flue itself, and only glass and rubber should be employed for connecting the sampling apparatus to the flue. Many of the CO_2 test results now being obtained are, in fact, of dubious value, owing to the neglect of these elementary precautions in sampling.

With regard to temperature determinations in the flues and at the chimney, these may be made either with a water pyrometer—a high temperature mercury thermometer—or with one of the various forms of electrical resistance pyrometer.

For ascertaining the heat inside the combustion chamber of the furnace one of the photometric methods should be employed. The theoretical temperature attainable in the furnace by the combustion of coal lies between 3,500 F. and 3,700 F.; the maximum attained under practical conditions is about 2,800 F. The temperature of the exit gases should not exceed 400 F. when chimney draught is employed; when artificial draught apparatus is installed the exit gases may be reduced to atmospheric temperature, if this is practically possible.

Draught tests can be made with any form of water gauge reading to $\frac{1}{10}$th of an inch. A portable U-tube gauge, that can be carried about, may be employed for testing the draught in individual boilers, but it is well to have a fixed draught gauge at the chimney base and on the main flue. Here again a glass tube is to be preferred for connecting the gauge to the flue. This tube should be removed at short intervals and thoroughly cleaned and washed.

If automatic recording apparatus be installed for taking the CO_2 temperature, or draught tests, glass tubes should be employed whenever possible for the necessary connections to the flues, and all the precautions already named must be taken to keep the tubes clean and free from deposits. The apparatus must be placed in all cases as close as possible to the flues from which the samples of gases are collected; otherwise the volume of stale gases in the connecting pipes and air leakage at the joints will cause error. When water jet air pumps are employed to draw the sample gases through the apparatus, a separate water tank with a filtering attachment should be used for supplying the pump, otherwise stoppage of the apparatus is likely to occur at inconvenient times by dirt, &c., collecting in the jet of the pumps. The results obtained by all recording instruments require checking occasionally by independent tests with other apparatus.

Draught, &c.

A good draught is only an aid to economy when other conditions are good. Too good a draught must not be employed with a thin fire, for it will cause too large an influx of air. Fuel of a large size will stand a powerful draught, but also demands a thick fire. With a good draught it may occur that the closing of the damper will not only check the rate of combustion of the fuel, but will cause smoke by reducing the indraught of air through the door grids. Boilers are thus best partly regulated by dampers which close the ash-pits, rather than altogether by dampers in the flues. The ash-pit damper properly applied and used will prove an aid to economy.

The production of a chimney draught with a temperature of waste gas, say 300° F. above atmospheric temperature, points to a consumption of heat about one-ninth of the total heat produced in the furnace. This fact points to the minimum air supply, which implies maximum furnace temperature and best efficiency of heating surface. Under normal conditions, however, from 20 to 30 per cent. of the total heat of coal goes up the chimney. It is claimed that a fan draught can be produced with about 1 per cent. of the total engine power, and that the use of a fan must therefore effect a great fuel saving. A fan will not save fuel unless it enables this to be burned more efficiently as above. A fan draught will give economy if by its aid a flue feed-water heater can be installed to reduce the excessive temperature of the flue gases. To use full effect feed heaters a high and expensive chimney is needed. Fan draught must therefore be considered in the light of enabling an economy in chimney construction to be effected, and full use made of feed-heating apparatus. It is also useful as enabling boilers to be forced to rapid steam production, and presents itself as a safeguard against sudden load in lighting stations and as a means of surmounting the load peak with excessive boiler plant. Fan draught is thus useful as a means of reducing capital expenditure on chimneys and boilers by promoting the rate of combustion of fuel at higher rates per unit of grate area. It enables the thickness of the fire to be regulated in better accordance with the fuel size and generally promotes elasticity. It is also useful in enabling the hot gases to be compelled to pass over all the heating surface, and baffles may be introduced that would otherwise be perhaps too great a hindrance. Its economy in other cases appears to demand the fullest practicable reduction of the calories in the exhaust gases by feed heaters, which in large stations may well be in two stages, and perhaps by air heaters for furnace supply.

When, however, it is attempted to utilise the last remnants of waste heat let it be remembered that we are, so to speak, working near the lower end of the curve of expansion, and that for each item picked up with one hand we are paying out with the other. All attempted economies, therefore, may cease to be commercial economies before they cease to reduce fuel expenditure per kilowatt.

Conclusions.

Finally, may the authors point out that the best results can only be attained if scientific methods of control are employed in relation to feed-water fuel, waste gases and draught. Automatic apparatus for testing flue gases or any other product can never take the place of the trained chemist; for an automatic apparatus demands not less but more skill in its control and management than ordinary apparatus, if the records obtained by it are to be of permanent value. The results now being obtained by CO_2 recorders in many electricity works are, in the authors' opinion, of doubtful value, owing to the lack of trained expert assistance in their management.

Automatic apparatus of all kinds is, we admit, of great service, but not in the direction popularly supposed. It enables one skilled and efficient man greatly to increase the number and extent of his duties, and practically to treble or quadruple his efficiency: but it does not, and cannot, give accurate and valuable records when placed in the hands of untrained men.

It is remarkable that engineers, after their long experience of automatic stoking appliances, should imagine that automatic testing apparatus will achieve the impossible. In each case the best results can only be attained when the automatic apparatus is under expert supervision and control; and for testing apparatus, the expert control required is that of a specially trained and skilled chemist. In the working of a large modern boiler plant the chemist is, in fact, as much in place as in a chemical works, and the recognition of this truth will undoubtedly promote the economical working of such plants.

The following words, written over 60 years ago by the pioneer in the movement to obtain more scientific use of coal and fuel in steam raising (we refer to that remarkable man, C. Wye Williams), are still applicable to the position in this year, 1905, and there are few present who would guess that they were a quotation from a book entitled "The Combustion of Coal,' published in the year 1841 in Liverpool, and dedicated to the Proprietors of the City of Dublin Steam Packet Co. :—

"It may be asked how it has happened that hitherto the smokeless combustion of fuel has not been effected. I answer, because the chemistry of combustion has been neglected, not in the laboratory but in practice; and because the construction of our furnaces has been too much left to those who know little of the chemical properties of the materials which are consumed in them."

Rules for Sampling Fuel.

As each barrow load or fresh portion of fuel is taken from the pile or store heap, a count is kept of the number used, and the whole contents of each tenth or twentieth barrow or portion are placed on one side, in a cool place, under cover. Care must be taken that the barrow or portion selected for the sample does not contain an unfair proportion of lumps or smalls.

At the end of the day, or period for which the sampling is to be carried on, the heap of fuel obtained for sampling purposes, as described above, is transferred to a sampling plate, and the larger lumps are all crushed down to walnut size. Should no sampling plates be available, four of the iron plates used for covering man holes and boiler flues may be utilised to obtain a hard, clean surface on the floor of the boiler house, and the crushing down of the sample may be carried out on these plates with any heavy and flat lump of iron at hand. The heap of fuel, after this first crushing, is thoroughly mixed by turning over and over with a shovel. The heap is then flattened down, two lines are made across it at right angles with the edge of the shovel, and two of the four opposite sections are selected to form the reduced sample. The lumps in this are again crushed, the sample is again mixed, and the quartering operation repeated, until about 8lb. or 10lb. of fuel only remain, with no lumps that will not pass through a ¼in. sieve. Two 1lb. tins, with ordinary or patent lids, are filled from this remaining heap of fuel, after thoroughly mixing the same with the hands or with a small shovel. One of these tins is to be sent per parcels post to the fuel expert for analysis; the other is to be kept for reference in case of dispute.

OVERHEAD MAINS FOR ELECTRIC DISTRIBUTION.*

BY G. L. ADDENBROOKE.

(Concluded from page 678.)

Having now dealt with the advantages of overhead electric power transmission and having met the chief objections which have been made to its use, we are now brought to the consideration of what is the practical position supposing transmission of this character is proposed in this country. I have already mentioned that the Board of Trade are now prepared to consider favourably proposals of this character. As regards passing near buildings and the class of district through which overhead wires may be taken, the Board of Trade have passed a series of routes in a case in which the writer is acting as engineer, which go as far in these respects as I think engineers can reasonably ask for at the present stage. The Board, however, still appear to have objections to high-pressure transmissions being erected along the sides of roads. Consequently, as things stand at present, wayleaves will usually have to be obtained for carrying the mains across the neighbouring fields.

In choosing a line of route, particularly in parts of the country where there are hedges and trees, it is very desirable that, as far as possible, it should be clear of these, should be accessible, should not have too many angles, and should be within sight of roads or good footpaths in order that the line may be inspected easily. An inspector should patrol all the main routes at any rate once a day. If a line is in sight from a good road, it is obvious that this inspection is easily and quickly made, and should a fault occur it can be traced by an observer from a gig, motor car or bicycle provided with repairing plant, and is easily remedied.

In many districts there will not be much difficulty in obtaining wayleaves, but it is in this matter exasperating to be at the mercy of an occasional cantankerous landlord or set of trustees, and it would be a great facility if there were in this country a set of laws and regulations such as have been made in several foreign countries, giving undertakers the power to obtain such wayleaves by a form of compulsory arbitration when it can be shown that the project is of public utility. It is, I understand, only occasionally that this power has to be put in force; the fact that this right of appeal exists in case of necessity is, as a rule, sufficient to enable an amicable arrangement to be made privately.

In this country such powers can at present only be obtained by a specific act of Parliament, which is far too cumbrous and expensive a method of procedure and is, moreover, impracticable, since it is only as a project develops that the routes of a great part of the mains can be definitely settled. To show the arrangements and formalities necessary to obtain such rights, a translation of the Swiss law relating to electric transmission is appended to this Paper. I have to thank Mr. E. G. Cruise for procuring it for me and kindly making the translation, together with some extracts of the General Law on Expropriation which bear on the subject. It will be seen that an undertaker desiring to obtain wayleaves and finding difficulty in doing so by private arrangement can at any time appeal to the Communal authorities, who must, after deposit of the plans, at once appoint a tribunal, consisting of three members, which acts immediately and must give its decision without undue delay. The procedure is thus prompt and inexpensive. I also append a translation of the Italian law and Rules on the same subject to which I would direct special atttention, as the whole is so clearly and comprehensively drawn up. For this I have to thank Mr. C. A. Baker.

I am aware that so far no such rights of expropriation have been granted in this country even to the Post Office, but I would ask whether the importance of electric communication is not now so great to the community as to warrant such an innovation, which would, by assisting in opening up the country, ultimately, I feel confident, prove to be in the interests of the landowners themselves.

Coming now to the more technical aspects of the question. When once the primary objections of the Board of Trade to granting permission for overhead distribution were overcome, I found a disposition on the part of the Board's electrical adviser to treat the question of regulations and rules in a broad-minded and fair spirit, and a disinclination to make specific rules at present, so long as the work is properly done in accordance with the best practice abroad, and until further experience has been gathered. This policy seems a very wise one, and I trust it will be met in a fair spirit by any engineers who may be contemplating overhead transmission. Now that a beginning has been made it is most desirable that the use of overhead mains should go forward on right lines, and that work of this character should not be further hampered or delayed by unnecessary restrictions or misunderstandings.

So far I have dealt chiefly with the branch of the overhead distribution problem, which for the moment concerns us most directly, but there is another aspect of it of nearly equal importance to which I will now allude—I mean the distribution of electrical energy at voltages suitable for lighting, running motors, heating, and other direct uses. As is well known, overhead distribution for these purposes is, and always has been, widely practised both on the Continent and in America, nevertheless, hitherto in this country, through official opposition, prejudice and other similar causes, almost nothing has been done of a similar character. To give an idea of what has been done in this direction the best way will be to quote from a report which the United States Government Department of Commerce and Labour has recently published, in which a number of data and statistics relating to work of this character are given.

There are, it appears, in the United States 1,892 towns or villages having a population of more than 2,400; of these, 1,511 have electric supply stations, and out of these 1,511 stations, 1,100 are in towns or villages having between 2,500 and 5,000 inhabitants. Now, how many such towns or villages in this country have electric supply? Not more than a dozen or two, although in the United Kingdom there are nearly 1,000 similar places. When we come to look into the reasons for this, we find that in the United States, out of a total of 125,000 miles of feeding and distributing networks, 117,000, or 93 per cent. of the whole, are overhead, there being in all the United States only 8,124 miles of underground circuits.

There is no reason why, with overhead distribution and a cheap system of wiring, such as is in use everywhere except in this country, all these smaller centres of population and the outskirts of the larger towns should not enjoy the benefits of electric light and power supply, which they are hardly likely to do for another 20 years without this system of distribution.

It is, further, worth pointing out that most of the local distribution abroad is at 110 volts. With 240 volts, such as we use largely here, the problems involved are much simpler, greater areas can be covered, and the sections of copper required lend themselves very well to being carried overhead. I myself carried out the lighting of a town in the Colonies some years since in this way, and was quite surprised, when I came to work out the mains, to note with what facility effective distributing arrangements could be made, and what distances it was possible to go by a little scheming without awkward drops in voltage, and without many regulating appliances. The advantages which would be secured by the smaller towns in this country, where gas is usually expensive and, in most cases, of inferior quality, by obtaining a system of electric supply would be very great, and the general adoption of electric lighting in the smaller class of houses would, I am sure, be an important factor in improving the general health of the population, one of the most deleterious factors in modern life being, in my opinion, the spending of evenings in small rooms lit by gas.

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* Paper on "The Value of Overhead Mains for Electric Distribution in the United Kingdom." Read before the Institution of Electrical Engineers, Feb. 9.

It ought to be the function of power companies to feed these towns and villages by lines of overhead mains radiating 12 to 15 miles in all directions round each power station, and the undertakings being in groups, economic and effective administration would be secured, and the disadvantages and lack of efficiency of separate small undertakings would be avoided. To do such work effectively, however, and in the best, safest and neatest manner, some powers of obtaining wayleaves, such as I have alluded to above, would be a great advantage.

That there is a large field open for future work in this direction no one who has studied the question will, I think, deny, and it is very much allied to the question of inter-urban electric railways, in which so much progress has already been made in the United States. The feeders for these railways are invariably overhead, and the same line of poles, if not the same circuits, should serve for the lighting and power supply of the districts through which an inter-urban railway passes.

Before closing I should like to say a few words on another class of overhead electric distribution which is fast attaining an important place—namely, distribution at very high pressure, such as 50,000 volts. The continued success and extension of such installations warrants our now considering them not only as local enterprises, specially arranged to meet some unusual set of conditions, but as being of general application. When electric distribution is effected at these voltages, not only do we get into a new order of phenomena electrically, but economically also. The capital cost of the line comes down to from 1s. 6d. to 2s. per kilowatt conveyed per mile, with a loss of, say, one-fifth of 1 per cent. per mile. From what I have seen in the Colonies I feel sure that such long-distance transmission lines will be of great value there and in India, and will open up many possibilities. The opportunities for advantageously employing them will probably not be many in this country, except, perhaps, in connection with railway work, but it is very desirable that every facility should be given for their erection wherever they would be clearly advantageous, for the sake of the practical example they would offer and the experience which would be gained in operating them on the spot.

The carrying out of work of the character I have been dealing with in this Paper would not only be a direct benefit to the electrical industry, and to those who had placed at their doors an important facility of modern life, but it would have a great indirect effect on the electrical and allied industries of the country in the following way.

This method of electric transmission is being used in our Colonies and by the other nations we trade with, and will be to a still greater degree in the future. Being well acquainted with the conditions in some of our Colonies myself, I feel assured from personal observation the overhead electric transmission of power and light will be one of the most potent factors in developing new industrial and mining regions in the next 20 or 30 years. If work of the same character is carried out on a considerable scale in this country, our engineers and manufacturers will have examples of it at their doors, will be able to take part in its development and improvement and will be able to carry out such work not only here, but in other countries also. If, on the other hand, there is no such work here, it is, in my opinion, idle to expect that manufacturers in this country will be able to develop serious industries in this direction in competition with rivals who have opportunities of keeping closely in touch with the work and can see more clearly what is needed, and learn from direct observation and inspection what is good and what is faulty and the best manner in which improvement can be made.

I have now touched on the salient points which are raised by the title of my Paper. It is not easy to present them in an interesting and concrete form, but I shall be well satisfied if I have succeeded in doing anything which will contribute towards putting this matter on a better basis in the United Kingdom. I have not attempted in this Paper to give any detailed description of systems of overhead distribution, because for some time at any rate we shall only be able to follow what has been done successfully in other countries, of which frequent descriptions have appeared in the technical press, my object being to bring the subject forward in its general lines with the view of promoting discussion and eliciting the opinions of other members. I wish to draw special attention to a pamphlet on the subject recently issued by the American Institute of Electrical Engineers. Some time since, the committee of the Institute appointed a Commission to inquire into the practice with regard to high-pressure transmission. This Commission formulated a large number of queries, which were forwarded to the engineers in charge of such plants. Replies were received from 46 installations, and the pamphlet consists of an epitome of these replies, which cover the whole field of high-pressure overhead transmission, and give the views and recommendations of experienced men on almost every point, including poles, arms, spans, conductors, insulators, leading in, effect on other conductors, lightning arresters, and numerous other practical points. No one who proposes to attempt such work in this country should be without a copy of this pamphlet.

APPENDIX.

ITALIAN LAW FOR THE TRANSMISSION TO A DISTANCE OF ELECTRIC CURRENTS

(June 7, 1894.)

Art. 1. Every proprietor is required to permit the crossing of his lands by electrical conductors, either overhead or underground, which may be required to cross the same, having permanent or only temporary right to be used for industrial purposes.

The faces towards the streets or public squares of houses, courts, gardens, orchards and the storehouses adjacent to houses are exempt from this.

Art. 2. Whoever demands such right of way must do all things necessary in making use of it and must eliminate every danger through carelessness of workmen. He may also be required to make use of work already put in hand by the proprietor and adapted to be used, compensating the proprietor for the expense that he has incurred, and contributing proportionately to the cost of maintenance.

Art. 3. Wayleave must also be granted for the conductors to cross canals or aqueducts or other works employed for such use, provided that no impediment or diminished utility is caused to the proprietor.

Art. 4. Where it is necessary, in the route of the electrical conductors, to cross public streets or rivers or streams or to touch the exterior of houses facing the streets or public squares, the special laws and regulations concerning streets and water and the directions of the competent authorities must be observed.

Art. 5. Applicants for wayleaves for electrical conductors must prove their ability to erect the same and demonstrate the value and the use of the conductors for industrial purposes; they ought, besides, to demonstrate that the wayleave requested and the manner of making use of the same is the most convenient and the least prejudicial to the lands used, having regard to the circumstances of the surrounding lands and to other conditions of the route and the place to which the electrical energy is to be conducted.

Art. 6. Before undertaking the construction of the conductors the applicant for wayleave ought to correspond with the proprietor of the lands to be crossed, proposing an indemnity to compensate him for the diminished value of the land which will be caused by the actual work to be done and by the subsequent operation of the same. In estimating compensation the land is to be considered as it exists and without deduction for the crops it bears and with super-valuation of one-fifth. The undertaker ought also to compensate the proprietor for immediate and subsequent damage owing to the intersection of the land or other deteriorating effects, as well as for the privilege of entering upon the land for the purpose of operating and for the maintenance of the electrical conductors.

Art. 7. Where wayleave for the conductors is requested for a period of not more than nine years, the agreed indemnity for the value of the land will be reduced by one-half, but when this period expires the land must be restored to its original condition at the expense of the undertaker who obtained the wayleave for the conductors. Undertakers obtaining temporary wayleave can, before the expiration of the term, make it permanent by paying the remaining half with the proper interest from the day when the wayleave was granted. When the first term has expired no account will be taken of what may have been paid for the temporary wayleave.

Art. 8. The undertaker must, in every case, observe that the conductors are, and must be, arranged with due regard to the legal and special regulations in regard to the matter and the special directions that are, and may be, established to regulate the working of telegraphic and telephonic communication.

Art. 9. Disputes which may arise in the application of the present law will be treated according to the usual custom, either before the magistrates or in the courts. All the proprietors of lands on which it is desired to place conductors can be convened before one judicial authority; in this case the magistrate of the place in which the land is situated, subject to the largest contribution towards the State, will be the competent authority.

Rules for Putting into Effect the above Law of June 7, 1894.

Art. 1. Electrical conductors for industrial use, by the law of June 7, 1894, No. 232, are all those destined to conduct energy to a distance by means of electric currents, except telegraph and telephone conductors, which are regulated by the law of April 7, 1892, No. 184.

Art. 2. When for the preliminary study of a projected installation of electrical conductors it is necessary to enter upon any lands and it is not possible to obtain the consent of the proprietor, the person wishing to establish the conductors can obtain from the Royal Magistracy of the Province in which are situated the lands to be entered upon an authorisation of access. He should be able to prove to the said authority the justification of the request for permission and present a demand in which are indicated:

(*a*) The period of time during which he intends to study the matter.

(*b*) The lands to be entered.

(*c*) The necessary details to furnish an exact idea of the importance of the installation.

Art. 3. The magistrate, having ascertained the justification for the permission, will authorise the applicant to enter upon the lands for the purpose of studying the project by suitable decree. In this decree the names should be indicated of the persons to whom it applies and the length of time that it is to remain in force.

Art. 4. Persons who have occasion to avail themselves of such authorisation must make use of it in the manner least prejudicial to the pro prietor of the lands, and will be called upon to restore any damage to the property. In regard to inhabited dwellings, the Mayor will fix, at the suggestion of the parties, a time and method when the permission can be exercised. When it is necessary to enter within the closures of a public railway it will be necessary to obtain also the permission of the Administration responsible for working the line.

To assure the payment of the indemnity, the magistrate can demand the deposit of a suitable sum of money from the applicant.

Art. 5. The conductors of an electrical installation which cross public streets, railways, rivers, streams, canals, telegraphic or telephonic lines for public service, or which come near to these lines, or if they pass them, or if they are near a public monument, they must not be constructed without the previous consent of the competent authority unless the work has already been declared of public utility. Additional conductors can be placed without the said consent, but ought to be notified to the same authority at least 10 days before putting the work in hand. Subsequent enlargements or alterations of the conductors can be made without notification, except the case that may arise under Art. 13.

Art. 6. The demand for a consent or the notification in regard to an installation is to be addressed to the Royal Magistracy of the province in which the installation is to be located. When the conductors cross public works or property comprised in the areas of two or more provinces, the demand for the consent or the notification is to be addressed to the Minister of Agriculture.

Art. 7. When for the working of an installation the consent of the competent authority is wanted in the terms of Art. 5, the undertaker, besides the proof of his right to ask for a compulsory wayleave, must produce to the same authority:

(*a*) A complete drawing of the installation with particulars of the conductors and of their supports, with an indication of the crossings of the public streets, railways, rivers, streams, and canals, and with a distinction, the telegraph and telephone lines near to the projected conductors.

(*b*) A description of the installation, indicating its character, whether alternating or direct current, the maximum effective values of the differences of potential and the strength of current in the conductors, the nature and section of the same and the system of insulation.

(*c*) The applicant must also give a definite address and a period within which he undertakes to have the installation in working order.

Art. 8. The authority indicated in Art. 6, or, where necessary, the public administration interested, in the project presented by the applicant in the sense of Art. 7, gives its consent that the installation may be set to work by the conditions of the present rules, under the responsibility of the undertaker for any damages that may result from the system adopted and with express reserve as to the opposition of interested parties in the sense of Arts. 5 and 6 of the law.

Art. 9. The notification to be made by the terms of Art. 5 must be accompanied by a general description of the installation.

Art. 10. The undertaker will be required to operate the installation and the electric conductors under his own responsibility, using all possible means of safety and safeguards from danger and such apparatus as is found advisable by science and practice, observing, besides, the following general conditions:—

1. For aerial conductors, he must adopt all the known precautions to prevent breakage of the conductors and the danger arising therefrom, having regard to their weight and potential.

2. Conductors between which a difference of potential exists must be placed in such a way that one cannot, by falling or by elongation, come in contact with another; in the cases where this condition cannot be conveniently fulfilled, some special arrangement ought to be adopted either in the supports or in the contrivance, to assure the suspension of the conductors or to render breakage as little dangerous as possible to persons and things, independently of the insulation of the conductor itself.

3. Conductors supported externally to the houses must be so arranged that no persons, other than those connected with the service, can touch them, either near the roofs or the supports. In the open places they must not be supported at a less height than six metres from the ground, in special cases greater heights may be necessary. The competent authority may concede placing of the conductors at a lower level than that above indicated, only in the case of electric tramways, and in such other cases in which it is possible to show not only the absence of danger, but also the practical necessity to place them at a lower level, for the use to which they are designed. On the façade of the houses the conductors must be away from the possible reach of the hand of a man standing at a window, or on the sill of it, or on a balcony, or on a terrace, or on the roof.

4. In wells and in shafts of mines and in similar excavations, in the tunnels of railways, tramways, or ordinary roads, in subterranean passages or cuttings and everywhere where the local conditions prevent putting into effect normal rules, the conductors must be rendered harmless from contact in the most efficient manner that is possible.

5. For conductors in contact with the earth the terms of Art. 11 are to be observed.

6. The poles, supports and other bearers for the conductors on which there is a dangerous potential must be provided with suitable defences to prevent anyone approaching the conductors without the aid of a portable ladder or some similar means.

7. All the supports ought to be arranged in the manner least prejudicial to the proprietor of the property, and such as present the necessary resistance in themselves and in their points of attachment.

8. Suitable means of protection must be adopted where there is any danger of contact between the conductors of energy and the telegraph or telephones lines in case of the breakage of either.

9. Special precautions must be taken in localities where the conductors might be touched by the agents in the service of the telegraph or telephone departments.

10. In the arrangement of underground conductors, possible contact causing accumulations of gas must be avoided, and likewise damage to other conduits of gas, water or similar things.

Art. 11. In the electrical conductors, as indicated in Art. 1, it is permissible to make connection with the earth at one point only of the circuit, but the circuit must always be entirely metallic, and, in the point of contact with the ground, have perfect joints and the section not less than would be required in a well-proportioned installation in which there was no connection with the earth. Such precautions must be observed as science and practice may be able to suggest to avoid possible damage owing to the earth connection.

Art. 12. In regard to the works of public interest and to rivers, streams and canals, besides the conditions of Art. 10 and those in force by the ordinary laws, the following rules must also be observed, as also any special rules which, during the construction of the conductors or in operating them, may be determined, case by case, by the competent authority, that is to say the administration interested:—

(*a*) *For Railways and for Tramways on their own Grounds.*

1. Where possible the conductors of electrical energy should not be laid along the railways, nor on the lands of the railway authorities, nor across the internal courtyards of the stations.

2. The electrical conductors ought to cross the railways at a right angle, and at a height of not less than seven metres from the level of the rails, modifications being allowed in the case of aerial conductors for electric tramways.

3. The supports of the electrical conductors ought to be arranged at such a distance from the lines that, falling, they cannot encumber the railway, and where this condition cannot be observed, they ought to be secured in such a manner as to prevent them falling on the lines.

4. The trenches for underground cables must be not less than 1 metre in depth, measured from the top to the bottom of the trench, and must be well formed as required by the conditions affecting the safety of the railway. Such trenches ought to be constructed so that any repairs can be effected without touching the surface of the railways.

5. For crossing underneath the railways with electrical conductors, where possible, separate trenches from those used for other conduits—water, gas, &c.—should be employed.

6. The undertakers for the electrical conductors may be compelled, when crossing a railway, to make use of any passages already constructed under the railways, and that may be suitable for the purpose, conductors for electric tramways being excepted; this will be done under the supervision of the railway administration, and subject to future interests.

(*b*) *For the Public Roads away from Dwellings, for Rivers, Streams and Canals.*

1. Along the public roads, the banks of rivers, streams and canals, on which there exists, or will have to be placed, telegraphic or telephonic lines for public service, the installation of electrical conductors is absolutely prohibited. This can be modified by previous agreement with the Minister of Posts and Telegraphs, with the object of adopting the best arrangement for both undertakings, in a manner the least objectionable to the undertaker of the electrical conductors. For crossings, the conditions of (*a*) para. 2, shall apply, with such modifications as the circumstances warrant.

2. The conditions which are promulgated from time to time by the competent authority must be observed in regard to the interpretation of the laws and regulations concerning streets and water.

(*c*) *For Public Streets and Squares.*

Respecting the wayleaves for the streets and public squares and the attachments to the façades of houses, the conditions prescribed by the municipality or other competent authority must be observed.

Art. 13. The installation of electrical conductors for which compulsory wayleave is obtained must be constructed in the manner least prejudicial to the proprietor of the lands traversed, and also in regard to any other purpose to which the land may be put. When along the route of the conductors there exists another electrical conductor or a telegraph or telephone line—unless a judicial decision has been made known—the reasonable necessities for the smooth working of both undertakings ought to be agreed, or the views accepted of the party having the best title to claim pre-eminence in public service, or if such titles be equal, then by reason of priority of existence. When the decision arrived at necessitates the removal or the modification of the conductors, the expense is to be borne by the party making the alteration necessary.

Art. 14. The proprietor of the land must not do anything to diminish the value of the wayleave or to render it more difficult, nor transfer the right of way to any other position than that originally fixed. The same obligation applies to the undertaker. If, however, the original arrangement has become more serious to the proprietor of the land, or if it hinders him in doing certain works, repairs or improvements, he can ask the undertaker to modify his arrangement of conductors, offering him a place equally convenient for his operations. This the undertaker must not refuse. Where the undertaker finds that a similar alteration would benefit him and no damage to the land would result, it is to be permitted.

Art. 15. The wayleave for the conductors does not convey to the undertaker the soil on either side under or over the conductors, or the relative supports, or the wall to which they may be hung. The Government taxes and other charges on the land still remain against the proprietor of the land.

Art. 16. The wayleave includes the installation and the use of the maximum number of conductors, and of the maximum section of the same that the undertaker has notified to the proprietor of the land when he made known his right of way, according to Art. 5 of the law of June 7, 1894, No. 232. It is thus within the right of the undertaker to follow the planned arrangements for the supports, and to place the conductors notified without asking further consents, and without obligation to pay further indemnities except always for the reinstatement to be done owing to damage caused whilst placing the conductors.

Art. 17. The fact that conductors are arranged in a certain way does not entitle the undertaker to exemption from the new regulations; such regulations may be modified to meet the conditions of the existing works on the representation of the undertaker.

Art. 18. In the cases foreseen by Art. 9 of the law of June 7, 1894, No. 232, it is the duty of the competent authority to permit the temporary execution of work in the manner and under the conditions that are deemed necessary to meet the public requirements and the rights of the proprietors of the lands.

Art. 19. The control of carrying into effect the law of June 7, 1894, No. 232, and of the present rules, in all cases the responsibility of the undertaker, concerns the Minister of Agriculture, who will look after it, where necessary, in accord with the other Administrations publicly interested. To the same Minister the magistrates will give immediate information of the consents granted for the installation of electrical conductors, and of the notifications received according to Arts. 8 and 9 of the present rules.

Art. 20. In regard to electrical conductors already existing, the proprietors who intend to claim rights against undertakers will not be able to enforce modifications of the arrangements of the conductors until the matter has received proper judicial consideration.

Expropriation in Switzerland in the Case of Electrical Works.

(See pp. 15 to 17 in Swiss Document.)

Swiss Federal Law. June 24, 1902.

The following clauses, extracted and briefly translated from the general law of above date relating to electrical undertakings, set forth the special provisions made for expropriation.

Art. 43. The Federal Council has the right to grant powers of expropriation to the owners of electrical undertakings, as also to the consumers.

Art. 44. Branches of trees endangering the transmission lines are to be removed on demand of the undertakers, and in case of dispute as to the necessity for removal, indemnity, &c., the Local Authority designated by the Government of the Canton will give a final decision within eight days. The costs of such proceedings to be to the charge of the undertakers.

Art. 45. Electrical transmission and distribution installations are defined as (1) the electrical conductors, whether aerial or underground, and their accessories; and (2) transforming stations and their accessories.

Art. 46. The right of expropriation can be exercised for private property and also for railways, but in the latter case the electrical works must not interfere with the working of the railway, and ample space must be allowed for the operation of the railway and its telegraph lines, &c. The public land and highways of the cantons and communes can be utilised, and rights of expropriation granted over the same for the transmission and distribution of electrical energy. When such employ of the public land of a commune for distribution of electrical energy is demanded, the commune can, to protect its own legitimate interests, refuse or restrict the demand, save in the case where the energy is required for the electrical working of a railway. The Government of the Canton can be appealed to within 20 days of such refusal or restriction, and its judgment can be further appealed against before the Federal Council within a further twenty days. The decision of the Federal Council will be final. Electrical undertakings cannot claim the use of the public land without also respecting the other uses to which the land may be applied

Art. 47. Expropriation rights can be demanded by the undertakers of electrical installations or by consumers, both for the absolute acquisition of the property or for its conditional possession whether permanently or temporarily.

Art. 48. The indemnity is to consist, according to the circumstances, of a capital sum or an annual charge. With the consent of the two parties, the indemnity can be made to include repairs for damage to crops or other damages similarly caused by alterations to the electrical constructions. If no arrangement in this respect has been made between the parties, the demands for indemnities which may be made during the working of the undertaking can, in case of dispute, be settled by the ordinary procedure.

Art. 49. Save the exceptions mentioned in Arts. 50 and 54 herewith, expropriation will take place in accordance with the provisions of the law of May 1, 1850.

Art. 50. To obtain powers of expropriation, the undertakers must address their demand to the Government Survey Department of Electrical Works, submitting a plan of the works and of the land required. The Federal Council will then grant expropriation rights if, within a period of 30 days from the deposit of the plans, there is no opposition. In case of opposition, rights will not be granted if the projected works can be modified without grave technical difficulties involving too great cost, or without danger to public safety. Where alterations appear necessary, a new application for expropriation rights can be proceeded with on the demand of the undertakers of the works, or of the party to be expropriated.

Art. 51. As well as depositing the plans with the Survey Department mentioned, plans are to be deposited in the communes affected, so that everyone concerned can note same. The deposit of the plans and demand for expropriation rights shall be made public, and in addition personal notification shall be sent to everyone concerned. If expropriation is demanded for particular property owners only, the provisions of Arts. 18 and following of the Expropriation Law of 1850 will apply.

Art. 52. As soon as the Federal Council shall have given their decision and approved the plans, the Estimating committee (Art. 54) will, if required by either party, meet and discuss the indemnity to be paid.

Art. 53. After approval of the plans, the works can be proceeded with, even though the Estimating committee may not have finished their inquiry, or though the indemity be not yet paid. Guarantees for such payment shall, however, be forthcoming, and in case of dispute the Estimating committee will fix the amount of the guarantees

Art. 54. Each canton shall supply an Estimating committee of three members, the Federal Court, the Federal Council and the Government of the Canton each nominating one member and two deputies for each member.

The decisions of the Estimating committee can be appealed against before the Federal Court in accordance with the provisions of the Expropriation Law of May 1, 1850.

MUNICIPAL WIRING.

A meeting of the London Section of the Electrical Contractors' Association was held on Friday last week to protest against the clauses of the London County Council (General Powers) Bill which propose to give the London Borough Councils power to borrow money for the purposes of wiring and fitting premises. Mr. R. Tweedie Smith, the honorary solicitor to the Association, read a Paper pointing out the facts of the case. In the year 1903 the London County Council attempted to get similar powers inserted in one of their bills, but thanks to the efforts of the Electrical Contractors' Association they failed, and by a large majority in the House of Commons the clause was rejected. In November last a deputation from the borough councils was appointed to meet representatives of the Electrical Contractors' Association to see if a clause which would meet the views of both sides could be framed. Eventually a clause was agreed to which would have allowed borough councils to supply electricity and to expend money in wiring houses as long as the work was done through contractors and not directly.

At the last moment a letter was received from the leading member of the deputation, and who had been mayor of Hampstead, saying: "I am sorry to have to inform you that I have just received a short note from the clerk to the London County Council stating that after careful consideration the committee cannot see their way to altering their original clause. Under these circumstances I only have to thank you sincerely for your courtesy and kind consideration that you have given this matter, and to express my regret that our efforts have been unsuccessful." This being the case the whole battle has to be fought over again. The clauses in question are Nos. 63 and 64 of the London County Council (General Powers) Bill, which are very crudely drawn and almost identical to the clauses rejected by Parliament in 1903. By these clauses power is sought to allow any Metropolitan borough council which supplies electrical energy to expend money "upon wiring and fitting and supplying with wires, fittings and apparatus the premises of their consumers or prospective consumers." Mr. Smith contended that such powers, if granted by Parliament, would lead to municipal trading in its worst form. Only those things which affected the general welfare of the public and which were not being efficiently performed by private enterprise were, in his opinion, within the legitimate sphere in which a municipality should ask for powers to trade. Large sums had been invested by private firms in the industry, and there was the utmost competition between them. If, however, the borough councils obtained Parliamentary powers to carry on the business of electrical contractors, they would have practically a monopoly in the area of their supply. Competition would be banished, and the interests of the general public would be seriously affected.

Companies supplying electricity in the metropolitan area had hitherto worked on amicable terms with electrical contractors, and had confined themselves to their proper sphere of supplying electricity. It could not be contended that there was any greater need for the powers to be granted to the metropolitan borough councils than to electric supply companies. On the ground of general policy it was inadvisable that electric supply undertakers should also engage in wiring and fitting work, inasmuch as supply undertakers required all installations to undergo certain tests before making a connection with their supply mains or giving a supply of electric energy, and it was probable that the engineers and inspectors of supply undertakers would be more exacting in their insulation tests in the case of installations carried out by private contractors, and also in regard to compliance with the general conditions and terms upon which supply should be given, than in the case of work done by a department of their own undertaking.

Probably the worst provision in the bill was that which enabled metropolitan borough councils to do wiring for "prospective consumers." The result, if the clause passed, would be that every speculative builder would be willing to have his houses wired at the expense of the local authority, because it would save him so much expense on capital account. If the house were a loss, the mortgagee who financed the builder would have the first charge, and would be able to claim the wiring and fittings, or at least to prevent their removal. Thus the loss would fall upon the ratepayers, of which electrical contractors formed a part. At the end of clause 63 of the bill were three ambiguous lines which could be read in many different ways, and made to mean many different things. They empowered metropolitan borough councils "to enter into and carry into effect agreements and arrangements with respect thereto and make such charges therefor, whether directly or otherwise, as they may think fit." These words would cover agreements with consumers of electricity as to payment for the use of wires, fittings, and apparatus, or agreements with owners of property concerning the same, but in neither case would such agreements operate against the rights of a mortgagee who had lent money on the property and who could prevent the wiring being taken away. Landlords could seize the fittings for rent, or execution creditors for debt. At the present time there were cases in which companies had obtained Parliamentary powers to expend money on wiring houses, but in such cases the companies were, of course, private enterprises, and invariably they had confined themselves to the sphere of generating electricity, whilst they had made arrangements with electrical contractors for the actual work to be done by them. Safeguards against seizure for rent or debt had, however, always been inserted in the Acts of private companies.

In the discussion that followed there was a general condemnation of the London County Council, and some very strong remarks were made use of, mainly on the political aspect of municipal trading. One or two remarks bearing directly on the Paper were made, however. One speaker thought that the London County Council had a good prospect of being allowed the powers in question inasmuch as they would permit of wiring being done on the hire-purchase principle, from some points of view a desirable and beneficial proceeding. Could not the contractors combine to practise such methods? The reply was immediately forthcoming, however, that the capital available would not permit of this, and that already a company which had been started with this object in view had had to abandon the "free" wiring portion of its business. Mr. Tweedie Smith, in reply, urged that applications should be made to their various members of Parliament, and proposed the following resolution, which was carried unanimously: "That this meeting of electrical engineers and contractors hereby pledges itself to use its utmost endeavours to prevent, by every legitimate means, clauses 63 and 64 of the London County County (General Powers) Bill becoming law, and that the Council of the Association be requested to wait upon the President of the Board of Trade and voice the feeling of the industry." A petition, which was signed by everyone present, has been lodged in Parliament against the Bill.

NEW SAFETY DEVICES FOR PREVENTING EXCESSIVE PRESSURE RISES IN ALTERNATING-CURRENT SYSTEMS.

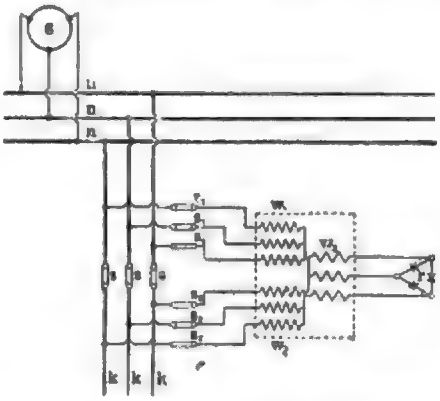
Two English patents have recently been granted for methods of preventing excessive pressure rises on opening or closing electric circuits. The first one (No. 11,168 of 1904) is granted to the Lahmeyer Co., and is entitled "Improvements in safety devices for protecting dynamo electric machinery and the like against the excessive voltage occurring when they are switched in or out." The other one (No. 22,536 of 1904) was granted to Messrs. Siemens Brothers & Co. on behalf of the Siemens Schuckertwerke, and is entitled "Auxiliary appliance for the prevention of the occurrence of excess pressures on switching on and off electrical installations of high voltages applicable also for testing purposes." The following is an abstract of the complete specification of patent No. 11,168 of 1904.

Experience has shown that when machines are switched in or out disruptive discharges may easily occur, and that this principally happens in the coils or parts of conductors which are nearest to the current-supplying mains. This is clearly seen by the following test made by the inventors. A three-phase motor wound for a phase voltage of 10,000 volts and having eight coils per phase was connected to a source of electromotive force of 10,000 volts. The voltages in the several coils then ascertained are recorded in the following table. It will be seen that while under normal conditions there is in each coil a pressure of $10{,}000/(1{\cdot}73 \times 8)$ or a little over 720 volts, there is set up in the first coil when the motor is switched in a voltage 11 times as high. To remove this dangerous pressure from the machine, the first coil, which showed the largest increase of voltage, was connected in series with a choking coil which chokes under normal working conditions the same amount of voltage as every armature coil.

Voltage on switching in the motor as measured along	Without any choking coil.	With a 720 volt choking coil switched in.	With a 1,100 volt choking coil switched in.	With a 1,800 volt choking coil switched in.
First coil	8,000 volts	4,000 volts	3,000 volts	2,000 volts
Second coil	4,000 "	2,500 "	2,000 "	1,500 "
Third coil........	2,500 "	1,600 "	1,500 "	1,150 "
Fourth coil	1,800 "	1,300 "	1,100 "	900 "
Fifth coil	1,300 "	1,000 "	900 "	820 "

It will be seen from the third column that the excess of voltage at the first coil is reduced from 8,000 to 4,000 volts, or one-half. Further measurement also showed that an increase of 8,000 volts took place at the choking coil. If an 1,100, or an 1,800, volt-choking coil be switched in, the excess of pressure in the choking coil is 10,500, and 18,300, volts. This action of the self-induction can be explained as follows:—When the self-induction is not switched in, the coils, or parts of conductors nearest to the supply main, exert a choking action when the current is turned on, so that the whole amount of excessive pressure is, so to speak, concentrated in these first portions of the coils. If, however, self-induction be switched in series with the machine, this self-induction takes up the excess of voltage. The self-induction coil can easily be so insulated that a disruptive discharge cannot occur therein. The choking coil may be short-circuited by another movement of the switch after the starting has been effected. A single choking coil may be used for several machines, this single choking coil being only switched in when a machine is switched in or out.

In patent No. 22,536 of 1904, Messrs. Siemens Brothers & Co. state that the object of preventing dangerous rises of pressure when switching on or off unloaded cables at high voltage is attained in the following manner:



Referring to the accompanying drawing, g represents a three-phase current generator, and n are the network conductors, from which the cables k are branched by means of the switches s. The auxiliary appliance consists of a transformer with three windings, of which w_1 and w_2 have the same number of turns and are connected in the same direction by means of switches s_1 s_2 respectively before and after the main switches s to the cables k. The third winding w_3 of the transformer, on the other hand, which is advantageously arranged for low pressures, is connected to a non-inductive loading resistance, r, of suitable value. Assuming, in the first instance, that the winding w_3 is open, but that all the switches are closed, then only the magnetising current of the transformer will flow in the equal windings w_1, w_2. As regards the conditions of magnetisation, nothing will be altered if the winding w_3 be connected up with the resistance r. Practically the same pressure of the connecting points w_1 w_2 will still be maintained if the switches s (which are to be considered as combined to form a three-pole switch) are opened; in consequence, no sparks can be formed at the switches, and no oscillations can be produced in the cables. In the same way, dangerous oscillations in the cables will be prevented, if now the switches s_1 be opened, as sparks are produced at these switches the extent of which depend upon the resistance r. Such sparks as is known, allow of no rapid oscillations, in contradistinction to the charging sparks produced on the switching in of unloaded cables. The application of the loading resistance therefore acts as a damper of oscillations.

The application of the arrangement, which can, of course, be applied to networks having any number of phases, will be as follows:—If the unloaded cables k are to be separated from the network n, then, in the first instance, the switches s_1 s_2 of the auxiliary appliance are closed, one after the other; the switches s are then opened and the direct connection between the cables k and the network conductors n thereby broken; the switches s_1, are then opened whereby the cables k are deprived of their pressure and by finally opening the switches s_2, the cables are separated from the auxiliary appliance. When connecting unloaded cables k to the network n the switches have to be manipulated in the reverse order by first closing s_2 then s_1, and by finally closing s. When the cables are connected to the mains direct, the switches s_1 and s_2 are opened one after the other and the auxiliary appliance thereby disconnected. The auxiliary appliance, described above, is also very suitable for testing cables under pressure. In this case the main switches s would be open or entirely dispensed with. If a higher pressure than that of the existing network pressure is to be used for the testing, then the translation ratio of the windings w_1 and w_2 is not made as before as 1 : 1, but is made to correspond with the intended testing pressure.

CORRESPONDENCE.

PAPERS AND DISCUSSIONS AT THE INSTITUTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I see from Mr. W. R. Cooper's letter in your last issue that in the matter of allowing or requiring authors to go through the formality of reading their Papers from cover to cover, and in the matter of curtailing, or rather of not curtailing, verbosity and irrelevance in debate, the Institution stands exactly where it did 10 or 15 years ago, when duty condemned me to regularly attend its meetings.

Ten or 15 years ago it was suggested in these columns that if Papers could not invariably be taken as read, like loyal addresses, they might, at any rate, be read in brief. Ten or 15 years ago it was suggested in these columns that to relieve the President of the exceedingly difficult and unpleasant duty of perpetually applying the closure, this function might advantageously be taken over by a 10-minute glass, which should ring a bell when it had exhausted itself, and thus give an unmistakable notification to the speaker that he had exhausted himself. It would then rest with the meeting, not with the occupant of the chair, to signify its pleasure.

I am no believer in the transatlantic doctrine of "hustle," and do not, therefore, advocate a rigid 10-minute rule because I believe there is any particular virtue in haste and hurry, but if it were known that ten minutes and no more would in the generality of cases be allowed to each speaker, each intending speaker would take good care to make up his mind beforehand what he meant to say, and his remarks would not suffer from that lack of previous preparation as do so many of the discursive discourses one hears at Institution discussions. In fact, a 10-minute rule would tend to precision, decision and concision.

As to allowing or requiring an author to read his Paper from end to end, never was there a more tedious and time-wasting formality. For formality it is, since, even if the reader should happen to be a master of elocution, no one can derive any benefit from hearing a Paper read, and no one under such circumstances is in a position to do justice to himself if called upon to speak. But, more often than not, no one hears or even listens to the poor member standing up before the blackboard by the President's side dribbling out in an inaudible patter what is very likely a valuable contribution to contemporary knowledge.

The fact, if fact it be, that the Institution cannot always command a sufficient supply of Papers is no justification for a tiresome and exhausting mode of procedure.—Yours, &c.,

W. G. BOND.

ARMATURE COILS AND OZONE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Under the title, "The Insulation of Armature and other Coils for High-tension Apparatus," you published in your issue of January 27th a very interesting article by Mr. J. S. Highfield, giving his experience with high-tension alternator windings. As a result of a number of special experiments, Mr. Highfield has come to the conclusion that coils become defective in actual use owing to the air left inside the micanite tubes.

Personally, I am not quite in agreement with Mr. Highfield's conclusions that it is impossible to produce a satisfactory winding if any air is admitted between the copper, iron and insulation. If this were impossible, then the same defects as those observed by Mr. Highfield would surely have appeared in the large number of high-tension installations which have been working for a considerable number of years on the Continent; for instance, at the Paderno (13,000 volts), Hauterive (9,000 volts), and numerous other high-tension installations in Switzerland in which the generator coils are, almost without exception, wound in insulating tubes. The fact that such trouble has not been experienced forms a clear proof that Mr. Highfield's conclusions are open to criticism.

As Mr. Highfield correctly points out, the insulation of a coil, in which the winding is threaded through a closed micanite tube, is excellent as compared with that of a coil in which the insulation consists of insulating tape or paper wound separately round the conductors. In my experience, troubles have only arisen when the designer has taken advantage of the excellent insulation of the closed micanite tube to economise in the amount of insulation on the actual conductors themselves. Where defects have become apparent after more or less lengthy periods of working, the insulation of a number of the conductors has been damaged at various points, and constant leakage of current has taken place from conductor to conductor. If such a defective coil is carefully cut out before the damaged insulation has become seriously charred, black spots will be observed on the insulation of the actual conductor where slight burning has taken place. These spots will correspond with similar ones on the neighbouring conductor, thus showing the exact position at which the discharge has taken place. Such defects may constitute intermittent faults, and may finally necessitate the complete re-winding of the machine.

The above defects can be entirely avoided by using ample insulation on the individual conductors, and a suitable type of winding. Care should be taken not to use too much wire per coil—that is to say, to use a large number of coils—and to arrange the conductors so that the difference in potential between neighbouring conductors is kept as small as possible.

It is of the utmost importance that the very best quality materials should be used in the varnishes and insulating coverings. I have often found that oxidisation of the copper has taken place owing to the use of an inferior quality shellac which has not been free from acid. This may have been used either on the conductor itself, or in building up the micanite tubes, or as a dressing on the Empire cloth or other insulation. If good quality shellac free from acid has been used in the winding, the insulating covering being well saturated with this shellac so that the copper conductor is surrounded by a waterproof and airproof insulation, I have never found any trouble arise. I conclude that in the case mentioned by Mr. Highfield, the insulating covering round the copper was more or less porous so as to allow both air and moisture to soak through it.

With regard to Mr. Highfield's concluding remarks as to the necessity of putting additional insulation on the two or three end coils, this is a point which I have long recognised. It is especially important in the case of asynchronous motors where, when the motor is suddenly switched on the line, the full voltage comes on the first few coils, and a very considerable difference in pressure exists between adjacent windings so that these coils are very liable to be broken down. For a considerable number of years I have made it a practice to wind the first sets of coils in all high-tension induction motors with a more heavily-insulated wire than that used for the remaining coils. In the case of generators and synchronous motors, the effect is less observable as the voltage in the stator only rises slowly under normal working.—Yours, &c.,

Münchenstein, Bâle, Feb. 9. J. BÜCHI.

THE SLIDING BOW *v.* THE TROLLEY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the discussion on Mr. Sayers' Paper on tramway overhead equipment materials, at which I could not be present owing to my absence in South America, I notice a remark in your current issue regarding a disadvantage of the sliding bow. Although Mr. Sayers professed to know little about the sliding bow, which is used in nearly 50 per cent. of the Continental tramways, he mentioned the dropping of lubricating material on the passengers riding on double-deck cars. As I have always advocated the use of the sliding bow as being specially adapted for use in this country on account of the much lighter overhead network in densely-populated towns, I beg to be permitted to refute this statement. The use of a lubricant in the slit of the soft aluminium sliding piece, which is easily renewable, is not exactly necessary, particularly in our damp climate, or it may be used in such small quantities that the dropping of molten grease will not occur.

However, the sliding bow can be made so long that its point of contact with the trolley wire reaches outside the top of the car. At greater speeds, when sparks are most likely to occur, the molten grease would be blown backwards by the wind pressure.

I have constructed over 300 miles of tramways using the sliding bow abroad and never had the slightest trouble from falling grease. Certainly, only single-deck cars were used, but at Sheerness-on-Sea, where a sliding bow is used on double deck cars upon my advice, no trouble has been experienced in this regard.

It will be well worth while if our engineers would study the advantages of the sliding bow more closely, as they are many, and as I have remarked before, it is specially adapted for use in this country where the complicated overhead construction in many large towns causes a disfigurement of the streets which is so often complained of.—Yours, &c.

London, S.W., Feb. 10. GERALD HOOGHWINKEL.

PARLIAMENTARY INTELLIGENCE.

The period for depositing petitions to appear by counsel and witnesses against bills originating in the House of Commons, expired on Saturday last. In addition to those already given the following have been presented:—

Central London Railway Bill.—South Eastern & Chatham Railway Co., St. George's Hospital, British India Steam Navigation Co., Great Eastern Railway Co., Carron Co., Thames Conservancy, Governors of Bank of England, Ecclesiastical Commissioners, Kensington & Knightsbridge Electric Lighting Co., Notting Hill Electric Lighting Co., Metropolitan Railway Co., Hammersmith Borough Council, promoters of Metropolitan Pneumatic Despatch Bill, Honourable Societies of Middle and Inner Temples, Union Bank of Scotland, Mercers Company, London County Council, Lord Iveagh, Westminster City Council, Lloyds Bank, Union Discount Company, Churchwarden of St. Michael, Commercial Union Assurance Co., Union Bank of Australia, North London Railway Co., London & South Western Railway Co., Metropolitan District Railway Co., London and North Western Railway Co., Brentford Gas Co., Great Western Railway Co., Kensington Borough Council, promoters of Hammersmith, City & North East London Railway, Corporation of London, Baker Street & Waterloo Railway Co., Charing Cross, Euston & Hampstead Railway Co., Great Northern, Piccadilly & Brompton Railway Co., London United Tramways Co., and numerous property owners.

Cork Junction Railway Bill.—Cork Corporation, Cork Harbour Commissioners, Cork Electric Tramways and Lighting Co., Cork, Bandon, and South Coast Railway Co., Cork Incorporated Chamber of Commerce and Shipping, Clyde Shipping Co.

Great Northern, Piccadilly & Brompton Railway (No. 2) Bill.—South Eastern & Chatham Railway Co., Ecclesiastical Commissioners, Hammersmith Borough Council, Metropolitan Railway Co., Governors of the Bank of England, Union Bank of Scotland, Mercers' Company, London County Council, London & South Western Railway Co., Brentford Gas Co., President and Governors of Charing Cross Hospital, Westminster City Council, Metropolitan District Railway Co., Great Western Railway Co., London and North-Western Railway Co., Metropolitan Water Board, Kensington Borough Council, Chiswick Urban District Council, Promoters of Hammersmith, City and North-East London Railway Bill, Corporation of London, Honourable Societies of Middle and Inner Temples, Central London Railway Co., and numerous property owners.

Hammersmith, City & North-East London Railway Bill.—South Eastern & Chatham Railway Co., St. George's Hospital, Great Eastern Railway Co., Carron Co., Worshipful Company of Girdlers, Thames Conservancy, Regent's Canal & Docks Co., Leyton Urban District Council, Wood Green Urban District Council, Hammersmith and Hackney Borough Councils, Governors of the Bank of England, Great Northern Railway Co., Tottenham & Forest Gate Railway Co., Metropolitan Railway Co., Honourable Societies of Middle and Inner Temples, Tottenham Urban District Council, London County Council, Westminster City Council, Metropolitan District Railway Co., Metropolitan Water Board, North London Railway Co., London & South Western Railway Co., Central London Railway Co., Brentford Gas Co., Walthamstow Urban District Council, Great Western Railway Co., London & North Western Railway Co., Kensington Borough Council, Edmonton Urban District Council, Corporation of London, Shoreditch Borough Council, Middlesex County Council, Baker Street & Waterloo Railway Co., Charing Cross, Euston & Hampstead Railway Co., Great Northern, Piccadilly & Brompton Railway Co., London United Tramways Co., Southgate Urban District Council and numerous property owners.

Heckmondwike Improvement Bill.—Bradford Corporation, Liversedge Urban District Council, Dewsbury Guardians, Lancashire & Yorkshire Railway Co., Batley Corporation, Yorkshire Electric Power Co., London and North Western Railway Co., Dewsbury Corporation.

London United Tramways (Extension of Time) Bill.—Wimbledon Urban District Council, Barnes Urban District Council, Richmond Corporation, Malden and Coombe Urban District Council, Croydon Rural District Council.

Metropolitan Pneumatic Despatch Bill.—Paddington Borough Council, Whitechapel & Bow Railway Co., Stepney Borough Council, Thames Conservancy, Hammersmith and Hackney Borough Councils, Great Western Railway Co., Metropolitan Railway Co., Westminster Electric Supply Corpn., London County Council, Camberwell Borough Council, Metropolitan District Railway Co., Westminster City Council, Central London Railway Co., Railway Companies within London, Chelsea, Islington, Lewisham, Woolwich Battersea, St. Marylebone, Kensington, Hampstead, Lambeth, Fulham, Shoreditch and St. Pancras Borough Councils, London Electric Lighting Companies, Great Northern, Piccadilly and Brompton Railway Co., Baker Street and Waterloo Railway Co., Charing Cross, Euston and Hampstead Railway Co., London United Tramways Co.

Aberdare Tramways Bill.—Great Western Railway Co., Taff Vale Railway Co., Aberdare Gas Co.

Accrington Corporation Bill.—Accrington Steam Tramways Co., Lancashire Electric Power Co., Haslingden Corporation, Lancashire & Yorkshire Railway, Rawtenstall Corporation.

Birmingham Corporation Bill.—Great Western Railway Co., Radnorshire County Council, London and North Western Railway, Monmouthshire County Council.

Dublin United Tramways Bill.—Rathmines and Rathgar Urban District Council, Dublin Corporation, Pembroke Urban District Council, Kingstown Urban District Council, Blackrock Urban District Council.

Great Northern, Piccadilly & Brompton Railway Co. (No. 1) Bill.—South Eastern & Chatham Railway Co., Thames Conservancy, Duke of Norfolk, London County Council, Westminster City Council, Central London Railway Co., Islington, Holborn and Lambeth Borough Councils, Promoters of Hammersmith, City and North-East London Railway Bill, and property owners.

London County Council Tramways Bill.—South Eastern & Chatham Railway Co., Honourable Societies of Inner and Middle Temples, Metropolitan District Railway Co., Crystal Palace Co., Lambeth Borough Council, Corporation of London.

London Southern Railway Bill.—London Brighton & South Coast Railway Co., South Eastern & Chatham Railway Co., Camberwell Borough Council, London County Council, South Metropolitan Gas Co., London and South Western Railway Co., South London Electric Supply Corporation, Lambeth Borough Council, County of London Electric Supply Co.

Metropolitan Electric Tramways Bill.—Great Eastern Railway Co. Metropolitan Water Board, Middlesex County Council.

North-East London Railway Bill.—Great Eastern Railway Co., Metropolitan Railway Co., Tottenham & Forest Gate Railway Co., Leyton Urban District Council, London County Council, Metropolitan District Railway Co., Corporation of London, Promoters of Hammersmith, City and North East London Railway Co., and property owners.

Shropshire and Worcestershire Electric Power Bill.—Cannock, Hednesford & District Gas Co., Seisdon Rural District Council, Staffordshire County Council, Great Western Railway Co., Lichfield Gas Co., Tamworth Gas Light & Coke Co., Lichfield Rural District Council, Cannock Rural District Council, Walsall Rural District Council, Lichfield Corporation, Tamworth Corporation, Bridgnorth Corporation, Cannock Urban District Council, Oswestry Corporation, Midland Electric Corporation for Power Distribution, Tamworth Rural District Council.

Rathmines and Rathgar Improvement Bill.—Alliance & Dublin Consumers Gas Co., Dublin Corporation.

South Wales Electrical Power Distribution Bill.—Llanelly Gas Co., Llanelly Urban District Council.

Swansea Corporation Bill.—Great Western Railway Co., Swansea Gas Light Co., Midland Railway Co.

Charing Cross, Euston & Hampstead Railway Bill.—South-Eastern & Chatham Railway Co. London County Council, Westminster City Council, Gordon Hotels.

Colne Corporation Bill.—Lancashire Electric Power Co., Lancashire & Yorkshire Railway Co.

Weybridge & Walton-on-Thames Electric Supply Bill.—Weybridge Urban District Council.

Wigan Corporation Bill.—Lancashire Electric Power Co., Lancashire & Yorkshire Railway Co., Hindley Urban District Council, South Lancashire Electric Tramways Co., National Telephone Co.

London County Council (General Powers) Bill.—Companies supplying electrical energy in the Administrative County of London, Electrical Engineers and Contractors in the County of London.

Edgware and Hampstead Railway Bill.—Hendon Urban District Council, London County Council.

Channel Ferry Railway and Quay Bill.—Dover Harbour Board.

Croydon Corporation.—County of London Electric Supply Co., South London Electric Supply Corporation, Beckenham Urban District Council, Penge Urban District Council, Crystal Palace Co., British Electric Traction, South Metropolitan Tramways and Lighting Co., Croydon Gas Co., Croydon Rural District Council.

Baker Street and Waterloo Railway.—London County Council, Westminster City Council, Gordon Hotels, St. Marylebone Borough Council.

Ealing Corporation.—Metropolitan Water Board, Metropolitan Electric Supply Co., Brentford Gas Co.

The Metropolitan Electric Supply Co.'s bill, which was opposed by the Willesden Urban District Council on Standing Orders, has been passed by the Examiners, the points of dispute having beeen settled between the parties.

The following bills have been passed by the examiners, during the week, as having complied with Standing Orders. There was no opposition: Aberdare Tramways, Gosport and Fareham Tramways, East London and Lower Thames Electric Power, Wigan Corporation, Paisley and District Tramways.

The consideration of the Glasgow Corporation Tramways bill, on Standing Orders, has been postponed until March 2, to allow the promoters to conclude negotiations with some local authorities as to consents.

Non-compliance with Standing Orders has been returned in connection with the Hastings Tramways bill, so far as the tramways proposed under clause 7 are concerned. These are entirely in Bexhill, and the consent of the Corporation not being forthcoming the point will be settled by the Standing Orders Committee.

The Wellingborough and District Tramroads and Electricity Supply bill has also been referred to the Standing Orders Committee for a similar reason. Certain tramways are proposed upon the sides of main roads, upon ground which is at present public property. The promoters argued that inasmuch as the lines were not proposed to be built actually upon the highway, the consent of the road authority was not necessary. The Examiner upheld the view of the road authority to the contrary, however, and reported a non-compliance.

LEGAL INTELLIGENCE.

Jandus Arc Lamp & Electric Lamp Co. (Ltd.) v. the Arc Lamp Co.

In the Chancery Division on Monday Mr. Justice Kekewich heard further evidence in this case, the hearing of which had been postponed in order that defendants might have an opportunity of making certain experiments.

Mr. BOUSFIELD, K.C., for defendants, said he had given to the other side a list of the experiments which had been made, and the plaintiffs had taken advantage of the invitation to see defendants' apparatus. He also stated that he suggested if anything further was to be done it should be done by an independent expert.

Prof. Cormack was called to give evidence regarding the experiments he had made with reference to the question of size of lamp and duration of carbon.

His LORDSHIP: Is your object to show that an envelope with a large diameter will produce the same results as an envelope with a small diameter?

Mr. BOUSFIELD: Certainly. We conceived beforehand that size had nothing to do with the matter. It was a question of leakage.

The Witness thereupon gave details as to the various experiments he had made.

Having regard to your experiments, has size of globe any material effect on the life of the carbon?—I cannot see that size makes any difference at all.

How do you account for the differences?—A slight variation in the neck of the lamp might possibly make a difference. The position of the arc and the quality of the carbons might also make a difference.

Is it possible to get uniform carbons for a series of experiments?—It can only be done by taking extraordinary care at the factory.

Leakage at the bottom of the lamp affects the light very seriously?—Yes. Leakage is the governing factor.

Cross-examined by Mr. Moulton, Witness admitted that when he tried a Beardsley lamp in the way described in the specification the globe blackened.

You gave no account to his Lordship of your experiment with Beardsley lamp with a narrow neck?—No.

And then you experimented and found that if you made Beardsley with a wide neck it would not blacken?—Some of them did blacken.

Your lamps have got a neck considerably shorter than shown in Beardsley's drawings?—Yes, I think they have. They were not intended to be exact copies of Beardsley's.

Further cross-examined, Witness said he thought the lamps he used in the experiments were fair representatives of what Howard meant in his specification. The lamps were run in series between two mains. He used commercial series lamps. The lamps fed regularly in series and did not require shunt coils. It was not the case that if one of the lamps shirked work it would never pick it up again. The lamps he used were well designed and could be used in series without a shunt coil. The lamps ran without accident throughout all the test.

Prof. SILVANUS P. THOMPSON stated that he paid two visits to University College to see the experiments, and his assistant went to St. Pancras. Running the lamps in series was the best way of making the test. The lamps got precisely the same current. The experiments showed that the size of the lamps had nothing whatever to do with the life of the carbons. The effect of running the lamps in series was to make the test more valuable than if the lamps had been run separately. Diameter had nothing whatever to do with the life of the lamp. Leakage was an important factor. He had experimented with Beardsley, and found that with a narrow tube at the top the lamp blackened. It was perfectly well known that if they enclosed a lamp too much, so that there would be no access of air, nothing could prevent blackening.

Cross-examined, Witness said that for some types of lamps to burn in series it was necessary for them to have shunt coils. Lamps were used with shunt coils which were not intended to burn in series, but to burn in parallel. There were some lamps which had a fine wire in place of a shunt. The defendants' lamps had no shunt coil, but the mechanism worked with a spring, and if the spring was properly adjusted then they worked well in series and were sold as series lamps. There was a positive advantage with the lamps defendants used because all the current went through the carbons.

Mr. JAMES SWINBURNE, called by plaintiffs as to defendants' experiments, gave evidence to the effect that series lamps must be used for series work if they desired to get any accurate experiments. The results of defendants' experiments did not show that any reliance could be placed upon them. Experiments which he had made proved that the diameter of the envelope did make a great difference in the life of the lamp.

Cross examined, Witness said he thought it a very probable thing that length of arc had nothing to do with life. He, however, had no reason founded on fact to suggest that that was true. He had not tried it himself.

Does it not seem to you that this is a case where the services of some independent gentleman would have been extremely desirable. Here we have apparently differing results?—I am quite sure Prof. Cormack and myself acted without bias in making experiments, but it is a very difficult question, and you have to make a large number of experiments to get results.

Is it really your view that the mere diameter of the envelope *per se* has any material effect on the life of the carbon?—I think it has, but I do not yet understand why.

You have learned a great deal from this case?—Yes. I have learned a great deal about arc lamps, and I have learned how little I understand about them.

When you went to see the lamps burning you saw them in series and you saw them burning perfectly regularly and smoothly?—The arcs were uneven. They were of slightly different lengths. I should not expect them to go wrong at the start. You must wait until they begin to feed.

Prof. ADAMS afterwards gave details as to the manner in which he checked experiments on behalf of the plaintiffs. If a man applied the Beardsley specification he would inevitably fail to produce a marketable lamp.

On the resumption of the hearing on Wednesday,

Prof. ADAMS said he had no particular reason to differ from Mr. Swinburne that a certain amount of leakage was necessary in order to prevent blackening.

Mr. TERRELL, in answer to his Lordship, saidhe should have to call Mr. Swinburne to speak as to the experiments which had been made.

His LORDSHIP said that that being so there must be another adjournment, and Mr. Bousfield had better prove his two experiments at once.

Mr. BOUSFIELD then called Prof. Cormack, who said he had arranged the lamp the learned counsel held in his hand, and ran it for 19 hours. The blackening which was on the globe came in the course of the running. He ran it in series as the others had been run. He took the voltages every quarter of an hour.

Cross-examined by Mr. TERRELL: The arc was going continuously during the time. The current varied slightly. The extreme of variation was 5·3 to 5·6. The variation in voltage was 81 to 84 as far as he could see. The bottom was sealed by means of a rubber tube. It was completely air-sealed at the bottom. In the other experiment he had four lamps in series, and the other three were blackening at the same time. There was no shunt coil on. They were all different lamps tried during the three experiments. He used about 80 volts, and 5 was the extreme of variation.

At this stage the further hearing was adjourned until Monday next in order that the plaintiffs might in the meantime have an opportunity of making experiments with a view to taking the evidence given on this part of the case by the defendants.

Tilling v. Dick, Kerr & Co.

In the King's Bench Division, before Mr. Justice Warrington, on Monday, plaintiffs sought to recover damages alleged to have been caused to plaintiffs' omnibuses by the operation of the defendants, who, under contract with the London County Council, were carrying out the conversion of the tramways in South London to electric traction.

Mr. H. AVORY, K.C., said that, speaking generally, the cause of action was a public nuisance created by defendants in laying and maintaining upon the highway raised rails for the temporary purpose of continuing the traffic of the tramways during their reconstruction operations. Defendants were clearly liable for damage caused to any individual lawfully using the highway unless they could show express statutory authority for doing the thing which was complained of as a nuisance. Short of that, however, it would be sufficient for him to show that they had been guilty of negligence in carrying out their statutory powers. From the statutes under which the L.C.C. were authorised to carry out this work, they could show no trace of authority or laying a raised rail above the surface of the road. The only authority they could show was one which strictly limited them to laying and maintaining the rails level with the surface of the road. So far as the facts were concerned plaintiffs' complaint came practically under two heads—first that the defendants laid and maintained a temporary line, or rather lengths of temporary line, within a few feet of the kerb, raised above the surface of the roadway so that the ordinary traffic of the road necessarily passed over it. This was done in many portions of the road where there was only a space of about 10ft. between the existing tramline and the kerb. The second head was that for the purpose of looping their up and down lines in some places where they did not lay a temporary line by the side of the other they used a cross-over, which also involved a raised rail. There was also the allegation of negligence, consisting in putting no barrier or warning to the public at the points where raised rails had been laid. The only question before the Court was that of liability, an agreed sum having been arrived at if the defendants were liable.

His LORDSHIP said he was prepared for that statement in view of the fact that there were 69 separate cases of damage, some of a few shillings each.

Mr. AVORY (continuing) said the temporary lines were not necessary in any sense except for defendants' own profit. It was done solely in order that they might maintain a regular system of tramcars, while the traffic could have been maintained in those portions of the road which were up by running on a single line. The defendants said, as to the first 67 of the alleged accidents, and the general damage shown by the fact that the average repairs to the plaintiffs' 'buses during this period were much more than in previous years, that the acts complained of were done in pursuance or execution or intended execution of certain statutes and plaintiffs' cause of action was debarred by the Public Authorities Protection Act, 1893, which sets up a six months period of limitations within which action must be brought. As to the remaining two cases which were within the period they paid £12. 15s. into Court. Plaintiffs replied that the defendants were independent contractors who expressly took upon themselves all liability for damage and injury, and the act did not apply to them.

Mr. RUEGG, K.C., for defendants, said the case involved one or two points which had never been decided before. The electrification of a tramway system was a work carried out largely for the convenience of the public and was authorised by Parliament, and it necessarily involved a nuisance to the public—viz., considerable interference with public rights and the user of the highways. He did not care about the old acts in the least. Of course they declared that the lines should be kept on a level with the roadway, but they dealt with the original construction of the lines. Parliament declared in 1900 that it was necessary to make most radical alterations and carry out most extensive works over a very long distance. One must look at these things reasonably. It was known to Parliament when they sanctioned this work that there would be considerable interference in one way or other with the rights of the public. There was nothing in the act which authorised them to be guilty of negligence, and if any fault was found with the system the responsibility belonged to the County Council, which insisted on the work being done in this way and with the double line being kept running. It was the Council doing these things through their agents, the contractors. Counsel went on to submit that all works reasonably necessary were under the protection of the Act of 1900, authorising the conversion of the South London tramways. It was impossible to do the work without interfering with the whole of the high road. It could not be suggested that the whole of the tramway system, extending for many miles, should be stopped altogether, and there was no alternative system which would be preferable to that which was actually adopted.

His LORDSHIP: There is no suggestion of a better form of raised rail, but was it quite impossible to have a sunken rail?

Mr. RUEGG: Would that be reasonable? See what it would mean. You would have to interfere still more with the roadway between the tramlines and the kerb, because you would have to take it up in order to lay the sunken rails.

His LORDSHIP: You would not lay it in the same way as a permanent track.

Mr. RUEGG said the road would have to be taken up, and that would be an unreasonable thing to suggest to a local authority or a contractor. These "turn-outs" were perfectly well known in tramway alterations, and were sometimes quite necessary, for it could not be doubted that the Council had adopted the best system. The cross-over system of the traffic going in both directions would have been quite impossible in South London.

His LORDSHIP: You say that, whereas the General Tramways Act prevents a permanent tramway from constructing lines above the surface of the road, you may construct a temporary line so that the rails are above the road if you can show that it is reasonably necessary.

Mr. RUEGG assented, and added that being empowered by the Act of Parliament to do what was reasonably necessary, they did nothing more than was reasonably necessary, and were not guilty of any default or want of care. Doubtless, there was some strain in going over these obstructions, but he should have thought that at a walking pace any strong vehicle could have gone over without injury. It had never until now been suggested that a contractor working for a public authority was not protected by the Act of 1893, and there were many cases where protection had been given to contractors for work imposed by statute where the public authority was liable, as it was in this case, if there was liability anywhere at all. If the County Council had been proceeded against it could not have placed the responsibility upon the contractors, who were acting as their servants or agents.

His Lordship reserved judgment.

Macartney, McElroy & Co. v. Brighton Corporation.

The appeal of the defendant Corporation against the judgment of Mr. Justice Grantham, delivered on May 20, 1904, in this action, came before the Court of Appeal (the Master of the Rolls, Lords Justices Mathew and Cozens-Hardy) on Friday. The facts of the case and the evidence at the original trial were given in *The Electrician* for April 29, May 6, 20 and 27 last.

For the appellants, Mr. FLETCHER MOULTON, K.C., said the judgment of Mr. Justice Grantham was, as far as its principal part was concerned, for the rectification of the contract, and the Corporation appealed, on the ground that there was no evidence whatever to go to the jury, and on various other grounds, for a new trial. Subsidiary points would arise, but the main point was the question of rectification, and if the Corporation succeeded on that, all other matters fell to the ground. According to Mr. Justice Grantham's judgment, the rectification of the contract meant that the contract was to be drawn up as if the Council intended to accept what would have been the highest or one of the highest of the tenders. He argued that that would be most unfair, and urged that in judging what were the intentions of the Corporation they ought only to judge by what actually came before them in their official corporate capacity. They made the contract, he contended, without a shadow of doubt as to its meaning, and if that contract was not to be construed fairly as it stood, he did not see what security the Public Health Act gave.

Lord Justice MATHEW said it seemed to him that the Corporation had had £14,000 worth of work, for which they were not, if Mr. Moulton's assumptions were correct, prepared to pay.

Mr. MOULTON: They were going to pay £102,000 for work under the contract. To him (Mr. Moulton) it was perfectly conclusive that the contract represented the intentions of both contracting parties.

The MASTER OF THE ROLLS asked if there was any part of the tender form which showed there was provision for excavating and concreting.

Mr. MOULTON considered the form of tender itself showed this.

Lord Justice COZENS-HARDY said it seemed to him a very misleading tender. In the tramway part they had measured out in yards super. the quantity of cement and concrete required and asked for a price for it; but there was nothing of the kind in the tender relating to road work.

Mr. MOULTON said the tramway part of the work was very much more complicated than the other, and there was therefore a detailed bill of quantities for that.

Lord Justice MATHEW said it appeared to him that in connection with these works the contractors had done extra work to the value of some £10,000 for which apparently they were not to be paid.

Mr. MOULTON said the whole of the work had been paid for when the total of the contract price had been reached. The plaintiffs' contract was only £2,500 less than some of the other offers, whose authors had not made any mistake.

Lord Justice MATHEW: But how do we know this?

Mr. MOULTON replied that either they must assume that all meant what the contract meant or they might look at the other tenders to find out whether or not they added any sum for excavating and concreting. The tenders showed that the other tenderers did add on for the excavation and concreting, and it was clear that they knew what was intended to be done by the contract, and that they knew what they were contracting to do.

Lord Justice MATHEW asked the amount of the highest tender.

Mr. MOULTON: £121,000, the lowest £102,400, the next lowest £104,900, and the next £105,500. Does your Lordship suggest that those who made the £104,900 tender were going to do £10,000 worth of work for nothing?

Lord Justice MATHEW: I consider the jury would be right in concluding that the lowest tenders did not include this work and that the highest tenders did.

The case was continued on Saturday, Wednesday and Thursday, Mr. MOULTON contending that the contract being under seal it could not be rectified unless there was something clearly identifying the intention otherwise than that expressed in the contract. He submitted there was no such evidence, and as a matter of law there could be no rectification.

Yesterday (Thursday), on their Lordships taking their seats, Mr. MOULTON stated that the parties had agreed to terms, and the Court would not be further troubled with the case.

Mr. CAUTLEY, for plaintiffs, said there would be judgment for the agreed amount and an end of the litigation.

Telegraph Poles in Streets.

At Sheffield Police Court last week, before the stipendiary, the Postmaster-General applied for permission to place a pole in St. Philip's-road.

Mr. COATH, for the Corporation, said his clients could not consent to a pole being placed in a street when there was a suitable site on private property.

The STIPENDIARY: Why not? The Corporation crowd the streets full of posts, and have no hesitation in putting them in when they want them themselves.

Mr. COATH: We can prove that there is another suitable site.

The MAGISTRATE: I cannot accept any such principle. The Corporation are only highway authorities. It is laid down by Acts of Parliament that various public bodies should have these advantages of erecting poles, &c., on the streets. The Postmaster-General is one of these and I do not see why he should be debarred from those advantages. This is a privilege Parliament meant them to have and to exercise. He must find in favour of the Postal authorities.

Callender's Cable & Construction Co. v. Killarney Electric Light Co.

Last week in the Chancery Division, Dublin, tenders were received for the sale of the Killarney Co.'s undertaking. Three offers were submitted, and that of Valentine Ryan at £615 was accepted.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.

A meeting of this Association was held at the Hotel Cecil, London, on Wednesday, to elect an executive committee to organise a general electrical exhibition.

Mr. Walter Davenport, secretary, was voted to the chair, and said the movement for holding the exhibition arose from the feeling among manufacturers that the holding of small exhibitions in all parts of the country had caused great expense to exhibitors, and was not so satisfactory as a great exhibition in or near London would probably be. In addition to the members of the Association, the proposal had the support of other electrical manufacturers and of electricity station owners and engineers. In consequence of the proposal put forward by the Association, the promoters of another electrical exhibition (at the Crystal Palace) had decided to join their forces. Various electricity supply undertakers had promised financial support, and he proposed that this support should be accepted by the Association in the form of donations. The Association would run no risk of losing any of their funds, even in the unlikely event of the exhibition not being a financial success, as a contract would be arranged (subject to the approval of the executive committee) with a contractor, whose name could not yet be disclosed, who would guarantee the expenses, other than the amounts paid for space by the exhibitors to the extent of any excess over the receipts, and on the other hand would receive a share of any profit that might accrue. It was also the view of the committee of the Association that a proportion of the profits, if any, might be returned to exhibitors, and the balance be devoted to a benevolent fund, which the Association were endeavouring to establish, or some other charitable purposes. It was proposed that the exhibition should be held at Olympia or the Crystal Palace. It was tentatively proposed to open in October next, remaining open for five weeks. It was not to be a promoters' exhibition, but an undertaking in which the exhibitors would have a vital interest. Representatives of supply stations throughout the country would be invited to a meeting next week composed solely of members of their own branch of the profession, to discuss the question and elect a proportion of the executive committee. It was intended that the exhibits should be working, and both continuous and alternating current would be available. The gas companies had given great support to the recent exhibition at Earl's Court with a view to popularising the use of gas, and it was expected that the support of electricity supply undertakers would be forthcoming in the same way for the exhibition now under consideration. There had not been a representative electrical exhibition since 1892.

In answer to a question whether foreign manufacturers would be allowed to exhibit the chairman said it would be proposed that they should, provided they had representatives in this country.

It was announced that support had been promised (in some cases conditional upon the details of the scheme being satisfactory) by Messrs. Crompton & Co., Bruce Peebles & Co., Electric and Ordnance Accessories Co., Johnson & Phillips, Taylor, Tunnicliff & Co., Cowans Limited, Bertram Thomas, Geipel & Lange, Union Electric Co., Tudor Accumulator Co., St. Helens Cable Co., Veritys Limited, Nalder Bros. & Thompson, Falk, Stadelmann & Co., Electrical Co., Electrical Power Storage Co., General Electric Co., Consolidated Electrical Co., Edison & Swan Co., Lahmeyer Electrical Co., N.S. Electric Storage Co., Western Electric Co., International Electric Co., and others while some firms were not opposed to the project, but would require further information.

A resolution approving the proposal was carried unanimously, and it was decided that the executive committee should consist of 15 members, being representatives of 10 manufacturers (five members of the Association and five others), four representatives of electricity supply stations and one representative of the electrical press. Eight membership firms were nominated to appoint representatives on the committee and those elected by ballot were: The General Electric Co., Edison & Swan Co., Electrical Power Storage Co., Veritys Limited, and the International Electric Co.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The directors of the Great Western Railway Co. require an electrical engineer for traction and lighting. Salary £600 per annum. Candidates must be under 40, and possess ample theoretical and practical knowledge. Applications to the secretary (Mr. G. K. Mills), Paddington Station, London, W., by 27th inst. See also advertisement.

The National Boiler General Insurance Co. (Ltd.), 22. St. Ann's-square, Manchester, require additional surveyors of electrical plant. Particulars of qualifications and conditions of service from the chief engineer, Mr. Edward G. Hiller. See advertisement.

Ayr Corporation invite applications for the position of manager of tramways. Salary £200. Applications by 18th inst.

Carlisle Electricity committee require a mains superintendent. Applications by 28th inst.

Mr. H. A. Neville, at present chief assistant engineer at Wakefield, has been appointed city electrical engineer at £300 per annum, rising by annual increments of £25 to £400 per annum.

Aldershot.—Application has been made for sanction to a further loan of £2,000 for electric lighting extensions.

Anglo-Continental Telephony.—The Post Office telephone department will, on and after March 1 next, afford telephonic communication between London and certain provincial towns in England and Besançon, Fécamp, Le Mans, Le Tréport and Lons le Saunier in France at the same rate of charge as for communication with Paris—at 8s. for each three minutes' communication.

"Artificial" Rubies.—It is stated that "artificial" rubies are being produced in France by a process of reducing small natural rubies into a very fine powder, calcined in an electric furnace, cooling rapidly and crystallising. In this way small natural rubies are said to be made to possess a comparatively high value. Tried upon emeralds and sapphires the intense heat of the electric furnace is said to discolour the stones.

Aston.—At a special meeting on Friday, the Council adopted a report of the Public Works committee accepting a scheme prepared by the consulting engineer (Mr. Robert Green) for the reconstruction of the remaining tramways within the borough, including street improvements. The total cost of the work (with overhead electrical equipment) is estimated at £68,270. The plans and sections of the work prepared by Mr. Green were approved, and tenders are to be invited.

Australia.—Newcastle (N.S.W.) Corporation have decided to supply current for private lighting in addition to the public lighting hitherto provided.

Austria-Hungary.—The municipalities of Gleisdorf, Steyermark and Kastelruth have recently decided to establish electricity supply for lighting and power.

Automobiles in Paris.—An Automobile Salon was recently opened in Paris, and some remarkably fine examples of up-to-date motor vehicles were shown. In France the automobile industry has advanced with rapid strides, and more particularly in regard to the vehicle de luxe. Visitors to Paris who have been absent from the City of Light for any lengthened period are surprised at the very large number of electric carriages to be seen in every part of the gay city. Several of the leading manufacturers of these vehicles have succeeded in meeting the demand for vehicles of handsome exterior and artistic interior furnishings. Perhaps the most noteworthy of these electric carriages are those of Mildé, Kreiger, Gallia and Electromotion. The make of these vehicles has become lighter, the working parts more completely under delicate control, and in regard to the accumulators employed every effort is being made to reduce their weight by every possible means. The demand for this class of automobile is largely in excess of present supply.

Barnstaple.—The gross profit on the second year's working of the electricity undertaking was £1,582, and, after deduction of interest and sinking fund (£1,290), there was a surplus of £291. There are 187 public lamps.

Bedlingtonshire.—The Council have asked the Northern Counties Electricity Supply Co. to state terms for the electric lighting of a portion of the district.

Belfast.—There has been trouble at Belfast this week among the employés of Messrs. J. G. White & Co., who are engaged in the work of constructing new routes and converting old tramway routes to electric traction. First a large number of labourers went on strike, and upon their return to work a number of carters felt it their business to join in a demand for increased wages.

Bexhill.—The electricity department are holding an electrical exhibition at the Kursaal from Feb. 17 to 25, inclusive.

Birmingham.—Last week the City Council discussed the terms provisionally arranged with the City of Birmingham Tramways Co. for the purchase of the company's lines in the city, the reconstruction of the steam and horse tramways leased to the company until Dec., 1906, and the purchase of Kyotts' Lake-road depot.

Ald. Beale, in outlining the proceedings taken by the Tramways committee, said mutual concessions had been made by the committee and the company, and the committee's action was confirmed.

Mr. Middleton urged that it should be stipulated that tramway material ordered by the committee should be of British manufacture.

Ald. Beale replied that if the committee could get a fair competition in this country they had no desire to go outside, but at present there were certain parts of cars, especially the "maximum traction trucks," which were an American patent, and nothing like them had been produced by the home builders.

The official inspection of the Small Heath tramway took place yesterday (Thurday).

Bradford.—At the City Council meeting on Tuesday,

Mr. Swithenbank moved that as Mr. C. J. Spencer, manager of the tramways, had applied for the post of manager of Newcastle Corporation tramways, he was dissatisfied with his post in Bradford, and should, therefore, be asked to resign. Mr. Spencer, who was appointed tramways manager in 1898 at £150 a year, was now receiving £700, and he thought Mr. Spencer had been ungrateful.

The mayor (Mr. W. E. B. Priestley) said that Mr. Spencer approached him first on the matter, and told him that he had been asked to apply for the Newcastle managership. He asked the mayor what course he should adopt, and the mayor told him he would give him a reply next day. He thought Mr. Spencer was entitled to apply, and gave him a testimonial.

After a long discussion, in the course of which Mr. Spencer's general ability was admitted, the resolution was defeated by 31 votes to 16.

The Tramways committee reported that they had discussed the question of allowing aggrieved employés to appeal to them against the decision of the general manager, and had decided to allow the right in case of dismissal or other disciplinary action for which the employé concerned was unable otherwise to obtain redress. The report was approved.

Burslem.—The price of current has been fixed at the flat rate of 5d. per unit, or 7d. per unit for the first hour and 2d. after; for power 2d. per unit or, at Council's option, 10s. per quarter per B.H.P. and 1½d. per unit.

Cardiff.—An inquiry will be held to-day (Friday) into the application of the Council for permission to borrow £37,868 for electric lighting extensions.

Cheap Labour.—In our last issue (page 682) we referred to a meeting which took place at Acton to discuss the question of the employment of what was described as "underpaid labour" on the electrification of the Metropolitan Underground Railways. At a meeting of Tottenham Council last week Mr. Councillor Broadbank carried an amendment to refer back for inquiry the method of sub-letting a contract for electric wiring of the new town hall buildings in course of erection. Mr. Broadbank said the contract "had been given to a non-union house while local men had been refused work." The contract in question had not been publicly advertised in the usual way, and to this he objected.

Conspicuous Gallantry.—Much admiration has found expression for an act of bravery which occurred at the Finsbury Park (London) Station of the Great Northern Railway on Dec. 21 last, when an elderly lady, missing her footing, fell from the platform just as an incoming train loomed out of the fog at a distance of only a few yards. Fortunately, Mr. A. V. Hardwick, a member of the London staff of the Direct United States Cable Co., was present, and with marvellous nerve leaped on to the line and in a twinkling succeeding in placing the lady and himself between the rail and the platform wall in such a position as to allow the train to pass without injury to either. A spellbound audience watched the daring act and greeted the re-appearance of the bewildered lady and her brave rescuer with ringing cheers. Mr. Hardwick was on Friday last at Buckingham Palace personally decorated by the King with the Albert Medal of the first-class for "an act of conspicuous gallantry."

Croydon.—A petition has been presented against the Croydon Corporation Bill by ratepayers and frontagers in Upper Norwood who object to the proposed extension of the tramways.

Customs Decisions.—In the new customs tariff for the Gold Coast (west of the Volta) apparatus and structural material for telegraphs, telephones and electric lighting are admitted free, as well as all machinery for electrical purposes; also plant, material and rolling stock for tramways.

Devonport.—Sanction to a further loan of £7,958 for electric lighting extensions has been received by the Council.

Exeter.—At the meeting of the City Council in committee on Tuesday, nearly two hours were spent in discussing the question of "the competency of the electrical engineer (Mr. H. D. Munro) to discharge the several duties devolving upon him"; and ultimately it was decided to appoint a sub-committee to investigate the matter, this sub-committee consisting of an equal number of "progressives" and "conservatives." The names of the committee are Messrs. Campion, Clapp, Dunn, Finch, Roberts, Stokes, Widgery and Wreford. The latter gentleman is vice chairman of the Electric Lighting committee. The matter which has brought about this condition of affairs at Exeter appears to have been a motion that Mr. Munro should take charge of the electrical equipment of the tramways. A section of the councillors objected to this proceeding, on the ground "that he had already mismanaged the lighting undertaking." Meanwhile we may say that the tramway work has been placed in Mr. Munro's hands.

The Tramways committee recommend the Council to authorise a limited tramway service on Sundays after 1:30 p.m.

As a result of a conference between the Electric Lighting and Tramways committees, it is recommended that the price to be charged for electric current for traction be 1½d. per unit for the first 100,000 units, and 1¾d per unit after. The electrical engineer (Mr. Munro) is to have charge of the overhead work and of the electrical apparatus on the tramway system and in the depot.

Farnham.—The Council have assented to the application of the Farnham & District Electric Supply Co. for a provisional order.

Fulham (London).—The Electric Lighting committee are considering the question of lighting the recreation room of the public baths with arc lamps.

Galashiels.—The Electric Lighting committee have received authority to enter into negotiations with a company for a transfer of the Council's provisional order.

Gillingham (Kent).—The Council have adopted a scheme of assisted wiring.

Gravesend.—Sanction to a loan of £4,500 for extensions to mains, &c., has been applied for.

Great Yarmouth.—The Marine Parade South is to be lighted by arc lamps at a capital outlay of £420 and an annual cost of £90. The consulting engineers (Messrs. Preece & Cardew) have offered to undertake the supervision of the electric lighting extensions at a reduced fee of 3½ per cent on the estimated capital cost of £10,000.

Guatemala.—The tramway lines in this city are to be converted to electric traction. Further information can be obtained from Mr. Richard Echeverria, Guatemala City.

Handsworth (Staffs.).—The Council propose to employ electric motors at the pumping station to be erected at the Witton waterworks.

Hornsey.—The chairman of the Electricity committee announced at the Borough Council meeting on Tuesday that since municipal electric lighting had been adopted the price of gas in the district had gone down 1s. a thousand. A reduction in the charge for electric current is now proposed.

Horsham.—The Council are recommended to apply for sanction to a loan of £4,500 for electric lighting extensions.

Hove.—The laying of the mains for electricity supply in Aldrington has been commenced. Brighton Corporation have offered to supply Hove Corporation with electricity in bulk at 4¾d. for the first hour's maximum demand and 1¼d. after, or 5d. and 1d. Hove has decided to pay the former rates and to charge private consumers in Aldrington 7d. per unit for the first hour and 4d. after.

Huddersfield.—At the Corporation meeting on Tuesday, Mr. A. Chatterton, in moving the adoption of the minutes of the Electricity committee, said:—

The most important recommendations were that £5,985 should be transferred from revenue and contingencies accounts to borough fund in aid of rates, and that the charges for current be reduced by a halfpenny per unit. He hoped the Council would regard the transfer of £6,000 as a repayment of money received from the rates, and not in the sense of an annual contribution from the department. He threw out the suggestion that it should not be applied to the reduction of the coming rate, but to the unfortunate deficit in the tramways account, or go to strengthen the water account, upon which heavy liabilities would fall before they were much older. Last July the committee reduced the charges for meter rents, and this, with the present proposed reduction of a halfpenny for current, would deplete the revenue of the department by between £3,000 and £4,000 per annum.

Islington (London).—The Board of Trade are to be asked to consent to an agreement between Islington and Stoke Newington Councils for the former to supply (at ordinary rates) current for six 2,000 c.p., six 500 c.p., and about 50 8 c.p. lamps, for premises on the north side of Blackstock-road, within the Stoke Newington area.

Italy.—The Unione Italiana Electric Tramway Co. has acquired a concession to construct an electric tramway from the Piazza di Negro, Genoa, to Rivarolo Ligure.

Keighley.—The tramways extension to Stockbridge was officially inspected on Wednesday.

Leamington.—The Leamington & Warwick Electrical Co. have conceded the demand of the Town Council that a double line of tramway should be laid, and the company announced that the work will be proceeded with forthwith.

Lewisham (London).—On Wednesday the Borough Council decided to ask the South Metropolitan Electric Light & Power Co. to refund £465. 4s. 1d. cost of reinstating roads and footpaths broken up during last quarter in laying mains, &c.

London County Council.—At Tuesday's meeting it was agreed to present petitions against the following Bills in Parliament:—

Edgware and Hampstead Railway, Administrative County of London and District Electric Power, Central Electric Supply, Charing Cross and Strand Electricity Supply, City of London Electric Lighting (Extension of Powers), County of London Electric Supply, East London and Lower Thames Electric Power, Metropolitan Electric Supply (Various Powers) and North Metropolitan Electric Supply.

Tramway Employes' Rates of Pay.—A lengthy report was submitted by the Highways committee in reference to the application made by the tramway employés and the Amalgamated Society of Tramway and Vehicle Workers for a revision of the conditions of labour on the tramways. The committee recommended that the applicants be informed that the Council was unable to accede to the requests except so far as they are covered by the alterations in the conditions of labour already made, and except that when the men are required to work during their "stand off" time they be paid at the rate of time and a quarter.

For the nine months ended Dec. 31 last £6,400 has been paid for accidents in respect of electric cars. The expenditure under this head for 1904 will be about £8,533. The amount provided in the estimates was £10,000

Louth.—The Electric Lighting committee recommend the Council to authorise the consulting engineers (Messrs. Handcock & Dykes) to submit an alternative scheme of electricity supply to provide for the use of producer gas.

Mexborough.—Inquiry was held here last week into the application of the Council to borrow £4,000 for electric lighting extensions.

Municipal Telephony.—Brighton Corporation Telephone committee last evening presented a report prepared by Mr. G. D. Barnes, the engineer and manager to the department. It is stated that the undertaking is showing a profit of £80 per month.

The Telephone committee recommend that application be made for the borrowing of £11,616. 11s. 8d. "to meet the cost of additional works in excess of what was intended in Mr. A. R. Bennett's original estimate." Of this sum £6,216. 11s. 8d. had been already incurred at the date of the report (Feb. 2). £4,208. 5s. 6d. is the cost of additional works sanctioned by the Council on April 7 last, and the balance of £2,008. 6s. 2d. is made up of various items which have from various causes cost more than was originally provided. There were at the date of the report 1,087 instruments working and 22 junction lines, or 1,070 completed lines. In addition, there were 1,229 partially completed lines. In Hove the department has 259 lines provided and 186 instruments working. Mr. Barnes has prepared a scheme to provide a number of additional lines in Hove estimated to cost £5,399. 11s. 5d. This and the above-mentioned items go to make up the amount for which it is proposed application should be made for borrowing powers.

The accounts for the 1904 (seventh) year's working of the States of Guernsey telephone department show capital expenditure on telephone construction £23,590. 5s. 3d. In addition, £2,885. 5s. 10d. has been expended on purchase of land and erection of buildings. At Dec. 31 there were 1,375 instruments (exclusive of junction lines), making the cost per line £17. 3s. 1d. The total revenue for the year 1904 was £4,546. 8s. 9d., or an average revenue per line of £3. 6s. 1½d. £5,086. 0s. 10d. has been set aside for sinking fund and depreciation, after paying interest, Post Office royalty and all working expenses, and £681. 18s. 5d. was set aside as a special contingency fund, leaving a net profit of £284. 14s. In addition to the 1,375 working lines there were at Dec. 31 several hundred spare partially-completed lines.

Newcastle-on-Tyne.—The acting general manager of the tramways (Mr. T. P. Easton) estimates that in the ensuing year the receipts will exceed by £79,472 the ordinary expenditure. The balance will be more than swallowed up, however, by the expenditure of £32,958 on maintenance work and £67,142 on the payment of interest and in redemption of loans. Traffic expenses are 3·89d. per car-mile.

Paddington Electrical Exhibition.—This exhibition, which is being organised by the Metropolitan Electric Supply Co. at Queen's-road Baths, Bayswater, has (we are informed) met with a most gratifying response from the electrical trade. Practically the whole of the space has already been allotted and the exhibits will be of a very interesting and varied character. Every effort is being made by the promoters to make the exhibition attractive as well as instructive.

Patent Amendment.—Mr. Frank Michael Lewis, electrical engineer, 2, Prestonville-terrace, Brighton, seeks leave to amend specification of letters patent No. 4,557 of 1903, granted to him for improvements in or connected with electric arc lamps. Particulars of proposed amendment are given in the Illustrated Official Journal (Patents), Feb. 8, and notice of opposition must be lodged within one calendar month from that date.

Plymouth.—A loan of £6,450 for tramway extensions has been authorised. The price of current between midnight and 6 a.m. has been reduced to 3d., with 10s. per quarter for meter, and current for power has been reduced by ½d. per unit.

Portsmouth.—At a special meeting of the Corporation on Tuesday it was decided to expend £8,000 in extensions of the electricity works.

Provisional Orders Revocation.—The Board of Trade have revoked the Barmouth Electric Lighting Order, 1900, and the Neath Rural District Electric Lighting Order, 1901, as to so much of the area of supply as is not included in the parishes of Blaenhonddan, Coedfranc, Dyffryn Clydach, Dylais Lower and Llantwit and Llantwit Lower.

Sale.—The District Council have given notice to Manchester Corporation of their desire to exercise the powers and assume the obligations conferred or imposed on the corporation by their Tramways Act, 1904, in relation to the construction, &c., of tramways in the Sale Urban District.

Southern Italy.—An electric railway line round the base of Vesuvius is now completed and taps many important towns and villages. But it is rather as an effective means of conveying market garden produce to the Naples markets that the line is being fonnd of immense service. The line also affords a comfortable and inexpensive route to Pompeii, reducing the cost of the journey from 8s. 4d. to 1s. 2d. The line runs through much beautiful country.

An electric tramway running from Castellamare to Sorrento along the high road is nearly completed, and will be ready in time for the spring tourist and visitor traffic.

Southwark (London).—A letter from the Assistant Controller of the London County Council (dated Feb. 4) stating that the Finance committee of the County Council have had under consideration (in connection with electric lighting loans sanctioned by the Council from time to time) the question of the undertaking given to provide a sinking fund or maintenance account for renewal of machinery, &c., and pointing out that as 5 years had elapsed since the undertaking of the Borough Council was established, they regard the creation of a reserve or renewal fund as very desirable in the interests of prudent finance, and stating that the County Council will be glad to learn that the Borough Council concur in this view, and that steps will be taken to form such a fund. This communication was referred to the Finance and Electric Lighting committees.

Stretford.—After March the charge for electric current for private lighting will be £7 (instead of £8) per kw. installed and 1½d. per unit. The total charge to the consumer for the year not to exceed 5d. per unit, or a fixed charge, irrespective of the number of lamps installed, at the rate of 4½d. per unit instead of 6d.

Switzerland.—Projects for three electric tramway routes have recently been approved for Berne, and an electric railway from Aigle to Sepey, Leysin and Feydey is to be constructed. For this latter project particulars can be obtained from the Aigle-Ollom Monthey Railway Co., Aigle, Switzerland.

Transvaal Imports.—The imports of electric cables, wires and fittings for the 11 months ended Nov. 30, 1904, were of the value of £65,000, compared with £60,000 for the corresponding 11 months in 1903. Tramway material to the value of £162,000 was imported in the same period, compared with £76,000.

Wakefield.—On Tuesday the City Council decided to apply for sanction to a loan of £18,000 for extensions of the electricity undertaking.

Workhouse Lighting.—Bedwellty Guardians have accepted the offer of the Tredegar Coal & Iron Co. for the supply of electric current to the workhouse at 4½d. per unit.

Dinner.—The first annual dinner of the Blackburn male staff of the National Telephone Co. was held on Saturday evening, representatives of every department being present. The district manager (Mr. C. Remington, M.I.E.E.) occupied the chair, and was supported by Messrs. Stevenson and Frost, Blackburn, and Mr. Callis, Burnley. A pleasant evening was spent.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Newport (Mon.) Electricity and Tramway committee invite tenders for a 300kw. continuous-current high-speed tramway generator and a 200kw. continuous-current high-speed steam balancer (engines of enclosed type), one (straight tube) water-tube boiler and superheater, one multiple switchboard, extensions to switchboard gallery; also for the supply of general stores, including general ironmongery, lamps, carbons, greases, chemicals, paints, general engine room and electrical stores, printing and stationery, &c. Specifications, &c., from the borough electrical engineer and tramways manager (Mr. H. Collings Bishop), Town Hall, Newport, Mon., after Feb. 20. Further particulars are given in an advertisement. Tenders to the town clerk by first post March 6.

Shoreditch (London) Borough Council invite tenders for stores for one year from April 1 next, including electric cables and sundries, gas pipe and fittings, engineers' stores, glass, &c., for street lanterns, smiths' and plumbers' work, timber, &c. Samples of articles required may be seen, and forms of tender obtained at, the Town Hall, Old-street, E.C. Tenders to the town clerk (Dr. H. Mansfield Robinson), Shoreditch Town Hall, Old-street, E.C., before 3 p.m. March 14. Further particulars are given in an advertisement.

Fulham (London) Borough Council invite tenders for the supply of electrical stores for the year ended March 31, 1906. Tenders (on printed forms) to the Town Hall, Fulham, by 4 p.m. March 15. See also an advertisement.

Hull Electric Lighting committee invite tenders for supply, &c., of mains and cables for 12 months. Specifications, &c., from the city treasurer, Mr. T. G. Milner. Tenders (addressed chairman of committee), to the town clerk, Town Hall, Hull, by noon March 1. See also advertisement.

Lowestoft Corporation invite tenders for supply and erection of one water-tube boiler with superheater, brickwork settings and accessories, together with the necessary pipework. Specifications, &c., after 23rd inst., from the town clerk (Mr. R. B. Nicholson), Town Hall, Lowestoft. The works are to be carried out to the plans and specifications of the consulting engineers (Messrs. Hawtayne & Zeden), 9, Queen-street-place, London, E.C., from whom further information (but not copies of the specification) can be obtained. Tenders to the town clerk by 5 p.m. March 9. See also an advertisement.

Ilford Urban District Countil invite tenders for supply during the year ending March 31, 1906, of Welsh coal, electricity meters and demand indicators, cables, incandescent lamps, arc lamp carbons and house service fuse boxes. Forms of tender, &c., from the chief electrical engineer, (Mr. A. H. Shaw), Electricity Department, Ley-street, Ilford. Tenders (addressed to Chairman of Council) to the clerk (Mr. John W. Benton), Town Hall, Ilford, by 27th inst. See also an advertisement.

King's Lynn Corporation invite tenders for the supply and erection of one 200kw. steam dynamo, condenser, steam and other pipes. Specification, &c., from the engineer, Mr. John Pilling, M.I.E.E. Tenders to the town clerk (Mr. J. W. Woolstencroft), Town Hall, King's Lynn, before noon 28th inst. See an advertisement elsewhere

Great Yarmouth Corporation invite tenders for supply and delivery of two water-tube boilers and a 300kw. steam alternator. Specifications, &c., of the consulting engineers (Messrs. Preece & Cardew), 8, Queen Anne's gate, Westminster, London, S.W. Tenders to the Town Hall by noon March 1. Further particulars are given in an advertisement.

The directors of the *Great Western Railway Co.* invite tenders for supply, delivery and erection of plant at their electricity generating station at Park Royal and proposed sub-stations and distribution centres, including high tension three-phase direct-current switchboards and battery boosters at Park Royal; three-phase static transformers and high and low-tension switchboards at various sub-stations and lighting distribution centres; and high and low-tension, three-phase direct-current switchboards at Royal Oak, Shepherd's Bush and Old Oak in sub-stations (*a*) three-phase switchboards, (*b*) direct-current switchboards, and (*c*) six motor-driven boosters in connection with storage batteries at Royal Oak and Shepherd's Bush sub-stations). Tenders to the secretary, Paddington Station, London, W., by March 13.

Stoke Newington (London) Council invite tenders for supply, delivery and erection of sub-station plant and mains, including transformers, three-phase motor generators, boosters, &c., extra h.t. and three-wire l.t. switchboards, storage battery and l.t. distribution mains. Tenders (addressed Electric Lighting committee) to the Town Hall, Stoke Newington, N., by 4 p.m. March 8.

Wimbledon District Council invite tenders for supply of stores during the year ending March 31, 1906, including engine-room stores, cables, joint boxes and jointing materials, transformers, meters, oils, incandescent electric lamps, carbons and accessories, and iron castings. Tenders (addressed Chairman of General Purposes committee) to the clerk (Mr. R. H. S. Butterworth), 12, Queen's-road, Wimbledon, before noon March 4.

Rathmines and Rathgar Urban District Council invite tenders for supply of electricity stores for the 12 months ending March 31, 1906, including arc-lamp carbons, cables, &c., general stores and coal (about 2,000 tons). Tenders, on official forms, to the clerk to the Council (Mr. F. P. Fawcett) by 20th inst.

South Shields Corporation invite tenders by March 13 for a marine type boiler, two engines and two 550kw. direct-current generators, a traction switchboard, and electric tramcars complete with Brill trucks.

Manchester Electricity committee invite tenders for supply and erection at Dickinson-street station and sub-stations of (*a*) motor generators and (*b*) five-wire balancers. Tenders to chairman by 10 a.m. 21st inst.

East Ham Town Council invite tenders for the supply and delivery of five double deck roof-covered tramcars, complete with electrical equipment. Tenders to chairman of Electric Lighting and Tramways committee by noon Feb. 21

Sunderland Corporation invite tenders for four 250kw. synchronous three-phase motor-generators. Tenders to chairman of Electricity and Lighting committee by noon Feb. 24.

South Shields Corporation require tenders by noon 18th inst. for marine type boiler, two open-type vertical engines, two 550kw. d.-c. generators, switchboard and tramcars.

Stockport Corporation require tenders by noon 20th inst. for points, crossings and special work in connection with tramway construction.

Halifax Corporation require tenders by noon March 6 for supply of stores and materials for the electricity, tramways and highways departments.

St. Mary, *Islington* (London), Guardians require tenders by 2:30 p.m. March 7 for supply of electrical requirements, engineer's work, &c.

Walthamstow District Council invite tenders until 5 p.m. 24th inst. for various supplies, including electricians' materials, &c.

Tenders are required by 4 p.m. 20th inst. for fitting electric "tell-tale" installation at *Kilkenny* District Lunatic Asylum.

Leeds Corporation invite tenders by 18th inst. for erection of sub-station and car shed.

Cheltenham Corporation require tenders by March 17 for supply of electric light fittings, tools, coal, &c.

Tenders will be opened at the Telegraph Department, 10, Calle de Carretas, *Madrid*, on March 12 for the supply of various kinds of telegraph and telephone material, to the estimated value of 35,337 pesetas (about £1,000), required by the Spanish Government Telegraph Department.

Tenders are also invited by March 14 at the Telegraph Department, *Madrid*, for the supply of 32,000 zinc cylinders for Callaud batteries, deliverable in four equal lots at Madrid, Cordova, Barcelona and Valladolid. Samples at the office of the Director-General of Telegraphs, 10, Calle de Carretas, Madrid. The maximum price has been fixed at 1,800 pesetas per 1,000 cylinders. The "Madrid Gazette" of Feb. 12 contains further particulars.

Dax (Landes) Municipal Council invite tenders until 25th inst. for concession for electric and gas lighting for 35 years. Particulars from and tenders to La Mairie de Dax (Landes).

Tenders are invited by the *Prussian* State Railway authorities, Dantzig, until 28th inst. for 191,000 arc lamp carbons.

TENDERS RECEIVED AND ACCEPTED.

Bradford Tramways committee have accepted the following tenders for stores during the ensuing year:—

J. Rushforth & Son, timber; Hy. Barrett & Son, iron and steel; Baxendale & Co., varnishes; Saml. Mason, dry colours; R. R. Minton & Co., paints and white lead; Stephenson Bros., painters' sundries; General Electric Co., electrical accessories; J. S. Heap & Sons, paint brushes; A. W. Fairless & Co., glass; Saml. Miller, oils, grease, &c.; Veritys Limited, lamp fittings; Thornton & Crebbin, iron castings; Thos. Gameson, malleable iron castings; Jonas Wells, steel castings; W. F. Dennis & Co., cables and wires; Wood & Saberton, bolts, nuts and washers, wood handles and shafts, galvanised iron and tinware, screws, nails and rivets, and hand tools; S. W. Whaley & Co., rope, twine, paper, &c.; Taylor & Parsons, lead, tin, &c.; J. W. Rowlands & Co., pinion wheels; London Transfer Depot, transfers; S. Dixon & Sons, trolley poles; W. Vaux, files.

Among recent contracts for stokers placed with Messrs. Ed. Bennis & Co., of Little Hulton, Bolton, may be mentioned the following:—

Birmingham: 20 stokers and compressed-air furnaces; Burton-upon-Trent: stokers and compressed air furnaces for Bennis type Lancashire boilers for the electric tramways department; Coventry: Bennis stokers and compressed-air furnaces for extension boilers; Dewsbury: Bennis stokers with compressed-air furnaces for extension boiler: London: 12 stokers and compressed-air furnaces for dry back marine type boilers for the Metropolitan Electric Supply Co.'s Willesden station; Middlesbrough: Bennis stokers and compressed-air furnaces for boiler extension; Sheffield: 8 Bennis stokers and self-cleaning compressed-air furnaces for boilers, fitted with special hot-air trunks and independent drives, for the Neepsend station extension.

Ferranti Limited have recently completed switchboards for the following stations:—

Bloemfontein, Borneo, Exeter, Hornsey, Johannesburg, Loughborough, Paisley, Partick, Wakefield and Watford; for the Great Central Railway at Gorton, and for the South Metropolitan Electric Supply Co., at Sydenham.

Among orders in hand are boards for Handsworth, Plymouth and Sydney (N.S.W.), for the Indian State Railways, and for Messrs. Henry Tate & Sons' sugar refineries at both Liverpool and London. For Portmadoc Ferranti E.H.T. three phase 10,000/12,000-volts switch gear is in course of construction for the main station and nine sub-stations operating in conjunction with the Portmadoc-Carnarvon Railway, which utilises H.T. overhead transmission lines. This is the first installation of this kind in Great Britain.

James Gordon & Co., 52, Lime-street, London, E.C., have secured a contract for the supply of a complete hydraulic and gas power plant for the electric lighting station at Buncrana (Ireland). This plant will consist of two high-pressure horizontal-shaft turbines, each to develop 60 H.P., to be direct coupled to dynamos. There will be a rivetted steel pipe line about 500ft. long for connecting to the head water. The gas power plant will comprise a 70 B.H.P. gas engine with suction-producer equipment.

Great Yarmouth Town Council have accepted the tender of the Brush Co. for cars for the Gorleston tramways at £5,646; that of the British Electric Equipment Co. for overhead equipment at £2,857. 0s. 3d.; that of W. F. Dennis & Co. for rail bonds at £480. 9s. and that of T. Small & Co. for 500 tons of granite setts at 20s. 6d. per ton. The Tramways committee have been authorised to order such extra materials from the above firms as may be necessary to extend the tramways in certain directions.

Mountain & Gibson, Elton Fold Works, Bury, Lancs., have secured a contract from Glasgow Corporation tramways department for 100 M.G. 21 E.M. electric motor trucks for tramcars, fitted complete with steel-tyred wheels and steel axles. These trucks are for 100 new cars which Glasgow Corporation are building and putting into service.

Erith Council have accepted the following tenders in connection with the tramways:—Brush Co., overhead equipment, poles, &c., £4,217; Callender's Co., feeder cables, &c., £2,590. 4s. and £51. 16s. for additional two years' maintenance; British Westinghouse Co., rotary converters, &c., £1,545. 5s.

Southwark Borough Council have placed an order with British Insulated & Helsby cables for 440yds. of 0·1 and 440yds. of 0·05 cable at £156. 15s.; also with the General Electric Co. for a dynamo for the public baths at £29. 10s.

Gravesend Council have accepted the tender of Cowan's Limited for a switchboard at £100. 10s., and that of the Western Electric Co., for laying mains, at £48.

Camberwell Borough Council have accepted the tender of W. H. Allen, Son & Co. for an engine for the electric lighting plant at the new baths.

West Ham Corporation have accepted the tender of Hunns & Co. at £22. 10s. for the covering with asbestos non-conducting cement of 180 steampipe flanges in the generating station.

Messrs. R. J. Nicholson & Co. have secured the contract for the electric lighting installation at the Isolation Hospital, Leftwich, near Northwich.

Burslem Council have accepted the tender of Babcock & Wilcox for steam piping and a pump for the electricity works at £621.

Swindon Council have accepted the tender of J. J. Horsfield & Co. for a Lancashire boiler at £1,385.

Pudsey Town Council have accepted the tender of Johnson & Phillips for supply and laying electric lighting cables at £3,044. 9s. 8d.

The Corporation have secured a loan of £1,000,000 for the purchaseof the tramways and their conversion to electric traction.

The tender of O. Melville has been accepted for wiring the High School, Kirkcaldy, at £182. 6s. 6d.

BUSINESS NOTICES.

Mr. Robert McLaren, for many years in the locomotive department of the Central Argentine Railway, has joined the firm of Topping & Seavill, engineers, Rosario, and in future the firm will trade as Topping, Seavill & McLaren, as engineers and agents in Argentina for Messrs. J. & H. McLaren, of Leeds.

Messrs. Wm. Hampson & Montague Wakefield Wickes (trading as the Liverpool Electrical Engineering Co.), 8, Harrison-street, Liverpool, have dissolved partnership.

BANKRUPTCIES, LIQUIDATIONS, &c.

At the London Bankruptcy Court last week the public examination took place of Henry Coles, electrical engineer, of 10, York-street, Swansea. Gross liabilities £3,727 (£2,986 unsecured) and assets £13. Debtor started in business as an electrical engineer at end of 1900 at Swansea, without capital, but with a guarantee of £100 at the bank. At the end of 18 months the overdraft was increased to £700 upon the security of the deposit of deeds. Examination concluded.

The trustee in the bankruptcy of Geo. Neale, electrician, trading with another at 2, Fulham Palace-road, London, as the South-Western Electrical Contracting & Maintenance Co., has been released.

The trustee in the failure of David Todd Cameron, mechanical and electrical engineer, 1, Magdala Villas, Saltash (formerly of 13, Clifford-terrace, Saint Budeaux, and 25, Barrack-street, Devonport), has been released.

The Electric Tramways Construction & Maintenance Co. (Ltd.) is to be wound up voluntarily. Mr. L. Morse, 76, Queen-street, London, E.C., and Mr. A. J. Paine, West-hill, Sydenham, are liquidators.

Plant, &c., for Sale.—Messrs. White Bros., engineers, High-street, Stratford, London, E., have some electric lighting plant for sale, including a pair of Ruston-Proctor compound horizontal engines, Crompton dynamo, loco-type boiler, portable Marshall engine, &c. See also advertisement.

Electric Phaeton for Sale.—Messrs. Marshall & Co., Campbell Works Stoke Newington, London, N., have for sale a new Cambridge electric phaeton, 80 cell 50 ampere-hour battery for 100 or 200 volts. See advertisement.

Premises for Sale, &c.—Messrs. Furber, surveyors, valuers and auctioneers, 3, Warwick-court, Gray's Inn, London, W.C., will offer for sale at the Mart, Tokenhouse-yard, London, on March 2 at 2 p.m., a substantial building, No. 158, Farringdon-road, comprising a warehouse and factory, of which particulars will be found in an advertisement elsewhere. These premises were formerly in the occupation of Messrs. Ely Bros., the well-known ammunition manufacturers, who have now erected new works at Edmonton, where the Farringdon-road branch of the business will be carried on.

Messrs. Stimson & Son, 3, Moorgate-street, E.C., and 2, New Kent-road, S.E., London, have extensive factory premises (close to Vauxhall and Nine Elms, with frontage to the main road) to let. See advertisement.

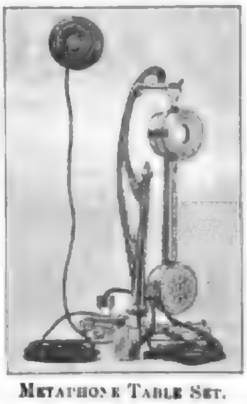
A ground floor, area 2,700 super. ft., equipped with electric power, and suitable for general engineering, is to let. Applications to Messrs. Marshall & Co., Campbell Works, Stoke Newington, London, N. See advertisement.

Conveniently situated factory premises in Willesden are advertised to be let in another column. Applications to Mr. J. H. Payne, 15, Chatsworth-road, West Norwood, London, S.E.

Catalogues, &c.—Johnson & Phillips have just issued a new pamphlet entitled "Switchboards Illustrated," and there are a number of fine examples of the firm's switchboard work shown.

The Oliver Arc Lamp Co. have issued a new price list showing various types of arc and incandescent lamp fittings for outdoor use. For Nernst lamps in side streets existing gas posts are very generally employed, and various designs of brackets for carrying Nernst lamps are shown in the list. Some of these brackets are made to fit over any ordinary size gas post spigot, being centred and held in position by means of three set bolts. Other brackets are made for affixing to flat or corner walls, or for clamping round tramway or other poles. Their insulation is very high, some having a substantial porcelain block on to which the holder for the lamp is mounted, and others are insulated with mica. A fitting has been designed more particularly for street lighting work or exposed positions. It is an anti-vibration fitting, the Nernst lamp being suspended inside the spinning by a special spring. This takes up any vibration caused by passing traffic, wind, &c., so saving the burner from damage, and therefore lengthening its life. The lamp globe is affixed to the reflector spinning, the whole being lowered completely by means of chains with hook attachments.

An exhaustive catalogue of Metaphone telephone apparatus has been issued by the National Telephone Co. and gives the fullest particulars concerning this useful line of apparatus. Metaphone instruments are supplied in a variety of designs for all purposes. The illustration shows a table set.



Metaphone Table Set.

The St. Helens Cable Co. have forwarded a catalogue of Dialite cables for collieries. It is claimed that Dialite is waterproof and that it is in every way suitable for the insulation of cables without lead covering, as a substitute for either indiarubber or vulcanised bitumen. The catalogue contains reports of a number of tests of this class of cable, some of which were carried out by Mr. C. H. Wordingham at Manchester, and all of them pointing to the useful properties of this dielectric. The catalogue also contains many useful hints as to the fitting of cables in mines and descriptions of the methods of jointing them.

Lists of ebonite and india-rubber goods, including accumulator boxes, rods, tubes, forks, &c., also casting machines and moulds, and a variety of accessories for accumulator makers, are listed by B. Kuettner & MacDonell, 8, Adam-street, Adelphi, London, W.C.

Mordey patent fuses of various types are listed in a pamphlet issued by Ernest F. Moy (Ltd.).

Additions to the price list of the Western Electric Co. are now available, and include arc lamps and accessories, fan motors, circuit breakers, small motors for sewing machines, &c., and motor driven grinders.

C. J. Thursfield & Co., of Clements-street, Birmingham, have prepared a new abridged catalogue of high-class electric light fittings. The catalogue includes illustrations of about 60 fine examples of hand-wrought fittings suitable for every type of artistic decoration and is especially strong in ceiling fittings of chaste design.

"Eclipse" electricity meters for continuous and alternating currents are listed in a pamphlet issued by G. Braulik.

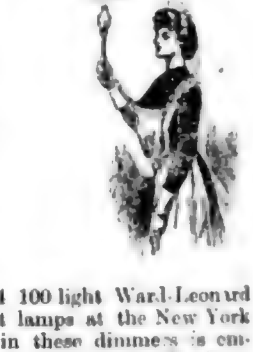
"Modern Electric Winches" is the title of a circular (No. 6) issued by Chambers, Scott & Co., Motherwell, N.B., and illustrating standard type machines of this firm's manufacture.

The London Electric Wire Co., Playhouse-yard, Golden-lane, London, E.C., have prepared a new trade list filled with tabulated particulars relating to the company's manufactures, and thumb-indexed in such a way as to afford facility for easy reference to any section of the list.

Siemens Brothers & Co. have ready a pamphlet (No. 10) describing the "Deadreckoner," an instrument for ascertaining a ship's position at sea by account. This is the invention of the Hon. Reginald Brougham, and is an instrument commended to the attention of navigators.

Some further leaflets (seven in all), showing diagrams of connections of machines, dimensions of motors, &c., have been issued by Siemens Brothers & Co.

New Electric Lamp Adjuster.—The London Electrical Fittings Co., of Hampstead-road, London, N.W., have introduced a new electric lamp adjuster, by means of which glow lamps can be withdrawn and replaced from pendants, brackets, &c., with ease, and without the inconvenience and danger of mounting ladders. The adjuster is in the form of a sensitive clip which enfolds the bulb, and allows the work of disengaging the lamp from the fitting and replacing a new lamp to be instantly performed without the lamp being handled. The illustration shows the new device in use.



Theatre Dimmers.—Messrs. Geipel & Lange, Vulcan works, 72A, St. Thomas-street, London, S.E., have received notification from New York that an order has been placed for 124 100 light Ward-Leonard dimmer plates to control 12,400 60 watt lamps at the New York Hippodrome. The resistance material in these dimmers is embedded in porcelain enamel attached to cast-iron plates. The large number of contacts employed in this apparatus, and the fact that there is no inflammable material used in the construction, makes the dimmers completely incombustible.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Feb. 8 to 14, with the ports of destination :—

Africa—Alexandria, £159; Cape Town, £665; **Durban, £548** (including £31 telegraph material); East London, £84; Port Elizabeth, £40. *Argentina*—Buenos Ayres, £1,602 (including £130 telegraph wire). ***Australasia***—Adelaide, £45; Auckland, £40; Melbourne, £133 (including £11 telegraph material); Perth, £28; Rockhampton, £36; Sydney, £590. *Belgium*—Antwerp, £40; Ghent, £10; Ostend, £10. *Brazil*—Rio Janeiro, £41; Santos, £16. *Canada*—Halifax, £23,880 (telegraph cable). *Ceylon*—Colombo, £116. *China*—Shanghai, £447. *Germany*—Hamburg, £377 (including £340 telegraph material). *Gibraltar*—£54. *Greece*—Piræus, £29 (telegraph material). *Holland*—Amsterdam, £174. *Hong Kong*—£22. *India*—Bombay, £1,538; Calcutta, £718; Madras, £121. *Japan*—Tokyo, £5,403; Yokohama, £1,445. *Italy*—Leghorn, £28. *Malta*—£45. *North Atlantic*—£4,110 (telegraph cable). *Portugal*—Lisbon, £56. *Russia*—Odessa, £70 (telegraph material); Reval, £5,000. *Straits Settlements*—Singapore, £347. *Uruguay*—Monte Video, £14. **Total, £48,144 against £37,115 in the corresponding week last year** (Feb. 11 to 17).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

December 17, 1904.

27,545 G. F. Allom. Northwood. Automatic fire or excessive heat alarm.

27,582 H. R. Mansfield. Leicester. Conduits for electrical cables.

27,605 E. E. Lebwess. Electric system of driving vehicles in an arena or course.*

27,627 A. Bergtheil. Portable conductors.

27,636 A.E.G. Electric lighting of trains. (Date applied for, Dec. 19, 1903, date of application in Germany.)*

27,637 J. T. H. Dempster. Vapour electric apparatus. (Date applied for, Dec. 19, 1903, date of application in U.S.)*

December 19, 1904.

27,638 C. P. Steinmetz. Vapour electric apparatus. (Date applied for, Dec. 19, 1903, date of application in U.S.)*

27,640 H. Nehmer. Metal caps for carbon contacts.

27,683 J. A. Fleming. Kummeters or instruments for the measurement of wave lengths in wireless telegraphy.

27,702 Siemens-Schuckert-Werke Ges. mit. bes Haft. Winding asynchronous electrical machines to produce a pole in the proportion of 1:2. (Date applied for, Feb. 13, 1904, date of application in Germany.)*

27,705 B. G. Lamme. Alternating-current motors. (Date applied for, Feb. 27, 1904, date of application in U.S.)*

27,707 G. Michaud and E. Delasson. Indestructible filament for gas and electric lamps.

27,713 W. P. Thompson. Incandescent bodies for lamps. (Deutsche Gasglühlicht Akt. Ges. Germany.)*

27,714 W. P. Thompson (Deutsche Gasglühlicht Akt. Ges., Germany). Incandescent lamp with incandescent body fused in the conducting wires.*

27,755 H. Aron and O. Runge. Counting mechanism for electricity meters.*

27,762 C. G. Conradi. Electrical apparatus for regulating and distributing electric currents.

December 20, 1904.

27,773 C. Mason. Stockton-on-Tees. Electro-deposition of metals on aluminium.

27,783 T. Dawson. Halifax. Supporting and connecting trolley wires.

27,803 A. C. Brown. Fire alarms.

27,801 C. D. Charlesworth. Birmingham. Self-regulating dynamos.

27,809 E. M. T. Boddam. Alperton. Hydraulic lifts electrically operated.

27,831 W. Goulton. Incandescent lamps.

26,842 P. A. Newton (American Inventions Co., U.S.). Electric tool drivers.*

27,844 H. C. E. Jacoby. Controlling electric lifts, elevators, &c.

27,849 A. Horstmann, S. A. Horstmann, G. O. Horstmann, E. H. Horstmann and W. T. Edgar. Time switches.

27,853 W. P. Thompson. Liverpool. Photophonic system and apparatus therefor. (F. Arnold, Germany.)*

27,859 Electricitäts Akt. Ges. Westfalia. Liverpool. Self-acting cell switches.*

27,860 W. Gardiner. Forming tank for accumulator elements.*

27,861 27,862, 27,900, 27,901, 27,902, 27,903, 27,904 and 27,905 W. Gardiner. Accumulators and grids therefor.*

27,865 H. S. Blackmore. Reducing aluminium and other metals.*

27,869 A. C. Burnett and J. Richmond. Contact maker and breaker for lifts.

27,887 E. Weintraub. Vapour electric apparatus. (Date applied for, Dec. 21, 1903, date of application in U.S.)*

27,908 G. Michalek. Magneto electric ignition devices for explosion engines.

27,913 R. J. Sheehy. Telegraphy.*

27,916 H. Hindereein. Locking apparatus for watchmen's electric controls and the like.*

28,166 G. Eichhorn. Germany. Connections for generation of electric oscillations. (Date applied for Dec. 29, 1903, date of application in Germany.)*

December 21, 1904.

27,926 F. M. Lewis and Reason Mfg. Co. Demand indicators.

27,929 C. W. S. Turner. Electric block signalling apparatus. (Date applied for Dec. 22, 1903, date of application in U.S.)*

27,950 F. J. E. Clarke and G. A. Pope. Birmingham. Fused electric motor switches.

27,986 N. S. Electric Storage Co. and J. T. Niblett. Batteries.

28,018 Siemens Brothers & Co. (Siemens-Schuckertwerke G.m.b.H., Germany.) Safety discharge apparatus for excessive voltages.*

28,035 J. Peticky, I. Cizek and F. Suchanek. Automatically connecting subscribers to telephone exchanges.*

28,044 S. Matthews. Electricity meters.

28,062 B.T.-H. Co. (G E. Co., U.S.). Treated carbon.

December 22, 1904.

28,113 W. Eastman and A. Warne. Electrical heating apparatus.

28,114 C. M. Dorman, R. A. Smith and H. G. Baggs. Salford. Automatic controlling apparatus switches.

28,122 J. Paxman and Davey, Paxman & Co. Electric ignition devices for internal combustion engines.

28,123 F. Biermann. Counting apparatus for electric and other meters.*

28,129 H. Hirtz. Permeable diaphragms for electrolytic cells.

28,140 J. C. A. Maddick. Liverpool. Mercurial temperature-contact devices.

28,147 C. O. Bastian. Electric vapour lamps.

28,154 H. Kuzel. Light-emitting bodies for electric lamps.

28,155 Phœnix Dynamo Mfg. Co., R. Pohl and F. Pohl. Dynamo-electric machines.*

28,156 Phœnix Dynamo Mfg. Co. and R. Pohl. Construction and ventilation of field coils of dynamo-electric machinery.*

28,157 G. A. Unterberg. Actuating apparatus for magneto-electric spark-ignition apparatus and the like.*

28,163 J. Young. Telephone systems.

December 23, 1904.

28,171 R. F. Hall. Birmingham. Sparking plugs for internal-explosion engines.

28,175 F. W. Baynes. Exeter. Electric tramways and railways.

28,176 H. Emmott. Halifax. Regulating electrical energy in an alternating-current circuit.

28,179 W. Aitken. Liverpool. Telephone indicators.

28,208 J. Burns and J. D. Allan. Trolley heads.

28,211 J. B. Stewart. Glasgow. Electric lamp for use under water.

28,212 F. G. Squirrell. Trolley poles for overhead electric traction.

28,235 J. W. Ewart. Arc lamps.

28,238 Bruce Peebles & Co. and J. L. la Cour. Liverpool. Alternating-current motors.

28,252 W. W. Stroud and G. H. White. Switches, plugs and the like.

28,253 W. W. Stroud. Incandescent lampholders.

28,254 F. Ritchie. Telegraphs.

28,255 F. Ritchie. Relays.

28,263 A. J. Hart. Fire-signalling apparatus.

28,268 F. H. W. Higgins. Telegraph transmitting instruments.

28,270 A. C. Bray and W. Aitken. Safety devices for use with suspended conductors.

28,278 W. M. Thornton. Instruments for indicating the charged or uncharged condition of cables or other electric appliances.

28,279 W. J. Davy. Arc lamps.

28,297 P. M. Oudin. Production of ozone.

28,301 S. Z. de Ferranti. Electric welding.

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28,329 R. L. Murray and F. T. Jackson. The working of telephonic systems.*

28,336 Veritys Limited and D. E. Rogers. Birmingham. Brush-holders.

28,345 C. D. Charlesworth and J. R. Charlesworth. Birmingham. Regulating gear for use with train-lighting and similar dynamos.

28,349 W. Dixon. Glasgow. Generation and distribution of electricity.*

28,530 E. A. J. Hooper. Birmingham. Attachment for use with suspended electric lamps.*

28,369 and 28,370 G. Harrison (M. Guett, U.S.). Switches.*

28,375 G. M. Zingel. Electric bipolar plates accumulator.

28,393 A. J. Boult (W. J. Richards, U.S.). Electric current governors.*

28,409 W. Fairweather (Marquette Electric Co., U.S.). Arc lamp.*

28,416 E. Arnold and J. Lassen la Cour. Liverpool. Appliance for the commutation current in armatures of dynamos.*

28,453 Sc. Anon. pour le Travail Electrique des Métaux. Continuous current motor. (Date applied for, May 10, 1904, date of application in France.)*

28,455 Siemens Brothers & Co. (Siemens and Halske Akt. Ges., Germany.) Central telephone station installations.*

28,458 F. W. Howarth. (J. H. Guest and C. I. Hills, U.S.) Incandescent lamp.

28,467 W. P. Thompson. (Deutsche Gasglühlicht Act. Ges. (Auer. Ges.) Germany.) Incandescent lamps.*

28,468 B. Gáti. Electrical conductors.*
28,471 Hultqvist. Combined starting and braking device for electric motors.*
28,495 A. Finley. Automatic switches.

December 28, 1904.

28,522 W. J. Mackenzie. Glasgow. Electric signalling on railways.
28,525 M. B. Mountain and G. M. Gibson. Manchester. Trolley standards for electric tramcars and the like.
28,546 H. H. Berry. Enfield. Armour-clad switch fuses.
28,551 A. J. Boult. (W. Hoskins, U.S.) Thermo-electric couples.*
28,601 W. R. King. Apparatus for electro deposition of metals.*
28,608 C. C. Regnart and Hunter Electric Candle Lamp Co. Electric candle lamps.*
28,618 Mavor and Coulson and H. A. Mavor. Motor-starting switches.
28,628 J. Rosemeyer. Arc lamps.*
28,629 I. B. Birnbaum. Drop signals or annunciators.*

December 29, 1904.

28,677 F. Owen. Liverpool. Safety device for electric railways.
28,678 F. W. Reed and Craven Bros. Manchester. Cranes and other lifting machinery driven by electric motors.
28,687 O. Carr and J. C. Birch. Leeds. Automatically starting, controlling and stopping single or multiphase alternating-current motors.
28,689 T. W. Maddox. Birmingham. Globe or shade carrier.
28,704 L. Kubitz. Germany. Electric massage apparatus.*
28,717 W. Defries. Operating gear for groups of switches and rheostats.
28,722, 28,723 and 28,724 C. Schwabe. Liverpool. Incandescent lighting devices.*
28,741 W. H. Astell. Electric ignition devices for internal combustion engines.
28,749 E. C. Lacey and J. Holman. Telephones for divers.
28,787 G. B. Stern and A. C. Greene. Switches.
28,791 L. Snoeck. Electric current distributors for luminous letters.
28,797 A. M. Anderson. Apparatus for indicating number of a telephone subscriber. Date applied for, March 30, 1904, date of application in Denmark.)*
28,804 Società Ceramica Richard-Ginori. Insulators for high-voltage lines. (Date applied for, June 22, 1904, date of application in Italy.)*
28,824 L. Renault. Electric ignition arrangements for internal combustion engines. (Date applied for, Feb. 2, 1904, date of application in France.)*
28,826 and 28,827 J. S. Stone. Bolometers and space telegraphy. (Date applied for, Feb. 15, 1904, date of application in U.S.)*

December 30, 1904.

28,840 J. A. Hirst and P. S. Brook. Chester. Self-acting motor-starting rheostat.
28,845 R. W. Bill and S. Bill. Handsworth. Anti-vibration electric couplings.
28,852 W. Hepworth-Collins. Manchester. Cable conduit.*
28,853 J. A. Hirst and P. S. Brook. Chester. Switch and circuit-breaker.
28,875 W. F. Simmonds. Plug adaptor for electric lamps.*
28,889 M. A. Abrahamson. Electric control circuits with heat indicators.
28,895 W. E. G. Read. Electric lamp for ovens.
28,899 W. Walker, jun. Electric bell pushes.
28,962 J. Richard. Galvanometers. (Date applied for, Feb. 3, 1904,

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1904.

11,274 Watkins. Telephone selecting systems.
14,933 Cohwen. Protection from "live rail" danger.
20,010 Regnart and Hunter Electric Candle Lamp Co. Holder for incandescent lamps.
21,796 Churchward. Controllers. (Date applied for, Oct. 10, 1903.)
22,653 Siemens Brothers & Co. (Siemens Schuckertwerke G.m b.H.). Electric motors.
23,797 Bristol. Temperature compensating devices for electrical measuring instruments.
25,095 Jungner. Accumulators.
25,105 Prested. Device for distinguishing poles of a circuit.
25,911 Jebsen. Couplings for dynamos, turbines, &c.
25,972 Galsworthy. Protection of conductors of flexible cords.
26,269 Sire. Coils for electromagnets, solenoids.
26,537 Wood. Vapour electric apparatus. (Date applied for, Dec. 17, 1903.)
26,538 Herbert. Fuse boxes, ceiling roses, wall plugs, &c.
26,696 Eisenstein. Apparatus for wireless telegraphy or telephony.
26,757 Siemens Brothers & Co. (Siemens & Halske Act. Ges.). Elec-signalling
26,820 Dorman, Smith and Baggs. Switches and cutouts.
26,920 Lindsay. Arc light electrodes and methods of making same. (Date applied for, Dec. 10, 1903.)
26,949 Mills (Edison). Continuous apparatus for nickel plating.
27,010 Kruh. Alternating-current frequency changes. Date applied for, Dec. 12, 1903.)
27,095 Adams-Randall. Telephony.
27,348 Eason. Switches
27,705 Lamme. Alternating-current motors. (Date applied for, Feb. 27, 1904.)
27,713 Thompson (Deutsche Gasglühlicht Akt. Ges. (Auergesellschaft). Formation of incandescent bodies for incandescent lamps.
27,714 Thompson (Deutsche Gasglühlicht Akt. Ges. (Auergesellschaft)). Incandescent lamp with incandescent body fused in the conducting wires.

COMPANIES' MEETINGS AND REPORTS.

St. James' & Pall Mall Electric Light Co. (Ltd.)

The ordinary general meeting was held on Tuesday, Col. Eustace J. A. Balfour in the chair.

The GENERAL MANAGER and SECRETARY (Mr. Frederic J. Walker) read the notice calling the meeting and also the auditors' report.

The CHAIRMAN said: You have before you the statement of accounts with the report of the Directors, recommending that the usual dividend be paid, making for the eighth consecutive year a distribution at the rate of 14½ per cent. on the ordinary shares. Last year when I met you I was at some pains to explain what at first sight appeared to be a set back in the progress of the business which had been made. I pointed out to you that the comparison of that year's work was made with one of quite exceptional prosperity, in which the Coronation led to unusual activity and display, which had a material effect upon our business. Further, that whilst we were passing through a period of trade depression, our own costs were unduly enhanced by the interest charges on the capital of the Central Company during the period of construction of that Company's important works. In the result we had to have recourse to the contingency fund, which we had specially provided for this emergency, and one-half of the sum was used, the balance being held in reserve for 1904, if required. I was able, however, to reassure you on all these points, and I myself was sanguine that our position would quickly improve. The accounts before you will show that for the past year we have done better than we expected. The Central Company has declared a dividend of 5 per cent. on its share capital, of which we hold half; so that not only have we drawn nothing from the contingency fund, but this dividend of £2,500, received since the closing of the accounts, will enable us this year to restore that fund to its original amount. In other words, 1904 has proved about £5,000 better than 1903. Further, the Central Company having commenced the year by charging us 2d. per unit was able—after paying all expenses, including a proper provision for depreciation—to amend its charge on the whole of its output for the year to one of 1⅞d. per unit, and there is reason to believe that on the current year it may be able to do better still. This matter, as you will see, is of vital importance to us. Our own capital is stationary; we have no large expenditure in contemplation. All future increase of supplies for our business will be drawn from the Central Company, and therefore the price at which we can deliver the unit of electricity to the consumers will depend more and more largely each year on the price at which the Central Company can generate it. For the past year we have been well satisfied. The supply has been furnished to us in a most regular manner and the charge is below that which we had anticipated. Meanwhile our own business has made steady progress. We have added during the year the equivalent of 24,421 8 c.p. lamps, making a total at the end of the year of 278,889. The output for the year amounted to 7,660,587 units, making an increased sale of 520,382 units over the preceding year. We have made substantial reductions to our consumers, and I may say in this connection that it is the settled policy of the Board to make the service cheap as well as efficient, so as to establish the business on the widest possible basis. The Company's works within the district have been fully maintained and are in first class order. At Carnaby-street station an artesian well has been sunk, from which the whole of the water required for steam-generating purposes is easily obtained. The position of the Central Company furnishes us with the reserve which enables us to take up promptly any new business that may present itself. Certain bills have been promoted in the ensuing session of Parliament which may affect the interests of this Company, but all proper steps have been taken to ensure that these interests are safeguarded. I now move the adoption of the report and accounts and the declaration of the dividend and bonus therein recommended.

Mr. WALTER LEAF (Vice-Chairman) seconded the motion, which was carried unanimously.

The retiring Directors and auditors having been re-elected,

The CHAIRMAN said: Before we part I want to say what I have said before so many times. The Board owe a deep debt of gratitude to the staff for the work which they do, and I am perfectly certain that the shareholders also feel that they owe the staff a debt of gratitude. We have a magnificent staff, who never spare themselves. Their first thought is of the interests of the Company. I should like to move a vote of thanks to them, and I hope someone among the shareholders will second it.

Mr. BOURN seconded the motion, which was carried unanimously.

Mr. F. J. WALKER, the General Manager and Secretary of the Company, returned thanks, and said the work at times was not free from anxiety, but it was gratifying to know that the Directors and shareholders were satisfied with the general result of the labours of their staff.

Mr. DOBSON (Chief Engineer): I also thank you very much, gentlemen, for myself and my staff.

A cordial vote of thanks to the Chairman and Directors terminated the proceedings.

Marconi's Wireless Telegraph Co. (Ltd.)

The eighth ordinary general meeting of the company was held yesterday (Thursday), Col. Sir Chas. Euan Smith presiding.

The SECRETARY (Mr. H. W. Allen) read the notice calling the meeting

The CHAIRMAN then said the profit for the past year amounted to £12,681, and although this result had called forth some criticism on the part of one or two of the journals connected with the cable interests, the directors did not consider it as being other than satisfactory. In 1902 the profit was £5,489, and in 1903, £10,607. In 1902, however, they received a subsidy of £16,000 from the Canadian Government, and in 1903 £20,000 from the British Admiralty. Critics of the balance-sheets for those years pointed to these payments as exceptional. In the year under review the Company had received no similar special payments. The profit of £12,681. 5s. 3d. for this year might, therefore, the board considered, be regarded as the more satisfactory as indicating a general expansion of the business from sales and royalties without any payment which might be looked upon as exceptional. It was not, of course, claimed that the Marconi wireless system was at present in full working order as a profit-earning concern. It was in process of development exactly in the same way as a gold mine had to pass through a process of development before it could work up to its full producing powers. What they had hitherto accomplished had been to lay the basis of their future operations on so sure a foundation that, by the contracts which they had entered into with various Governments and companies, they were in a position to which no other system, even if successful as an invention, could attain, for reaping whatever benefits might accrue from the commercial applications of wireless telegraphy in the future. In this connection it might be useful for those who read the constant criticisms that appeared in the newspapers affecting the Marconi system to reflect upon what was the actual position of affairs. What were the practical results? In Italy, in Germany, in France and in other countries one heard a great deal of the inventions for wireless telegraphy which had been patented by the subjects of those countries; but in Germany the Marconi system held the field upon the German liners. The Italian Government had not only embodied the Marconi system in the public telegraphic service of that country, but the Italian men-of-war and other vessels were equipped with the Company's apparatus. The French liners, the ships of the American Trust, Dutch ships, Canadian ships, all carried Marconi apparatus. In England, His Majesty's Post Office is in close alliance with them. The British Admiralty had adopted their apparatus for use throughout the entire navy. At present the Marconi system was, as far as the directors knew, the only one that was generally utilised for commercial purposes, and they could safely assert that it was the only one which, so far as long-distance wireless telegraphy was concerned, had shown any practical results. The board believed the company to be upon the brink of completing the machinery necessary for a regular trans-Atlantic commercial service, and it was deemed advisable to put before the shareholders, for the information of those who were ignorant of the subject, an estimate of the earnings of a single pair of stations in a year. The figures on which this estimate was based, as furnished by the company's scientific advisers, were given in the report, and it was competent for anyone to form his own conclusions as to whether or not the amount of £56,000 per annum, set forth as the estimated earnings of such stations, was correct or otherwise. In this connection the small capital involved was also a most important point for consideration; for whereas the whole issued capital of the Company was only about £250,000, the cost of a single cable between England and America was probably not less than £800,000. Their agreement with the Postmaster-General had already borne fruit in the notification by the Post Office that on Jan. 1 last messages from the United Kingdom could be transmitted from the postal telegraph offices to ships at sea through the Company's shore stations. This was a step in advance which, as the board had reason to know, was highly appreciated and made use of by those whose friends were on the water. In another direction they had been able to accentuate their union with the Post Office authorities. On the occasion of a recent temporary breakdown of the cable system between the Scilly Islands and the mainland, they were asked by the Post Office to carry on telegraphic communication by wireless telegraphy. This they gladly consented to do, and with complete success; though the financial results which accrued therefrom were not of a formidable character, still the union thus begun might, he hoped, be productive of more profitable results hereafter. The board awaited the result of the discussions of the proposed Berlin Conference with complete confidence. They did not anticipate that the decision at which the Conference might arrive would prove injurious to the material interests of the Company in face of the contracts which they had concluded and were in their possession. He concluded by moving the adoption of the report.

Mr. G. MARCONI seconded the motion.

Mr. O'BRIEN said that there had been reports of litigation between the De Forest Co. and themselves, and he should be glad if the chairman would say how the matter stood.

Mr. CHAMBERS inquired whether the Company's code had been completed and published, and, if so, what progress it was making? He should like to know whether the ships using their apparatus were also using their code.

The CHAIRMAN, in reply, said he thought it was a very wise rule not to talk about legal proceedings when they were in process of being carried on. As a matter of fact, however, they were not in litigation with the De Forest Co.; it was the American Marconi company, not themselves. The Company's code had been completed, and was now in use and giving promising results.

The report was then adopted unanimously.

CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.)—The report for 1904 states that to meet the increasing demand for energy a large extension has been made to the works and additional plant and machinery have been ordered, of which part is already delivered and at work. A new scale of charges for electrical energy at reduced rates came into force on July 1. During 1904 there was added to the mains the equivalent of 3,074 8 c.p. lamps, making a total of 47,112. The number of units supplied were 523,298, an increase of over 51,000. After paying all charges, and placing £1,000 to depreciation, the balance is £6,691. 17s. 9d., which, with £1,342. 9s. 6d. from last year, makes £8,034. 7s. 3d. An interim dividend of 2½ per cent. (1,903. 4s. 3d.) has been paid, and after deducting debenture and other interest (£155. 2s. 2d.) there remains £5,676. 0s. 10d., and the directors recommend a dividend of 4½ per cent. (making 7 per cent. for the year), and leaving to carry forward £1,716. 15s. 10d.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPN. (LTD.)—The directors' report for the year ended Dec. 31 last relating to the company's *West-end Undertaking* states that a new sub-station has been built in the Green Park for supplying the public lamps in the Mall and parks, the Queen Victoria Memorial and other purposes. The lamps added during the past year were 73,722 8 c.p., an increase of nearly 25 per cent. on the highest number previously obtained in the West-end areas in any year, and bringing the total number to 409,663. The total mains laid is 325 miles. The regulations of the London County Council required that all theatres be furnished with supplies from two separate sources. The dual or alternative supply provided by the directors, under the advice of the company's engineer, has been approved as complying with these regulations. Revenue from sales of current for 1904 amounted to £122,877. 11s. 6d., against £110,083. 12s. 2d. in 1903. The balance of net revenue is £55,942. 8s. 9d., and the preference dividend will absorb £17,718. 15s.; a dividend on ordinary shares of 8 per cent. will require £28,000, leaving £10,223. 8s. 9d. to be carried forward.

City Undertaking.—The erection of the first half of the generating station at Bow, of a capacity the equivalent of 800,000 8 c.p. lamps connected, is now completed, and already contains plant to supply 600,000 lamps. The four sub-station buildings in the City are completed, and contain large storage batteries and plant of sufficient capacity to supply 450,000 8 c.p. lamps connected, with space to more than treble this capacity. Mains have been laid in all the principal and most of the secondary streets in the City, and are of sufficient capacity to supply upwards of 500,000 8 c.p. lamps. Spare ways increase the provision for bringing up the number to 1,000,000 lamps. There are 265 miles of mains now laid. There have been added during the year the equivalent of 58,968 8 c.p. lamps, bringing the total to 301,081. Gross revenue from sales of current amounted to £78,431. 2s. 1d., or £22,394. 13s. 2d. in excess of 1903. Net revenue account shows a profit of £15,670. 1s. 11d., which has been applied towards payment of the 4½ per cent. preference dividends to Dec. 31, the balance of such dividends being provided under the guarantee of the West-end undertakings.

The directors, to enable the corporation to comply with the increasing demand for electrical energy for railway, tramway and other power purposes, will apply to Parliament for an extension of the areas of supply and further powers, and the bill for conferring such powers was approved by resolutions passed at a meeting on Feb. 8.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—The directors' report for 1904 states that the profit is £35,062. 14s. 6d., which, with £1,200. 5s. 7d. brought forward, makes £36,263. 0s. 1d. After deducting debenture and other interest (£7,255. 3s. 4d.), interim dividend on 6 per cent. preference shares (£900), interim ordinary dividend at rate of 4½ per cent. per annum (£4,999. 1s.), and amount written off suspense account (£2,362. 18s. 8d.), the balance is £20,746. 2s. 6d., which the directors recommend shall be appropriated as follows:—Renewals and depreciation fund £10,344, final preference dividend £900, final ordinary dividend at rate of 7½ per cent. per annum (making 6 per cent. for year) £8,331. 15s., leaving £1,170. 7s. 6d. to be carried forward. Further expenditure of £8,874. 18s. 11d. has been incurred during the year in connection with changing the pressure of supply from 100 to 200 volts. This amount has been added to suspense account, from which £2,362. 13s. 3d. has been written off, leaving that account at £4,725. 6s. 8d. The number of lamps connected at Dec. 31, 1904, was 210,659, an addition of 15,424 during the year, and the improvement in the units sold per lamp continues. The total units sold in 1904 was 3,212,412, or 473,060 more than the previous year. During the year an issue of £25,000 debenture stock was made at £107. 10s., and the net premiums (£1,604. 14s. 10d.) have been carried to debenture stock premium redemption fund.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The directors have decided, subject to audit, to transfer £45,500 to reserve and to recommend the payment of the following final dividends for 1904:—*Preference*: 6s. per share, making 6 per cent. for the year (less tax). *Ordinary*: 7s. per share, making 6 per cent. (less tax). About £22,000 will be carried forward.

The transfer books and register of members will be closed from 22nd inst. to March 8 inclusive.

GIANT'S CAUSEWAY & PORTRUSH ELECTRIC TRAMWAY CO. (LTD).—The directors' report states that a considerable increase in the receipts took place last year, and 11,722 additional passengers were carried, bringing the number up to 119,876. The net profit for the year was £1,479. 1s. 9d., against £1,241. 14s. 8d. in 1903. The number of miles run electrically increased to 28,489, or about 5,500 over the number for 1903. This has been brought about by the successful working of the new overhead electric system. The engineer to the company (Mr. W. A. Traill, C.E.) reported that the increased electric mileage had given most satisfactory results, and if steam haulage could be done away with and electricity alone be used the result would be still more favourable.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—The report for 1904 states that during the year the number of houses and shops connected has increased from 3,210 to 3,451, while the number of 8 c.p. lamps increased from 280,133 to 303,048. After providing for amount placed to renewal account (£5,502. 8s.), writing £3,000 off cost of purchase of Kensington Court Co., and paying interim preference dividends and an interim dividend at the rate of 10 per cent. per annum on the ordinary shares, the net balance is £18,659. 4s. 9d., of which £2,125 has been appropriated to preference dividends, and the balance ordinary dividend at the rate of 10 per cent. and a bonus of 2 per cent. for the year (making 12 per cent.) will leave £9,184. 4s. 9d. to be carried forward.

LIVERPOOL OVERHEAD RAILWAY CO.—At the meeting on Tuesday the chairman (Sir W. B. Forwood) regretted there had been a falling off in traffic, notwithstanding reductions made in fares to meet competition. They carried during the half-year 5,613,752 passengers, against 5,896,503 in the same half-year of 1903, a reduction of 4·8 per cent. The relaying of the line was now practically completed. The net income for the half-year was £12,187, against £12,935. After paying debenture interest and preference dividend, a dividend on the ordinary shares at the rate of 1¼ per cent. per annum was recommended. They had earned per passenger 1·90d. Their highest earnings under this head were 1·99d. in 1897. The ratio of expenditure to revenue was 76·77, against 76·91. Their lowest ratio was 58·60 in 1899, proving that their accelerated service had not produced the increase in traffic they hoped for. The revenue per train mile had increased since the acceleration from 20·54d. to 22·78d., and their expenditure was 17·10d., against 18·43d. A special committee to deal with items of expenditure had not achieved much. They had received many suggestions, but shareholders should not forget that the competing tramways paid no rates. The company's rates for the half-year came to as much as the dividend they proposed to pay. The tramways had no costly structure; the roads were given to them, and even widened without cost, and, of course, they had no traffic to pick up at the roadside.

LONDON ELECTRIC SUPPLY CORPN (LTD.)—The directors' report for the year to Dec. 31 last states that the profit on the working for the year is £65,333. 6s. 4d. and interest and amount brought forward (£2,137. 0s. 9d.) makes £67,470. 7s. 1d. £15,478 5s. 11d. in interest has been paid, leaving £51,992 1s. 2d. The dividend on the 6 per cent. preference shares (including interim payment) requires £16,452 and a dividend of 3 per cent. on the ordinary shares for the year £9,990. £18,540. 10s. 6d. is put to reserve (making it £25,000), £5,000 to contingencies, and £2,009. 10s. 8d. is carried forward. The supply of current for power and lighting has been efficiently maintained during the year, and the anticipated decrease in cost of production more than fulfilled. The number of units sold was 10,531,785, compared with 4,102,099 for 1903. Capital expenditure for the year was £49,377. 15s. 8d., necessitated by the expansion of the company's business.

NEWCASTLE & DISTRICT ELECTRIC LIGHTING CO. (LTD.)—The report for the year ended Dec. 31 states that 3,259,389 units of electrical energy have been sold, compared with 2,649,841 units in the previous year. The gross earnings were £17,095 (including profit on land sold by company), and after paying interim dividend and interest the directors recommend a dividend at the rate of 8 per cent. per annum for the half-year ended Dec. 31 (making 7½ per cent. for year), carrying forward £370.

NORTH EASTERN RAILWAY CO.—At the meeting at York on Friday the chairman (Sir Edward Grey, M.P.) said that the electrical railways in the Tynemouth district had attracted so much attention that he felt it desirable the shareholders should be acquainted with the results of the working so far as they had been obtained. He had no hesitation in saying that the main result achieved had been satisfactory. They all knew how serious an effect tramways were having on railway receipts, and he had nothing to qualify in the statements which had been made on behalf of other companies with regard to the seriousness and hardship of that competition. The North-Eastern Co. were gratified to find that, though having to face tramway competition, instead of having to report a falling off in the number of passengers carried, they had carried on the electrical railway 675,000 more passengers than in the corresponding half-year. He took that as evidence that the public on the whole appreciated the convenience of electric trains. From the results obtained so far, any proposal to discontinue electric trains, and go back to steam on that particular line, would be regarded by the public, as a whole, as a reactionary and undesirable measure. There had been two difficulties. There had been complaints of overcrowding on the electric trains. That, he thought, was unavoidable until the trains could be adjusted to public needs. The company had been doing their best by carefully watching the trains and the hours at which overcrowding occurred, with the object of increasing the number of cars at those hours, and they proposed to go on doing that until they grappled with the difficulty, which had already greatly diminished. Another difficulty was the inconvenience which arose from the abolition on the electric railway of first-class carriages and the running of third-class carriages only. He pointed out that before the electric trains were introduced first-class passengers represented only 2 per cent. of the public travelling on those lines. Where increased facilities were being given by running more trains, it was impossible to provide for so small a portion of traffic without some sacrifice of economy in working. But the company proposed to devise some method by which, at any rate, some first-class accommodation would be provided. The financial result of the electric railway had so far been satisfactory. There had been an increase in receipts of £17,000—equivalent to 27 per cent.; and after deducting working expenses, interest on capital and depreciation, there was a certain net profit.

NORTH LONDON RAILWAY.—At the meeting yesterday the chairman (Lord Rathmore) said the gross receipts for the half-year to Dec 31 showed a decrease of £19,005, and the expenses an increase of £5,891. This was a very serious state of affairs. The receipts from passenger traffic continued to be very seriously affected by the competition of the Great Northern and City tube. To meet the altered condition of affairs one of the suggestions was that they should immediately follow the example of other metropolitan railways, who were using or preparing to use electrical power for traction, but the North London Co. had a very considerable amount of minerals and goods traffic, whereas the other metropolitan lines had only to deal with passenger traffic. Again, many of the North London trains ran over other lines, notably the North-Western and Great Northern, and until those companies adopted some uniform system of electrification, it would be useless for the North London Co. to attempt to electrify their line.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD.)—The report of the directors for the year 1904 shows that the supply of current, which on Dec. 31, 1903, was provided for the equivalent of 602,129 lamps of 8 c.p., had increased by Dec. 31, 1904, to the equivalent of 711,679 lamps. The length of roadway in which continuous-current mains have been laid now exceeds 75 miles, making about 286 miles of ways, into which upwards of 234 miles of copper strip and cable have been drawn. In addition three miles of trunk mains (12 miles of ways) are laid in the company's area to connect the stations with the Central Electric Supply Co.'s station at St. John's Wood. This station has supplied a large amount of current to this company at a considerably lower rate than in the previous year. There being a growing demand for current at a low price, the directors consider than any additional profit should for the present be devoted to the development of the company's business by the reduction in the rates of charge. A reduced scale of charges came into force on Jan. 1, which will affect the receipts for the current year, and a sum is carried forward sufficient to meet the temporary diminution of profits which may result from the reduction in price. After allowing for depreciation, sinking fund and other charges, the net balance is £56,328. 11s. 4d., from which the second half-year's preference dividend absorbed £3,342. 14s. 10d., leaving £52,985. 16s. 6d., and the board now recommend a dividend at the rate of 15 per cent. per annum (less tax), making 14 per cent. for the year, and carry forward £13,798.

YORKSHIRE ELECTRIC POWER CO.—The half-yearly report states that since the meeting in August the buildings connected with the Thornhill power station have been completed and, with the exception of the turbo-generators, all the plant has been delivered and installed. The first two of the turbo-generators are completed and are now being tested at the makers' works at Rugby, and it is anticipated that they will be erected in the station during the present month. A supply of electricity was available at the works before the end of December, and the first consumer was connected on Jan. 21. A general scheme of transmission has been decided upon, and plans have been prepared and apparatus ordered for a number of sub-stations. The laying of mains is being rapidly proceeded with so as to give an early supply in Birkenshaw, Drighlington, Gomersal, Liversedge, Mirfield, Pudsey, Ravensthorpe, Thornhill and other districts. At Dec. 31, 50 miles of cable had been ordered, of which 26 miles were actually laid. In addition to the agreement with Mirfield Council agreements have been entered into with the Corporation of Pudsey and Liversedge District Council for supply in bulk, the agreement with the latter, as with the Mirfield Council, enabling the company to supply large power users direct. Negotiations are proceeding with other local authorities, and agreements have been made with several large users of energy for power in the districts in which mains have been already laid.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANY.

ELECTRIC FLASH LIGHTS (LTD.) (83,520.)—Reg. Feb. 9, capital £25,000 in £1 shares, to acquire from B. Sherman the benefit of certain existing inventions relating to electric flash-light advertising, and to carry on the business of advertising agents and contractors, electrical engineers, manufacturers of and dealers in all kinds of electrical machinery, fittings, &c.

STATUTORY RETURNS.

ADELAIDE ELECTRIC TRAMWAYS (LTD.)—Return to Dec. 26, gives capital as £3,000 in £1 shares, of which seven have been taken up. No calls have been made. Mortgages and charges, nil.

BRITISH RAILWAY TRAFFIC & ELECTRIC CO. (LTD.)—In return to Jan. 12 capital is £100,000 in 100,000 shares of £1 each, of which 60,000 have been taken up. £1 per share has been called up on seven, 10s. on 5,000, and 6s. per share on 54,993 shares, and £19,004. 18s. has been received. No mortgages or charges.

BRITISH THOMSON-HOUSTON CO. (LTD.)—The return to Dec. 29 gives capital as £800,000 in 40,000 ordinary and 40,000 preference shares of £10 each, all of which have been taken up. £10 per share has been called up on 32,531 ordinary and 40,000 preference shares. £725,310 has been received. £74,690 is considered as paid on 7,469 ordinary. Mortgages and charges, £212,000.

LANCASHIRE ELECTRICAL ENGINEERING CO. (LTD.)—Return to May 6, 1904, gives capital as £5,000 in 5,000 shares of £1 each, of which 1,883 have been taken up. £1 per share has been called up on 50, and £50 has been received. 1,833 shares are considered as fully paid. No mortgages or charges.

MORTGAGES AND CHARGES.

CHISWICK ELECTRICITY SUPPLY CORPN. (LTD.)—Issue on Jan. 17 of £200 debentures, part of series created Nov. 2, 1900, and March 8, 1901, to secure £50,000, charged on company's undertaking and property, present and future, including uncalled capital. Holder, Miss H. Heybourne. No trustees. Previously issued of same series, £33,500.

LLANGOLLEN & DISTRICT ELECTRIC LIGHT & POWER CO. (LTD.)—A debenture, dated Feb. 4, 1905, and a mortgage of even date (by way of collateral security), to secure £1,000, has been registered. Property charged: (By debenture) company's undertaking and property, present and future, including uncalled capital; (by mortgage) certain leasehold premises. Holder, S. L. Jones.

WOKING ELECTRIC SUPPLY CO. (LTD.)—Issue on Jan. 21 of £200 debentures, part of series created Nov. 2, 1899, to secure £25,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £24,650.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Feb. 11	1,059	− 41	37	59,972	+ 5,753
Airdrie	„ 8	195	...	5	967	...
Ayr Corporation	„ 11	176	+ 14	39	11,903	+ 517
Barnsley	„ 8	1 5	+ 8	5	675	+ 21
Barrow	„ 8	193	...	5	840	...
Bath Electric Trams, Ltd.	„ 8	826	+ 21	6	5,166	+ 379
Bexley District Council	...	...	...	...	...	...
Birkenhead	...	...	...	...	...	...
Birmingham Corporation	„ 11	848	...	6	17,921	...
*Birmingham & Mid.	„ 8	1,706	+ 232	5	7,749	+ 601
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	„ 9	815	+ 24	45	65,290	+ 6,487
Blackpool and Fleetwood	„ 11	191	+ 5	6	1 081	− 106
Blackp'l, St. Anne's & Lytham	„ 9	136	− 15	18	1,563	...
Bolton Corporation	„ 12	1,677	+ 96	46	88,081	+ 453
Bournemouth Corporation	„ 8	285	− 7	‡45	64,897	+ 2,146
Bradford Corporation	„ 11	3,817	+ 376	48	199,614	+ 29,182
Brighton Corporation	„ 12	753	+ 43	45	41,920	+ 3,578
Brisbane Tramways	Dec. 21	2,405	− 298	26	(68,963)	+ 810
	„ 28	3,196	+ 414			
Bristol Trams & Carriage	Feb. 10	4, 20	− 84	1	4,540	− 84
Buenos Ayres & Belgrano	Jan. 8	8,414	+ 1	13	55,410	− 437
	„ 15	8,220	+ 253			
Buenos Ayres Elec. Trams	„ 7	1,138	...	2	2,174	...
	„ 14	1,036	...			
Burnley Corporation	Feb. 11	1,084	+ 145	19	6,349	+ 3,596
Burton Corporation	„ 12	287	− 15	¶45	15,429	...
Calcutta Tramways Co.	„ 11	a36,475	+ a479	6	a216,890	+ a22,428
Camborne-Redruth	„ 18	99	+ 6	15	13,545	− 202
Cardiff Corporation	„ 11	1,403	− 110	45	91,780	+ 1,975
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	„ 11	7,156	+ 30	6	41,190	+ 947
Chatham & Dist. Lt. Rys.	„ 9	600	+ 74	6	3,283	+ 263
*City of Birm'gh'm Tram Co.	„ 8	5,308	+ 105	5	24,846	+ 317
City & South London Rly.	„ 12	2,596	− 401	7	21,401	− 1,134
Colchester Corporation	„ 9	161	...	2	312	...
Cork Electric Trams Co.	„ 9	415	+ 37	6	2,542	− 47
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	„ 8	483	− 17	5	2,111	− 66
Dover Corporation	„ 11	160	− 9	46	10,041	− 138
Dublin & Lucan Railway	„ 10	99	+ 8	6	551	+ 10
Dublin Southern District	„ 10	832	+ 180	6	16,0 1	+ 820
Dublin United	„ 10	3,758	+ 98			
Dudley—Stourbridge	„ 8	758	+ 45	5	3,884	− 15
Dundee Corporation	„ 8	600	...	¶17	22,057	+ 291
East Ham Council	„ 11	660	+ 51	45	31,9 7	+ 1,737
Gateshead & Dist. Trams	„ 8	525	+ 5	5	4,114	+ 51
Glasgow Corporation	„ 11	13,956	+ 1,271	†37	525,060	+ 25,475
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	„ 8	186	− 17	5	873	− 65
Gt. Northern & City Rly.	„ 11	1,611	...	6	9,5 6	...
Greenock & Port Glasgow	„ 8	547	+ 40	5	2,424	+ 132
**Halifax Corporation	„ 8	3,411	+ 216	45	64,971	+ 4,769
Hartlepool Tramways	„ 8	244	− 5	5	1,133	− 31
Huddersfield	„ 11	1,194	+ 115	45	61,189	+ 8,876
Hull Corporation	„ 11	2,0 6	− 18	45	99,606	+ 10,905
‡Ilford District Council	„ 11	869	+ 30	¶45	30,127	+ 1 003
Ilkeston Corporation	„ 8	105	− 18	12	2,061	− 881
Ipswich Corporation	„ 11	326	− 6	45	21,012	—
Isle of Thanet Co.	„ 11	239	+ 10	19	5,467	+ 10
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	„ 8	95	+ 3	5	480	− 1
Kirkcaldy Corporation	„ 8	208	+ 18	...	...	...
Lanarkshire Trams Co.	„ 9	694	+ 95	6	3,763	+ 214
Leeds Corporation	„ 11	5,916	+ 493	47	262,569	+ 14,772
Leicester Corporation	„ 11	1,696	...	6	10,313	...
Liverpool Corporation	„ 4	9,817	+ 167	5	49,358	+ 1,312
Liverpool Overhead Rly.	„ 11	1,556	− 76	7	10,833	− 412
*London County Council	„ 4	14,455	+ 3,192	§44	552 616	+ 15,498
Lowestoft	„ 11	182	− 19	6	745	...
Maidstone Corporation	„ 9	101	...	30	4,067	...
Manchester Corporation	„ 11	11,004	+ 1,013	43	549,259	+ 24,571
Mersey Railway	„ 11	1,577	+ 116	6	9,681	+ 624
Merthyr	„ 8	178	− 14	5	811	− 71
*Metropolitan Elec. Trams	„ 8	1,805	+ 896	5	9,047	+ 3,945
Middleton	„ 8	275	+ 27	5	1,214	+ 99
Nelson Corporation	„ 11	104	+ 10	46	5,851	+ 1,330
Newcastle-on-Tyne Corp.	„ 11	3,456	+ 75	6	21,244	+ 769
Newport (Mon.)	„ 11	425	+ 26	19	9,624	+ 1,803
Oldham, Ashton & Hyde	„ 8	546	+ 11	5	2,301	+ 6
Oldham Corporation	„ 12	1,573	+ 336	46	57,618	+ 4,053
Perth (W. A.) Elec. Trams	„ 10	1,461	+ 132	6	8,851	+ 6 2
Peterborough	„ 8	101	− 7	5	471	− 32
Poole and District	„ 8	215	+ 2	5	1,017	− 24
Portsmouth Corporation	„ 11	1,414	+ 41	§45	61,5 7	+ 6,147
Potteries	„ 8	1,714	+ 71	5	7,724	+ 264
Reading Corporation	„ 9	572	− 1	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	„ 8	37	− 2	5	214	+ 14
Salford Corporation	„ 13	3,819	+ 151	44	184,179	+ 9,001
Sheerness	„ 1	43	+ 2	5	237	+ 39
Sheffield Corporation	„ 12	4,461	+ 331	‡43	2 4,024	+ 5,602
Southampton Corporation	„ 8	502	+ 85	45	41 437	− 2,403
Southend Corporation	„ 8	216	+ 11	45	15,705	+ 1,075
Southport Tramways	„ 8	223	− 25	5	1,010	− 98
‡S. Staffordshire Trams	„ 8	449	− 15	5	2,951	− 167
Stockport Corporation	„ 10	434	+ 51	45	24,551	+ 8,378
Sunderland Corporation	„ 12	1,019	− 9	45	56,595	+ 1,454
Swansea Trams	„ 8	452	+ 13	5	2,1 0	− 6
Taunton Trams	„ 8	29	− 9	5	160	− 31
‡Tynemouth and District	„ 8	164	− 30	5	843	− 152
Tyneside Trams Co.	„ 9	340	+ 61	6	1 812	+ 211
Wallasey District Council	„ 11	651	+ 60	§45	33,567	+ 2,370
Walsall	„ 11	459	...	6	2,191	...
Warrington Corporation	„ 9	327	+ 26	45	14,419	+ 530
West Ham Corporation	„ 9	1,102	...	53	49,377	...
Weston-super-Mare	„ 1	22	− 9	5	121	+ 16
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	„ 8	353	+ 31	5	1,585	+ 56
Worcester	„ 8	254	+ 119	5	1,178	+ 674
Wrexham	„ 8	95	...	5	431	− 84
Yorkshire Woollen District	„ 8	604	+ 121	5	2,545	+ 237

(a) These comparisons are with the corresponding period last year. † Minus 8 days ‡ Minus 2 days § Plus 2 days. ¶ Plus 3 days. ** Fortnight. * Partly electrical.

CITY NOTES.

MEMORANDA (Feb. 16).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 28$\frac{1}{16}$d. per oz. Consols 90⅜—90½ for money, 90$\frac{7}{16}$—90$\frac{9}{16}$ for account; 2½ per cent. annuities 89¼—89¾. Consols Pay Day, March 1. Stocks and Shares Continuation Days, Feb. 22 and March 13; Ticket Days, Feb. 23 and March 14; Pay Days, Feb. 24 and March 15; Mining Share Carry-over Days, Feb. 21 and March 10.

BAKER STREET & WATERLOO RAILWAY CO.—During the week applications were invited for £500,000 4 per cent. perpetual debenture stock.

BRITISH ELECTRIC TRACTION CO (LTD.)—An extraordinary meeting will be held to-day (Friday) to approve the promotion of the Wellingborough and District Tramroads and Electricity Supply Bill.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—The directors have declared a dividend for half-year ended Dec. 31 at the rate of 11 per cent. on the ordinary shares, making 10 per cent. for year.

MATHER & PLATT (LTD.)—The directors have declared an interim ordinary dividend at the rate of 6 per cent. per annum (tax free) for the half-year ended Dec. 31.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The directors recommend the following dividends for 1904:—2½ per cent. on preference shares (making 5 per cent. for year); 5½ per cent. on the ordinary shares (making 8 per cent. for the year); 3½ per cent. on the ordinary shares allotted in connection with purchase of the Walker & Wallsend Union Gas Co.'s electricity undertaking (making 6 per cent. for year).

OXFORD ELECTRIC CO. (LTD.)—Subject to audit, the directors recommend a dividend of 7 per cent. for 1904 (tax free), including the interim dividend of 2½ per cent.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Feb. 23 a special settling day in a further issue of 30,016 £1 fully-paid shares of *Marconi's Wireless Telegraph Co. (Ltd.)*. The committee have been asked to appoint a special settling day in and to grant a quotation to scrip (fully and partly paid) for £150,000 5 per cent. debentures of the *Havana Electricity Co. (Ltd.)*.

THE CITY OF CARLISLE ELECTRIC TRAMWAYS CO. (LTD.).—The surplus for the past year was £2,949, a decrease of £68 compared with 1903, and after providing for interest, &c., £1,555 is available for distribution. The directors propose to add £500 to depreciation, and to carry forward £1,055. The car miles run in 1904 were 359,756, the number of passengers carried 2,935,002, and the total receipts were £10,718.

TRAMWAYS & GENERAL WORKS CO. (LTD. & REDUCED).—A petition for confirming a resolution reducing the capital of this company from £14,000 to £6,000 is to be heard in the High Court by Mr. Justice Buckley, and the list of creditors is to be made out as for March 23.

COLONIAL AND FOREIGN INVESTMENTS.

	Last Dividend.	Name.	Price Wed., Feb. 15.	Rate per cent. Yielded.	Dividend Due.	Business, Week to Feb. 15. Highest.	Business, Week to Feb. 15. Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
	8/0	Anglo-Argentine Ord. Shares	8¼– 8½	8 10 7	Ap, Oc	8$\frac{7}{16}$	8¼
	2 6	Do. 5% Cum. Pref.	4⅝–4⅞	4 5 1	—	5¾	5⅝
4t	6%	Do. Permanent 6% Deb. Stock	140 —145	4 3 11	—	142	..
4	5%	Auckland Elec. Trams 5% Deb. (red.)	104 —106	4 15 3	—	105	..
1	6%	Barcelona Tramways Ord.	11½–12½	2 9 0	—	12⅛	..
1	5/0	Do. 5% Cum. Pref.	9¾–10	5 0 0	—	..	..
4t	4½%	Do. 4½% Deb. Stock (red.)	98 —100	4 10 0	..	..	..
0	5%	Do. 5 per Cent. Debs.	99 —102	4 18 4	..	..	..
	..	Brisbane Electric Trams. Invest. Ord.	1¼–1¾	..	..	..	..
£	4/6	Do. 6 per Cent. Cum. Pref.	3¾–4¼	5 17 8	—	..	..
4t	4½%	Do. 4½ per Cent. Db. Prov. Cu	94 —98	4 11 10	..	96½	..
St.	6%	British Columbia Elec. Rlwy Def. Ord.	102 —105	5 14 4	—	103½	103¼
St.	5%	Do. Pref. Ord. Stock	100 —103	4 17 2	—	101½	..
1	1/0	Do. 5% Cum. Perp. Pref.	10 —10½	4 10 11	..	..	..
1	4½%	Do. 4½ per Cent. 1st Mort. Dbs	102½—104½	4 6 9	..	103½	..
100	4½%	Do. Vancouver Power Debs.	99 —102	4 8 3	..	..	..
1	1/6	Buenos Ayres and Belgrano Ord.	3½– 4	5 12 6	—	4	3⅞
1	5 0	Do. 6 per Cent. "A" Cm. Pref	4¾–5¼	5 2 2	—	4⅞	5⅛
1	1/0	Do. "B"	5⅛–5⅜	6 9 1	—	5$\frac{5}{16}$	5$\frac{3}{16}$
St	5%	Do. 5 per Cent. Debs.	106 —108	4 12 7	—	..	—
St	5%	Do. 5% 2nd Deb. Stock Prov Certs.	102 —105	4 15 3	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	94 —97	5 3 1	..	..	..
1	5 0	Calcutta Tramways	1¾–1⅞	5 11 4	—	1$\frac{13}{16}$	1⅞
100	4½%	Do 4½% 1st Deb. Stock (red.)	106 —108	4 3 4	..	107	..
	1/6	Cape Electric Tram Shares	1⅝–1⅞	3 14 0	..	1$\frac{11}{16}$	1$\frac{9}{16}$
St	5%	Colombo Trams & Ltg. 5% 1st Mt Deb. (red)	102 —104	4 18 1	..	..	..
St.	5	Madras Elec. Trams 5% Deb. Stk.	101 —103	4 17 3	Ja, Jul	..	..
100	5%	Montreal St. Ry. St'g 5% Mort Debs. (1908)	101 —104	4 16 2	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922).	102 —104	4 6 7	..	..	..
St	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	102 —105	4 15 3	..	..	..
		ELECTRICITY SUPPLY.					
1	2/0	Calcutta Electric Supply Ord.	9 —9½	3 10 3	..	9¼	9$\frac{1}{16}$
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	88 —91	5 9 11	..	..	..
10	..	Havana Electricity Co. Shares	9¾–10¼	—	—	10$\frac{1}{16}$	10$\frac{1}{16}$
1	..	Kalgoorlie Elec. Power & Ltg 6% Cum. Pref.	⅞–1⅛	..	—	..	..
1	..	Rand Electric	1 –1¼	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	100 —102	4 8 9	Ap, Oc	..	..

*In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., Feb. 15.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to Feb. 15. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
1	..	Bath Elec. Trams Pref. Ord.	1¼–1½	..	..	..	..
1	1½d.	Do. 5% Cum. Pref.	1¼–1⅜	4 14 1	..	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	96 – 98	..	..	97½	..
10	8%	Bristol Tramways and Carriage Ord.	19 –20	4 0 0	Feb, Aug	..	..
10	6%	Do. Cum. Pref. (fully paid)	10 –10½	5 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 –108	3 14 [illegible]	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	9½–9¾	6 2 11	..	9⅞	9⅝
10	6/0	† Do. 6 per Cent. Cum. Pref.	11 –11½	5 6 8	Feb, Aug	11⅛	11⅛
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 –122	4 2 0	—	121½	121½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	97 –99	4 10 11	..	98½	98½
St.	4%	†Central London Ordinary Stock	90 –92	4 7 0	June, Dec	91½	91
St.	4%	† Do. 4 per Cent. Pref. Stock	99 –101	3 19 2	—	..	..
St.	4%	† Do. Deferred Stock	86 –87	4 12 0	—	..	..
100	4%	Do. 4 per Cent. Debs.	109 –111	3 [illegible] 0	—	111	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4¾–5¼	4 17 6	—	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	101 –104	3 17 8	..	102	..
St.	1½%	†City and South London Rly. Con. Ord.	44 –46	5 0 0	Feb, Aug	47½	46
St.	5%	† Do. 5 per Cent. Perp. Pref. (1891)	120 –123	4 1 4	Feb, Aug	..	..
St.	5%	† Do. (1896)	118 –121	4 2 8	..	119½	119
St.	5%	† Do. (1901)	115 –118	4 4 9	..	116½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	105 –108	3 14 1	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13 –14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	16½–16¾	3 12 9	—	..	..
10	4 0	†Gt. Northern & City Rly. Prf. Ord. (4%)	6 –6½	3 12 0	—	6⅜	6¼
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8½–8¾	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19 –20	4 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	15 –15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	111½–113½	4 0 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½–4	5 13 4	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	60 –62	6 6 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	8½–8¾	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 –10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10¾–11¼	4 14 0	..	10⅝	10½
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 –105	3 16 2	—	104	103½
St.	..	Mersey Con. Ord. Stock	6 –7	..	—	6	..
St.	..	Do. 3 per Cent. Perp. Pref.	10 –15	..	—	..	..
1	..	Metropolitan Electric Trams Def	⅛–¼	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	⅞–1	5 0 0	—	1	..
St.	4½%	Do. 4½% Deb. Stock	104 –106	4 5 0	..	106	104½
5	..	Kew Gen. Tract. 6 per Cent. Cum. Pref.	¼–1½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	8½–9	5 11 2	..	..	..
10	5 0	† Do. 5 per Cent. Cum. Pref.	8¾–9¼	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 –102	4 8 3	—	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London	58 – 59	8 2 0	..	59½	58½
St.	3½%	†Waterloo and City Ord.	92 – 94	3 6 5	June, Dec	93	91
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 – 102	4 0 0	Jan, July	..	..
10	..	Amazon Telegraph	1 –1½	..	Jn, Dec ..	..	..
St.	17/6	†Anglo-American	58 – 60	4 11 8	F,My,Ag,N	59½	58½
St.	35/0	† Do. Preferred	103 –105	5 6 9	F,My,Ag,N	104½	103½
St.	2/6	Do. Deferred	18⅝–19¼	..	F,My Ag,N	19⅛	18⅞
100	8%	Commercial Cable Capital Stock	170 –180	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95 –97	4 2 6	Jn Ap,Jy,O	96½	96½
10	6/0	Cuba Submarine Ord.	5½–5¾	5 8 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 1	Feb, Aug	17½	..
5	2/0	Direct Spanish Ord.	3½– 3¾	5 11 9	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	5 –5½	9 1 8	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	100% –102%	4 10 0	Jan, July	..	..
20	8/0	Direct United States Cable	11½–11¾	4 [illegible] 2	Ja,Ap,Jy,O	11⅝	11½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 –102	4 7 7	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	138 –141	4 [illegible] 3	Ja,Ap,Jy,O	141	137½
St.	17/6	Do. 3½ per Cent. Pref. Stock	88 –90	3 17 9	Ja Ap,Jy,O	89¼	87½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106 –108	3 14 1	May, Nov	..	..
10	2/6	Eastern Extension	13½–14	5 0 0	Ja,Ap,Jy,O	13¾	13½
St.	4%	Do. 4 per Cent. Deb. Stock	104 –106	3 [illegible] 7	Feb, Aug	105	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1900	103 –105	3 18 5	Feb, Aug	100½	100
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101% –103%	3 17 8	May, Nov	..	..
10	8/0	Great Northern (of Copenhagen)	[illegible]	4 [illegible] 9	Jan, July	[illegible]	[illegible]
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100 –102	4 8 8	June, Dec	..	..
25	12/6	Indo-European	46 –48	5 4 2	May, Nov	46½	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	98 –101	3 19 2	June, Dec	..	—
10	6/0	West African Telegraph Shares	7½–7¾	6 9 2	—	..	..
2½	..	West Coast of America	[illegible]	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	99 –101	3 19 2	Jan, July	..	..
10	..	West India and Panama	1½–1¾	..	May, Nov	1	1½
10	7/6	Do. 6% 1st Pref. ex 7 -on act. of arrears	5 –5½	7 13 0	May, Nov	5⅛	5
10	..	Do. 6 per Cent. 2nd Pref.	7½–8	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	102 –104	3 [illegible] 3	Jan, July	102½	..
10	8/0	Western Telegraph	13½–14	5 0 0	Mr,Jn,O,D	13⅞	13½
100	5%	* Do. 5% Debs. (2nd Series, 1900)	101 –103	4 17 1	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	102 –104	3 16 11	—	..	..
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	6¼–6½	5 7 8	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	1⅛–1¼	3 11 9	..	..	..
St.	6%	National Co. Pref. Stock	109 –110	5 9 1	..	110	109½
St.	6%	Do. Def. Stock	109 –111	4 10 1	..	111	109½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 –14	4 5 8	Feb, Aug	13¾	13½
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12 –13	4 12 4	Feb, Aug	12½	12½
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	4¼–4¾	4 10 11	Feb, Aug	5⅛	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 –100	3 10 0	June, Dec	98	97½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 –104	3 16 11	..	103½	103½
..	24/0	Do. Do. Prov. Certs, all paid	102 –104	3 16 11	..	103½	..
1	0/7½	Oriental	1⅛–1¼	5 7 3	April, Oct	..	—
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛–1¼	4 11 5	..	..	..
St.	20/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101 – 104	..	..	103½	102
5	3 0	United River Plate	7 –7½	5 8 8	July......	7½	7⅜
5	2/0	Do. 5 per Cent. Cum. Pref.	5 –5½	4 17 9	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	106 – 107	4 13 5	June, Dec	107	..
		FINANCIAL, INVESTMENT, &c.					
5	2/0	Elec. & Gen. Investment 5% Cum. Pref.	4½–4¾	5 17 1	—	..	..
10	2/0	Globe Telegraph and Trust	10½–10¾	5 4 9	Ja Ap Jy,O	10½	10⅜
10	3/0	Do. 6 per Cent. Pref.	13½–14½	4 4 11	Ja,Ap,Jy,O	14¼	13¾
100	6%	Submarine Cables Trust (Cert.)	121 –124	4 16 9	April, Oct	123	..
		ELECTRICITY SUPPLY.					
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½–13½	6 5 6	..	12½	..
10	4/6	† Do. 4½ per Cent. Cum. Pref	9½–10	4 10 0	..	..	—
10	6/0	† Do. 6% Cum. Second Pref.	11 –12	5 0 0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104 –106	4 4 10	—	..	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	4½– 5½	3 9 7	..	4¾	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 0	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½–11	4 10 11	..	10⅞	10⅝
5	3/6	Do. 7 per Cent. Pref.	10½–10¾	3 5 1	Mar, Sept	10½	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105 – 108	3 14 1	..	107	..
5	4/0	Charing Cross & Strand Electric Sup.	8½– 8¾	4 11 6	Feb, Aug	8½	8½
5	2/3	† Do. 4½ per Cent. Pref.	5½ –5¾	3 16 8	Feb, Aug	5⅝	5
St.	4%	Do. 4% Deb. Stock (red.)	102 –104	3 16 11	..	103	102½
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅞–5⅛	4 4 9	—	5⅛	..
5	2/3	Do. Do. (1903)	4⅞–5⅛	4 4 9	..	5⅛	..
5	2/3	Chelsea Electric Supply Ord.	6½–7½	4 0 8	March ..	6⅞	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 –110	4 1 10	Jn, Dec ..	..	..
10	8/0	City of London Electric Lighting Ord.	12½–13	3 16 11	Feb, Aug	13¼	12⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	13½–14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122 –126	3 19 4	Jn, Dec ..	—	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 –104	4 6 7	..	..	..
10	4/0	County of London Elec. Supply Ord.	9 –9½	4 4 2	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 –12½	4 16 0	Mar, Sept	12⅛	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	108 – 111	4 1 1	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	102 –104	4 6 7	..	103½	102½
5	2/0	Folkestone Electricity Supply Co. Ord.	5½–6	4 11 9	—	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 – 104	4 6 7	—	..	—
5	8/0	Hove Electric Lighting Ord.	7½–8	5 6 3	..	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	100 –102	4 8 9	..	..	..
5	5/0	Kensington & Knightsbridge Ord	13 –13½	4 8 11	..	..	..
5	6%	Do. 6 per Cent. 1st Pref	6½–7	4 8 9	Jan, July	—	—
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 –104	3 17 8	—	..	..
5	..	London Electric Supply Ord.	2¾–3¼	..	—	2⅞	2¾
5	3/0	Do. 6 per Cent. Pref.	5¾–6	5 0 0	..	6	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 –98	4 1 8	Mr,Jn,S,D	98½	..
10	9/0	Metropolitan Electric Sup. Ord.	18½–19½	4 18 8	April, Oct	19¼	18½
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¾–6¼	3 18 8	Jan. July	6	6
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 – 115	3 18 8	Jn, Dec ..	112½	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 – 98	3 11 8	..	98	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	97 –100	4 10 0	..	98½	97½
10	9½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	13 – 13½	5 3 5	Feb, Aug	..	..
5	8%	Newcastle Elec. Supply Ord.	8 –8½	4 19 3	Feb, Aug	..	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	6½ – 6¾	3 19 2	Feb, Aug	..	..
1	5%	Northern Counties Elec. Sup. 17/- paid	16/3–16/9	3 6 0	Mar, Sep	..	..
10	6/0	Notting Hill Electric Ord.	14½–15½	4 0 0	March....	14⅞	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	102 –104	3 17 0	..	103½	102½
5	2/6	Oxford Electric Ord.	5½–6¼	5 2 2	March ..	6⅛	..
St.	4%	Do. 4% Deb. Stock	98 –100	4 0 0	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	13½–14½	3 9 0	Feb, Aug	14⅛	13⅞
5	2/6	Do. 7 per Cent. Pref.	8½–9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98 –100	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3½ – 3¾	5 3 1	—	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	82 – 86	4 13 1	..	..	..
5	3/0	South London Electric Supply Ord.	4½– 4¾	5 6 5	—	..	..
1	..	South Metropo'n Elec. Lt. & Power Ord.	½–1	..	—	..	..
1	0/8½	Do. 7% Cum. Pref.	1⅛–1¼	4 15 4	—	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & conv.)	107 –110	4 2 8	—	..	..
5	2/6	Urban Electric Supply Ord.	5 - 5½	4 17 8	..	5¼	..
5	2/6	Do. 5% Cum. Pref.	5¼ – 5½	4 16 3	..	5¼	5⅛
St.	..	Do. 4½% 1st Mort. Deb.	106 –107	—	..	106	..
5	5/6	Westminster Electric Supply Ord.	13 – 13½	5 0 0	Mar, Sept	13¼	13
5	2/6	Do. 5 per Cent. Cum. Pref.	6½ 6¾	3 15 6	—	6¾	6⅝
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	½–¾	5 6 6	..	..	..
1	6d.	Aron Elec. Meter 6% Cum. Pref.	½–¾	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5½–6½	6 5 3	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	4½–4¾	5 4 4	Jan, July	..	—
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 –104	4 5 6	—	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 –103	4 10 6	—	..	..
5	3/0	British Westinghouse 6% Pref.	4½– 5	..	—	4⅞	4¾
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	87 –89	4 9 11	..	88½	87½
1	..	Brush Electrical Engineering	½–⅞	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½–1¾	7 7 6	Mar, Sept	1¾	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	95 –100	4 14 6	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	77 – 82	5 12 6	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	9½–10	5 5 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼–5½	4 9 10	Jan, July	5⅜	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	105 – 107	4 4 0	Nov, May	..	..
1	6½d.	Castner-Kellner Alkali Co. (fully paid)	1¾–2	4 9 5	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	91 –96	4 18 9	..	..	..
1	0/6	Chadburn's (Ship) Telegraph Ord.	⅞–1¼	3 17 8	..	..	..
2	1/6	Crompton and Co. (Nos. 1 to 54,000)	2¼–2½	3 0 8	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	93 –95	5 2 0	Jan, July	—	..
5	10/0	Dick, Kerr & Co. Ord.	7½–8½	6 1 3	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	5¼–5¾	4 18 0	Sept	5½	..
St.	4½%	Do. 4½% Deb. Stock	106–107	4 4 6	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½–¾	..	Feb, Aug	—	..
5	..	Do. (£5 paid)	1 –1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 –82	4 17 8	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 –84	6 0 6	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5½–6¼	5 12 0	H'lf-yearly	6⅛	6
5	3/0	Do. 6 per Cent. Cum. Pref.	6 –6½	4 16 0	—	6⅛	6⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106 –108	4 3 5	..	107½	..
2	1/7½	Electric Construction Co.	1½–1¾	5 5 0	July	1⅝	1½
2	2/9	Do. 7 per Cent. Cum. Pref.	2½–2¾	5 12 3	July	2⅝	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 –99	4 0 10	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –93	5 5 5	—	..	—
10	5/0	General Electric (1900) 5% Cum. Pref.	9½–10	5 0 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91 –96	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	11 –11½	6 1 9	Feb, Aug	11⅛	11⅛
5	2/3	Do. 4½ per Cent. Pref.	5½–5¾	4 3 9	Feb, Aug	5⅝	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	111 –113	3 19 7	Feb, Aug	111½	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	15 –16	6 5 0	Feb, Aug	16	15¾
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	99 –102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11 –11½	4 7 0	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	34 – 36	6 13 4	Mar, July	36	35
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101½–102½	3 17 8	Jan, July	..	..
5	—	Willans and Robinson Ord.	1½–2½	—	Apr, Oct	1⅝	1½
5	—	Do. 6 per Cent. Cum. Pref.	3 –4	—	Apr, Oct	3⅛	3
..	4%	Do. 4 per Cent. 1st Mort. Debs.	77 – 82	4 17 7	May Nov	80½	80

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

THE conversion of the extensive horse tramway system in Adelaide to electric traction has now been taken in hand by the South Australian Government, and the purchase price of the existing lines is to be determined by arbitration. By the terms of the South Australian "Tramways Electric Traction Act, 1904" the Government may not reconstruct the lines and work them itself, but has to invite offers from contractors of the terms upon which they will lease and construct. In spite of the elasticity of the powers given to the Government under the above mentioned Act there is no reason to believe that it will not carry the matter through to the end. The conditions of tender, which we give on another page, will therefore be read with interest by British tramway contractors, the more so if taken in conjunction with the article appearing on page 475 of our issue for January 6th, which summarised the whole of the conditions upon which the tramway system in Adelaide is to be reconstructed for electric traction. The opportunity is an exceptional one for the home contractor, for although "foreign" interests are already strong in Adelaide, it is clear that the South Australian Government is determined to secure the best that the markets of the whole world can offer. We therefore feel justified in giving prominent notice to the matter.

◆

DR. BARKLA, who is already known by his work on secondary Röntgen radiation, has communicated to the Royal Society a noteworthy Paper which we give in abstract in another column. Hitherto the study of this secondary radiation has, probably, been prosecuted largely in the hope that it might prove to be a sign of atomic disintegration produced by Röntgen rays in non-radioactive elements. Dr. BARKLA, however, has suddenly turned the phenomenon to the settlement of an older problem, the question of the possibility of polarising Röntgen rays, which has been prominent ever since their discovery. The matter is an important one, inasmuch as it affords the supreme test between the two rival theories – propagation by transverse or by longitudinal vibrations.

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JUST two years ago BLONDLOT published an account of his experiments showing that the X-rays stimulated a small electric spark to the greatest extent if the latter was parallel to the cathode stream in the focus tube. This undoubtedly indicated the existence of polarisation in the rays. But the same series of experiments led M. BLONDLOT to the discovery of the N-rays, and the original observations have since fallen somewhat into discredit. Dr. BARKLA, however, has now produced experimental evidence, and has given a convincing chain of reasoning, which, taken together, amount, practically to irrefutable proof that Röntgen rays can be polarised—that they consist, therefore, of progressive disturbances taking place transversely to the direction of their propagation. We need not recapitulate his arguments. It is sufficient to say he shows that if Röntgen rays from a focus tube are polarised then the secondary radiation they give rise to, by agitating the free electrons in their path, must be strongest in a definite direction. It will be seen from the Paper that the experimental results bear out the theory most precisely; and that the plane of polarisation in the primary rays is the same as was deduced, vaguely, from BLONDLOT'S experiments.

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THE final rules for the installation and use of electricity in mines are about to be issued by the Home Office, and we publish them in full this week. On page 689 of Vol. LII. of *The Electrician* we gave the draft regulations, and it will be seen that there is considerable difference between them and the revised edition. During the period which has elapsed between the publication of the two sets of regulations, various mine owners and others have been consulted by the Home Office, and suggestions as to amendments have appeared from time to time in the columns of *The Electrician*. Practically all of these suggestions, we are pleased to observe, have been acted upon. We had pointed out, for instance, that the total prohibition of live metal work within eight feet of the platform on the front of a switchboard carrying more than 250 volts was not in accordance with standard practice. This has now been altered so as to refer to switchboards carrying more than 650 volts. At the same time, the opinion was expressed that there was no necessity for all cables, other than lead-covered and armoured cables, to be protected by a strong covering. This regulation has also been modified so as to exempt all armoured cables, whether lead-covered or not. Mr. W. B. WOODHOUSE, in a letter to *The Electrician* of March 4, 1904, objected to the compulsory installation of a motor switch which would only permit of the machine being started up gradually. He very properly said that this regulation could not refer to squirrel-cage polyphase motors, and we are glad to see that it has been entirely deleted. To meet another suggestion by the same gentleman the paragraph relating to the over-load capacity and time limit of fuses has been amended, but is still open to the objection that no time limit is actually specified, although the current at which the fuse must blow has been increased from 100 to 200 per cent. Mr. WOODHOUSE also suggested that the provision of reverse-current cut-outs for generators should not be made compulsory; in the amended regulations these devices are only insisted upon for continuous current machines running in parallel, but in view of past events it is doubtful whether the Home Office is wise in pressing even this point.

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IN *The Electrician*, Vol. LIII., p. 48, there appeared a contribution on the same subject from a correspondent, who suggested that, as an alternative to carrying wires in earthed metal casing or strong armouring they might be fixed apart in such a manner that danger from fire or shock would be reduced to the minimum; this addition has been made, but the rule is not to apply to trailing cables. It is interesting to observe also that the stipulation as to the earthing of metallic lamp holders has been deleted. Under the draft regulations it was not permissible to employ a voltage greater than 650 for any motor or transformer of less than 75 B.H.P., but this figure has been reduced from 75 to 20 B.H.P., and the rule only applies to underground machines. Our correspondent also objected to the application of a test pressure to machinery of 50 per cent. above normal working pressure for half-an-hour. The Home Office has evidently recognised the stringency of this and has substituted leakage limit. The bunching of separate conductors carrying different pressures in the same grove or duct is not to be prohibited as was originally proposed, and it will be observed that the regulation affecting the number of switches and fuses in circuits has been greatly modified. Automatic cut-outs have been referred to already, but it is interesting to note that both automatic maximum cut-outs and switches will not now be insisted on between generators and 'bus-bars. Doubtless at our correspondent's suggestion, the entire paragraph which stipulates that a switchboard carrying current at a higher voltage than 250 may not be cleaned or repaired while in use has been omitted. Probably for the same reason a hand-wheel brush rocker is not insisted upon. Objections had been raised to the specification with regard to temperature rise of motors, and the specification has now been omitted altogether.

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THE alterations or amendments, as outlined above, will be welcomed by electrical engineers, and indicate the extremely reasonable attitude which has been adopted by the Home Office throughout. Congratulations are therefore due to this hard-worked Department and its electrical adviser on having successfully concluded a task which was of considerable magnitude and beset with innumerable difficulties.

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SINGLE-PHASE repulsion-induction motors are now in fairly frequent use throughout the country for various purposes, but we would draw special attention to the FYNN repulsion-induction motor driving a condensing plant which is described elsewhere in this issue, for we are informed that the commutation is perfect throughout the whole range of rating despite the fact that the supply frequency is as high as 75 ∼ per second. The question of sparking is usually the only one seriously put forward against single-phase motors with commutators. Efficiency and power-factor are not very high, but with lower frequencies these figures could no doubt be improved upon. It is a good feature of the motor, however, that both its efficiency and power-factor vary but little from their maximum values between 9 H.P. and 20 H.P.

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Royal Society. Among the Papers down for reading yesterday was one by Mr. G. T. Beilby on "Phosphorescence caused by the Beta and Gamma Rays of Radium." Part II. Communicated by Prof. J. Larmor, F.R.S.

Manchester Section of the Institution of Electrical Engineers.—The annual dinner of the Manchester Local Section of the Institution of Electrical Engineers will be held at the Midland Hotel, Manchester, on Friday, March 10th, at 6.45 p.m. for 7 p.m.

School Wrecked by Lightning.—A public school, situated 5 miles from Campbeltown, Argyllshire, was wrecked by lightning last Friday. The disaster happened just before the hour for the pupils to assemble, and fortunately no personal injuries were sustained.

Cable Interruptions.	Date of Interruption.
Cayenne—Pinheiros	Aug. 18, 1903
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1903
Tarifa—Tangier	Jan. 18, 1904
Cayenne—Paramaribo	July 13, 1904
Marmaritza-Rhodes	Jan. 30, 1905
Jamaica—Colon	Jan. 10, 1905
Martinique—Paramaribo	Feb. 14, 1905
Gibraltar—Tangier	Feb. 20, 1905

A Dragon Controlled by Telephone.—At a recent performance of "Siegfried" in New York, the dragon was worked by a couple of small boys, and there had been no time for a rehearsal. In these circumstances the stage manager conceived the idea of conveying instructions to the boys by telephone. He therefore strapped a receiver to the head of each and directed them comfortably from the prompt corner and with considerable success.

The Admiralty Inquiry into the Submarine Disaster.—An inquiry into the circumstances of the recent disaster on board Submarine A 5 in Cork Harbour was opened on Wednesday. Commander S. S. Hall, R.N., said he had examined the boat after the explosion and he thought that an explosive mixture of petrol vapour had been ignited by sparks on the commutator of a motor, while the latter was being started.

Automatic Translation on Long Land Lines.—With reference to our recent article on "Direct Wheatstone Working between England and Teheran," we learn that a somewhat similar arrangement was tried between St. Petersburg and Mukden a few years ago with about seven automatic translations. We believe that the result of these trials was satisfactory, but have been unable to ascertain whether the method of working has been actually adopted on this line.

The Institution of Mechanical Engineers.—According to the annual report of the council for the year 1904, the total number on the roll of the Institution at the end of 1904 was 4,477, which, as compared with 4,211 at the end of the previous year, shows a net gain of 266. During the past year 460 candidates were elected, of whom 47 were formerly graduates, and two elections became void, thus making 411 names added to the register. The total deductions have been 145, made up of 50 deceases during 1908, 59 resignations which took effect on January 1, 1904, and 36 removals.

University College, London.—The Fishmongers' Company have granted £1,000 towards the amount necessary for the incorporation of University College in the University of London. In addition to this grant there is still required to complete the funds necessary for incorporation a sum of £17,000, a total of £183,000 having now been raised for the purpose. On receiving from Prof. L. F. Vernon-Harcourt his resignation of the chair of Civil Engineering and Surveying, the council adopted the following resolution:—

> That the council, in accepting with much regret the resignation of Prof. L. F. Vernon-Harcourt of his office of Professor of Civil Engineering and Surveying, desire to place on record their high appreciation of the services he has rendered to the college during his long connection with it, and of the distinction he has conferred upon the chair he has held.

The Musgrave Heaphy Testimonial.—On Thursday of last week, Messrs. S. G. C. Russell and A. T. Snell, Hon. Secretaries to the Musgrave Heaphy Testimonial Fund Committee, travelled to Brighton, and presented the gold watch and chain, album of signatures and engrossed address to Mr. Musgrave Heaphy, as arranged at the meeting of subscribers held on January 27. In returning thanks, Mr. Heaphy said he appreciated very keenly the great honour which had been done to him both by the electrical and insurance professions, as well as by the Phenix Assurance Company. He wished each subscriber to know of the intense gratification and pleasure which their extremely kind and sympathetic action had given him, and that as long as he lived their address and testimonial would be the source of the greatest pride and satisfaction to him.

New Atlantic Cable—The Commercial Cable Co. are making arrangements to lay their fifth cable in the Atlantic. The order for the manufacture and laying of the cable will, it is announced, be given to an English firm, and we understand that tenders are being invited. The new cable is to be laid from Ireland to Nova Scotia, about 2,300 miles, and its cost is estimated approximately at £450,000. It is announced that Mr. George G. Ward, vice-chairman of the Commercial Company, in the course of a recent interview, stated that his company was in no way lacking in patriotism, but there was no American company equipped for the task of making and laying such a cable, and such work had to be left to English firms, who have complete facilities for the manufacture of, and cable laying and repairing steamers specially designed and equipped for laying such cables.

Wireless Telegraph Notes.—It is announced that messages may now be sent to Cunard mail steamers at any stage in their voyage across the Atlantic. During the first three or four days after the vessels leave Liverpool the messages will be despatched from Poldhu, Cornwall, direct to the steamer. Afterwards they will be forwarded by cable to North America and repeated thence to the approaching ship. The charge for direct messages will be 2s. 0½d. per word, and for those re-transmitted from the other side 3s. 0½d. per word.

An Alexandria correspondent of the *Manchester Guardian* states that the wireless telegraph station which has been under construction for some time by Lloyd's at the Red Sea extremity of Suez is expected to be in final working order about the middle of March. Wireless communication will then, for the first time, be practicable with ships in the Red Sea provided with wireless telegraphic apparatus, as well as throughout the entire course of the Suez Canal.

Opening of the Carnarvon Electricity Works.—The electricity works which have been erected at Carnarvon by the National Electric Construction Co. under an agreement with the Corporation, will be opened to-day. A provisional order was granted to the Corporation in 1902, and a lease has been granted to the Company by which the works can be purchased at stated periods, the Corporation having borrowed the necessary capital in the usual manner, and the company paying the charges thereon. Mr. Price F. White, the resident engineer to the Bangor Corporation, has acted as consulting engineer, and a three-wire continuous-current system has been adopted. The power station contains two Paxman "Economic" boilers and two Peache-Lancashire Dynamo and Motor Co.'s generating sets, the total capacity being 200kw. There is also a battery of 256 Hart cells having a capacity of 400 ampere hours at the 10 hours rate, and a Lancashire Dynamo Co.'s balancer booster set in the station. The cables are by the British Insulated and Helsby Cables Co. The tariff is 5d. per unit for lighting and 2½d. per unit for power. Mr. A. C. Goodman is resident engineer.

The Society of Architects.—A Paper on the "Lighting of Buildings, &c., by Electricity and Incandescent Gas" was read by Mr. B. R. Tucker before the Society of Architects on Thursday of last week. The author prefaced his remarks by saying that the latter part of the Paper had been read and corrected by an official of the South Metropolitan Gas Co.; but he did not say who, if anyone, had scrutinised his remarks on electric lighting, and it is to be imagined that these remarks were the outcome of the author's unaided efforts. Mr. Tucker admitted his ignorance of electro-technical matters, but we are bound to express our disagreement with a large number of his other statements. His Paper and the debate which followed were largely devoted to an attack on electric lighting and to comparisons between gas and electric lighting adverse to the latter method. The defence was ably undertaken by Mr. E. T. Ruthven-Murray, who said that Nernst lamps had a life of 1,000 hours as compared with the 400 hours put forward by the author, and that the Union flame arc lamp was the bitterest pill that gas people had ever had to swallow. It was absurd to say that a room was better ventilated by incandescent gas lamps than by electric lamps, except, of course, when the former were fixed immediately under chimneys leading to the open air. He did not think, however, that they, as architects, would design buildings with ventilating shafts specially for gas burners.

Fifteenth Annual Dinner of the General Electric Co.—This enjoyable function took place at the Trocadero Restaurant last Saturday evening, and was attended by about 400 guests, among whom were a number of prominent members of the electrical profession and industry. Mr. Max. Byng occupied the chair, and in proposing the "Staff" referred to the early struggles of the directors of the General Electric Co. They had worked morning, noon and night, and he urged the staff to follow their example. Messrs. Brooker and Dumas replied. In proposing the "Visitors," Mr. H. Hirst referred to the troubles and worries to which the company had to submit in the shape of "specifications for a dozen lamps and 2lb. of fuse wire." He had heard that Mr. Philip Dawson had devised a scheme whereby the ozone at Brighton would be converted into oxygen, and the electricity produced thereby employed for running the L. B. & S. C. trains. Mr. Dawson did not, however, confirm this statement in the course of his reply to the toast. Another name coupled to the "Visitors" was that of Mr. Gaine, general manager of the National Telephone Co., who refused to disclose anything relating to the agreement with the Government not already known to the public. He was sure, however, that great developments would occur in telephony before the transfer actually took place. Mr. Irwin (chairman of the Dublin Electricity Committee) also replied to the same toast. Mr. Medhurst proposed the "Directors of the General Electric Co."; Mr. Bevis replied, and the toast of the "Chairman" was given by Sir Richard Audrey. An excellent entertainment was provided during the evening, and all speakers were unanimous in praise of the General Electric Co.'s manufactures.

University College Engineering Society.—On Friday, February 3rd, Mr. R. Sawers (student) read the first part of a Paper on "Electric Tramways" before the Engineering Society of University College, London, Dr. J. A. Fleming, F.R.S. (Vice-President of the Society) being in the chair. Mr. Sawers dealt with the construction of the permanent way, overhead equipment &c., (contending that the grooved ear had an advantage over the soldered type), and trolley heads, illustrating the Paper with specimens of the various parts and samples, concluding with a description of generators and the system of feeding. On Friday, February 10th, Mr. R. Sawers continued his Paper describing the different types of tramcars and their equipment, &c. Mr. Sawers then exhibited one of Messrs. Dick, Kerr, & Co.'s series parallel tramcar controllers (Short system), explaining fully the connections and mode of operation. Dr. J. A. Fleming, in proposing a hearty vote of thanks to Mr. Sawers for his interesting and instructive Paper, referred to the difficulties which had had to be overcome before the electric tramcar could reach its present day form, pointing out that each piece of apparatus was, so to speak, a case of "the survival of the fittest." He then gave an outline of the great problem which electrical engineers in this or the next generation would have to combat—viz., the electrification of main line railways, referring to the work which is being done at the present time with respect to suburban lines, and the different experiments with high and low-tension transmission which are now being, or are about to be made, by various railway companies. The following students took part in the discussion:—Messrs. A. F. C. Pollard (Vice-President), W. A. Erelebach, N. H. Hamilton, F. C. Prentice, F. J. Kean, and J. S. Westerdale.

Mercury Vapour Lamps in a Newspaper Printing Works.—The following is a brief summary of the electrical equipment of the new building of the *New York Times*, which contains 21 miles of conduit and 74 miles of wire, and will take, it is said, no less than 1,000kw.-hours daily from the mains of the New York Edison Company, it having been decided quite early not to put in an isolated plant. The electrical equipment includes, according to the *Electrical World* of New York, 111 motors of different makes—4,000 incandescent, 15 arc and 42 Cooper-Hewitt lamps. The Cooper-Hewitt mercury tubes are employed in both the composing and press room. There are 12 such lamps in the former department, and for the make-up tables they are considered by those who have worked under them very satisfactory, giving a cool, soft light, not unlike that of daylight. With regard to the type-setting machinery, &c., as the light casts no shadow the type can be seen from any position. New type also can be easily read, as it has a dull appearance and casts no reflection. There are also four lamps in the mailing department. In the press and stereotype rooms 26 Cooper-Hewitt lamps are installed, lighting four double, quadruple, octuple presses and two autoplate machines. These tubes take the place of 132 incandescent lamps and 14 arcs, consuming but one-third of the current. They light the four presses thoroughly, as well as the area of 17,000 sq. ft. of floor space with a ceiling 21ft. high. The original estimate for current with arcs and incandescents was 15kw. The Cooper-Hewitt outfit consumes 5·46kw. The type of lamps used, taking 3·5 amperes per pair, have for 109-125-volt circuits a light-giving length of 20½in. and a total tube length overall of 27½in. The diameter of the tube is 1in., and the length of the suspension bar varies from 3in. to 4ft. With only a 3in. suspension bar the lower end of the lamp is 15in. from the ceiling.

Board of Trade Return of Tramways and Light Railways.—A Board of Trade return has just been published showing the amount of capital authorised, paid up and expended, the length of line authorised, length open, &c., of all the tramway and light railway undertakings in the United Kingdom. The figures are given down to December 3, 1903, in respect of companies, and March 31, 1904, in respect of local authorities, and particulars are also given of the gross receipts, working expenditure, net receipts and their application, the number of passengers carried, quantity of electrical energy used, and the number of miles run, as well as the number of horses, engines and cars. The return is in an enlarged form compared with previous years, this having been necessitated by the inclusion of lines sanctioned under the Light Railways Act, and the increased information required to adapt the tables to the circumstances of electric traction. From a comparative Table prefixed to the return it appears that, as compared with 1878, the number of route miles open for traffic has increased from 269 to 1,840 in 1903-4, the capital expenditure from £4,207,350 to £46,151,444, the number of passengers carried from 146 millions to 1,799 millions, and the net receipts from £230,956 to £2,912,110. The capital expenditure includes the cost of both old and new permanent way in the case of horse tramways reconstructed for electric traction, and also the purchase price of horse tramway systems that have been acquired by local authorities. At the periods mentioned above there were 1,462 miles 1 chain of tramways in the United Kingdom worked electrically, 108 miles 58 chains of steam lines, 29 miles 70 chains of cable trams, 4 miles 2 chains driven by gas power, and 235·22 chains of horse-drawn tramways. Of this total 1,147 miles 59 chains were in the hands of local authorities, and the remainder, 692 miles 14 chains, in the hands of companies. There were on March 31, 1904, 162 municipal tramway undertakings, and on December 31, 1903, 150 company undertakings. The return comprises 57 pages of small type and figures, and is in two parts, the first relating to capital and the second to traffic. The tramways supplement issued with *The Electrician* for February 3rd gives particulars to December 31, 1904, on many points dealt with in the above return.

Smoke Prevention in Different Countries.—A circular was addressed last May by the Marquess of Lansdowne to the British representatives in various foreign places, requesting them to report on the laws in force in their respective countries for regulating, restricting or preventing the emission of smoke. These reports, 13 in number, have now been published. Austria has no special laws relating to the regulation of smoke emission, but the sanitary laws empower the authorities to refuse sanction for the establishment of factories "which are calculated to endanger or harm the surrounding neighbourhood by the emission of an injurious quality of smoke." Although no special laws have been framed in Bavaria for the purpose mentioned, yet the smoke and soot nuisance may be dealt with by a number of laws on kindred subjects. Belgium, too, is without any special laws, but a licence must be obtained from the authorities previous to the erection of any works or factories of a dangerous, unhealthy or objectionable nature. The smoke question is dealt with in France by a police ordinance which prohibits the prolonged emission of thick black smoke from industrial works, but allows an emission—after stoking furnaces every morning and after each successive stoking during the day—three times as long as that allowed in London. In 1899, 240 well-founded complaints were lodged; in 1900, 104; in 1901, 88; and in 1902, 84. In Prussia, there is a State aided system of education for stokers, by which they are trained in correct methods of firing. At Buda-Pesth, all chimneys used for boilers having a heating surface of 3 square metres (32 sq. ft.) or more or for furnaces consuming upwards of 44lb. coal per hour must be furnished with smoke-consuming appliances to be approved by the engineering department of the municipality. In Italy, works emitting noxious fumes must be established in the country and at a distance from inhabited houses. In the Netherlands no building which may cause annoyance may be erected without the permission of the municipal authorities. The municipality of Dresden forbids the constant emission of smoke, and has appointed an inspector. This inspector is assisted by an expert foreman stoker, who, it appears, is frequently called upon to give practical illustrations of skilful stoking in reducing the volume of smoke. In the United States the regulations vary in different States. Philadelphian regulations set up a colour scale, and forbid, for instance, the emission of smoke of a density sufficient to cut off 84 per cent. of light in the case of a chimney less than 50ft. high. This does not apply to smoke emitted between 4 a.m. and 7 a.m. The penalty is $25 for each offence, and the violation has to be notified within five days. The smoke nuisance is dealt with in the State of New York in accordance with the Public Health Law. This gives the authorities power to remove the source of annoyance if the owner does not do it himself when requested. Chicago has a chief smoke inspector, and no one may be prosecuted for the emission of dense smoke unless at least three notices have been served within 10 days prior to the prosecution.

The British Association.—*Nature* has published a preliminary announcement with regard to the meeting of the British Association for the Advancement of Science which will be held in South Africa this summer. The "official party" of guests invited by the central executive committee at Cape Town, and nominated in the first instance by the council of the Association, numbers upwards of 150 persons, comprising members of the council, past and present general officers and sectional presidents, the present sectional officers and a certain proportion of the leading members of each section. To this list has yet to be added, on the nomination of the organising committees, the names of representative foreign and colonial men of science, the total number of the official party being restricted to 200, including the local officials. It is hoped, however, that many other members of the Association will also attend the meeting. The presidents-elect of the various sections are as follows :—

A (Mathematical and Physical Science), Prof. A. R. Forsyth, F.R.S. ; B (Chemistry), Mr. G. T. Beilby ; G (Engineering), Colonel Sir Colin Scott-Moncrieff, G.C.S.I., K.C.M.G., R.E. ; L (Educational Science), Sir Richard C. Jebb, M.P.

In view of the numerous towns to be visited by the Association, in which lectures or addresses will be given, the number of lecturers appointed is much larger than usual. Among these are :—

Cape Town: Prof. Poulton on Burchell's work in South Africa ; and Mr. C. V. Boys on a subject in physics. *Durban*: Mr. F. Soddy on radioactivity. *Maritzburg*: Prof. Arnold on compounds of steel. *Johannesburg*: Prof. Ayrton on distribution of power ; Prof. Porter on mining. *Kimberley*: Sir William Crookes on diamonds.

Most of the officials, and other members of the Association, will leave Southampton on July 29th by the Union Castle mail ss. "Saxon," and arrive at Cape Town on August 15th, the opening day of the meeting ; but a considerable number will start from Southampton on the previous Saturday, either by the ordinary mail boat or by the intermediate steamer sailing on that date. The sectional meetings will be held at Cape Town (three days) and Johannesburg (three days). Between the inaugural meeting at the former and the concluding meeting at the latter town, opportunities will be offered to members to visit the Natal battlefields and other places of interest. Subsequently a party will be made up to proceed to the Victoria Falls (Zambesi) ; and, should a sufficient number of members register their names, a special steamer will be chartered for the voyage home, via Beira, by the east coast route, as an alternative to the return through Cape Town by the west coast route. Thus all the colonies and Rhodesia will be visited by the Association. The tour will last 70 days via Cape Town, or a week longer via Beira (all sea), leaving Southampton on July 29th and returning thither on October 7th or 14th. A central executive committee has been constituted at Cape Town, with Sir David Gill as chairman and Dr. Gilchrist as secretary ; while local committees have been formed at Johannesburg and other important centres. Prof. G. H. Darwin, F.R.S., is the president-elect, and among the vice-presidents-elect are the following :—The Right Hon. Lord Milner, the Hon. Sir Walter Hely-Hutchinson, Sir Henry McCallum, the Hon. Sir Arthur Lawley, Sir H. J. Goold-Adams, Sir David Gill, and Sir Charles Metcalfe. At the invitation of the Association the local committee in Johannesburg has nominated the following as vice-presidents and secretaries respectively of the different sections :—

Mathematics and Physical Science: Vice-president, Dr. Breyer ; secretary, Mr. R. T. A. Innes. *Chemistry*: Mr. J. R. Williams, Mr. W. A. Caldecott. *Engineering*: Mr. S. Jennings, Mr. E. Williams. *Educational Science*: Mr. E. B. Sargant, Prof. Hele-Shaw.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) **FRIDAY, February 24th.**

PHYSICAL SOCIETY.

5 p.m. Ordinary Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda :—(1) "On the Curvature Method of Teaching Geometrical Optics," by Dr. C. V. Drysdale ; (2) "Exhibition of Dr. Meisling's Colour Patch Apparatus," by R. J. Sowter ; (3) "A Method of Illustrating the Laws of the Simple Pendulum and an Exhibition of String Models of Optical Systems," by J. Schofield.

INSTITUTION OF ELECTRICAL ENGINEERS : MANCHESTER STUDENTS' SECTION.

7.30 p.m. Meeting at the Manchester School of Technology. Paper to be read : "Metallography," by Mr. Buttenshaw.

RUGBY ENGINEERING SOCIETY.

8 p.m. Meeting in the Benn Buildings, High-street, Rugby. Mr. J. T. Milton will commence a course of three lectures on "The Minute Structure of Metals."

ELECTRO-HARMONIC SOCIETY.

8 p.m. Concert (ladies' night) at the Holborn Restaurant (King's Hall).

SATURDAY, February 25th.

INSTITUTION OF ELECTRICAL ENGINEERS : STUDENTS' SECTION.

2.30 p.m. Visit to the Great Northern & City Railway. Meet at Moorgate-street station.

4.30 p.m. Visit to the Post Office Central Telephone Exchange.

MONDAY, February 27th.

INSTITUTION OF ELECTRICAL ENGINEERS : NEWCASTLE LOCAL SECTION.

7.30 p.m. Meeting at the Durham College of Science. The discussion on Mr. H. Riseley's Paper, "Description on Some Plants inspected during a Recent Visit to the United States," will be continued, and Dr. W. M. Thornton will read the following Paper : "Notes on Alternating-current Working."

SOCIETY OF ARTS.

8 p.m. Cantor Lecture III. : "Internal Combustion Engines," by Dugald Clerk.

TUESDAY, February 28th.

SOCIETY OF ARTS : COLONIAL SECTION.

4.30 p.m. Ordinary Meeting. Paper to be read : "The Manufactures of Greater Britain.—I. Canada," by C. F. Just.

INSTITUTION OF ELECTRICAL ENGINEERS : MANCHESTER LOCAL SECTION.

7.30 p.m. Meeting in the University (Physical Laboratory). Paper to be read : "Mechanical Construction of Steam Turbines," by W. J. A. London.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read : "Surface Condensing Plants and the Value of the Vacuum Produced," by R. W. Allen.

WEDNESDAY, March 1st.

INSTITUTION OF CIVIL ENGINEERS : STUDENTS' SECTION.

2.30 p.m. Visit to inspect the works in progress for the widening and enlargement of Victoria Station, L. B. & S. C. Railway.

INSTITUTION OF ELECTRICAL ENGINEERS : STUDENTS' SECTION.

7.30 p.m. Meeting at 92, Victoria-street, Westminster, S.W. A Discussion will take place on "The Gas Engine *v.* The Electric Motor for Small Workshop Driving."

THURSDAY, March 2nd.

GLASGOW UNIVERSITY ENGINEERING SOCIETY.

7.45 p.m. Ordinary Meeting at the University. Paper to be read : "Some Problems of Electric Traction," by Theodore Rich.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Extra Meeting. Paper to be read : "Type Setting by Telegraph," by Donald Murray.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

8 p.m. Meeting at Caxton Hall, Westminster. Paper to be read : "Engineering Expert Evidence," by James F. Reade.

RÖNTGEN SOCIETY.

8.15 p.m. Meeting at 20, Hanover Square, London, W. Dr. William Deane Butcher will open a discussion on "The Necessity of Accurate Measurement in X-Ray and High Frequency Work."

FRIDAY, March 3rd.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at Westminster Palace Hotel. Paper to be read : "Possible Improvements in Locomotive Practice," by W. Longland.

ROYAL INSTITUTION.

9 p.m. Evening discourse : "Recent Advances in Wireless Telegraphy," by G. Marconi.

SATURDAY, March 4th.

GLASGOW TECHNICAL COLLEGE : SCIENTIFIC SOCIETY.

7.30 p.m. Meeting at 38, Bath-street. Paper to be read : "Steam Generators and their Failures," by G. Ness.

THE TELEPHONE AGREEMENT.

The Postmaster-General has issued a memorandum dated February 14, 1905, and setting forth an Agreement, dated February 2, 1905, between the Postmaster-General and the National Telephone Co. This Agreement has been placed before the House of Commons, whose consent to it is to be granted before it is finally ratified. The provisions of the Agreement are summarised by Lord Stanley as follows:—

On November 18, 1901, the Postmaster-General entered into an Agreement with the National Telephone Co. (Ltd.) for the purchase of the plant of the company in the London exchange area on the termination of the company's licence, that is, on December 31, 1911. The plant was to be purchased at its value *in situ*, and no payment was to be made in respect of compulsory purchase, goodwill or past or future profits, in other words, the purchase was to be made on what are known as "tramway terms." The Agreement also provided for intercommunication between the systems of the Postmaster-General and of the company in London during the continuance of the company's licence, and for uniformity of rates. This Agreement was in effect approved by the House of Commons, after full discussion, on January 27, 1902.

An Agreement, on similar lines, has now been made in relation to the whole country. On December 31, 1911, the Postmaster-General will take over the whole business carried on up to that date by the company, and will acquire the plant of the company on "tramway terms." No payment will be made in respect of goodwill or profits except in the case of the private wire business of the company (which can be carried on without the Postmaster-General's licence) and in the very few cases where the company's licence has, under the provisions of the Telegraph Act, 1899, been extended beyond 1911.

At the option of the Government three-fourths, and, with the consent of the company, the whole, of the purchase money may be paid by way of annuity for a term not exceeding 20 years.

Certain powers of objecting to plant as unsuitable for purchase are reserved to the Postmaster-General; and rules for the construction of plant are laid down.

During the continuance of their licence the company are to allow intercommunication without additional charge between the systems of the Postmaster-General and of the company. The company will be precluded from showing favour or preference as between subscribers, and the rates charged by the company will be confined within certain limits. If, on complaint and after full enquiry, it is proved that the company is giving an inefficient service in any district, the Postmaster-General may take over the company's business in that district at once, without any payment for goodwill.

Certain provisions of the London Agreement which are not of general application remain in force. In other respects the provisions of that Agreement have been assimilated to those applicable to the rest of the country.

The Agreement will become binding when confirmed by a resolution of the House of Commons, or on August 31 if not disapproved by Parliament before that date.

The preamble of the Agreement refers to the various other agreements in force between the Post Office and the National Telephone Co. The first of these is the Licence of 1884, by which the company was licensed to work a telephone exchange business until December 31, 1911, the main conditions being that the company should not receive or deliver written messages, and that it should pay to the Government, as royalty, 10 per cent. of the gross receipts. At the end of 1890, 1897 or 1904, however, on giving six months' previous notice, the Postmaster-General had the option of purchase at a price fixed by mutual agreement or by arbitration. No mention in this licence was made of any terms of purchase at the end of the period of the licence. The second Agreement was in 1896, when the Post Office arranged to take over the trunk lines from the National Telephone Co. The third Agreement, known as the "London Agreement," was dated November 18, 1901, and it was agreed then (*inter alia*) that the Postmaster-General should, on December 31, 1911, on the expiry of the Licence of 1884 in the London exchange area, purchase all such plant of the company within that area as was in use for the purposes of the company's London system at the latter date and was then suitable for the requirements of the telephonic service of the Post Office in that area.

Reference is also made to the fact that under the provisions of the Telegraph Act, 1899, the Licence of 1884 has been extended within certain areas, on the grant of Telephone Licences to local authorities within these areas. These are tabulated in the following schedule:—

SCHEDULE I. **Areas where the Licence of 1884 has been Extended beyond December 31, 1911.**

Exchange area.	Date to which licence of 1884 extended.	Date of agreement relating to extension of licence of 1884.
Glasgow	December 31, 1913	July 8, 1901.
Portsmouth	June 30, 1926	August 11, 1902.
Tunbridge Wells	April 30, 1925 (subject to determination by Postmaster-General on Dec. 31, 1911, under agreement of Oct. 10, 1903)	August 11, 1902.
Swansea	December 31, 1920	September 27, 1902.
Brighton	April 30, 1926	May 16, 1904.

The terms of purchase are set forth in the following clauses of the Agreement:—

2. *Purchase and Sale.*—(1) Subject to the provisions of this Agreement the Postmaster-General shall buy and the company shall sell and convey on December 31, 1911:—

(*a*) All plant, land, and buildings of the company brought into use with the sanction of the Postmaster-General, and in use by the company on December 31, 1911, for the purposes of the licensed telephonic business of the company.

(*b*) Any licensed telephonic business of the company which, by virtue of the Telegraph Act, 1899, or of any of the agreements in writing between the Postmaster-General and the company particularly specified in the first schedule hereto, or of any other Agreement in writing between the Postmaster-General and the company (whether made before or after the date of this Agreement) can be transacted for any period after December 31, 1911.

(*c*) Any private wire business of the company, together with all plant, land and buildings in use by the company on December 31, 1911, for the purposes of such business.

(*d*) All stores which, on December 31, 1911, are in the company's possession, and which are suitable for use in accordance with the methods of work described in the specification and rules set forth in the third schedule hereto,* and all furniture in the company's possession at the same date provided such stores and furniture are reasonably necessary for the purposes of the telephonic business of the company according to the ordinary and business-like way of carrying on such business.

(2) Spare plant of all descriptions in the possession of the company on December 31, 1911, including works of all kinds in course of construction at the same date (provided such plant and works are reasonably necessary for the purposes of the telephonic business of the company, according to the ordinary and business-like way of carrying on such business) shall be deemed to be plant in use by the company on December 31, 1911, for the purposes of the company's telephonic business.

(3) Plant, land, and buildings shall be deemed to have been brought into use with the sanction of the Postmaster-General if such plant, land, and buildings comply with one of the following conditions, but not otherwise (that is to say):—

(*a*) If such plant, land, or buildings are in use (or are in process of being brought into use) for the purposes of the company's business at the date hereof; or

(*b*) In the case of plant, if such plant is after the date of this Agreement constructed by the company in accordance with the specification and rules set forth in the Third Schedule hereto;* or

(*c*) In the case of land and buildings, if such land and buildings are after the date of this Agreement acquired or constructed with the consent in writing of the Postmaster-General.

Provided that no exchange which has a capacity of more than 300 direct subscribers' lines, and the construction of which was commenced after August 15, 1904, shall be deemed to have been brought into use with the sanction of the Postmaster-General unless its site and capacity shall have been approved in writing by the Postmaster-General, or unless at the time when the question arises it shall be determined by arbitration that such exchange will be suitable for the requirements of the telephonic service of the Post Office on December 31, 1911.

3. *Suitability.*—(1) In the case of—

(*a*) Plant not constructed in accordance with the specification and rules set forth in the third schedule hereto (other than switchboards and internal exchange plant in use on August 15, 1904, and specified in a list furnished by the company to the Postmaster-General within six months from the date of this Agreement), and

(*b*) Plant of any kind, land and buildings in use on January 1, 1911, for the purposes of the company's licensed telephonic business in competitive exchange areas† (whether such plant is constructed in accordance with the said specification and rules or not),

the Postmaster-General may, by notice in writing given to the company not later than January 1, 1911, object to buy such plant, land or buildings as he considers will be unsuitable for the actual requirements of the telephonic service of the Post Office on December 31, 1911.

(2) Any question of the suitability of plant, land or buildings for the requirements of the telephonic service of the Post Office raised by the Postmaster-General under the last preceding sub-clause shall, if the parties differ, be referred to arbitration, and if the company (otherwise than through any cause beyond their control) fail on or before June 30, 1911,

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* See p. 740.

† *Schedule II.*—Competitive Exchange Areas: Abergavenny, Bridgend, Brighton, Briton Ferry, Cardiff, Glasgow, Hull, London, Merthyr Tydvil, Newcastle-upon-Tyne (with Gateshead), Newport (Monmouthshire), Pontypool, Pontypridd, Portsmouth, Swansea.

to obtain an award of the arbitrator or tribunal to which such question is under the provisions of this Agreement referred, to the effect that any plant, land or building specified in any notice of objection given by the Postmaster-General under the last preceding sub-clause will, in the opinion of the arbitrator or tribunal, be suitable for the actual requirements of the telephonic service of the Post Office on December 31, 1911, the objection of the Postmaster-General shall be deemed valid, and he shall not be bound to buy such plant, land or building as aforesaid, any other provision of this Agreement to the contrary notwithstanding.

(3) For the purposes of this clause the Postmaster-General may give one or more notices of objection, and all questions of suitability of plant, land, or buildings raised by him may be the subject of one reference to arbitration, or different questions may be the subject of different references as may be agreed between the parties, and the provisions of the clause shall apply in either case.

(4) The right of objection reserved to the Postmaster-General by this clause in relation to plant, land and buildings in competitive exchange areas, shall extend to plant constructed and to buildings constructed or acquired, and to land acquired by the company in such areas during 1911, provided the Postmaster-General gives notice in writing within three months after December 31, 1911, that he objects to buy such plant, land, or buildings. In such case the provisions of this clause as to arbitration shall apply, and the question referred shall be the suitability of the plant, land or buildings for the actual requirements of the telephonic service of the Post Office on December 31, 1911, and the date before which an Award must be obtained by the company (otherwise than through any cause beyond their control) shall be September 30, 1912.

(5) In the event of any plant being excluded from the Postmaster-General's purchase under the provisions of this clause or otherwise, the company shall give the Postmaster-General, at the cost in all things of the Postmaster-General, all reasonable facilities for the construction of alternative plant in connection with the company's telephonic system for use upon the transfer of that system to the Postmaster-General.

4. *Value.*—(1) The value on December 31, 1911, of all plant purchased by the Postmaster-General in pursuance of the provisions hereof, shall be deemed to be its fair market value at the time of the purchase, due regard being had to the nature and then condition of such plant and to the state of repair thereof, and to the circumstance that it is in such a position as to be ready for immediate working and to its suitability for the purposes of the Postmaster-General's telephonic service, and no addition shall be made to such value in respect of compulsory purchase or of goodwill or of any profits which might have been or be made by the company by the use of such plant, and in determining the value of any plant no advantage arising from the construction of such plant by leave of the Postmaster-General upon any railway or canal over which the Postmaster-General possesses exclusive rights of way for telegraphic lines shall be taken into account.

(2) The value on December 31, 1911, of all land, buildings, stores and furniture purchased by the Postmaster-General in pursuance of the provisions hereof shall be the fair market value thereof at that date.

(3) The value on December 31, 1911, of any licensed telephonic business of the company, which by virtue of the agreements referred to in the first schedule hereto or of any other agreement in writing between the Postmaster-General and the company can be transacted as aforesaid after December 31, 1911 (apart from the plant, land and buildings used therein which are to be valued as hereinbefore in this clause provided), shall be such sum as may be agreed between the Postmaster-General and the company, regard being had to the net profits of such business and to the circumstances and conditions under which the company would carry on such business after December 31, 1911.

(4) The value on December 31, 1911, of any private wire business of the company (apart from the plant, land and buildings used therein which are to be valued as hereinbefore in this clause provided) shall be taken to be three years' purchase of the net profits of such business on the average of the three years ending December 31, 1911.

(5) All matters of difference arising under this clause shall be determined by arbitration.

5. *Optional Purchase.*—The Postmaster-General shall have the option of purchasing, on December 31, 1911, any property or assets of the company not specified in the preceding clauses of this Agreement, and the price to be paid therefor shall be determined by arbitration in case the parties differ.

Clause 6 relates to the details of the transfer of the business on December 31, 1911, or "on such subsequent day or days during the year 1912 as may be fixed by the Postmaster-General."

Clause 7 provides that the Postmaster-General shall have the option of paying the purchase money by way of terminable annuities, running over a period not exceeding 20 years, such annuities being calculated so as to pay the whole of the purchase-money by the end of the period fixed, with interest at the rate of 3 per cent. per annum. If the company desire it, however, part of the purchase-money not exceeding one-quarter will be paid in cash.

Clause 8 relates to the probability of the officers and servants of the company being retained in the service after the transfer, and is as follows:—

1. It is probable that the Postmaster-General will be prepared, upon the transfer to him of the plant, property and assets of the company as provided by this Agreement, to take into his service a considerable proportion of such officers and servants on terms to be arranged between himself and them, but the Postmaster-General will not accept any obligation to recognise service under the company as giving any officer or servant any claim to consideration at the hands of the Postmaster-General, either a sregards service, emolument, pension, gratuity or compensation, it being the intention of this Agreement that any claim on the part of the officers or servants of the company arising from their service under the company for pension or compensation shall be dealt with by the company.

2. If any officer or servant who has been continuously in the service of the company from August 15, 1904, to December 31, 1911, is taken into the service of the Postmaster-General and placed upon the permanent establishment of the Post Office, his service under the Postmaster-General shall (provided the authority of the Treasury or of Parliament be obtained in that behalf) give him a claim to a superannuation allowance after the rate and under the conditions provided by the Superannuation Acts, 1834 to 1892 or any statutory modification thereof, notwithstanding that he may at the date of his retirement have served less than 10 years.

During the period between the date of this Agreement and December 31, 1911, a number of "temporary arrangements" are provided for in Clause 9, to ensure that the company shall maintain all their plant and their system generally in good and efficient working order. As in the London Agreement, no favour or preference is to be shown to any subscriber, and the company may not, as a condition of giving a telephone service in connection with any exchange system, require from any person "the grant of any facility except for the purpose of giving such service to that person." The tariff in the London area is to remain the same as that fixed by the London Agreement,[*] and for other areas a schedule of maximum and minimum rates (Schedule IV.[†]) is provided. In cases, however, in which at the date of this Agreement the company's charges in any exchange area exceed the maximum or fall below the minimum charges specified in this said Schedule, these maximum or minimum charges (as the case may be) are substituted. With the consent in writing of the Postmaster-General other rates of charge (including rates for private branch exchanges and other special services) not falling within the scale of rates specified in Schedule IV. may be adopted. The company and the Postmaster-General agree to give one another all reasonable facilities for local intercommunication between subscribers to Post Office and company exchanges in the same area without payment of any terminal or other additional charge, each party providing the junction wires for conversations originated on this system. The Postmaster-General and the company will use every reasonable endeavour to come to an agreement as to the rates to be charged for the use of the exchange system of either party in such areas, it being the intention that in such cases the rates to be charged by the Postmaster-General and the company shall be uniform. Any question relating to rates in any of these areas as to which the parties may differ is to be referred by them to the Treasury, whose decision shall be final. No terminal charges will be made in respect of messages passing over the trunk wires between the subscribers to Post Office and company exchanges. A clause in the London agreement (No. 7) relating to the renting by the Post Office of underground lines and conduits to the company is made applicable to the whole country with certain modifications as to price. The rent to be paid by the company will be at the rate of £1 per mile of double wire per annum with a minimum of £50 per mile, except in the case of underground wires not exceeding a quarter of a mile in length led from a main cable to a distribution point, and of underground wires not exceeding 50yds. in length led from a main cable to a group of at least 10 subscribers' offices. Where the company desire to replace large overhead systems by underground systems the rate to be charged for underground work may be the subject of special agreement.

The following sub-clause is added relative to the renting of exchange switchboards:—

On the like conditions the Postmaster-General will provide for the use of the company in new or refitted exchanges of the company switchboards adapted to the Postmaster-General's exchange system, the rent to be paid by the company (to cover interest on cost of construction and depreciation) being 9 per cent. upon the cost of construction, such cost to include an allowance of 10 per cent. on the cost of materials and labour in respect of supervision by the head office staff and local staff of the Post Office.

Another important sub-clause is as follows:—

The Postmaster-General will extend and afford to the subscribers and persons using any exchange system of the company all such postal, telephonic and telegraphic facilities (so far as the same may be available) as he affords to subscribers and persons using any Post Office exchange system, and upon similer terms and conditions.

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[*] *The Electrician*, Vol. LXVIII., pp. 180 and 313.

[†] See p. 741.

A clause of the London Agreement (No. 11)[*], referring to wayleaves along railways and canals is extended to apply to all other exchange areas.

Clause 10 gives the Postmaster-General compulsory powers in the case of inefficient service :—

10. *Provision in the Event of Inefficient Service.*—If at any time before December 31, 1911, representations are made to the Postmaster-General that the company are giving an inefficient service in any exchange area, and upon an inquiry by an impartial person appointed by the Board of Trade at which inquiry the company and the person or persons making the representations shall be entitled to be heard by counsel and to adduce evidence, it shall be ascertained by the award of such person that the company's service in that area is inefficient, and that such inefficiency is not caused by the unreasonable withholding of wayleaves by any local authority, it shall be lawful for the Postmaster-General, at his option, either to require the company to take such steps as he may deem necessary to render their service efficient or to call upon the company to sell to him the plant, land and buildings used by them in such exchange area. In the first case if the company make default in complying with the Postmaster-General's requirements, and in the second case forthwith the company shall sell to the Postmaster-General the plant, land and buildings used by them as aforesaid, and all the provisions of this Agreement in relation to the sale to the Postmaster-General of the company's plant, land and buildings on December 31, 1911, shall apply to a sale under this clause so far as such provisions are applicable. Upon such day as the Postmaster-General shall fix in such case the company's licence to transact telephonic business in such area shall cease, and the company shall not be entitled to any payment in respect of compulsory purchase or goodwill or prospective or hypothetical profits in respect of their business in the said area.

Clause 11, modifying the London Agreement, is as follows :—

11. *Modification of London Agreement.*—(1) Clause 9 of the London Agreement shall as from the date of this Agreement cease to be of effect and the provisions of this Agreement in relation to the purchase of the company's plant, land, buildings, private wire, business stores and other property and assets and to the transfer of the company's business shall have effect in the London exchange area.

(2) Without prejudice to any arrangements heretofore made or now in progress between the Postmaster-General and the company as to particular works, the rent to be paid by the company for the use of any underground wires which the Postmaster-General may at any time after the date of this Agreement provide for the company in the London exchange area, under the provisions of the London Agreement, shall be at the rate of £2 per mile of double wire per annum where the wires are provided and maintained by the Postmaster-General, and at the rate of £1 per mile of double wire per annum where the wires are provided by the Postmaster-General but are maintained by the company, such rents being respectively calculated as though every underground work contained 50 double wires at the least, except in the case of underground wires not exceeding a ¼ mile in length, led from a main cable to a distribution point, and of underground wires not exceeding 50yds. in length, led from a main cable to a group of at least 10 subscribers' offices. And the rents in this sub-clause specified shall be substituted for the rents specified in the second schedule to the London Agreement.

(3) The provisions of this Agreement relating to the maintenance of the company's plant between the date of this Agreement and December 31, 1911, to the provision of switchboards for the company by the Postmaster-General and their maintenance by the company, and to the extension to the company's subscribers of postal, telephonic and telegraphic facilities, shall have effect in the London exchange area, and any provisions of the London Agreement which are inconsistent with those provisions shall cease to be of effect.

(4) Save as aforesaid, and save as is otherwise herein expressly provided, the London Agreement shall remain in full force and effect.

Clause 12 provides that the company shall facilitate the passing of any act which the Postmaster-General may deem necessary or desirable to carry out the provisions of the Agreement. It also binds the company to furnish the Postmaster-General with all such information as may be reasonably required by him for the purposes of the purchase and the subsequent transaction of telephonic business.

Clause 13 prohibits the company from assigning its powers without the consent of the Postmaster-General.

Clause 14 maintains the present rights of the Postmaster-General, particularly with regard to entering into agreements with or granting telephone licences to any other company or person.

Clause 15 states that, unless specifically provided for in the Agreement, all matters of difference shall be referred for arbitration to the Railway and Canal Commission, or, failing them, in accordance with the Arbitration Act of 1889.

The third Schedule to the Agreement is a modification of the specification attached to the London Agreement. We give it *in extenso.*

SCHEDULE III.—Specification and Rules as to Plant.

1. *Definitions.*—In this schedule the term "exchange subscriber's circuit" or "circuit of an exchange subscriber" means the wires and apparatus connecting a call office or a subscriber's office (whether on an exclusive line or a party line) with an exchange and the term "junction circuit" means the wires and apparatus which connect any two exchanges in the same exchange area, or an exchange and a prescribed Post Office in the same exchange area.

The term "test cable" means a telephone dry-core cable, the wires of which have a loop resistance of 88 ohms per mile and an average mutual electrostatic capacity of 0·054 mfd. per mile between wire and wire of each pair and an average insulation of not less than 200 megohms per mile between wire and wire of each pair all measurements being made at 60°F.

The term "test instruments" means common battery instruments fed by a battery of 22 volts through a circuit which, except so far as it consists of exchange apparatus and subscribers' instrumente, shall have a resistance of 300 ohms (all being in accordance with the specification and diagram identified in duplicate before the execution of this Agreement by the signatures of the engineer-in-chief to the Post Office and the engineer-in-chief to the company).

2. *Circuits.*—(1) All circuits, whether exchange subscribers' circuits or junction circuits, shall be metallic.

(2) All circuits when used for speaking on local exchange lines or through to a trunk circuit which itself is free from disturbance, shall be free from inductive or other disturbances.

(3) All circuits shall be so arranged that each exchange subscriber shall be unable to overhear what passes on any other than his own circuit or those to which it is joined through.

3. *Conductors.*—The use of iron conductors shall not be permitted in any portion of a circuit.

4. *Cables.*—(1) All buried cables shall be efficiently protected by iron pipes or by ducts of glazed earthenware laid in concrete or by cement blocks thoroughly matured or by such other means as the Postmaster-General may approve before the cable is laid.

(2) Cables in subways or tunnels shall be supported in such a manner as to prevent fracture of the lead covering.

5. *Overhead and Underground Plant.*—(1) Distributing wires (that is, wires from a distribution point to exchange subscribers' offices) may be carried either overhead or underground as may be considered desirable, and overhead distributing wires may either be open or be contained in a cable.

(2) No overhead wire extending more than a ¼ mile from a distribution point shall be considered to be a distributing wire.

(3) Wires other than distributing wires may be carried overhead—

(*a*) Either open or in lead-covered cables, provided that on one line of poles or other supports not more than 104 wires in all may be carried, of which only 64 may be open.

(*b*) In cables of any kind across a river, canal, estuary or railway, or across overhead electric wires used for the purpose of lighting traction, or the transmission of power.

(4) Wires other that distributing wires may be carried overhead either open or in cables without reference to the limitation contained in the last preceding sub-clause—

(*a*) In connection with any exchange system or part of an exchange system which at the date of this Agreement consists substantially of overhead lines (a list of which exchange systems and parts of exchange systems has been furnished by the company to the Postmaster-General, and is identified by the signatures of the secretary to the Post Office and of the general manager of the company). Provided that—

(i.) In no case shall more than 104 circuits or 208 wires be carried in cables on any one line of poles or other supports, to be hereafter erected, or more than 104 circuits or 208 wires be hereafter added in cables to any one line of poles or other supports now existing ; and

(ii.) All cables hereafter erected shall be lead covered when practicable ; and

(iii) The case of each exchange system or part of an exchange system which is specified in the aforesaid list and which is established in a town having a population of 50,000 inhabitants and upwards according to the last census shall, if the company so request, be specially considered, and in respect of each such exchange system or part of an exchange system the Postmaster-General shall notify the company within six calendar months from the date of the company's request whether he is prepared to provide from time to time such underground works as the company may require for extending or adding to such exchange system or part of an exchange system on a systematic plan, and in default of his giving to the company an assurance to provide such works the first preceding proviso to this sub-clause shall not apply in the case of such exchange system or part of an exchange system.

(6) In cases where the company are unable to execute underground works by virtue of any powers which they may possess, or are unwilling to execute such works in consequence of the terms and conditions proposed by a local authority, and the Postmaster-General (whether the company possess such powers as last aforesaid or not), after application to him by the company in that behalf, refuses or fails to agree within a reasonable time to provide the underground works specified in the company's application.

(5) Except as aforesaid no wires of any kind shall without the consent in writing of the Postmaster-General be carried overhead.

6. *Test of Audibility.*—All instruments, wires and apparatus shall be such that the transmission of speech thereby shall not be inferior in

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[*] *The Electrician*, Vol. XLVII., p. 313.

audibility to that afforded by test instruments connected by a length of test cable in accordance with the following regulations:—

(1) When—

(*a*) Any two exchange subscribers' circuits are connected together on the same exchange, or

(*b*) The circuit of an exchange subscriber whose office is on one exchange in an exchange area is connected with the circuit of another exchange subscriber whose office is on a different exchange in the same exchange area, and the radial distance between the two exchanges does not exceed 10 miles,

the standard of speech shall not be inferior to that afforded by test instruments connected by a length of 20 miles of test cable:

Provided that where an exchange subscriber's office situate more than 5 miles from an exchange is connected with another exchange subscriber's office situate more than 5 miles from another exchange, the standard of speech between such offices shall be deemed satisfactory if not inferior to that afforded by test instruments connected by a length of 25 miles of test cable.

(2) When the circuit of an exchange subscriber whose office is on one exchange in an exchange area is connected with the circuit of another exchange subscriber whose office is on a different exchange in the same exchange area, and the radial distance between the two exchanges exceeds 10 miles, but does not exceed 50 miles, the standard of speech shall not be inferior to that afforded by test instruments connected by a length of 30 miles of test cable:

Provided that where an exchange subscriber's office situate more than 5 miles from an exchange is connected with another exchange subscriber's office situate more than 5 miles from another exchange, the standard of speech between such offices shall be deemed satisfactory if not inferior to that afforded by test instruments connecsed by a length of 35 miles of test cable.

(3) When the circuit of any exchange subscriber is connected to a prescribed post office in the same exchange area for the purpose of being connected to a trunk wire of the Postmaster-General, the standard of speech through the exchange subscriber's circuit and the junction circuit or circuits combined (exclusive of the trunk wire) shall not be inferior to that afforded by test instruments connected by a length of 5 miles of test cable.

Provided that where the radial distance between a prescribed post office and an exchange when added to the radial distance between an exchange subscribers' office and the same exchange exceeds 9 miles, the standard of speech through the exchange subscribers' circuit and the junction circuit or circuits combined (exclusive of the trunk wire) shall be deemed satisfactory if not inferior to that afforded by test instruments connected by a length of 8 miles of test cable.

7. *Exchanges.*—All new and reconstructed exchanges shall be provided with automatic calling and clearing apparatus on every exchange subscriber's circuit, and the calling and clearing signals shall be effective in all conditions and upon the longest circuits used in an exchange area when connected together:

Provided that automatic calling and clearing apparatus need not be provided in any new or reconstructed exchange designed for an ultimate maximum capacity of not exceeding 1,000 direct subscribers' lines and a fitted capacity of not exceeding 400 such lines, if in any such case a thoroughly efficient method of calling the exchange and signalling the close of a conversation is provided.

8. *Exchange Equipments.*—In exchange equipments on the multiple system the multiple jacks shall be connected on the branching system, except in cases in which not more than 10 jacks are in series.

9. *Junction Circuits.*—Junction circuits connecting exchanges with prescribed post offices shall be provided with automatic signalling arrangements of a character approved by the Postmaster General and suitable for working in connection with his trunk lines, and shall be worked in accordance with such regulations as he may from time to time prescribe.

10. *Subscribers' Instruments.*—The apparatus fitted at exchange subscribers' offices shall be efficient for trunk line communication and where separate batteries are provided at each exchange subscriber's office for speaking purposes the E.M.F. shall not at any time fall below 2 volts, and such apparatus shall be so fitted as to admit of a clearing signal being transmitted by the exchange subscriber to the prescribed post office to indicate the close of a trunk conversation.

11. *Notice of New Equipment.*—With a view to avoid difficulty under the last two preceding clauses the company shall, at least six calendar months before the bringing into use of a new exchange equipment in an exchange, furnish the Postmaster-General with diagrams illustrating both the exchange subscribers' circuits and the method by which it is proposed to actuate the signals on the junction circuits at the prescribed post office.

12. *Protection of Circuits.*—Where an overhead electric system used for the purpose of lighting, traction or the transmission of power is worked in the neighbourhood of any overhead circuits of the company, suitable safety devices, including fuses and heat coils, shall, in all circuits likely to be affected, be provided both at the exchange and at the exchange subscribers' offices.

13. *Lightning Protectors.*—Efficient lightning protectors shall be provided on all circuits.

14. *Modification and Savings.*—(1) Proposals for the modification of the foregoing specification and rules, either generally or in relation to any particular case, will be considered by the Postmaster-General or the company (as the case may be).

(2) The fact that overhead work is for some purposes authorised by the specification and rules contained in this schedule is not to prejudice the right of the Postmaster-General to raise any question with regard to the value of overhead work which he is authorised to raise under clause 4 of this Agreement.

(3) The specification and rules contained in this schedule do not apply to the internal exchange plant of the company specified in the list to be furnished by the company to the Postmaster-General under clause 3 of this Agreement.

(4) Notwithstanding anything contained in the specification and rules contained in this schedule, the existing internal exchange plant of the company may be utilised to the extent of the capacity for which it has been designed, but such internal exchange plant may not be extended beyond the capacity for which it has been designed otherwise than in conformity with the said specification and rules. Provided that if any question arises between the Postmaster-General and the company as to the capacity of any internal exchange plant the question shall be determined by arbitration.

The following are the contents of the fourth Schedule, specifying maximum and minimum charges under clause 9:—

SCHEDULE IV.—**Maximum and Minimum Charges for Use of the Exchange Systems of the Company other than the London Exchange System.**

A.—FOR EXCLUSIVE LINES.

(α) Where the office of the exchange subscriber is within 1 mile of the exchange with which such office is immediately connected—

I. Unlimited service rate: maximum £10 per annum, minimum £5 per annum.

II. (1) Message rate: maximum £5 per annum, plus 2d. per message, minimum £2 per annum, plus ½ per message.

(β) Where the office of an exchange subscriber is situate more than 1 mile from the exchange with which such office is immediately connected: over and above the respective charges aforesaid, for every additional ¼ mile or part thereof, a maximum additional charge of 25s. per annum.

B.—FOR PARTY LINES.

(α) Where the main circuit does not exceed 1 mile in length and the spur circuits do not respectively exceed 220yds. in length—

I. Unlimited service rate:

(1) Where two exchange subscribers use the same party line: maximum £8, minimum £3 per annum per subscriber.

(2) Where three or four exchange subscribers use the same party line: maximum £6, minimum £2. 10s. per annum per subscriber.

II. Message rate:

(*a*) Where two exchange subscribers use the same party line: Maximum £3 per annum per subscriber.

(*b*) Where three or four exchange subscribers use the same party line: maximum £2. 10s. per annum per subscriber.

(*c*) Where more than four exchange subscribers use the same party line: maximum £2 per annum per subscriber.

Plus (for either *a*, *b* or *c*) 2d. (maximum) to ½d. (minimum) per message.

(β) (1) Where the main circuit exceeds 1 mile in length, in respect of every additional ¼ mile or part thereof: for every exchange subscriber whose spur circuit issues from the main circuit at a point exceeding 1 mile from the exchange, maximum 15s. per annum.

(2) When the spur circuit exceeds 220yds. in length: in respect of every additional ¼ mile or part thereof, maximum 25s. per annum.

C.—FOR EXTENSION LINES.

(α) Where the two offices connected by the line are situate in the same building or curtilage—

(I.) Where the line does not exceed 110yds. of double wire in length: maximum 30s. per annum, minimum 15s. per annum.

(II.) Where the line exceeds 110yds. of double wire in length—

For the first 110yds. of double wire: maximum 30s. per annum, minimum 15s. per annum.

For each additional 110yds. of double wire or part thereof: maximum 10s. per annum.

(β) Where the two offices connected are not situate within the same building or curtilage—

(I.) Where the line does not exceed ¼ mile of double wire in length: maximum £3. 10s. per annum, minimum 25s. per annum.

(II.) Where the line exceeds ¼ mile of double wire in length—

For the first ¼ mile of double wire: maximum £3. 10s. per annum, minimum 25s. per annum.

For each additional ¼ mile of double wire or part thereof: maximum 25s. per annum.

D.—FOR CALL OFFICES.

For the transmission of a message from a call office to any other office on an exchange in the same exchange area: maximum 3d., minimum ½d.

For the receipt of a message at a call office from any other office on an exchange in the same exchange area: maximum 3d.

NOTES.—These charges do not cover the supply of special instruments or apparatus for the convenience of particular subscribers. Where the charges for telephonic communication are on the message rate system the company may fix an annual minimum payment for messages, and in no case shall the total annual amount payable by an exchange subscriber be less than £1.

The distances referred to in so much of this schedule as relates to exclusive lines and external extension lines shall be deemed to be measured in a straight line on a horizontal plane. The same mode of measurement may be applied in place of actual route measurement in relation to party lines in any exchange area provided all party lines in the same area are measured in the same manner.

ELECTRICITY METERS.*

BY C. H. W. GERHARDI.

(Continued from page 661.)

Thomson Meters.—The Thomson type K integrating induction watt-hour meter is a neatly designed instrument of simple construction. Fig. 29 shows this meter with its cast aluminium cover removed. The rotating parts consist of a steel spindle having a polished base which rests on a jewel, the latter being supported by a spring to prevent injury by vibration or any sudden jar. The spindle carries an aluminium cylinder having small ribbed spokes on the top. The cylinder and spokes are all in one piece, the whole forming a strong though light rotor. The motive part, as may be seen in Fig. 30, consists of two hollow main coils placed outside the cylinder, with a shunt magnet placed equidistant from the axes of the main coils. The rotating cylinder passes through the air gap of this magnet, the main portion of which is inside the cylinder. The iron of the upper limb is in two portions, the shunt bobbin being placed over both. A secondary coil, which is short-circuited through a resistance, is wound on the upper half of this horizontal limb. This serves as a starting coil; it is fixed independently on a bracket, and can be shifted so as to create a small shifting field in conjunction with the shunt field, and is provided with a screw adjustment. By this means a torque can be produced necessary to overcome the mechanical friction and thus a high degree of accuracy on light loads can be obtained. This coil also helps to create the 90° lag between the shunt and series fluxes.

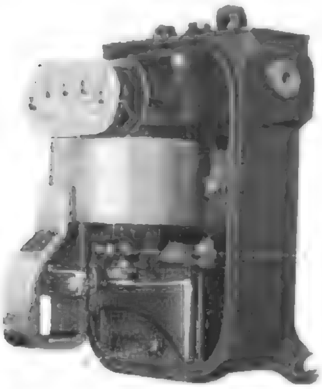
FIG. 29.—TYPE K WATT-HOUR-METER. SIDE VIEW, WITH COVER REMOVED.

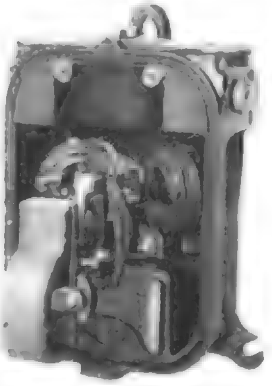
FIG. 30. TYPE K WATTMETER, WITH COVER, ROTATING PARTS AND REGISTERING MECHANISM REMOVED.

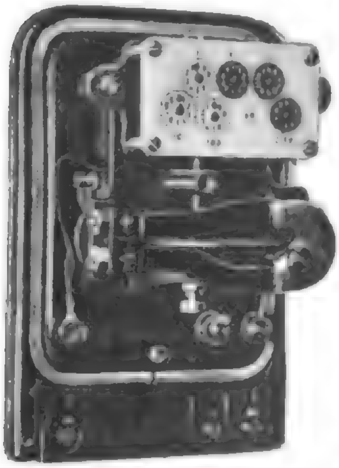
FIG. 31.

On the under portion of this same limb is another secondary winding which is not made use of in meters intended for high frequencies, but by short-circuiting this coil through a resistance provided the meter becomes compensated for a low-frequency supply. The ends of these resistances are brought down to the choking coil which is seen in Fig. 29 behind the permanent magnet support.

By simply unscrewing two screws the dial train and top-bearing bracket can be removed, when the disc and spindle may be lifted out; thus the working parts are easily inspected and can be replaced without affecting the calibration. The meter has a torque which is higher than that of most induction meters, the full-load torque being about 4·7gr.-cm. The main moving portion is somewhat heavier than that of other meters of the same class, its weight being approximately 42 grammes, but the difference in weight is more than compensated for by the increased torque.

The Thomson Type A.C.T. meter is the latest type of integrating induction watt-hour meter brought out by British Thomson-Houston Co., and is a very small compact meter. Fig. 31 illustrates the meter which, in sizes up to 50 amperes inclusive, measures 7¼in. long by 5¼in. wide by 4¾in. deep, and weighs 5¾lb. Its cover beds on to a cotton packing and is fixed by a single thumb screw. The main moving part consists of the usual main spindle carrying a copper disc. The spindle is supported on a jewel resting on a spring, and no clamping gear is provided. The stationary portion of the motor is of simple design as may be seen in the diagram (Fig. 32). The shunt coils are wound on the upper magnet, which has long pole-pieces, the main coils being wound, one on the pole-pieces of the shunt magnet, and the other on the laminated core underneath the horizontal air-gap through which the disc passes.

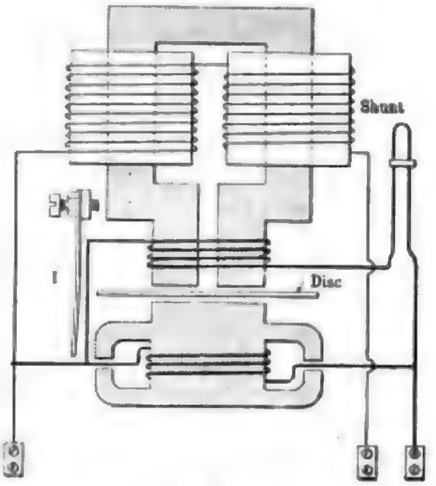

FIG. 32.

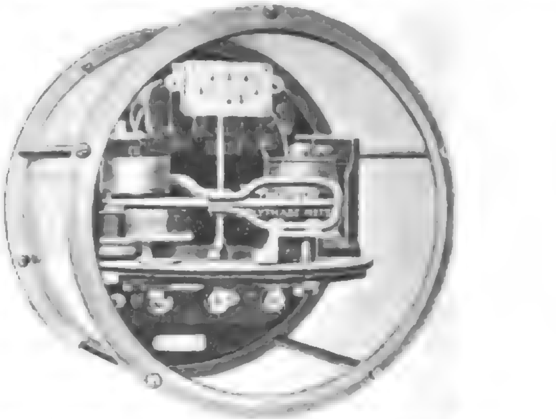
FIG. 33.—THOMSON POLYPHASE METER. SWITCHBOARD TYPE, "ROUND" PATTERN.

The compensation for accuracy on inductive loads is effected in this case by producing a resultant main flux by means of the additional main coil and the resistance in series with the main coil of least self-induction, final adjustment being made by altering this resistance. The adjustment on low loads is made by causing a leakage path for the shunt flux through the horizontal air-gap and disc and the thin piece of iron I on the left, the alteration being made by regulating the distance between the bottom end of this piece of iron and the core on which the lower main coil is wound. An iron plate is placed in front of the motor and shields the permanent brake magnet as seen in Fig. 31. The brake field strength is

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[*] From a forthcoming book to be published by "The Electrician" Printing and Publishing Co. All rights are reserved.

adjusted by altering the leakage path by means of the screws in the iron plate facing the magnet poles.

This meter has been found to have a very straight line law with no difference in the constant on a circuit the power-factor of which was 0·5.

The shunt current of these meters is very small—viz., 0·0235 for 100-volt, and 0·009 for 200-volt meters. Notwithstanding this a very fair full load torque is obtained, it being about 2·4gr. cm. The dial plate is of silvered metal and dial runs can be obtained in short periods by means of the fractional dials, which indicate 0·1, 0·01, and 0·001 units per division on the smaller meters. In order to prevent confusion in reading, these dials are blackened. Where any trouble is anticipated due to meter readers making incorrect readings the hands on the fractional dials may be removed after testing.

For two and three-phase supply circuits a meter of a special type is made by the British Thomson-Houston Co., as illustrated in Fig. 33. It is stated to be suitable for either balanced or unbalanced loads, and consists of two motors acting on a common disc-armature, which also serves as the brake disc, being retarded by two permanent magnets of the usual Thomson type. Fig. 33 is a view of the switchboard type of this meter; it is also made in a rectangular pattern, with zinc cover and front connections. For circuits in excess of 150 amperes and 650 volts, current and potential transformers are used.

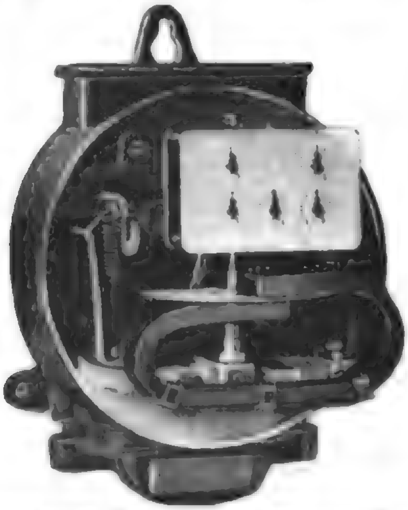

Fig. 34.—Single-phase Westinghouse Integrating Wattmeter with Cover Removed.

The Westinghouse Integrating Wattmeter is another example of the induction motor meter. It is the outcome of the Shallenberger, which was of much heavier design and probably the heaviest electricity meter made, although the moving portion was light. The Westinghouse meter is much lighter and smaller than the Shallenberger meter, being a very compact instrument. Fig. 34 is a view of the meter with its cover open, and shows the rather novel shaped permanent magnet which supplies the brake field. The disc is of aluminium, and the steel spindle engages with the first wheel of the train by means of a pinion, the worm being introduced higher up in the train. The terminal box is at the top: the mains entering from behind are fixed in the terminals by vertical screws, the heads of which are below the terminal box cover. This arrangement of the mains entering from behind the meter is rather awkward, particularly for making connection when testing *in situ*, as the meter has to be taken off the backing board to insert the standard instrument in circuit. The Westinghouse Company have recently altered the design of this portion, which will be a great improvement.

A better view of the motor is that in Fig. 35, in which the dial train and permanent magnet are removed. The two shunt coils are placed above the disc on a core, which is a closed iron circuit with the exception of a gap (hidden by the spindle) in the centre between the two upper poles, and the air-gap between the upper and lower poles in which the disc passes. Underneath the disc, immediately below the two upper poles, is the other pole which carries the series or main coil. The shifting of the flux in this meter has already been described. A choking coil, fitted in the base of the meter, is connected in the shunt circuit. The compensation for inductive loads is obtained by the secondary windings on the shunt magnets, which are short-circuited through short lengths of wire by which the final adjustments are made. Compensation for friction and adjustment at low load can be effected by obtaining a small shifting flux due to the shunt fields by adjustment of these resistances so that the secondaries are slightly unbalanced.

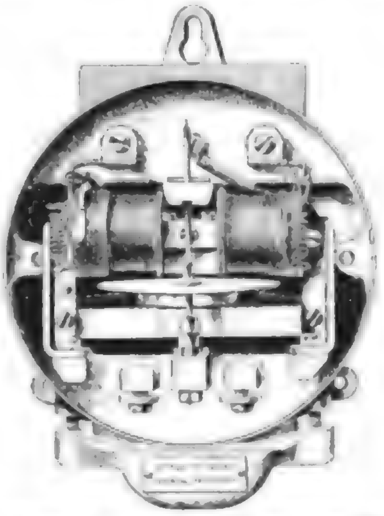

Fig. 35.—Single-phase Westinghouse Integrating Wattmeter with Counting Train and Permanent Magnet Removed.

A uniform speed has been chosen of 50 revs. per min. at full load for all sizes. In three-wire meters a second series coil is introduced, one series coil being connected in circuit with each outer. The meters are also made for registering the energy on two and three-phase circuits. These meters contain two motors, the rotors being fixed to the same shaft.

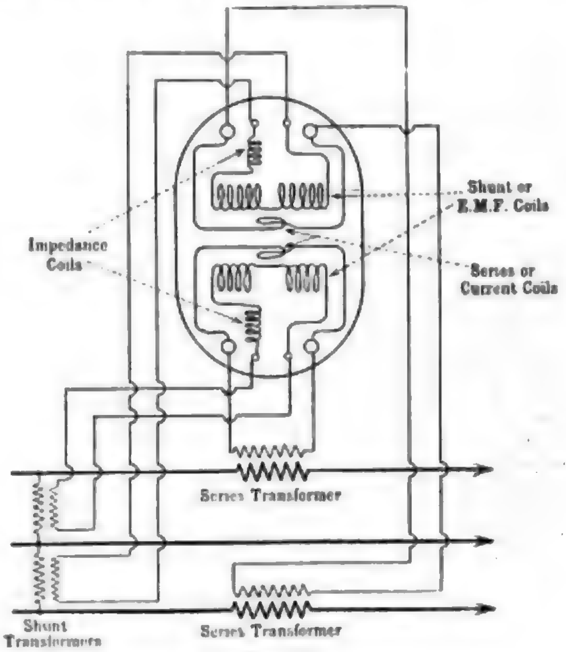

Fig. 36.

The full-load torque is rather low; from a test on a 100-volt 20-ampere meter it was found to be just over 1gr.-cm. The shunt current of the same meter was 0·08 amperes, and assuming the lag in the shunt circuit to be 80deg., the true shunt watts would be 1·4. The watts lost in the main coil are small and do not exceed 5 watts in the 5-ampere meter.

The connections of a polyphase meter of this make are seen in Fig. 36, where the meter is connected in a three-phase circuit by means of series and shunt transformers, as would be the case on high-pressure circuits. The meter is thus insulated from the high-pressure mains. For low-pressure circuits, the transformers may be dispensed with and the meter connected direct into the circuit. For a two-phase circuit the connections are very similar, the top connections being connected in one phase and the bottom ones in the other phase.

Fig. 37 illustrates a single-phase Westinghouse meter of the latest type, with its cover removed. This view shows the improved design of terminal box, in which the mains are inserted through holes in the top, the heads of the clamping screws facing towards the front.

Two other improvements have been introduced into this meter, the first being a shield for screening the brake magnet from the stray fields of the motor, more particularly the intense field which may be generated on a bad short-circuit. This screen consists of an iron shield with a long, narrow slot in it to allow the disc to pass through it freely. It is fixed as shown, between the coils and the permanent magnet, covering the whole of the stationary portion of the motor.

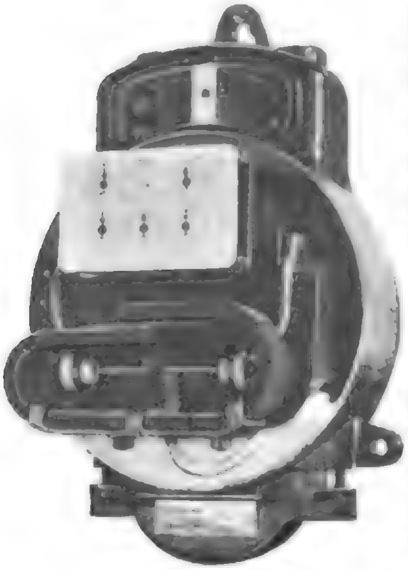

Fig. 37.

The second improvement is the introduction of a simple low-load or starting adjustment, consisting of a rod held by insulators, and having a sliding terminal which is capable of being moved up or down the rod and clamped in any desired position. This, as seen in Fig. 37, is placed in the centre of the brake magnet in front of the screen. Moving the terminal along the rod to the right increases the friction compensating torque, and a point is reached when the disc just turns when on open circuit. The sliding terminal should be clamped in the position where the disc just stops.

(To be continued.)

A FAULTY BY-PRODUCT.

The connection between the accompanying photos and an electric supply main is not very apparent, but there is one and it will probably be of interest to many mains engineers. Some little time ago a navvy drove a steel wedge through an earthenware duct and into a 0·75 sq. in. paper-insulated and lead-sheathed conductor at 500 volts positive P.D. from earth. The negative side of the system being earthed through a resistance of about 5 ohms limited the current through the fault to about 100 amperes, consequently the feeder circuit breaker did not open and the arc went merrily on for some 10 minutes before the trouble was located and the earth connection opened. Some 60 out of the 96 strands of the cable were melted down for about 9in. and mixing with the lead of the sheath formed a lead copper alloy with a rather remarkable structure, which forms the subject of the photo-micrographs. The fracture of this alloy has the appearance of nearly pure copper, with a very coarse columnar structure. If, however, it is cut with a saw or filed up it has the appearance of lead with just enough copper in it to redden it slightly. Examination under a low microscopic power shows it to be composed of a matrix of lead and copper alloy through which a large number of fine holes pass, and that each hole is lined with red copper. The diameter of the holes varies from about 0·001in. to 0·005in.: the larger sizes being confined to the outer edges of the mass, while their lengths average about 0·05in. They are in fact minute copper tubes imbedded in the lead-copper matrix. Fig. 1 shows a transverse section of some of the larger tubes. This specimen was ground flat and the copper etched off with nitric acid. Figs. 2 and 3 are from fractures and show the finer tubes from the centre of the mass, Fig. 2 being a break across the tubes and Fig. 3 along the length of them. All three figures are magnified about 50 diameters. The structure is probably due to entrapped gas bubbles formed by the decomposition of the insulation, but why apparently pure copper should have solidified out round the bubbles while two metals have remained mixed elsewhere is not quite evident.

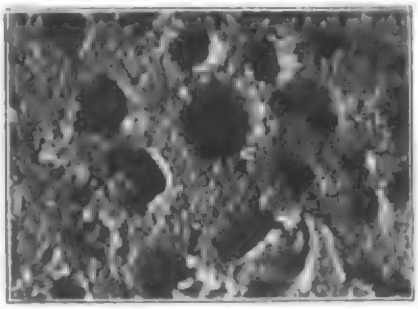

Fig. 1.

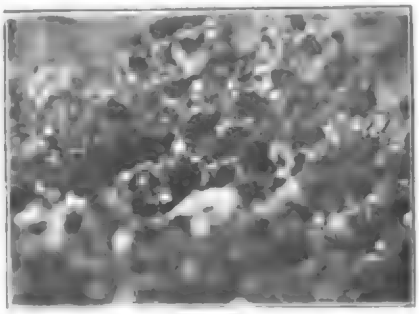

Fig. 2.

Fig. 3.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Mechanical Appliances, Mechanical Movements and Novelties of Construction." By G. D. Hiscocks. (London: Archibald Constable & Co.) 12s. 6d.

"The Mechanical Engineering of Collieries." Vol. I. By T. C. Futers. (London: Chichester Press.) 7s. 6d.

"Elektrische Traktion." By G. Sattler. No. XI. of Repetitorien der Elektrotechnik. Edited by Alex. Konigswerther. (Hanover: Gebruder Janecke.) M.4.20.

"Arc Lamps and How to Maintain Them." By. H. Smithson and E. R. Sharpe. 2nd edition. (London: Rentell & Co.) 1s.

"Gas and Oil Engines Simply Explained." By W. C. Runciman. No. 26 of the Model Engineer Series. (London: Percival Marshall & Co.) 6d.

"The Inventors' Guide to Patent Law and the New Practice." By J. Roberts. (London: John Murray.) 2s. 6d.

THE SELECTION OF ELECTRIC CABLES.*

BY L. B. ATKINSON AND C. J. BEAVER.

(Continued from page 701.)

VULCANISED BITUMEN CABLES.

The cost of rubber cables and the search for cheaper substitutes led to the adoption of bitumen in early days as a covering for cables. The early bitumen cables consisted of a wire coated with pure bitumen, but these cables were found to decentralise with more or less rapidity. Later, a cable was introduced by the Callender Cable Co., under the name of "Vulcanised Bitumen," insulated with a material produced by sulphurising a product of the distillation of certain oils, which has been very extensively used, and which alone or with other compounds forms the basis of several well-known insulating compounds. We may here remark that one of the greatest problems in connection with this product was to obtain supplies of reasonably uniform consistency and composition, and while uncertainty in the state of the product itself existed, there was naturally some doubt about the uniformity of the finished goods. Scientific methods have come to the rescue to some extent, and the buying and selling of the material is in many cases based on the results of analysis.

The properties of some such cables may be considered by taking three examples of cables made by well-known cable-making firms, which will be referred to as A, B and C, of which the compositions were shown in the following table:—

Table I.

Dielectric from cable.	Specific gravity.	Ash.	Saponifiable matter.	Uns'p'nifiable matter (org.).	Total sulphur.
A	1·076	7	76·2%	12·7	4%
B	1·31	34·7%	18·0%	45·1%	2·1%
C	1·15	18·27%	30·0%	47·5	1·2

In order to find out how this class of cable behaves under various circumstances, a series of experiments was carried out by Mr. Bertram Blount, F.I.C., at his laboratories in London, after consultation with the authors. To determine the tendency to decentralise in cables of this class, particularly at a moderately high temperature, short lengths of cable were loaded, the bare ends of the conductor being supported. The load was carried by a saddle across the cable, equivalent to 1lb. per lineal inch of cable as shown in Fig. 2. Table II. shows the amount of decentralisation which occurred after six hours in an air bath at a temperature of 90 C. = 194 F.

Table II.

Specimen.	Size of cable.	Before test. Thickness of dielectric.	After test.	
			Thickness. Upper side.	Thickness. Lower side.
A	Not tested	..	..	..
B	19/16	0·121	0·115	0·12
C	19/16	0·125	0·12	0·13

To determine more exactly the action of such compounds under load, bearing in mind that considerable weights of cable are often supported in a manner which concentrates the weight at one point, experiments were carried out to measure the deformation of samples of the material under definite loads, and the results are shown in Fig. 3. The upper lines shew the percentage compression of the samples A, B and C under the various loads given by the abscissæ. The lower lines show, for the same loads, the residual deformation on removal of the load. Sample B buckled when the load was removed, hence the permanent distortion could not be measured. These results show that with loads capable of very largely compressing the material, the elasticity is good; but they point out that with such materials some care must be exercised by judicious design of methods of support, to avoid the localising of supporting and other stresses.

The permanency of such dielectrics is, of course, an important element; it is by many thought that they are absolutely permanent, but they are so only relatively, as they all contain elements affected by various external agencies, and at least it is desirable in considering the use of such dielectrics in various situations, to realise how far the possible attacking agencies may have weight. The action of the air gradually tends to oxidise and harden such compounds, particularly if they contain free oils or other oxidisable materials. Acids met with in mines, alkalies in works of various sorts, and some soils acting on other elements of the composition, have other effects.

To ascertain the effect of various reagents representing actions likely to occur in practice, the following were chosen:—(1) Copper sulphate 10 per cent., $CuSO_45H_2O$; (2) Ferric sulphate 10 per cent., $Fe_2(SO_4)_3$; (3) Ferrous sulphate 10 per cent., $FeSO_47H_2O$; (4) Sulphurous acid, saturated solution, SO_2; (5) Hydrochloric acid 10 per cent., actual HCl; (6) Sulphuric acid, H_2SO_4 10 per cent. by weight. In these solutions the three typical samples, A, B, C, were exposed for five days. Solutions 1, 2, 3, 4, practically had no effect on any sample; in 5, sample B became somewhat harder; in 6, all were slightly hardened, most markedly in the case of B. Care must, therefore, be used in adopting such cables, particularly class B, where acids are expected to be met with.

Oxidising agents were next tried as follows:—

Ozonised air, containing 0·4 per cent. O_3 by volume, seventeen days exposure. A. Superficially hardened. B. Considerably hardened as a whole. C. Superficially hardened.

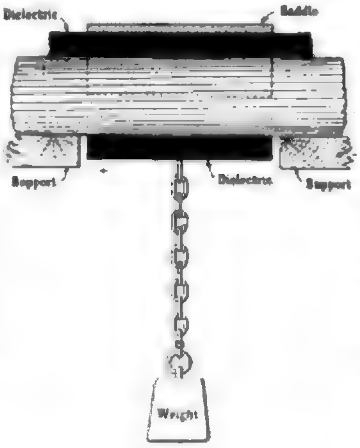

Fig. 2.

Hydrogen dioxide (10 per cent. H_2O_2). Five days exposure. A. Moderately hardened as a whole. B. Slightly more hardened than A. C. Only slightly hardened.

Chromic acid (10 per cent. CrO_3). Five days exposure. A. All the samples were attacked. Sample C best withstood the action of the chromic acid. Samples A and B were most severely attacked.

Chromic acid (1 per cent. CrO_3). Five days exposure. A. All the samples were somewhat hardened, samples A and B being most affected.

Chromic acid (0·5 per cent. CrO_3). Seventeen days exposure. A. Somewhat hardened as a whole. Surface not much more affected than body of material. B Hardened through the mass. C. Superficially hardened.

Potassium permanganate (2 per cent. $K_2Mn_2O_8$) and sulphuric acid (1 per cent H_2SO_4). Five days exposure. A. Little affected (1 per cent. H_2SO_4). Five days exposure. B. Somewhat hardened. C. Little affected.

Potassium permanganate (2 per cent. $K_2Mn_2O_8$), and caustic soda (1 per cent. NaOH). Five days exposure. All samples severely attacked.

The action of alkalies was next tried.

Caustic soda (10 per cent. NaOH). Five days exposure. A. Not tested. B. Softened and attacked, became hard and friable after removal from solution. C. Softened and attacked. The action was too severe to afford useful differentiation.

Caustic soda (0·5 per cent. NaOH). A. Somewhat attacked and softened, became hard and friable on washing and drying. B. Ditto. C. Ditto, but recovered fairly on washing and drying.

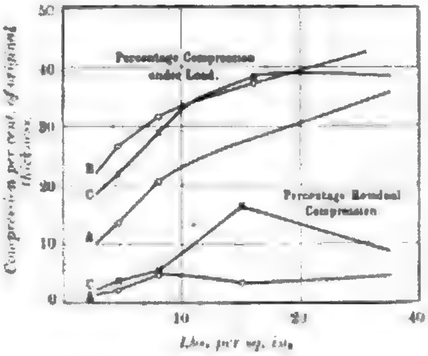

Fig. 3.

The following are Mr. Blount's notes of the microscopical observation of the effects of various reagents on the samples:—

Sulphuric acid (10 per cent. H_2SO_4). One day. A. Considerably thinned. The attack not uniform. B. Attacked unevenly. C. Evenly thinned.

Hydrogen dioxide (10 per cent. H_2O_2). One day. A. General thinning, slight differentiation. B. Some thinning, considerable selective attack. C. General thinning, slight differentiation.

Ferrous sulphate (5 per cent. $FeSO_47H_2O$). One day. A. Slight uniform thinning. B. Section slightly thinned, some selective attack. C. Slight uniform thinning.

Chromic acid (1 per cent. CrO_3). One day. A. Uniform change of structure. B. Considerably thinned. C. Very slightly thinned.

Caustic soda (10 per cent. NaOH). One day. A. Specimen shrunken. B. Marked selective attack. C. Very slight thinning.

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* "Some Points on the Selection of Electric Cables," read before the Manchester Local Section of the Institution of Electrical Engineers on Jan. 31. Slightly abridged.

The results of these experiments show how certain attacking and deteriorating agents not only have a surface action gradually thinning the insulating layer, but may by selective action be penetrating the mass. This latter effect would, of course, be enormously increased with cables carrying continuous-currents and having earths on the circuit, on account of osmotic pressure forcing the chemical ions through the dielectric. Such action would be in some degree the equivalent of electrolytic action in lead-covered cables. This is worthy of note, as the freedom from such action is claimed as one of the strongest points in favour of the vulcanised bitumen type of cable.

Regarding the whole of the above results broadly, the conclusion forced upon one is that, to attain maximum efficiency in every respect, vulcanised bitumen compounds must be designed, made and applied with the greatest possible care. For instance, physical properties (such as resistance to decentralisation) must not be obtained by the sacrifice of chemical inertness. Efforts in this direction usually take the form of stiffening the compound by the addition of mineral loading matter, and, as shown above, this results is not only laying open the material to loss of coherence among its particles (and incidentally rendering it liable to fracture in very cold weather), but also encourages the action of oxidising influences, and the selective actions which have been described.

FIBROUS DIELECTRIC WATERPROOF-SHEATHED CABLES.

This class of cable is cheap, and if well constructed of good materials, is very efficient. Its high dielectric strength and low specific capacity render it eminently suitable for extra high pressure work, and it can be designed (by suitable adjustment of the ingredients of the impregnating compound) to give a high insulation resistance without (contrary to popular ideas) any deterioration of the dielectric, physically or mechanically. Such dielectrics have rather high temperature co-efficients, and, therefore, engineers should be careful in specifying insulation resistance to state the corresponding temperature also. We are able to show in Fig. 4 a curve illustrating the variation of insulation with temperature. This shows roughly the order of such variation on a well-known type of paper cable. It is seen that a cable which gives an insulation resistance of 500 megohms at 60° F. would only give 100 megohms at 70° F., this being approximately equivalent to a variation of 10 per cent. per degree F.

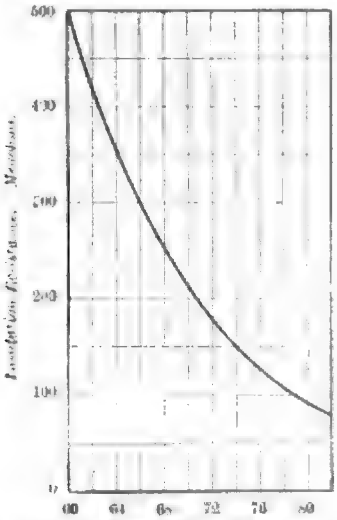

FIG. 4.—Curve showing Relation between the Insulation Resistance and Temperature for Paper-Insulated Cables.

The fibrous materials generally used are of two classes—viz., paper and fibre, the latter being usually jute or cotton, applied in the form of yarns and afterwards impregnated. The former usually consists of Manilla paper, and comprises the great majority of cables which are now made with fibrous materials. The oils used are generally resin oils, or mixtures of resin and resin oils, while Messrs. W. T. Glover & Co. use a compound made from oils called "Diatrine."

As regards the quality of the fibrous materials, there is little chance of adulteration in the case of those applied to the cable in the yarn form; but in the case of paper it is different, as the materials of which the paper is formed have to pass through a set of complex processes before they become paper, and it is practically impossible for even an expert to detect fraudulent admixtures by ocular examination. Engineers usually content themselves with specifying that pure Manilla paper must be used in their cables. The term "Pure Manilla" in cable specifications is intended to mean that the fibres of which the paper is composed shall consist solely of Manilla fibre. This, however, is not quite an adequate specification, for the reason that ordinary paper manufacturers and merchants would not, in the ordinary course of their business, so interpret the phrase. "Manilla Paper," to a paper maker or merchant, means a certain class of paper, in which one mill may make a dozen or more different grades at prices varying from 6d. to 3d. per pound. Obviously they cannot all be the pure Manilla demanded by the specification. Analysis will probably show that only two or three of the dearest of them are made from pure Manilla fibre only. One will learn on inquiry that this paper is sold for some particularly delicate purpose, such as wrapping valuable coloured fabrics for export, and that lower grade papers cannot be used for this work, as they affect the colour of the goods. Large quantities of paper cable have been sold and used in the past containing small proportions of Manilla (and in many cases none at all), and large proportions of straw, esparto, chemical wood, and even mechanical wood. Samples of Continental and American cables have been examined in which chemical and mechanical wood papers were used entirely, and some German makers have gone so far as to maintain that chemical wood is preferable to Manilla.

The chief disadvantages of the introduction of straw, grass or wood fibres in place of Manilla are as follows:—(a) Lower dielectric strength and insulation resistance and higher capacity. (b) Deterioration in strength and elasticity of the paper when heated continuously or intermittently and consequent brittleness. (c) Danger of rotting in course of time through the action of residual chemicals.

It has been amply demonstrated by comparison of cable for 10,000-volt working pressure of a first-class British firm, made with pure Manilla paper, with foreign cable, made for the same working pressure, &c., the paper insulation of which contained chemical and mechanical wood only, that 70 per cent. greater thickness of the wood paper was required to obtain the same dielectric strength as the Manilla; and that even at the increased thickness the capacity of the foreign cable was not so low as the British cable: the calculated specific capacity being about double that of the British make: only a small part of the difference being due to the superiority of the British impregnating compound.

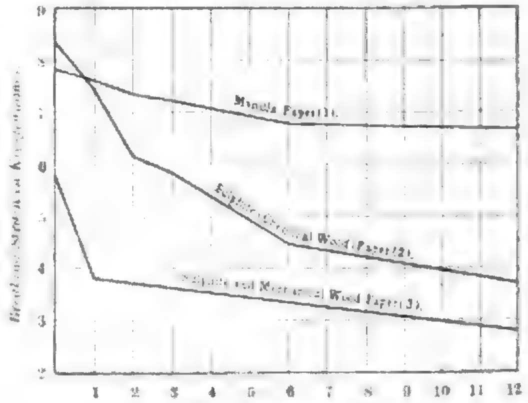

FIG. 5.—Curves showing the Effect of Heating on the Strength of Papers of Various Composition. In Oil at 310 F.

The extent and rapidity of the deterioration of woody papers under the influence of heat is shown in Fig. 5. Subsequent analysis of the chemical wood paper indicated that traces of residual chemicals probably had something to do with the more rapid deterioration as shown on the diagram. The curves shown represent the average results of about 100 separate tests on each class of paper in some experiments carried out by one of us some years ago. Some methods of impregnation of paper cables must have a deteriorating effect on the strength of the paper as compared with an increase of about 15 per cent. in the strength after impregnating by the processes used in the manufacture of Diatrine cables. The heating of the paper under the working conditions of a paper cable will be much more marked than under the conditions of these tests, as they will be more or less exposed to air, instead of being excluded from it, as in these experiments. The tests represented by the curves may be regarded in the light of ageing tests.

The occlusion of the chemicals used in the preparation of straw, esparto and wood fibres by the fibrous material is well known, and the reason why this does not occur in carefully-made manilla is that the latter can be prepared with very little chemical treatment, and for cable purposes without bleaching, whereas in the former very severe and drastic chemical treatment is necessary, and it is practically impossible to free the fibre from every trace of the reagents used.

Appendix II. includes a specification for paper which should safeguard the interests of the buyer.

(To be continued.)

THE PATERSON CONDENSATION-WATER PURIFIER AND GREASE ELIMINATOR.

Greasy condensation water from the modern high-speed type of engine generally contains a large proportion of the oil in the form of an emulsion, which gives it its characteristic milky appearance, and the inadequacy of any system of mechanical filtration can be readily shown by passing such water through the very finest filter papers, when it will appear, after the process, exactly as it did before. In the Paterson condensation water purifier shown in Fig. 1, it is claimed that the mechanically suspended and emulsified oil is completely removed by a system of coagulation and filtration.

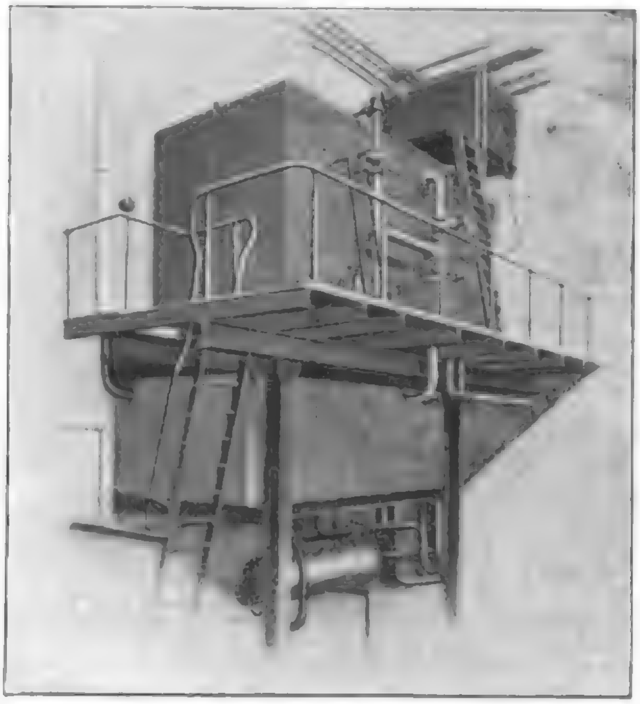
Fig. 1.—General View of Paterson Water Purifier and Grease Eliminator.

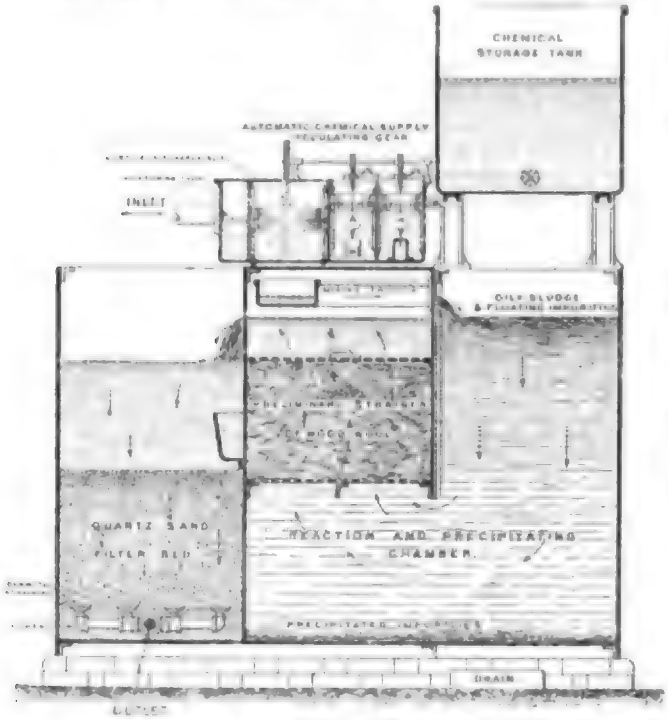

Fig. 2.—Sectional Elevation

Referring to the sectional elevation (Fig. 2) of the purifier, the greasy condensation water enters by the inlet pipe, and after passing through a perforated baffle plate to free it from undue agitation, it enters the measuring chamber, in the side of which there is a narrow vertical discharge slit, or tumbling bay, through which the condensation water discharges into the mixing trough below. It is obvious that the level of the water in this measuring chamber bears a definite relation to the amount of condensation water passing through. The weir being long and narrow gives a large range of motion to the float, which rides on the surface of the water The float is counterpoised by a balance-weight, to which it is connected by a flexible metallic cord passing round, and fixed to, the motion pulley keyed to the cross spindle from which the needle valves, controlling the discharge of coagulant, are hung. These needle valves are from 4in. to 6in long, carefully calibrated so as to give an annular discharge orifice which permits the escape of an amount of coagulant bearing a direct proportion to the greasy condensation water. They have a ground seat formed on the top, so that when the supply of greasy condensation water is cut off, and the measuring float sinks to the bottom of the measuring chamber, these ground seatings prevent any escape of reagent. On the arrival of the condensation water the float rises in the measuring tank to the level corresponding to the amount of greasy condensation water passing, and remains stationary so long as the load is constant, the needle valves, of course, rising with the float and giving their proportionate discharge. The level of reagent in these valve tanks is maintained constant by a ball-cock connected to the storage tank alongside.

The greasy condensation water, with its coagulant, is thoroughly mixed in the mixing trough before passing into the reaction and precipitating chamber, where the bulk of the free oil separates out in the form of a thick sludge, the heavy impurities falling to the bottom. After passing upwards through a strainer of wood-wool fibre, the water overflows into the quartz sand filter bed, where the final purification takes place, from whence the purified water is discharged.

The Paterson Engineering Co. inform us that they guarantee the absolute removal of the last trace of oil at a cost not exceeding ¼d. per 1,000 gallons, with a maximum drop in temperature between the inlet and outlet of not more than 10 F.

The quartz and filtering medium is cleansed in place by reversing the current of water through the bed, which is agitated and sterilised by the injection of compressed air through a steam jet air compressor provided with, and fixed on, the apparatus. The waste overflows into the waste gutter, shown on the sectional elevation, and passes thence to the drain.

THE WATERLOO AND CITY RAILWAY.—WORKING RESULTS.*

BY HERBERT JONES.

The total length of the line is 1 mile 46 chains. It is double throughout and in separate tunnels. The cast-iron lining of the tunnels consists of a series of rings each 20in. long. A ring is made up of seven segments and a key piece at the top. The minimum internal diameter of the tunnels is approximately 12ft. The gradients and curves on the line are exceptionally severe, there being four curves of 5 chain radius on each of the running roads, and an incline of 1 in 60 over half a mile in length.

The generating station, repair shops and offices are at the Waterloo end of the line, and are now undergoing considerable alteration owing to a portion of the space occupied being required for the enlargement of the London and South Western terminus. The boilers, which were originally fitted with mechanical stoking gear, are now hand fired with the best Welsh steam coal. Each has a grate area of 30·5 sq. ft., and a heating surface of 1,112 sq. ft. The working steam-pressure is 160lb. per square inch. The rated evaporation of each boiler is 7,000lb. per hour. The boilers are fitted with "Hotchkiss" cleaners, which have improved the circulation and reduced the cost of cleaning. Duplicate steam mains are provided and each boiler and engine can be opened out to either main. Only one main is kept heated up, except when mains are changed over.

In the engine room are six high speed self-lubricating Belliss engines, directly coupled to Siemens bipolar dynamos. They are of the vertical, three-crank, tandem-compound type, and can develop 360 I.H.P. when running at 380 revs. per min., with a steam pressure of 160lb. per square inch and a vacuum of 25in. The governing is excellent, between the usual working limits of quarter load and full load the variation in speed does not exceed 2 per cent. It will be seen from Fig. 2 that the variation of voltage is only 4 per cent., although the amperes vary from 130 to 895, and are never steady for many seconds together. The 200kw. dynamos are compound wound with the series winding adjustable between 0 and 32 turns,

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* Abstract of a Paper read before the Tramways and Light Railways Association yesterday.

by Google

in steps of four turns. Such a wide range of adjustment is, however, found unnecessary. The average of tests, taken at the works of Messrs. Belliss & Morcom, gave a combined mechanical and electrical efficiency of over 87 per cent. at full load, and a steam consumption of 27lb. per kilowatt-hour at full load, and 30lb. at half load, running condensing.

The main switchboard consists of six dynamo panels, one voltmeter and feeder panel and two panels with switch-gear for control of five motor-driven pumps at different parts of the line. In each feeder there is an ammeter and overload cut-out; the latter is mechanically interlocked with a hand-switch which is connected in series with it. The locking does not allow the hand-switch to be either closed or opened before the cut-out, so that the circuit is always completed by the switch but broken by the cut-out. In the event of closing on to a short-circuit the cut-out opens immediately the hand-switch is closed. The lighting of the stations and tunnels is controlled from a separate switchboard. Two special lighting 'bus bars are fixed at the back of the main switchboard, to which the positive terminal of each dynamo can be connected through a switch and fuse. These two 'bus bars are never during traffic hours supplied from the same dynamo. The two lighting 'bus bars on the main board are connected to two 'bus bars on the lighting board through Thomson-Houston wattmeters. Each lighting feeder can be switched to either of these 'bus bars by means of a throw-over switch. The lights at each station are divided and connected to two separate mains, which are normally switched on to either 'bus bar, and so are supplied by different dynamos. Gas is also provided throughout the stations, and is kept alight on the by-pass, so that a whole station can be turned full on from a cock in the main. The tunnels are provided with 16 c.p. lamps, spaced 60ft. apart and wired five in series. The motors driving the feed pumps, condenser pumps, air compressor and machine tools are connected up to the lighting switchboard.

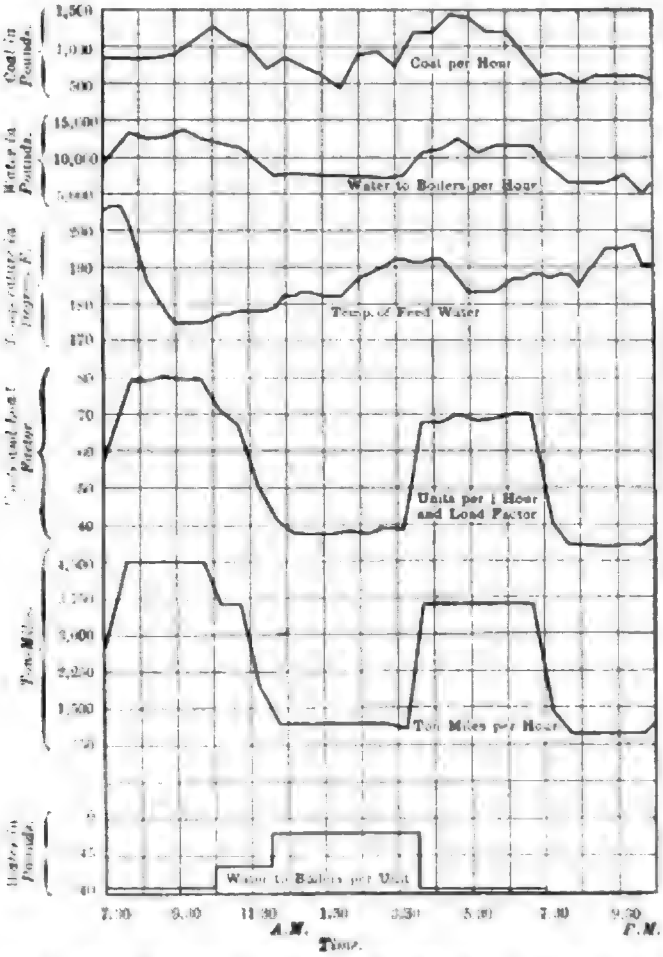


Fig. 1. 24-Hour Test. Record over Running Hours, March 16, 1904.

Two main feeders, each of 1 sq. in. sectional area, are run from the automatic circuit-breakers on the main switchboard to link boxes at Waterloo Station. Each feeder consists of two cables connected in parallel, and the links are so arranged that any cable can be entirely disconnected without interfering with the working of the line. From Waterloo to the City a cable of 0·5 sq. in. sectional area, insulated with jute and lead covered, is run through each tunnel. Each of these cables is divided into nine lengths of about 800ft., connected up by link boxes. The conductor rail in each tunnel is also divided up into nine sections, with a sectional insulator opposite every link box. The cable and conductor rail are connected on each side of every sectional insulator through a link, and are, therefore, in parallel with a cross-connection every 800ft. By this arrangement the best use is made of both the feeder and the conductor rail for supplying energy to the moving train. The feeder and conductor rail in parallel have a conductivity equal to that of about 1·1 sq. in. of copper.

The conductor rail is a steel channel 4in. by 2in. and ½in. thick. It has a cross-section of 4·5 sq. in. and weighs 46lb. per yard. It is laid in 30ft. lengths, joined together with copper fish-plates placed inside the inverted channels, and riveted up with four ¾in. rivets countersunk flush with the top of the channel. The conductor rail is supported on porcelain insulators with oil lips; the use of oil is, however, found quite unnecessary. At the ends of each section, and at crossings, anchor insulators are provided to which the conductor rail is bolted. The conductor rail is central between the running rails, and at the same level. At crossings it is raised 1in., and the ends are bent parallel to the switch rail, so that the contact shoe passes over the gap without touching the running rail. The resistance with bonds and short cables connecting the sections to the link boxes is 0·09 ohms per mile. The insulation resistance, as shown by the leakage test, is usually about 10,000 ohms per mile.

The running rails are bull-headed, and weigh 87lb. per yard. They are carried in cast-iron chairs on longitudinal sleepers in the iron tunnels, and on cross sleepers in the stations and sidings. Originally the rail joints were bonded with 2in. by ½in. copper bars, which bridged across the fishplate and two chairs placed one at each end of the fishplate. The bonds were riveted to the web of the rail by three ¾in. rivets at each end. This type of bond is much too rigid, and after being in use about two years breakages became frequent. Trials were made with several types of bonds, and as a result the author decided to renew the solid bonds when broken with three flexible bonds, each of 37 strands 0·0756in. in diameter. The terminals, which are fused on to the strands and afterwards forged, are riveted into the old holes in the web of the rail by a hydraulic riveter carried on a bogie, and worked by a hand-pump. The rivets are closed under a pressure of about 40 tons. None of the solid bonds were found broken until the third year of working, when there were 55; in the fourth year there were 85, in the fifth 196, and in the sixth 102. The total number of rail joints is about 1,100. The broken bonds have usually been in the outer rail of curves, but they are now being found at other parts of the line where the speed of running is high. Measured on a potentiometer the resistance of a joint bonded with flexible bonds is about 0·00005, as compared with 0·00004 ohm for an equal length (4ft.) of continuous rail. Rail renewals are now being made with 90lb. rails in 45ft. lengths, making a slight reduction in the resistance of the return circuit and a considerable reduction in the cost of bonding. The two running rails are cross-bonded every 100ft., and, in addition, the rails in the "up" and "down" tunnels are connected at each of the 10 cross passages. A supplementary return, consisting of a bare copper conductor of 1 sq. in. section, is laid in each tunnel for a distance of 3,300ft. from the Waterloo end of the line. The two conductors are cross-bonded to the rails every 100ft. by a connection of 0·125 sq. in. in area. The four running rails and two supplementary cables are connected to a common negative terminal board at Waterloo Station. This board is connected to the negative 'bus bar on the main switchboard by two cables, each of 0·75 sq. in. section. The resistance of the return circuit between the far end of the line and the negative 'bus bar on the main switchboard is approximately 0·016 ohm. The drop of voltage in the return is always well within the Board of Trade limit of 7 volts.

The line is used chiefly as a feeder to the City, hence the bulk of the passengers are carried between 8 a.m. and 11 a.m. on the up line, and between 4 p.m. and 7 p.m. on the down line. During the morning load a four-minute service of trains is run with trains consisting of four cars and seating 204 passengers. A four-minute service with single cars is maintained from 7:30 a.m. to 3:30 p.m. and a five-minute service for the remainder of the day. It may be of interest to compare the output curves (Fig. 2); the full lines give the total output of the generating station while the four-car trains are running, and the dotted lines while the same service is being maintained with the single cars. The ton mileage per hour is 4,500 in the former case, and 1,170 in the latter.

Each of the six four-car trains, now provided, is made up of two motor-cars and two intermediate trailer-cars. Each car is carried on two four-wheeled bogies, the first and last bogie of the train carrying a motor on each axle. The motors are "iron-clad" and of a nominal output of 60 B.H.P. each. The armature is built direct upon the axle, and the magnets are carried by two bearings, one each end of the armature, the thrust of the magnets being taken upon the bosses of the wheels. A special cable coupler is used for connecting between cars, by means of which all the cables are connected or disconnected in one operation. This direct method of control has many advantages when compared with the indirect electro-magnetic and electro-pneumatic systems. This is more especially the case now that the Board of Trade consider it advisable that motors be placed on only the front and rear carriages of a train. These advantages are:—Lower first cost, lower cost of maintenance, less complication and therefore less likelihood of failure and less delay to traffic when a breakdown occurs, all moving parts of the control apparatus are directly under the eye of the motorman and not divided up between all the motor-cars on the train, the ammeter in front of the motorman indicates the total current used on the whole train and not on the one car only.

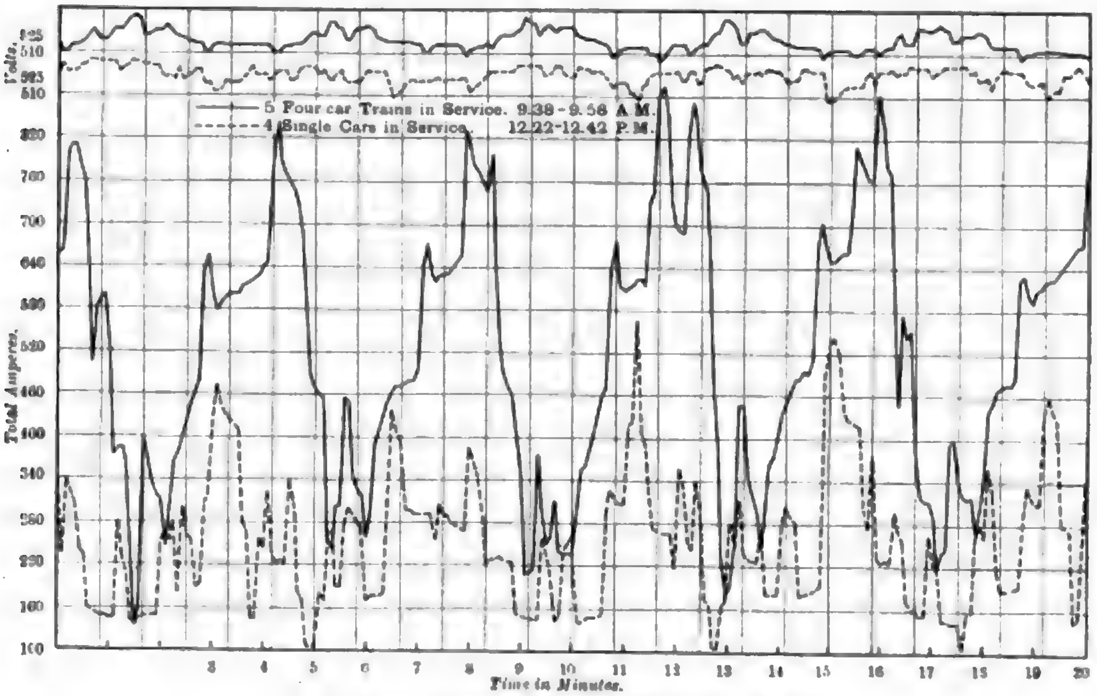


Fig. 2.—Output Curves. 4-Minute Service, May 10, 1904.

During the six and a half years the Waterloo and City Railway has been opened the cables running throughout the trains have given very little trouble, and have been the cause of only three slight delays to the train service.

Each single car is carried on two four-wheeled bogies, each of which is fitted with a single reduction gear motor driving the outside axle. The motors are rated at 75 H.P. each, and the gear ratio 3·8 to 1.

The signalling arrangements are very complete, electric locking and treadles entering extensively into the scheme. A further safeguard is provided for cutting power off a train should it approach too close to a signal at danger, and also upon entering the City station and cross-over siding at Waterloo. In addition to the usual series winding, every circuit-breaker on the trains has a shunt solenoid to work across the full pressure of 500 volts. This coil is connected between the inner, or train side of the circuit-breaker, and an insulated wire brush, or "slipper" carried by the equalising bar on the left side of the leading bogie. The "slipper" rubs along a piece of conductor rail fixed 16ft. in advance of every signal in the stations and sidings, and from 50ft. to 150ft. in advance in the tunnels. This distance and the length of the bars vary according to the maximum speed at which the train could be travelling when the "slipper" engages with the bar. These "slipper bars" are set 10in. outside the gauge and 2in. above rail level, and are carried on insulators. A connection is made from the "slipper bar" to rails through a switch actuated by the signals, the switch being "open" when the signal is "off." Should a train run into a "slipper bar" when the signal is at danger, there is a complete circuit from the circuit-breaker to rails, through the shunt coil, slipper, slipper bar and switch on the signal. This opens the circuit-breaker, and shuts all power off the train. At the City station and cross-over siding at Waterloo "slipper bars" are provided, which are connected directly to the rails.

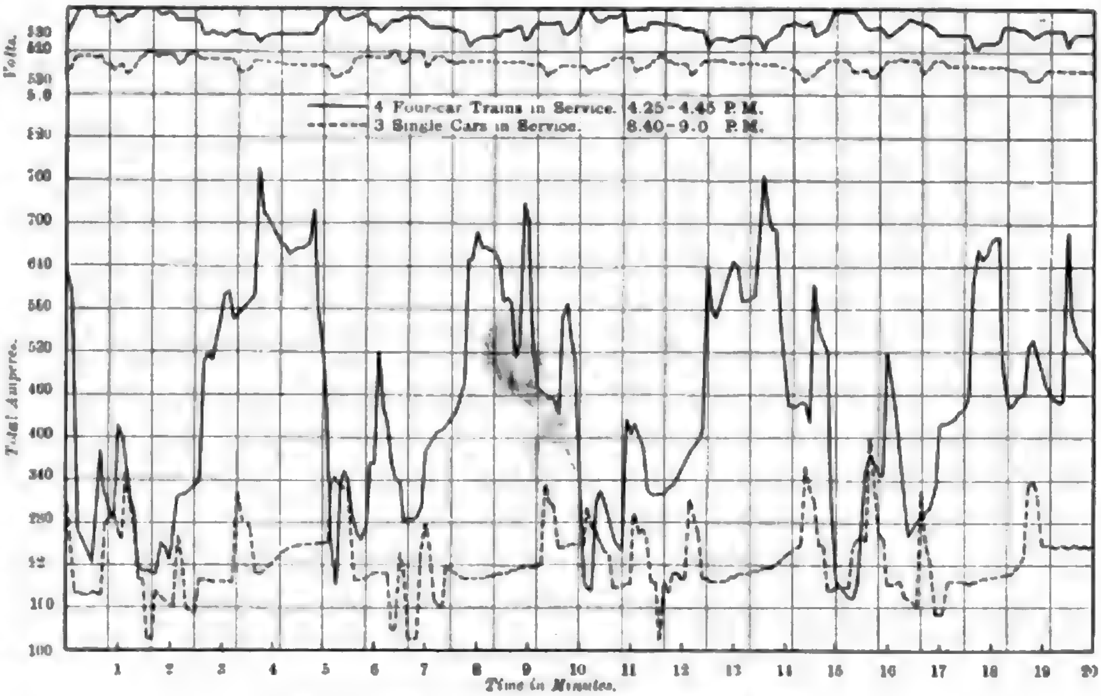


Fig. 3.—Output Curves—5-minute service. May 10, 1904.

Air for the Westinghouse brakes on the trains is supplied on the "storage" system. The pump room at the generating station contains, in addition to the feed pumps, three 8in. by 7½in. Westinghouse air pumps of the usual pattern and one "Christensen" motor-driven pump. The train reservoirs can be charged while the trains are being loaded with passengers in less than a minute, and the trains run four hours between the charges. The cost of power for compressing air for approximately 800 applications of the brakes per day is about a shilling. The electrical equipment of the generating station, line and four-car trains was carried out by Messrs. Siemens Brothers & Co. Mr. W. R. Galbraith and Dr. A. B. W. Kennedy were the consulting engineers. The single-car stock was supplied by Messrs. Dick, Kerr & Co. to the design of Mr. Douglas T. Heap, who preceded the author as electrical engineer.

Twenty-four hour tests are now taken frequently, during which the coal is weighed out separately to each boiler in 200lb. lots. The output varies from day to day by less than 5 per cent., so that from the 24-hour tests the coal consumption for the half-year can be estimated, and a comparison made with the actual quantity of coal used, as obtained from the coal deliveries and stock at the beginning and end of the half-year. The water supplied to the boilers is measured by a "Kennedy" water meter of the displacement type, which is checked by the fall in the level of the water in the feed tank. This meter is found to register well within 1 per cent. The total units generated are measured by Siemens-Halske watt-hour meters, connected between the positive brushes of each dynamo and the switchboard. The meters are checked periodically, by being connected in series to one of the dynamos; a variation of not exceeding 3 per cent. from the mean is allowed by the author, and the instruments are usually well within the limit. During the tests readings of the water meter, water-gauge levels, thermometers, draught and steam-pressure gauges are taken every 15 minutes; and the watt-hour meter and vacuum gauge readings every half-hour. The results obtained during the running portion of one of these tests are plotted in Fig. 1. The main engines were running condensing, the average vacuum being 24in. The coal used was the "best Welsh steam," the calorific value of which was 14,780 B.T.U. per pound, or 15·80lb. water evaporated from and at 212°F.

Date of test	Mar. 16, 1904	Oct. 19, 1904
Duration of test	24 hours	24 hours
Total coal used	15,500lb.	14,800lb.
Coal burnt per sq. ft. of grate area per hour, averaged over running hours	10·84lb.	9·98lb.
Ashes from boilers, percentage of coal	10·8	11·5
Total water to boilers	157,120lb.	142,250lb.
Water evaporated per sq. ft. of heating surface per hour, averaged over running hours	3·30lb.	2·95lb.
Feed-water temp., averaged over running hrs.	186°F.	182°F.
Actual evaporation per lb. of coal over 24 hrs.	10·14lb.	9·61lb.
*Equivalent evaporation per lb. of standard coal from and at 212°F.	10 84lb.	10·32lb.
Mean steam presure over running hours, lbs. per sq. in.	155 6	158·6
Average draught at base of chimney	0·65in.	0·58in.
Efficiency of boilers alone (based on coal)	71 per cent.	68 per cent.
Efficiency of boilers with economisers	77 per cent.	73 per cent.
Water to boilers per unit over 24 hours	45·7lb.	47·7lb.
Coal to boilers per unit over 24 hours	4 51lb.	4·97lb.

* Corrected for standard coal, which is capable of evaporating 15·21lb. of water per lb. of coal from and at 212°F.

Trains on the line are run at fixed intervals, with the result that the output curves repeat at intervals corresponding to the train service. This is shown clearly on Figs. 2 and 3, although it is more easily followed with the four-car trains in running than with the single cars. As a general rule there are two minutes of heavy load, followed by two or three minutes of light, according to whether the four or the five-minute service is being run. Incidentally, each period of heavy load causes a slight variation in both the voltage and vacuum, so that the number of trains run during the day can be checked by the number of peaks on the recorder charts. The punctuality of the service is also clearly indicated, a delay of a minute altering the charts to a noticeable extent. The results of output tests taken on April 10, 1904, are tabulated below:—

Train service	4min.	4min.	5min.	5min.
Average weight of train in tons	100	26	100	26
Mean speed between stations, m.p.h.	16	21	16	18
Total output per hour	284·1	136·5	238·5	123·5
Traction output per hour	217·7	80·5	174 0	58·9
Lighting output per hour	43·3	31·1	39 3	33·1
Auxiliary motor output per hour	23·1	24·9	25·2	31·5
Units per train-mile	4·83	1·78	4 83	1·63
Units per ton-mile	0 048	0·068	0·048	0·062
Units per seat-mile	0·023	0·035	0·023	0·032

The five-minute service with single cars (column 4) is run after 8:15 p.m., and the controllers are not worked beyond the series position; hence the reduction in the mean speed and in the units as compared with the four-minute service (column 2).

(To be concluded.)

Electric Speed Indicator.—The *Elektrotechnische und Polytechnische Rundschau* describes a speed indicator based on the fact that an intermittent voltage applied to a choking coil or a transformer sends a current through it depending on the frequency. The intermittency is produced by a commutating device connected directly or through gearing to the shaft, the speed of which is to be measured. An ammeter is connected in the circuit (or, in the case of a transformer, to the secondary winding), and its scale is marked off to read speeds.

FUEL ECONOMY IN STEAM POWER PLANTS.

The following is an abstract of the Discussion which took place at the Institution of Electrical Engineers in connection with Messrs. Booth and Kershaw's Paper on the above subject. The Paper was published in full in our last four issues.

Thursday, January 26th.

Col. R. E. CROMPTON said that the methods introduced into this country, when water-tube boilers were first erected, of putting the furnaces very close to the cooling surface of the tubes were now known to be barbarous methods, and a great deal of the early discredit that was brought upon this type of boiler was really due to mistakes in the setting and in calculation of that kind. At the same time even now a large number of practical engineers were of the opinion that it was impossible to consume the smoke without making great losses. So long as it was a mere question of excess of air this was true to a certain extent, but he ventured to suggest that the authors' method of giving a refractory lining to the furnaces, so that the flames were not cooled before perfect combustion had taken place, was the true remedy. It prevented smoke and did not cause losses. On the contrary, it had been found efficient and satisfactory in those stations where it had been introduced. He spoke on this point with considerable knowledge, having at Calcutta introduced water-tube boilers against the advice of all the practical engineers of Calcutta. They had told him that, with the Bengal coal, he would be fined and fined over and over again for smoke nuisance, and that he would be unable to produce the large amount of power that would be required. But the Calcutta works were the only smokeless works there, and it was due entirely to following the principles laid down by the authors. All the same, in London there were works alongside each other where heavy fines had resulted in the abandonment of cheap coal with a constantly increasing cost. Other works properly fitted with smoke-consuming apparatus had not found it necessary to do this. The next point was thermal storage, but as he saw Mr. Druitt Halpin present he would say no more than as a user of the system he believed that thermal storage had come to stay. It was going to be one of the greatest advantages that electrical engineers had ever introduced into their works where there was a peak load, for not only did it reduce the quantity of boiler plant, but it introduced economies which were altogether unexplained and unexpected at the present time. Probably this was due, to some extent, to the causes put forward by the authors, but there was no certain knowledge yet available to tell us why, when the boilers were filled with water from a storage reservoir having practically the same temperature as the boiler itself, but which was supposed to have had in it none of the latent heat units, an increased efficiency of 200 per cent. was obtained instead of the 25 or 30 per cent. which might be expected. How was it done? He did not pretend to say, but that it was done there was no doubt. It was being done every day, and it had been measured so many times that there was no question of doubt. He did not agree with the authors that we must wait to find out the cause of it before it was used. They had found out the facts and that ought to be enough for them. Further, the use of thermal storage reduced the coal consumption in a record station, all other things being equal, as 4 was to 2·9. Mr. Booth's advocacy of Lancashire boilers seemed to be on the wane. He had remembered Mr. Booth writing in the technical Press to the effect that electrical engineers were absolutely ignorant of boiler engineering because they used water-tube boilers. Now he had probably changed his mind. No doubt he had a progressive mind. The only way to make a Lancashire boiler an economical boiler as regards fuel consumption was to put the fire in front of it in some kind of retort, complete the products of combustion and then pass them through the boiler. But this introduced all kinds of difficulties well known to boiler makers. The question of furnaces was a question of fuel. Many furnaces worked extremely well with easier fuels, but when you come to difficult fuels in which there are large and varying percentages of ash the advantage of using a moving furnace was enormous, as they could be used at varying speeds to suit the varying quantities of ash. The authors described an inclined grate with a gravity-shaking effect. Those who had been in America had seen a good deal of the Roney grate. He had made very many inquiries as to what could be done with it, but he did not think the results to be obtained were comparable to what could be got with a flat grate working on the principle which impelled the fuel from the front to the back and only passing it through the damping bar at the back after the whole of the combustible material had been consumed. He agreed with the authors in having continuous records of waste gases. With regard to superheated steam, everyone knew that this was a subject upon which he was very keen, but he felt glad to say that there were a great many other people of the same opinions as himself in whose company he was not ashamed to be. He had discussed it at very great length with Prof. Elihu Thomson, one of the leading physicists of the world, who was as convinced as himself that the future of the steam engine would be brought on a level with the internal combustion engine, and that it would possess many advantages which the internal combustion engines did not have, if we only had the pluck to go high enough in temperature. The authors seemed to think that the sole use of superheating was to dry the steam. He hoped the Institution would not go away with that idea. Thermo-dynamic advantages were obtained the whole way up the scale by the use of superheated steam—*i.e.*, 1,000deg. were better than 500deg. and so on. Prof. Elihu Thomson and others had built small engines, and by the use of very highly superheated steam had produced results which could not be accounted for by the ordinary third law. The only way to account for them was to say that those who had been teachers had been all wrong. He regretted that the authors had not mentioned the work of Profs. Callendar and Nicholsen in 1898. He hoped they would all read this Paper, which went on to show that cylinder condensation—initial condensation which was the bugbear of the engineer—was not initial condensation at all, but most of it was valve and piston leakage, and they showed that it was most in these engines which used the same ports for steam and exhaust. He had made a few experiments himself, and one of the most interesting things was that superheated steam was given a bad name simply because it was supposed to score and cut the cylinders, to evaporise the lubrication and do all kinds of things which it never did. What it did do was that, under certain conditions, with the forms of superheat that had been used up to quite recently, there was wet steam passing over the surfaces, and this had the most terrible effect upon the lubrication of those surfaces. But by keeping up a steady supply of superheated steam which could now be lubricated, there would be less lubrication necessary and the surfaces would not be cut. It was possible by using 300 or 400deg. of superheat above the saturation point to reduce the actual consumption of existing steam engines some 30 to 40 per cent., not 15 per cent. These were words which had been proved up to the hilt by constant experiment during the last two or three years, and from these experiments it was clear that we could build up a new practice in steam engineering. What was more, it would be possible to get quite as high economy out of steam as it was hoped to get from the internal combustion engine, and the cost of the latter, in proportion to their power, would be much higher than that of the steam engine and boilers combined. The idea that the production of steam was the mere question of producing a fluid and passing it into cylinders at a 350deg. temperature, and bringing it out and throwing it away at 180deg. temperature was entirely exploded. The time was coming when we should take the steam in at 11,000deg. and discharged it at 250deg., and results would then be obtained with which no present results were comparable. At present we had got down to 2·9lb. of coal burned per unit on the switchboard. This would be brought down to 1·5lb., and it would be done by adopting improved boiler devices such as he had mentioned.

Mr. H. BOOT, referring to the statement in the Paper that there was considerable difficulty in separating oil and grease from the condensed water, said he experienced no difficulty at all in this provided the grease separator was put in the proper place and arranged at the right levels, and the steam was taken up well before it got into the condenser. This system required no care and no attention. The only objection, which was more or less serious where water was expensive, was that there was an average loss of 5 per cent. in addition to the ordinary losses. He had been trying a system of feed-water heating by passing the water from a hot well, after it left the economiser, into a system of trays in the steam space of the boiler, and this had the effect of heating the water up to the same temperature as the water in the boilers before it mixed with the water in the boiler. After some four years testing he could confidently say that this did not produce wet steam. The only trouble was that it was necessary to provide carefully for contraction and the expansion in the trays. He did not know whether any of the engineers present had tried the effect of putting an air lining in the boiler between the ordinary brick lining and the firebrick and passing the air through this lining before it arrived in the grate of the boiler. He had made one or two trials, but owing to the difficulty of construction he was not able to give any figures of economy yet. He did not think it would be possible to carry out the periodical tests suggested by the authors because it would require so many more men for that purpose or else a lot of overtime. For all practical purposes it was sufficient test to take the ordinary log readings and obtain from this the number of pounds of coal used per unit generated, and as soon as it was found that these were going up instead of down, the plant should be separated and the losses located. He had been using both Lancashire and water-tube boilers, and he must say that the engineer was happy who had such a combination. He would like to know if the authors had found that the placing of a superheater in the down take in a Lancashire boiler had set up serious vibration. He had attempted to do this by taking away the feather wall and placing the superheater in its place, but had encountered certain difficulties. The only way he had been able to get over this was by removing some of the tubes of the superheater and replacing them by the original feather wall. It had often been a surprise to him why makers of water-tube boilers, knowing what an excellent thing they had, continued to sell a water-tube boiler designed on barbarous principles so far as combustion of fuel was concerned. Was it because the repair of refractory furnaces was so heavy? The Paper spoke of the necessity of always using a cheap class of fuel. Surely this depended entirely upon the location of the town. If there was a railway rate of 12s. per ton it would be found best to use the highest steam-raising fuel that could be obtained in the market. With regard to the superheated steam question, he had been conducting some tests, first with saturated steam and then with 150deg. superheat, and although he had never yet been able to get above 18 per cent. saving with superheated steam, he thought it was a very good reason for adopting it.

Mr. J. DALE, of Messrs. Crossfield's Warrington Works, the fuel department of which for 10 years he had been in charge of, said the results obtained there by following upon lines similar to those advocated by the authors proved a very appreciable gain, far greater than was generally supposed to be possible. If he was not mistaken, he thought it was Messrs. Crossfield's works to which the authors alluded in the Paper when they spoke of having seen a water sampling arrangement. In dealing with the water from the Mersey, where the hardness was between 16 and 26, with an occasional abnormal hardness of 50 or 60, frequent analysis was necessary. As to the advantage of passing exhaust steam containing mineral oils into the feed water, it seemed to him that if the exhaust steam contained only a reasonable amount of mineral oil, it should not act injuriously, provided the water were kept, by suitable treatment, on the alkali side. Of course, care should be taken to exclude animal oils from the feed water. With regard to the percentage of carbonic acid in the gases, he quite agreed that in the large majority of works, the CO_2 was not much higher than 4 or 5 per cent. He spoke with experience on this matter as he had carried out tests at a great many works in England and Scotland. When using slack of medium quality the carbonic acid should reach 13 per cent. in regular working. It was not advisable, as a rule, to allow it to exceed this figure greatly, as beyond this percentage there was a danger of finding appreciable quantities of carbonic oxide. These remarks did not apply to furnaces in which hot air was used, and under these conditions a higher percentage of CO_2 might be obtained. The object should be to secure the highest possible percentage of carbonic acid consistent with the elimination of the carbonic oxide. The automatic apparatus for gas analysis referred to was undoubtedly useful under certain conditions, but it required checking periodically by a direct analysis. The great defect of the apparatus was its inability to give information respecting carbonic oxide. For example, 15 per cent. of CO_2 might be indicated although a much higher percentage of CO might be present, so that the economy would be more apparent than real. The results of a simple analysis of fuel he entirely agreed with. An approximate analysis of ash, water-fixed carbon, and volatile matter was all that was required for ordinary purposes, and from this the calorific value could be calculated. In some cases it might be desirable to conduct, also, an ordinary calorimeter test. On the subject of superheating he pointed out that at his works, at Warrington, he had found great advantage from an arrangement which he did not think was very well known in this country—at any rate it was not very extensively used. Most of his Lancashire boilers were 30ft. by 9ft., and instead of covering the top, as was usual with a non-conducting material, they utilised it as a heating surface. Over this they fixed the horizontal tubes, each being about 30ft. long and 3in. in diameter. The heat was made to traverse the whole length of the pipes. Of course it was only the gases which in ordinary conditions would be leaving the boiler which were led up into this chamber. The temperature of the gases did not exceed 400°C. There was a gain of about 70deg. or 80deg. of superheat. This might appear small, but it was uniform and continuous. They had used this system for several years and had found it very satisfactory. If any member of the Institution were sufficiently interested to pay a visit to Warrington he would be pleased to go into the matter further with him.

Mr. DRUITT HALPIN (who was imperfectly heard) referred first to the difficulty of removing from the boiler the dirt carried in with the feed water. He could not understand the authors' recommendation to use zinc slabs and rods bolted in suitable position to the stays and angle plates of the boilers, or why "these metal projections into the body of boiling water would help to promote regular steaming." Perhaps it was a misprint. On the question of coal sampling he agreed with all that the authors said. Coal ought to be bought by the heat units it contained. Instead of looking at a heap of coal and judging as best we could what it might weigh and offering so much for it, we at least went through the formality of weighing it, but we might go a step further. He did not believe in paying fancy prices for best Welsh coal. A large quantity of cheap fuel was sold and was burned with the highest possible effect and without the sligthest bit of smoke. The authors made comparisons between chimneys and fans. Although each case should be dealt with on its own merits, the work certainly seemed to be done more effectively and more cheaply with fans. It was a question of the large capital in the chimney without any repairs against the capital charges for fans, engines and motors, &c., with very heavy wear and tear plus the power for driving them. Concerning the authors' remarks on dampers, Mr. Halpin again described the apparatus which he referred to in the discussion on Mr. R. S. Downe's Paper before the Incorporated Municipal Electrical Association last year (see *The Electrician*, Vol. LIII., p. 636), and also referred to the tests of the boilers at the Frankfort Exhibition 12 years ago, full particulars of which were also given in *The Electrician*, Vol. LIII., p. 637.

Thursday, February 9th.

Mr. DRUITT HALPIN, continuing his remarks on the question of air leakage, said that this was particularly important in the case of water-tube boilers, where the wall area was so large compared with the brickwork in other boilers. The experiments at the Frankfort Exhibition threw great light on this subject. He agreed with the remarks in the Paper about the radiation from pipes. Great care was necessary, especially in connection with flanges, bolts, &c., which were most efficient radiators. Many chain-grate stokers left much to be desired, because the motion of the grates was not uniform, with the result that enormous quantities of air were let in at the back. He had seen a drawing of a grate which he thought was as perfect as it was possible to be with our present state of knowledge. This was known as the Fryer. He had very much doubt whether the system of trays described in the Paper for the purpose of excluding superfluous air would work satisfactorily. He thought, however, that the controllable superheater referred to was a very good thing. The authors had been good enough to send him a pamphlet describing this arrangement. In principle this superheater consisted of a couple of annular tubes, and probably the complication shown would be very difficult to deal with, whilst another difficulty might be the passage of lime in the very narrow space available. It might be replied that all water should be purified before it went into the boilers, and he quite agreed, but it could not always be properly done, and with these annular tubes the lime trouble might exist to a very considerable extent. He disagreed with the figures, given towards the end of the Paper, about the maximum available temperatures. In making this statement the authors had not stated the calorific value of the coal, but, taking 13,000 B.Th.U. the temperatures worked out very much higher than those mentioned, and with best Welsh, with 14,500 B.Th.U., temperatures up to 4,500deg. with the ordinary amount of air were possible.

Mr. J. H. ROSENTHAL said he did not take the dismal view that Col. Crompton did of the knowledge of central station engineers on the subject of the Paper. There was really nothing at all mysterious about thermal storage. The results at the station of the Kensington & Knightsbridge Co. only showed what could be theoretically expected from thermal storage. Naturally, it was better to feed a boiler with very hot water instead of cold, and naturally the boiler would do more work, but it was quite a mistake to suppose that the less the range of temperature, the greater would be the amount of heat units transmitted through a given amount of surface. Then again, dealing with the question of fuel supply the Paper intimated that specially-trained men were necessary to analyse coal and the flue gases, water, &c. This was not so. Analysing flue gases and coal and water were very simple matters, and he was quite certain that any central station engineer could easily acquaint himself with all that was necessary, and do it as well as any expert. At any rate, anyone who desired to be fully acquainted with the subject had his firm's laboratory at his disposal. Then Mr. Boot spoke of barbarous ignorance on the part of water-tube boiler makers in designing furnaces. At any rate they had erred so far as to design a plant that gave 85 per cent. of what there was in the coal back in steam. He had had 25 years' experience with mechanical stokers, and he could say most positively that they were absolutely the only cure for smoke with smoky fuel, and no amount of furnance designing—other than properly-designed mechanical stokers—would prevent smoke unless the boiler was being run at 6lb. per square foot of grate, as was done 20 years ago. At any rate, in central stations it was impossible to burn bituminous fuel smokelessly without mechanical stokers. Then the poor chain grate stoker had come in for much abuse, and was supposed to allow a great deal of excess air. Of course, excess air was a trouble in furnace management, but it was a bigger trouble in hand firing than with mechanical stokers, and probably the authors of the Paper were not aware that there were at present devices in regular use with chain grates which enabled boiler plant to be run with 10 to 12 per cent. of CO_2. The question of air blown into the furnace for mixing the gases was also dwelt upon in the Paper. That was a common practice in the Belleville naval boilers, but the action of the air was purely mechanical. If the furnaces of these boilers were sufficiently large, the air would be of no benefit whatever, and would be quite unnecessary. Air was a good thing, however, in retarding the gases in the furnace before they touched the heating surface of the boiler when the surfaces were small. Then the Paper stated that there was no thermo-dynamic gain from the use of superheating. The previous speaker had already stated that this was entirely wrong. Superheating to-day was too common for such a notion to take permanent ground. He could give hundreds of instances in which plants were worked with superheat, and the gain was in the coal bill. One of the most recent instances was at Hampstead, where separately fired superheaters were put in. These were not as advantageous in respect of fuel economy as superheaters that formed an integral part of the boilers, but they were far better than none at all, and the best proof was that at Hampstead the saving in the actual cost of fuel for units generated was 10 per cent.

Mr. H. N. HOLLAND referred to the slighting references to batteries in the Paper, which he did not consider quite fair. This was a question which station engineers had to face, and, in modern plants, with high-pressure generation and distribution from sub-stations with direct current, batteries were absolutely necessary. A burn-out of any synchronous motor or dynamo would throw all the synchronous machinery out of step, and it would mean a complete shut down. They must then start up on the direct-current side with several motor-generators on a big load and a dead network; this would take half an hour, whereas with sufficient battery power it could be done in five minutes. In fact, if the battery were big enough the lights need not be out at all. He agreed with the previous speaker that there were plenty of central station engineers who could use a calorimeter, but at the same time they must not depend upon that test only. He had a complete set of plant, pumps, CO_2 recorders and other apparatus, all ready to couple up to any boiler at a few hours' notice. Men in the boiler-cleaning gang were trained for this work, and they could be called from their regular work at any time to do this testing. Under these conditions tests on the boilers were not expensive, and they supplemented what had been done in the laboratory with the calorimeter. The Paper stated that water-tube boilers were not good for big loads and recommended Express boilers. But the latter would not work with mechanical stoking. They needed hand-firing and special stoking by higher-paid men. With mechanical stoking on water-tube boilers, a fog load could be dealt with quite easily. It was simply a question of having a sufficient number of banked boilers. At his station every morning reports were received from the sub-stations as to the weather conditions, and if there were heavy clouds, &c., about they got the boilers in hand in case of fog or darkness coming over. Glazed brickwork was recommended as a preventative against air leakage. This certainly was more impervious than the ordinary brickwork, but he did not think it a real cure. They wanted to go more to the root of the trouble. In water-tube boilers especially, a great deal of cracking was due to the differences of expansion. They had an external brickwork which was bonded to the shell of the boiler. This was bound to expand, and something had got to go. It was generally the external brickwork that went. Further trouble was caused by bad ironwork, loose bolts, not enough bolts, and bad placing of them. From these causes he had seen large masses of brickwork pulled away. A good plan was to build the firebrick lining entirely separate from the external shell of the boiler. This allowed further room to expand without tearing down the brickwork. It did not last so long, but any trouble was noticeable at once and repairs were a simple matter, as the outer wall of the boiler did not have to be touched at all. Another method was to put a second external shell around the boiler. This need not necessarily be brickwork; it might be of expanded metal. With an air space of 2in. or 3in. there would be an external shell comparatively cold, and there would be no trouble with the insulation. The true insulation of all non-conducting coverings was their air space. On the question of chain grate stokers he endorsed all that Mr. Rosenthal had said. A chain grate stoker with properly designed brickwork was absolutely smokeless, and, further, a chain grate stoker did not need cleaning for a week on end. The Paper showed some designs for brickwork, and the authors recommended a chain grate stoker which contradicted the very principles laid down in an earlier part of the Paper. It was about as badly designed as possible. One of this type was working in the Mersey Railway power station, but the railway company was being constantly prosecuted and fined for smoke emission. He would like to put in a word for superheating and steam jackets. Both means were very economical when there was a high initial heat. As long as engines were liable to break down there must be a means of starting the other engines rapidly, and in order to keep them continually ready for service they must have a steam jacket or a leaky stop valve. He endorsed the favourable opinions expressed concerning the Ados recorder. He had one locked up in a cupboard where everyone could see it, but where no one could tamper with it. It had the effect of promoting a healthy competition between the stokers, and there was no difficulty in getting 12 to 20 per cent. CO_2 in regular working. The results needed checking, however, by some other method.

Mr. L. GASTER, who expressed his intention of sending in a communication for publication in the *Journal*, complained that the authors had not given sufficient attention to the possibilities of liquid fuel.

Mr. W. M. MORDEY gave a figure which he thought might be useful to those who wanted a rough means of estimating radiation losses. In designing transformers a few years ago, he found that the losses from transformer cases painted grey, like the surfaces of lagged steam pipes, amounted to 1 watt for 3 sq. in. when the surface was raised 40°F. above the air. That, of course, was a very moderate temperature, but they must realise how enormously important were these radiation losses in steam work.

Mr. W. H. MOLESWORTH pointed out that no reference was made in the Paper to pulverised coal. Some tests which he had got from B. & W. boilers with pulverised coal showed a saving of 29 per cent. This was with hand firing and there was smokeless burning. With mechanical stoking, and an equal amount of vibration, the saving was 25 per cent., whilst with an equal amount of coal and an increase in vibration the saving was 48·8 per cent. in favour of pulverised coal.

Mr. W. C. THOMSON said the authors did not appear to have taken into consideration the question of preventing smoke at the time when boilers were being got away on an evening load. Most power stations of any size had, perhaps, 20 or 30 boilers, and five of them would be sufficient to run the load during the day. He would like to know how it was possible to bring up to full steam 15 or 20 boilers at night, when the load came on, by burning bituminous coal without making smoke. He agreed with the authors that bituminous coal could be burned in furnaces which were properly constructed, but he was sorry to disagree with Mr. Rosenthal that all smoke could be prevented by the use of chain grate stokers. No chain grate stoker would prevent trouble in starting up a big bank of boilers when the load came on.

Mr. E. T. RUTHVEN-MURRAY thought everyone would regret that more had not been heard from those in charge of plants. There were a great many points, and of enormous importance, touched upon in the Paper, and he thought the authors had hardly given the credit they should to those who were running plants. The latter could not afford to experiment, and it was the maker's place to demonstrate the improvements that could be effected. There were many things that could be done, however, without expense, and several speakers had already referred to some of them. One of them was the question of radiation and air-leakage loss. This was a trouble which a great deal could be done to minimise in a very simple and inexpensive way—viz., by the use of glazed bricks. He could speak from actual facts. He had put in glazed brick settings, the cost of which was not more than 12 per cent. above ordinary bricks, and they were of enormous advantage in reducing the amount of air leakage through the settings, and if these did crack owing to the expansion, the cracks could be seen every day and filled up immediately. Further, there was the advantage of the smooth surface instead of the rough one, the heat dissipation in the settings being much less. The heat of the settings was as high as 140°F. on the outside, and by thus keeping this heat in the settings instead of its being dissipated a great advantage was obtained. With these settings it was quite a common thing for the boilers to be pumped up with cold water and to find the full pressure with banked fires that had been standing for 12 or 14 hours. He agreed with previous speakers that the stoker illustrated in Fig. 8 of the Paper did not actually suffice to prevent smoke. There was a large power house near him which used the stokers, and the presence of smoke was very evident by observing its chimney shaft.

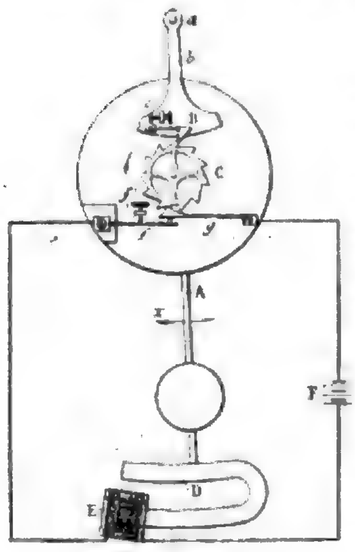
Mr. W. H. BOOTH, in reply, said that several speakers had gone on the assumption that he was entirely against water-tube boilers. This was entirely a mistake. About 21 years ago the Babcock boiler was brought over from America. The boiler insurance companies in the North of England, with which he was connected at the time, had succeeded by dint of 30 years' hard work in abolishing cast iron in connection with boilers. When the Babcock boiler came over from America, except for the shell and tubes, it was made of cast iron. The insurance companies insisted on mild steel. It was also stated that the circulation was so rapid that there was no deposit in the tubes. The insurance companies objected, and the Babcock and Wilcox Company now admitted this because they made a water softening plant. The furnace of the B. & W. and most water-tube boilers was not suitable for burning bituminous fuels. He now took no exception to the B. & W. boiler, because it was made entirely of mild steel, and even one of the Lancashire boiler makers agreed that it was a splendidly made boiler. But it was not so originally.

It had had punched rivets for instance, and 20 years ago we did not follow all that was told us from the United States. He had not come round to the water-tube boiler, as Col. Crompton had said; the water-tube boiler had come round to him—except for the furnace, which was still made on a wrong method. Yet there were water-tube boilers that were perfectly smokeless. There was one at Kensington, and Col. Crompton had one at Chelmsford. As regards chain grate stokers, he was sorry to say that he had had seven years more experience with them than Mr. Rosenthal, and he knew that they were not a cure for smoke. It was a cure with a Lancashire boiler with a sufficient amount of air, but the water-tube boiler would not be cured with mechanical stokers unless there was a very small amount of CO_2, which was a loss. A water-tube boiler was better than a Lancashire, because a better furnace could be put into it. Some speakers had referred to the stoker in Fig. 8 as one which he had put forward as a good one. He had done nothing of the sort. It was put forward as a form of inclined grate, which prevented an excessive amount of air getting into the fire. It was a picture of one not in use in this country. It was not the Roney stoker. What he did put forward as a very good form of surface was on Fig. 2. That stoker was working perfectly. Mr. Holland raised a great many questions, all of which he would find fully replied to in the Paper.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

New Electric Clock.—An electrically-driven clock having a free escapement is described by C. Féry, and illustrated in the diagram. When the pendulum swings in the direction of the arrow, the ratchet B, attached through *b* to the pendulum, pushes forward the tooth it has caught. The movement is limited by the spring *g*, which also makes contact for the battery F and the coil E. The duration of the contact is regulated by the screw *f* attached to the spring *f*. The magnetised coil E attracts the armature bob D. On the return swing, B slides over, and C is held in position by *g*. This escapement is the same in principle as that used in marine chronometers. The efficiency of the electric motor system is 70 percent., and a single standard silver chloride cell is capable of driving the clock, the energy required being half a watt per annum. The diurnal variation does not exceed 0·3 second.



[C. Féry, *Comptes Rendus*, January 23, 1905.]

Conductivity of Lithium.—A. Bernini has redetermined the resistance of lithium, and found a very marked change in it at the melting point. Since the metal must not be exposed to air, he fused it into a glass tube, but found that fused lithium strongly attacks glass and bursts the tube. He overcame this difficulty by forcing a plug of cotton wool soaked in vaseline through the tube, thus leaving a very thin lining of vaseline attached to the inner wall. He obtained the value 10·66 for the conductivity at 18deg., the unit being the conductivity of pure mercury at zero. This is in substantial agreement with Mathiessen's value 10·69. The author then proceeded to determine the conductivity at different temperatures, and found that if the resistance at 0deg. is put as unity, it becomes 1·8 for the solid at the melting point, and 3·5 for the liquid. This sudden change, which is much greater than the corresponding change in potassium and sodium, indicates a considerable change in density on melting. The limits of resistivity, as far as measured, lie between that of iron and of antimony.

[A. Bernini, *Physikalische Zeitschrift*, February 1, 1905.]

Manufacture of Ozone.—H. Wommelsdorf has studied the "noxious charges" which impair the efficiency of influence machines, and which are therefore avoided as much as possible by makers of such machines. These become a minimum at a certain distance between the plates, and that distance, therefore, brings about the maximum efficiency. At a certain smaller distance between the plates the loss by the "noxious charges" becomes very large. The external effect of the machine approaches in fact to zero, and the electrical work is all done inside the machine. When that occurs, an enormous quantity of ozone is produced by the machine. This indicates a possibility of producing ozone in a much more direct manner than has been hitherto possible. An influence machine can be made into a combined generator, transformer and ozone tube, and it might even be made to act as its own aspirator. It could be enclosed, and the loss of ozone would be reduced to a mimimum. It should be possible to generate ozone in a very economic manner.

[H. Wommelsdorf, *Annalen der Physik*, No. 15, 1904.]

Blaze Currents.—Mrs. Waller continues her husband's work on the electrical responses to stimulation exhibited by animal and vegetable living tissues, which responses he has designated "blaze currents." These response currents may either be in the direction of the stimulating current (homodrome) or in the opposite direction (antidrome). She found that the gall bladder of the frog exhibits effects of extraordinary intensity, which persist for 24 hours after death. Weak stimulus elicits one antidrome blaze; to stronger stimulus the response may be triphasic: antidrome, homodrome, antidrome. The first and antidrome response is a large effect and soon over; the galvanometer spot flies off and quickly returns to zero and beyond, indicating the second and homodrome effect, which is a prolonged change lasting about two minutes and slowly subsiding. The second effect is often larger than the first. The blaze is a local effect, abolished by strong tetanus at one spot, but found to persist in other parts on turning the bladder round. The blaze is abolished by boiling the gall bladder or by subjecting it to strong chloroform vapour, or by tetanus. The experiments show the gall bladder to be an organ whose tissues possess great "chemical lability." The cathode of the single induction shock is more effective than the anode whether the stimulus occurs in the smooth muscle fibres or in the columnar mucous epithelium, so that the blaze is first post-cathodic, then post-anodic. Occasionally the usual mucous to serous blaze occurs, but of the two components of the structure the smooth muscle fibres appear to give the blaze current more readily than the columnar epithelium. The gall bladder presents a very striking instance of the equivocal or antidrome blaze current.

[Alice M. Waller. Paper read before the Royal Society, January 26, 1905.]

Speed of Atmospheric Ions.—For determining the number, species, and speed of atmospheric ions as distinguished from the more numerous ions produced by radio-activity or X rays, H. Mache and E. von Schweidler use an Ebert aspirator, but add to it a second cylindrical condenser of the same dimensions as the first. Most of the ions are caught by one or the other. They also add the following practical directions: First, observe the loss of potential due to the passage of a measured quantity of air, say, 2,000 cubic cm., then charge the additional condenser to some 15 volts, and measure the loss of potential with the same quantity of air. Plot the charges as abscissæ, and the losses of potential as ordinates, and determine graphically the point at which the loss of potential vanishes. Call this value of the charge ΔV. Then if l is the length of the cylinder of the additional condenser, R its outer and r its inner radius, and Φ the volume of air sucked through, then the mean velocity of the ions is

$$u=\frac{\Phi \log \frac{R}{r}}{2\pi l \Delta V}.$$

The authors give tables of values obtained at Seewalchen on the Atter Lake in Upper Austria. The negative ions had on the whole the greater speed, its ratio to that of the positive ions being 1·23.

[H. Mache and E. von Schweidler, *Physikalische Zeitschrift*, February 1, 1905.]

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THE TELEPHONE AGREEMENT.

The agreement which has been entered into between the Postmaster-General and the National Telephone Co., subject to ratification by the House of Commons, is set forth in this issue of *The Electrician*. Although of considerable interest to those who are connected with telephony as well as to those engineers who follow the relations between the Government and the various branches of the electrical industry, it has excited more comment in the general press and in business circles than the occasion really warrants. As is well known to the majority of our readers, the licence under which the National Telephone Co. is working expires on Dec. 31, 1911. Nothing in this licence referred to any arrangement for Government purchase at that date, and in the ordinary course of affairs the Post Office would have had the option to buy up the company's plant or not, as it thought fit. It was but natural, however, that the Post Office would buy the plant, or at all events, the greater part of it, on the expiry of the licence, in order to avoid a discontinuity in the service (except in the unlikely event of the company being thoroughly beaten in its competition with municipal and Post Office exchanges); and it was also natural that the Government would not pay the company more than the actual value of its plant, for under these conditions there would be no question of allowance for compulsory purchase or future profits. The transfer of the property would therefore necessarily take place on what is known as "tramway terms." Hence, in its general tenour, the present agreement confirms what was almost a foregone conclusion with regard to the purchase. In drawing up the new agreement, there can be no doubt that the Government was actuated mainly by a desire to avoid any falling off in the efficiency of the service during the few years which will precede its acquisition of the whole telephone system of the United Kingdom, and also to prevent the occurrence of any serious inconvenience to the public at the time of the transfer. Unless some provision were made for the contingency, it was not improbable that the Company might be disinclined to spend money on extending its system right up to the end of the period of the licence, and by agreeing on purchase at mutually favourable terms at this date, this contingency is avoided, and the security is given which is necessary before any new capital could be borrowed from the public or the company's shareholders.

The case is somewhat complicated, however, by the existence of "competitive" telephone areas. Of these the most important is London, in which the Post Office itself has established a telephone system. An agreement, very similar to the present one was entered into with regard to this area, an agreement by which the two systems are being worked rather in partnership than in competition, and evidently with a view to the gradual establishment of one complete system which will fulfil all the requirements of telephony in London by the time the transfer is to take place. Next in importance, as competitive areas, come the five towns in which municipal telephone exchanges have been established in competition with those of the National Telephone Co. The licences obtained by four of these local authorities last longer than 1911: Glasgow until 1913, Swansea until 1920, Brighton and Portsmouth, 1926;—Hull Corporation is the fifth, and has a licence only until 1911. In these four cases, the National Telephone Co., in accordance with the Telegraph Act of 1899, has had its own licence prolonged for the same period as the municipal licence, and the Government must therefore purchase these four of the company's systems at a valuation which takes into account the profits that may be made between 1911 and the dates of expiry of the prolonged licences. The third class of competitive exchanges are the small exchanges in the provinces, in which the Post Office has established a more or less experimental service in addition to the company's service, but in practically all of these there has been no serious competition with the company. In all three classes of competitive exchanges the Postmaster-General only binds himself to buy so much of the plant as is suitable; but this will probably exclude but little of the existing plant and material at the time of the transfer. In London the extension of the telephone service is being continued by the Post Office and the company in such a way as to avoid duplication of plant as much as possible. The company's new exchanges and the system generally are arranged in accordance with the best and most modern practice in telephone engineering, as set forth in a specification attached to the agreement of 1901 and repeated in a modified form in the new agreement. The same policy has been followed—although not compulsorily in this case—in the towns in which the company has to contend with municipal competition, and up-to-date exchanges have been erected there which will probably conform better with the Post Office ideas of "suitability" in six years' time than the cheaper systems that have hitherto been preferred by municipal telephone committees.

Returning now to the general arrangement as to purchase, it will be noted that while it is evidently the intention of the Government to acquire the whole system in 1911, conditions have been inserted to safeguard the Post Office from being saddled at that date with antiquated plant and methods. All the extensions made in the coming six years will have to be carried out in accordance with a strict specification which demands not only the employment of first-class material, but also the adoption of those systems of telephony which are now recognised as the best that are available. Moreover, in addition to the inducement of the actual purchase conditions, other facilities are offered to the company to extend its system in an efficient manner, for the Post Office undertakes to lease to the company underground wires and to provide it with suitable exchange switchboards at a fair rental, so that there may be no excuse for hampering the proper development of telephony during the interval that must elapse before the Government takes over the business. Even the question of the transfer of the company's staff is not forgotten, although the undertaking with regard to this must necessarily be more or less indefinite.

In view of the importance of telephony in commercial and social life, the delay in incorporating the telephone system as an integral part of the telegraph system of the country has been a grave mistake on the part of successive Governments. A few years ago, the acquisition of the National Telephone Co.'s undertaking would have been a comparatively simple matter. Whether the service was provided by a company or by the Government, however, nothing could prevent its growth, for the telephone has become almost a necessity in our everyday life. In addition to the money spent by the Post Office on the trunk lines and its London system, and the investments of municipal authorities in their telephonic ventures, the National Telephone Co. has expended over nine millions of pounds on its system, and has now an annual turnover of over two millions (out of which one-tenth is paid to the Government as royalty). The transfer of such an enormous system as this is naturally no simple matter, and the Government has evidently realised this in allowing nearly seven years for its effective completion. The most serious blunder that was made was the ridiculous experiment in competitive telephony, doomed to failure from the outset, made with the passing of the Telegraph Act of 1899. At that time the Government should have made arrangements for taking over the National Telephone Co.'s system in 1904, at which date it could have bought compulsorily under the Company's 1884 licence, instead of encouraging municipal authorities to waste their ratepayers' money in a spiteful and futile competition with existing telephone interests, and itself wasting the taxpayers' money on a competitive service in London which had to be practically amalgamated with the company's service two years later.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign book.

"Light Energy: Its Physics, Physiological Action and Therapeutic Applications." By Dr. Margaret A. Cleaves. (London: Rebman Limited.) 21s.

Owing to the great importance that the study of vibration of all kinds is assuming in the present day, a volume of such sterling worth as that Dr. Margaret Cleaves of New York has sent us, is to be most gladly received, entering, as it does, upon a field of work up to the present time thinly provided with literature. Many are doing something with Light Treatment, but few have as yet done much, or collected many statistics that can be put before the public, so that the 11 years Dr. Cleaves has devoted to its study and treatment make her volume the more acceptable. What impresses us most about the book is the indomitable courage she shows in facing the hard facts and problems that come in the way of establishing the nature and value of Light Energy. Beginning with the theories of light, its manifestations and transmission, she comes on to a careful study of the spectrum, devoting much space to the ultra-violet frequencies, with their rich chemical properties, then the action of light on elementary forms of life, vegetable organisms and bacteria, and leading up to an exhaustive analysis of sunlight, whose energy she speaks of in the following terms:—

> The sun is only a private in the host of heaven, a single star among millions, but he alone among the countless myriads is near enough to effect terrestrial affairs in any sensible degree, and his influence upon them is such that it is hard to find the word to name it, it is more than control and dominance. He is almost absolutely in a material sense the prime mover of the whole. To him can be traced directly nearly all the energy involved in all the phenomena, mechanical, chemical or vital. Cut off this energy even for one month and the earth would die, all life upon its surface would cease. This fact has always been more or less distinctly

recognised, but a practical application of its truth is not always made, even by the physician, whose duty it is to bring to bear all forms of energy, physical or medicinal, in the prevention and treatment of disease.

Treating fully of the nature and value of sun baths, other sources of light are examined, the electric arc with an analysis of its nature and properties, its great use as a substitute for solar light and its curative power over many forms of disease. The incandescent light bath with its therapeutic indications then follows, with reference to the use of blue and red light, high-frequency currents, Röntgen rays and vacuum tube discharges. Even N-rays find a place, and a chapter is devoted to α, β and γ rays of radio-active substances, and the newly-found metals radium, uranium and thorium and their properties. Dr. Cleaves has marshalled the investigations and opinions of all the leading authorities of this many-sided study, and has not flinched from invading the territory of kindred science. Her book is the production of a far-reaching scientific knowledge, but we cannot, however, help complaining that a subject fraught with such vivid and enchanting interest has not been handled with more pleasure to the reader. "The nearer the bone the sweeter the meat" Dr. Cleaves evidently thinks, and she has kept very near the bone all through. Nothing has been left for the imagination, perhaps rightly, but a little more illustration borrowed from the common things of life would have made the book more readable. Hard scientific facts are reeled off all in the same tone of voice, and many will find the first part of the book, at least, hard reading. We could have wished it had been in two vols., for its 800 odd pages make it too heavy to hold, though the letterpress is clear and plenty of margin is given to the pages. Although scarcely for students it is a work that will be valued much by all who have sufficient scientific knowledge to follow Dr. Cleaves in her successful efforts to elucidate difficult and at the present time unfamiliar phenomena.

Mathematische Einführung in die Elektronentheorie. By Dr. A. H. Bucherer. (Leipzig: B. G. Teubner.) 8m.20.

The author has brought together in a small compass a large proportion of the work done towards the elaboration of the electron theory of electricity and magnetism, which, from a small germ hidden in the theory of dispersion, has developed so far as to embrace all those phenomena whose seat is not the pure ether. The latter is still in undisputed possession of Maxwell's original theory. Indeed, as the author points out, the two theories are no rivals. They mutually supplement each other, and between them we seem to be gradually approaching a state of finality and ultimate truth which is very refreshing after so much wandering in the wilderness of speculation. Readers of *The Electrician* will be glad to notice that Heaviside's methods and notation are adopted throughout this work, and are applied with brilliant effect to the work of foreign physicists like Lorentz, Wiechert, Kaufmann and Abraham. It is a pity that the author was not in time to include the fine work of Sommerfeld on the field of electrons having any given motion. E. E. F.

SOUTH AUSTRALIAN "TRAMWAYS ELECTRIC TRACTION ACT, 1904."

In our issue for January 6th, p. 475, we gave a summary of the terms of the South Australian "Tramways Electric Traction Act, 1904," which enables the South Australian Government to take steps to convert the present system of horse tramways in Adelaide to electric traction. The Act was assented to on November 24, 1904, and already a start has been made to exercise the powers conferred by it upon the South Australian Government.

Sub-sec. 1 of sec. 7 reads as follows :—

> "The Government may at any time, after one month's notice in writing to the company of its intention to do so, purchase the whole of the tramways and undertakings referred to in the acts mentioned in the first schedule (18 tramway acts relating to Adelaide are set out in the schedule) at a price to be determined, and in default of agreement, as hereinafter mentioned; provided that such notice be given within two years from the date when this Act shall come into force."

This notice has now been given.

Sub-sec. 3 of sec. 7 provides for a settlement of the price to be paid for these tramways as follows :—

> Failing agreement in writing as to price within one month after the expiry of the said notice (sub-sec 1) one arbitrator shall be appointed by the Government and one by the company, and all matters relating to such purchase shall be submitted to the decision of such arbitrators; and such arbitrators shall state the value of the movable plant of such tramways and undertakings.

The period of one month referred to in the above sub-sec. 3 expired on February 14, and we are advised that at the end of January, as there was little probability of any arrangement by mutual agreement, preliminary steps were then being taken for the appointment of arbitrators. The Government, however, is not called upon to carry out the purchase, after the award of the arbitrators is made known unless, within 12 months of the publication of the award, a tender has been let for the conversion of the whole of the lines to electric traction. Should such a tender be let, the purchase is to be completed within two months. Failing this, the compulsory power of purchase of the Government shall only be exercisable at the expiry of every successive period of five years. Purchase may, however, be carried out by agreement.

Assuming that the purchase is duly carried out the Government will call for tenders, the conditions of which will be somewhat on the following lines :—

1. Each tender shall state the number of years' lease of the tramways and undertakings required by the tenderer in consideration of effecting the conversion and constructing the works specified in the conditions of tender and in plans and specifications to be prepared by the Government.
2. The tenderer shall purchase, at the same price as that paid by the Government, all the tramways and undertakings bought by the Government under sec. 7 of this Act.
3. The tender and the specifications shall, so far as possible, be framed so as not to advantage any particular person, firm, or company.
4. The work of conversion shall commence within six months from the date of acceptance of tender, and as regards the tramways mentioned in the second schedule shall be completed as to 20 miles of tramways within one year from such date, and as to the remaining portions of such last-mentioned tramways within two years from such date.
5. As to the rest of the tramways acquired by the Government under this Act, the lessee shall convert the same into a system of electric traction within 12 years from the passing of this Act, but so that not less than nine miles of tramway shall be so converted in every three years after the expiration of the time limited by sub-sec. 4 hereof until the whole of the tramlines mentioned in the first schedule shall have been electrified.
6. Until the whole of the tramways shall be electrified the lessee shall, as to those portions of the tramways which are agreed to be electrified, agree to work and shall work the same, or such portions thereof as shall not have been electrified, with the plant as taken over by the Government and purchased by him, with as little interruption and diminution of the then existing traffic as possible, until the process of conversion is complete.
7. The lessee shall work the whole of the tramways comprised in his lease so that at least the same number of cars shall run thereon as are now run and as are specified in the time-tables published on August 1, 1904, by the various companies to which such tramways belong.
8. Every tenderer shall deposit with the Treasurer of the State such sum of money, not being less than £20,000, as the Government shall require as security for the due performance by him of the covenants, provisions and conditions of his tender, which sum of money shall be forfeited to the Government for non-compliance with the covenants, provisions and conditions of his tender, under circumstances to be specified in the conditions of tender for the lease.
9. The conditions of tender shall state that neither the lowest nor any other tender shall be necessarily accepted, and the lease shall state that no employé shall work more than 48 hours per week, except in cases of emergency, for which overtime shall be paid, and contain such other terms and conditions as to the Government may appear to be necessary.

SPECIAL RULES FOR THE INSTALLATION AND USE OF ELECTRICITY IN MINES.

In connection with the Installation and Use of Electricity in Mines, the following set of "Special Rules" has been prepared by the Home Secretary (after consultation with the mine owners), to be observed, as far as is reasonably practicable, in coal mines where electrical installations are to be put down. The draft regulations, which were the outcome of the deliberations of a Departmental Committee, appeared in *The Electrician*, Vol. LII., p. 689.

DEFINITIONS.

The expression "pressure" means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and earth as read by a hot wire or electrostatic volt-meter, and (*a*) Where the conditions of the supply are such that the pressure at the terminals where the electricity is used cannot exceed 250 volts, the supply shall be deemed a low-pressure supply.

(*b*) Where the conditions of supply are such that the pressure at the terminals where the electricity is used, between any two conductors, or between one conductor and earth, may at any time exceed 250 volts, but cannot exceed 650 volts, the supply shall be deemed a medium-pressure supply.

(*c*) Where the conditions of supply are such that the pressure at the terminals where the electricity is used, between any two conductors, or between one conductor and earth, may at any time exceed 650 volts, but cannot exceed 3,000 volts, the supply shall be deemed a high-pressure supply.

(*d*) Where the conditions of supply are such that the pressure at the terminals where the electricity is used, between any two conductors, or between one conductor and earth, may at any time exceed 3,000 volts, the supply shall be deemed an extra high-pressure supply.

SECTION I.—*General.*

1. (*a*) All electrical apparatus and conductors shall be sufficient in size and power for the work they may be called upon to do, and, so far as is reasonably practicable, efficiently covered or safeguarded, and so installed, worked and maintained as to reduce the danger through accidental shock or fire to the minimum, and shall be of such construction, and so worked that the rise in temperature caused by ordinary working will not injure the insulating materials.

(*b*) In any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, the covering shall be constructed so that, as far as is reasonably practicable, there is no danger of firing gas by sparking or flashing which may occur during the normal or abnormal working of the apparatus.

(*c*) All metallic coverings, armouring of cables, other than trailing cables, and the frames and bedplates of generators, transformers, and motors other than portable motors shall, as far as is reasonably practicable, be efficiently earthed where the pressure at the terminals where the electricity is used exceeds the limits of low pressure.

2. Where a medium-pressure supply is used for power purposes, or for arc lamps in series, the wires or conductors forming the connections to the motors, transformers, arc lamps, or otherwise in connection with the supply, shall be, as far as is reasonably practicable, completely enclosed in strong armouring or metal casing efficiently connected with earth, or they shall be fixed at such a distance apart, or in such a manner, that danger from fire or shock may be reduced to a minimum. This rule shall not apply to trailing cables.

3. Where a medium-pressure supply is used for incandescent lamps in series the wires or conductors forming connections to the incandescent lamps, or otherwise in connection with the supply, shall be, as far as is reasonably practicable, completely enclosed in strong armouring or metal casing efficiently connected with earth, or they shall be fixed at such a distance apart, or in such a manner that danger from fire or shock shall be reduced to the minimum.

4. Motors of coal-cutting and such other portable machines shall not be used at a pressure higher than medium pressure. No transformer used for supplying current at a pressure higher than medium pressure, and no motor using such current, shall be of less normal rating than 20 b.h.p. for use underground.

No higher pressure than a medium pressure shall be used in any place or part of the mine to which General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies.

5. No higher pressure than a medium-pressure supply shall be used other than for transmission or for motors, and the wires or conductors other than overhead lines above ground forming the connections to the motors or transformers or otherwise in connection with the supply shall be completely enclosed in a strong armouring of metal casing efficiently connected with earth, or they shall be fixed at such a distance apart, or in such a manner that danger from fire or shock shall be reduced to the minimum.

The machines, apparatus, and lines shall be so marked as to clearly indicate that they are high pressure, either by the use of the word "Danger" at frequent intervals, or by red paint properly renewed when necessary.

6. The insulation of every complete circuit other than telephone or signal wires used for the supply of energy, including all machinery, apparatus, and devices forming part of or in connection with such circuit, shall be so maintained that the leakage current shall, so far as is reasonably practicable, not exceed $\frac{1}{1000}$ of the maximum supply current, and suitable means shall be provided for the immediate localisation of leakage.

7. In every completely insulated circuit, earth or fault detectors shall be kept connected up in every generating and transforming station, to show immediately any defect in the insulation of the system. The readings of these instruments shall be recorded daily in a book kept at the generating or transforming station or switch-house.

8. Main and distribution switch and fuse boards must be made of incombustible insulating material, such as marble or slate free from metallic veins, and be fixed in as dry a situation as practicable.

9. Every sub-circuit must be protected by a fuse on each pole. Every circuit carrying more than 5 ampères up to 125 volts or 3 ampères at any pressure above 125 volts must be protected in one of the following alternative methods :—

(*a*) By an automatic maximum cut-out on each pole.

(*b*) By a detachable fuse on each pole, constructed in such a manner that it can be removed from a live circuit with the minimum risk of shock.

(*c*) By a switch and fuse on each pole.

10. Fire buckets, filled with clean, dry sand, shall be kept in electrical machine rooms, ready for immediate use in extinguishing fires.

No repair or cleaning of the live parts of any electrical apparatus except mere wiping or oiling shall be done when the current is on.

Gloves, mats, or shoes of indiarubber or other non-conducting material shall be supplied and used where the live parts of switches or machines working at a pressure exceeding the limits of low pressure, have to be handled for the purpose of adjustment.

11. A competent person shall be on duty at the mine when the electrical apparatus or machinery is in use ; and at such time as the amount of electricity delivered down the mine exceeds 200 B.H.P., a competent person shall be on duty at the mine above ground, and another below ground. Every person appointed to work any electric apparatus shall have been instructed in his duty and be competent for the work that he is set to do.

12. No person shall wilfully damage, interfere with, or without proper authority remove or render useless any electric line or any machine, apparatus, or part thereof, used in connection with the supply or use of electricity.

13. Instructions shall be posted up in every generating, transforming, and motor house containing directions as to the restoration of persons suffering from electric shock.

14. Direct telephonic or other equivalent means of communication shall be provided between the surface and the pit bottom or main distributing centre in the pit.

15. Within three months after the introduction into any mine of electric motive power, notice in writing must be sent to H.M. Inspector of Mines for the district. Notice must also be sent of any existing electric motive power installation at any mine within three months after the coming into force of these rules.

16. A plan shall be kept at the mine showing the position of all permanent electrical machinery and cables in the mine, and shall be corrected as often as may be necessary to keep it up to a date not more than three months previously.

SECTION II.—*Generating Stations and Machine Rooms.*

1. Where the generating station under the control of the owner or manager of the mine is not within 400 yards of the working pit mouth, an efficiently enclosed locked switch box or boxes, or a switch-house, shall, where reasonably practicable, be provided near the pit mouth, for cutting off the supply of electricity to the mine.

2. There shall be a passage way in front of the switchboard of not less than 3ft. in width, and if there are any connections at the back of the switchboard, any passage way behind the switchboard shall not be less than 3ft. clear. This space shall not be utilised as a storeroom or a lumber room, or obstructed in any manner by resistance frames, meters, or otherwise. If space is required for resistance frames or other electrical apparatus behind the board, the passage way must be widened accordingly.

No cable shall cross the passage way at the back of the board except below the floor, or at a height of not less than 7ft. above the floor.

The space at the back of the switchboards shall be properly floored, accessible from each end, and, except in the case of low-pressure switchboards, must be kept locked up, but the lock must allow of the door being opened from the inside without the use of a key. The floor at the back shall be incombustible, firm and even.

3. Every generator shall be provided with a switch on each pole between the generator and the bus-bars.

Where continuous-current generators are paralleled, reversed current cut outs shall be provided.

Suitable instruments shall be provided for measuring the current and pressure of each generator.

Every feeder circuit shall at its origin be provided with an ammeter.

4. If the transmission lines from the generating station to the pit are overhead there shall be lightning arresters in connection with the feeder circuits.

5. Automatic cut-outs must be arranged so that when the contact lever opens outwards no danger exists of striking the head of the attendant. If unenclosed fuses are used they must be placed within 2ft. of the floor, or be otherwise suitably protected.

Where the supply is at a pressure exceeding the limits of medium pressure, there shall be no live metal work on the front of the main switchboard within 8ft. of the floor or platform, and the space provided under Rule No. 2 of this section shall be not less than 4ft. in the clear. Insulating floors or mats shall be provided for medium-pressure boards where live metal work is on the front or back.

6. All terminals and live metal on machines over medium pressure above ground, and over low pressure under ground, where practicable shall be protected with insulating covers or with metal covers connected to earth.

7. No person other than an authorised person shall enter a machine or motor room, or interfere with the working of any machine, motor, or apparatus connected therewith.

SECTION III.—*Cables.*

1. All conductors (except as hereinafter provided) shall in every case be maintained completely insulated from earth, but it is permissible to use the concentric system with earthed outer conductor, if proper arrangements are made to reduce the danger from fire or shock to the minimum, but the neutral point of polyphase systems and the middle wire of three-wire continuous-current systems may be earthed at one point.

2. Unless fixed as far as is reasonably practicable out of reach of injury, all conductors, other than armoured cables, must further be protected by a suitable covering. Where lead-covered cable is used the lead shall be earthed, and electrically continuous throughout.

The exposed ends of cables where they enter the terminals of switches, fuses, and other appliances, must as far as is reasonably practicable be properly protected and finished off, so that moisture cannot creep along the insulating material within the waterproof sheet, nor can the insulating material, if of an oily nature, leak out of the cable.

3. All joints must be mechanically and electrically efficient, and, where reasonably practicable, must be suitably soldered. In any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, suitable joint boxes must be used, and the conductors connected by means of metal screw clamps, connectors, or their equivalent, constructed in a safe manner. Provided that in any place or part of a mine where a shot may be fired, joints may be soldered by or in the presence of a person authorised in that behalf by the manager, but the same precautions in regard to examination and removal of workmen as are prescribed by paragraphs (*f*) and (*i*) of General Rule 12 shall be observed in all cases, and where the place is dry and dusty, also the precautions as to watering prescribed by paragraph (*h*). Wires, other than signalling wires, or cables must not be joined by merely twisting them together.

4. Overhead bare wires on the surface must be efficiently supported upon insulators, and clear of any traffic, and provided with efficient lightning arresters.

5. All cables used in shafts must be highly insulated and substantially fixed. Shaft cables, not capable of sustaining their own weight, shall be properly supported at intervals varying according to the weight of the cable. Where the cables are not completely boxed in and protected from falling material, space shall be left between them and the side of the shaft that they may yield, and so lessen a blow given by falling material.

6. Where the cables in main haulage roads cannot be kept at least 1ft. from any part of the tub or tram, they shall be specially protected. When separate cables are used they shall, if reasonably practicable, be fixed on opposite sides of the road.

The fixing with metallic fastenings of cables and wires not provided with metallic covering to walls or timbers is prohibited.

Cables underground when suspended shall be suspended by leather or other flexible material in such a manner as to allow of their readily breaking away when struck, before the cables themselves can be seriously damaged.

Where main or other roads are being repaired, or blasting is being carried out, suitable temporary protection must be used so that the cables are reasonably protected from damage.

7. Trailing cables for portable machines shall be specially flexible, heavily insulated, and protected with either galvanised steel wire armouring, extra stout braiding, hose pipe, or other effective covering. Trailing cables shall be examined at least once in each shift by the person in charge of the machine, and any defects in them promptly repaired.

At points where the flexible conductors are joined to the main cables, a fixed terminal box must be provided, and a switch shall be fixed close to or in the terminal box capable of entirely cutting off the supply from the terminal box and motor.

SECTION IV.—*Switches, Fuses, and Cut-outs.*

1. Fuses and automatic cut-outs shall be so constructed as effectually to interrupt the current when a short-circuit occurs, or when the current through them exceeds the working current by 200 per cent. Fuses shall be stamped or marked, or shall have a label attached, indicating the current with which they are intended to be used, or where fuse wire is used each coil in use shall be so stamped or labelled. Fuses shall only be adjusted or replaced by an authorised person.

2. All live parts of switches, fuses, and cut-outs not in machine rooms, or in compartments specially arranged for the purpose, must be covered. These covers must be of incombustible material, and must be either non-conducting or of rigid metal, and as far as practicable, clear of all internal mechanism.

3. All points at which a circuit other than those for signals has to be made or broken shall be fitted with proper switches. The use of hooks or other makeshifts is prohibited, and in any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, the use of open-type switches, fuses, and cut-outs is prohibited; they must either be enclosed in gas-tight boxes, or break under oil.

SECTION V.—*Motors.*

1. All motors, together with their starting resistances, shall be protected by switches capable of entirely cutting off the pressure, and fixed in a convenient position near the motor of 10 B.H.P. or over in a machine room underground shall be provided with a suitable ammeter to indicate the load put upon the machine.

2. Where unarmoured cables or wires pass through metal frames or into boxes or motor casings, the holes must be substantially bushed with insulating bushes, and where necessary, with gas-tight bushings which cannot readily become displaced.

3. Terminal boxes of portable motors must be securely attached to the machine, or be designed to form a part thereof.

4. In any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, all motors, unless placed in such rooms as are separately ventilated with intake air, shall have all their current-carrying parts, also their starters, terminals, and connections completely enclosed in flame-tight enclosures, made of uninflammable material, and of sufficient strength as not to be liable to be damaged should an explosion of firedamp occur in the interior, and such enclosures shall not be opened except by an authorised person, and then only when the current is switched off. The pressure shall not be switched on while the enclosures are open.

5. In any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, a safety lamp or other suitable apparatus for the detection of firedamp, shall be provided for use with each machine when working, and should any indication of firedamp appear on the flame of the safety lamp or other apparatus used for the detection of firedamp, the person in charge shall immediately stop the machine, cut off the current at the gate end or nearest switch, and report the matter to an official of the mine.

6. (*a*) A coal-cutter motor shall not be kept continuously at work for a period of time exceeding a maximum period which shall be specified in writing by the manager, so that the roof may be carefully examined.

(*b*) The casing or inspection doors of all portable motors used underground and the casings of their switches and other appliances shall at least once a week be opened by a competent person appointed by the manager, and the parts so disclosed shall be cleaned and examined before the coverings are replaced. In special cases requiring a motor to run continuously longer than one week, the motor shall be examined at the end of the run. A report of such examination shall be entered in a report book.

7. The person in charge of a coal-cutter or drilling machine shall not leave the machine while it is working, and shall, before leaving the working place, see that the current is cut off from the trailing cables. He must not allow the cables to be dragged along by the machine. No repairs shall be made to any portable machine until the pressure has been cut off from the trailing cables.

8. If any electric sparking or arc be produced outside a coal-cutting or other portable motor or by the cables or rails, the machine shall be stopped, and not be worked again until the defect is repaired, and the occurrence shall be reported to an official of the mine.

SECTION VI.—*Electric Locomotives.*

1. Electric haulage by locomotives by the trolley wire system is not permissible in any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies. On this system no pressure exceeding the limits of medium pressure may be employed.

2. In underground roads the trolley wires must be placed so that they are at least 7ft. above the level of the road or track, or elsewhere, if sufficiently guarded, or the pressure must be cut off from the wires during such hours as the roads are used for travelling on foot in places where trolley wires are fixed. The hours during which travelling on foot is permitted shall be clearly indicated by notices and signals placed in a conspicuous position at the ends of the roads. At other times no one other than a duly authorised person shall be permitted to travel on foot along the road.

On this system either insulated returns or uninsulated metallic returns of low resistance may be employed.

3. In order to prevent any other part of the system being earthed (except when the concentric system with earthed outer conductor is used) the current supplied for use on the trolley wires with an uninsulated return shall be generated by a separate machine, and shall not be taken from or be in connection with electric lines otherwise completely insulated from earth.

4. If storage battery locomotives are used in any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, the rules applying to motors in such places shall also be deemed to apply to the boxes containing the cells.

SECTION VII.—*Electric Lighting.*

1. All arc lamps shall be so guarded as to prevent pieces of ignited carbon falling from them, and shall not be used in situations where there is likely to be danger from the presence of coal-dust. They should be so screened as to prevent risk of contact with persons.

2. Small wires for lighting circuits must be either conveyed in pipes or casings, or suspended from porcelain insulators, or tied to them with some non-conducting material which will not cut the covering, and so that they do not touch any timbering or metal work. On no account must staples be used. If metallic pipes are used they must be electrically continuous and earthed. If separate uncased wires are used they must be kept at least 2in. apart, and not brought together except at lamps or switches or fittings.

3. In any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, electrical lamps, if used, must be of the vacuum or enclosed type; they shall be protected by gastight fittings of strong glass, and have no flexible cord connections, and shall only be changed by a duly authorised competent person. While the lamps are being changed the current shall be switched off.

4. In all machine rooms and other places underground, where a failure of electric light is likely to cause danger, some safety lamps, or other proper lights, shall be kept for use in the event of such failure.

SECTION VIII.—*Shot Firing.*

1. Electricity from lighting or power cables shall not be used for firing shots, except in sinking shafts or stone drifts, and then only when a special firing plug, button, or switch is provided, which plug, button or switch shall be placed in a fixed locked box, and shall only be accessible to the authorised shot-firer.

The firing cables or wires shall not be connected to this box until immediately before it is required for the firing of shots, and shall be disconnected immediately after the shots are fired.

When shot-firing cables or wires are used in the vicinity of power or lighting cables, sufficient precautions shall be taken to prevent the shot-firing cables or wires from coming in contact with the lighting or power cables.

The foregoing rules shall not apply to telephone, telegraph, and signal wires, to which the rules of this section only shall apply.

SECTION IX.—*Signalling.*

1. All proper precautions must be taken to prevent electric signal and telephone wires from coming into contact with other electric conductors, whether insulated or not.

2. Contact makers or push buttons of electric signalling circuits shall be so constructed and placed as to prevent the circuit being accidentally closed.

3. In any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, bare wires shall not be used for signalling circuits except in haulage roads, and the pressure shall not exceed 15 volts in any one circuit.

SECTION X.—*Electric Relighting of Safety Lamps.*

1. In mines to any place or part of which General Rule No. 8 of the Coal Mines Regulation Act, 1887 applies, when safety lamps are relighted underground by electricity, the manager shall select a suitable station or stations, which are not in the return airway, and in which there is not likely to be any accumulation of inflammable gas; and no electric relighting apparatus shall be used in any other place. All electrical relighting apparatus shall be securely locked, so as not to be available for use except by persons authorised by the manager to relight safety lamps, and such persons shall examine all safety lamps brought for relighting before they are re-issued.

SECTION XI.—*Exemptions and Miscellaneous.*

1. Notwithstanding anything contained in these rules, any electrical plant or apparatus installed or in use before the coming into force of these rules may be continued in use unless an inspector shall otherwise direct, or subject to any conditions affecting safety that he may prescribe.

In case any difference of opinion shall arise between an inspector and an owner under this Rule, the same shall be settled as provided in section 42 of the Coal Mines Regulation Act, 1887.

2. Any of the foregoing requirements shall not apply in any case in which exemption is obtained from the Secretary of State, on the ground either of emergency or special circumstances, on such conditions as the Secretary of State may prescribe.

POLARISED RÖNTGEN RADIATION.*

BY CHARLES G. BARKLA, D.SC.

Experiments on secondary radiation from gases and light solids subject to X-rays showed that the character of this radiation differs only very slightly from that of the radiation producing it, and that the energy of this radiation is proportional merely to the quantity of matter through which a beam of Röntgen radiation of definite intensity passes, being independent of the kind of matter. These results, and the agreement between the energy experimentally determined and that calculated, led to the conclusion that this radiation is due to what may be called a scattering of primary X-rays by the corpuscles or electrons constituting the molecules of the substance.

On the hypothesis that Röntgen rays consist of a succession of electro-magnetic pulses in the ether, each electron in the medium through which these pulses pass has its motion accelerated by the intense electric fields in these pulses, and consequently is the origin of a secondary radiation, which is most intense in the direction perpendicular to that of acceleration of the electron, and vanishes in the direction of that acceleration. The direction of electric intensity at a point in a secondary pulse is perpendicular to the line joining this point and the origin of the pulse, and is in the plane passing through the direction of acceleration of the electron. On this theory, a secondary beam whose direction of propagation is perpendicular to that of the primary, will be plane polarised, the direction of electric intensity being parallel to the pulse front in the primary beam. If the primary beam be plane polarised, the secondary radiation from the charged corpuscles or electrons has a maximum intensity in a direction perpendicular to that of electric displacement in the primary beam, and zero intensity in the direction of electric displacement. The secondary radiation from light substances was too feeble to allow accurate measurement of the intensity of the tertiary radiation.

A consideration of the method of production of primary Röntgen rays in an X-ray tube, however, leads one to expect partial polarisation of the primary beam proceeding from the anticathode in a direction perpendicular to that of propagation of the impinging cathode rays, for there is probably at the anticathode a greater acceleration along the line of propagation of the cathode rays than in a direction at right angles; consequently, in a beam of X-rays proceeding in a direction perpendicular to that of the cathode stream there should be greater electric intensity parallel to the stream than in a direction at right angles. Such a beam was therefore used as the primary radiation, and the intensity of secondary radiation proceeding in a direction perpendicular to that of propagation of the primary beam from a radiator placed in that beam, was studied by means of electroscopes.

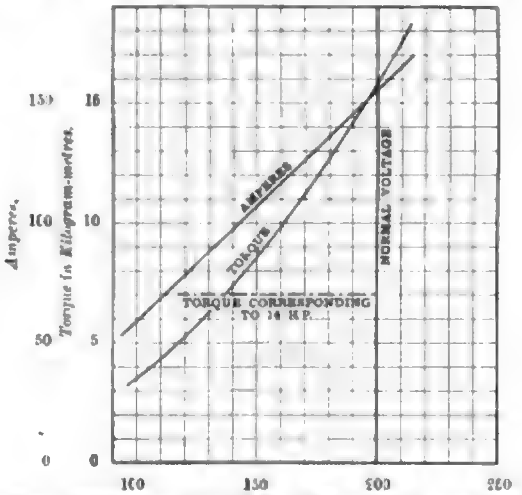
In the final form of apparatus the intensity of secondary radiation was measured in two directions perpendicular to that of propagation of the primary radiation and to each other, while the intensity of the primary beam was measured by a third electroscope. Using paper, aluminium, or air, as the radiator, as the bulb was turned round the axis of the primary beam studied, the intensity of a secondary beam was found to reach a maximum when the direction of the cathode stream was perpendicular to that of propagation of the secondary beam, and a minimum when these two were parallel, one electroscope recording a maximum rate of deflection when the other recorded a minimum. Many experiments were made which proved the evidence of partial polarisation conclusive. When heavier metals, such as copper, tin and lead, which emit a secondary radiation differing considerably in character from the primary producing it, were used as radiators, no variation in intensity of secondary radiation was observed as the bulb was rotated. This result was not found to be affected by a considerable variation in the penetrating power of the primary radiation. Experiments were made with several X-ray tubes.

CONDENSING PLANT DRIVEN BY FYNN REPULSION-INDUCTION MOTOR.

In drawing up the designs for the recent extensions at the Burton-upon-Trent Corporation electricity station, it was thought preferable to drive the condensing plant for the new 500kw. extension set from the alternating-current side of the station instead of connecting it to the continuous-current side. The Fynn repulsion-induction motor, the patents of which for Great Britain and the Colonies are controlled by Messrs. Witting, Eborall & Co., was chosen for this purpose owing to the fact that when starting with a torque equal to that of full load, the starting current is as low as three-quarter to full-load current. This single-phase induction-repulsion motor was fully described and illustrated in *The Electrician*, Vol. LIII., p. 646.

The surface condensing plant was manufactured by Messrs. Cole, Marchent & Morley, of Bradford, the motor also being supplied through them. It consists of the Edwards type of three-throw air pump, and circulating pump by Messrs. Gwynne; the former is driven at 135 revs. per min. through gearing, while the latter is coupled direct to the motor, which runs at 1,440 revs. per min. The valves of the pump cylinders are of the Kinghorn type. The total length of the circulating pipe which draws from and delivers to the River Trent is 808ft. and the maximum height above normal river level is 17ft. According to the specification the plant has to deal with 13,500lb. of steam per hour, with no superheat, and give a vacuum at the condenser of 27in. with circulating water at a temperature of not more than 60deg.F. The whole set is compact and has successfully dealt with as much as 650kw. at the generator. A floor space of 14ft. 9in. by 7ft. 9in. is taken up by the entire set, and the condenser stands 4ft. 9in. high above floor level. There is a grease separator by Messrs. Templer & Ranoe through which the exhaust steam passes before entering the condenser. The grease and water are separated out, each being automatically discharged, whether the plant is running condensing or non-condensing, by a Bundy trap.

The motor is of 14 B.H.P. with an overload capacity of about 40 per cent. Its stator is constructed on similar lines to that of the stator of an ordinary three-phase motor, while the rotor is generally similar to the armature of a rotary converter. It has two interconnected windings on it, the free ends of one being connected to slip rings, while the ends of the coils of the other are connected



After 4 hours' run at 15·5 H.P. at 200 volts, 91 amp., increase of temperature:—(1) Stator-Iron 36 C.; Winding 25 C. (2) Rotor-Iron 30 C.; Winding 30 C.

To convert torque in kilogram-metres to torque in lb.-ft., multiply by 7·2, thus: 7·0 kg./m. = 7·0 × 7·2 = 50·4 lb.-ft.

Fig. 1.—Starting Performance of Burton Single-Phase Motor (Repulsion-Induction Type), 14 b.h.p., 200 Volts, 82 Amp., 75 ~, 1,460 r.p.m.

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* Abstract of a Paper read before the Royal Society on Feb. 16, 1905.

up to a commutator. After closing the main switch, thus putting the current on to the stator windings, the starting switch is moved to the first notch of the resistance in circuit with the brushes on the commutator side of the machine. The motor driving the condensing plant reaches a speed on the first notch of 1,060 revs. in 5 seconds. There are 13 resistance notches, the speed rising to a maximum as the switch moves over them. The slip rings are next short-circuited by pushing in a projecting knob at the spur-wheel end of the motor shaft. Then the starting switch is moved back to the first position, and all the brushes which bear on the slip rings are raised in one operation by means of a small handle. The whole operation, as outlined above, can be done in from 1 minute to 1¼ minute. Commutation is absolutely sparkless under all conditions, and the starting current is just about equal to full-load current, being 82 amperes. With a lower frequency than 75 ~ per second, it would be possible to reduce this starting current materially. The efficiency guaranteed was 83 per cent., but as a fairly high power-factor—*i.e.*, 80 per cent.—was subsequently demanded, the efficiency fell slightly below the figure named. It will be noted from Figs. 1 and 2 that the efficiency and power-factor are almost constant from 9 H.P. to 20 H.P.

This particular motor is not arranged for reversing, as such an operation is not necessary. When the motor is required for reversing, however, and if it is undesirable to shift the brushes, then a second winding is provided on the stator in quadrature to the first winding, the two being in series. Hence, when it is desired to change the direction of rotation, all that is necessary is to change over one of the windings. It will be seen, therefore, that both windings are always operative.

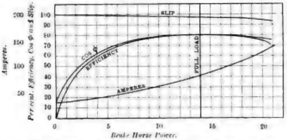

FIG. 2—TEST CURVES OF BURTON SINGLE-PHASE MOTOR (REPULSION INDUCTION TYPE)—14 B.H.P., 200 VOLTS, 82 AMP., 75 ~, 1,450 R.P.M.

In the larger sizes of Fynn motors, from 50 H.P. upwards, including traction motors, the Fynn method of self-excitation is provided. This is a very important feature, and has the great advantage of enabling the motor to work at all loads with a power-factor of unity, the efficiency only being affected to a very trifling extent. The actual power consumption when the condensing plant was dealing with, approximately, 13,500lb. of steam per hour was 12·9kw. at a power-factor of 80 per cent. Allowing for the efficiency of the motor, this gives a brake-horse-power of 13·8 for driving the whole set.

Our thanks are due to Mr. P. J. Pringle, Borough Electrical Engineer and Tramways Manager of Burton-upon-Trent, for furnishing us with the particulars for this article.

ROBERTSON LAMPS.

A number of gentlemen were entertained at lunch last Monday by the Robertson Electric Lamps, Ltd., and were then conducted over the factory, where all the various processes of lamp-making were explained by the staff. The company's business has been continuously increasing of late, the output of lamps having amounted to 4½ millions last year, and at present some 15,000 lamps are made daily. The premises have been extended from time to time to meet the demand, and the number of workpeople employed has increased proportionately, the employees now numbering some 600. Improvements in the processes of manufacture have kept pace with the growth of business, and electric driving has been substituted for steam power. This "electrification" has been going on since the middle of December last, and is now practically completed. Single-phase current at 2,200 volts is obtained from the Hammersmith Corporation and transformed down to 200 volts on the premises. The transforming plant has been erected by the Hammersmith Corporation especially for these works, which take some 30,000 units monthly at a cost of a little over a penny per unit. The low-voltage single-phase current is then led to a single-phase 35 H.P. motor of special design, with three slip-rings, from which it is possible to obtain three-phase current. Although the three phases obtained in this manner are not quite of equal strength, they are sufficient to operate satisfactorily all the three-phase motors in the works, even when starting against full load. There are 22 three-phase motors, ranging from ½ H.P. to 20 H.P., distributed throughout the buildings, and used for driving vacuum pumps, fans, &c. Where the motors are required to run at variable speeds, as is the case with fan motors, regulation is obtained by inserting resistance in the rotor circuit. The 35 H.P. motor referred to above is directly coupled to a 400-volt continuous-current dynamo, which is used for charging two 200-volt storage batteries in series. Where a steady current is required, as in testing, photometry, &c., the current from these batteries is employed, but if perfect steadiness is not essential, as in life tests, alternating current from the 200-volt supply is used. The motor equipment has been installed by the General Electric Co., (Witton Works), and we understand that the actual saving in money due to the substitution of electric for steam power, after taking into account capital charges, interest and depreciation of the new equipment, amounts to about 20 per cent.

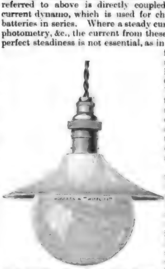

FIG. 1.—WYTELITE LAMP WITH SHADE. Scale about one third actual size.

The visitors were shown a novelty in the "Wytelite" lamp, which the firm is now putting on the market. Figs. 1 and 2 illustrate this lamp, which burns with a much whiter light than ordinary incandescent lamps, and is, for this reason, especially suitable for lighting shop windows, &c. It is to all intents and purposes an ordinary glow lamp, but over-run to obtain whiteness of the filament. In order to make the consequent increase in temperature possible without decreasing the life of the lamp or effecting a premature blackening of the bulb, the glass globe is perfectly circular in shape and considerably larger than an ordinary bulb. In this way a greater radiating surface is obtained which does not show the effect of blackening so readily as the small ordinary bulb.

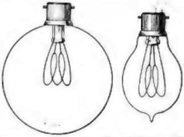

FIG. 2.—COMPARATIVE SIZE OF 20 TO 25 C.P. "WYTELITE" LAMP AND AN ORDINARY ROBERTSON 16 C.P. INCANDESCENT LAMP. Scale one-third full size.

It is stated that the lamp is made for all voltages, has a useful life of from 800 to 1,000 hours, an efficiency of from 3 to 3½ watts per c.p., an illuminating power of from 20 c.p. to 25 c.p. in a horizontal direction and from 40 c.p. to 50 c.p. in a vertical downward direction. The globe is partially frosted, as a rule, and is supplied together with the small opal reflector shown in Fig. 1, at a price slightly higher than that of an ordinary lamp.

TESTING THE RESISTANCE OF STEEL RAILS.

Messrs. Elliott Bros. have placed on the market a new testing panel for ascertaining rapidly the resistance of track and conductor rails. The resistance is ascertained by passing a known current through the rail and measuring the drop of potential across a given length, the resistance being V/C by Ohm's law. A 5ft. length of rail, 100lb. to the yard, has a resistance of only about 0·000028 ohm at 70 F. so it will be seen that the milli-voltmeter must be sensitive; the maximum current that practice has found advisable is under 200 amperes, and this gives a drop of about 0·0056 volt. At lower temperatures and with material of higher conductivity, however, a loss of about 0·0028 is not unusual. The instruments are of the sector pattern, and possibly of the illuminated dial type, this particular instrument being chosen for the length of scale it is possible to obtain. The ammeter is calibrated from 0-200, and is provided with Campbell's compensating device, which automatically corrects the readings of the ammeter for changes of temperature. This device is incorporated in all Elliott Bros. standard ammeters. The milli-voltmeter is a polarised instrument, with zero in the centre of the scale, and reads as a rule to 0·02 volt either side of zero. A double-pole change-over main switch is provided, for reversing the current through the rail, the connections being arranged so that the direction of the current through the ammeter always remains the same. Readings are taken on either side of the scale on the milli-voltmeter, the mean of the two readings being taken as the correct voltage. In this way, thermo effects, &c., are eliminated.

The current is supplied by two 50 ampere accumulators, and the amount of current passing through the rail is regulated by four single-throw switches placed immediately below the main change-over switch. When all these switches are open, the circuit is broken. The current is increased in steps of about 50 amperes at a time by closing one or more of these switches, which parallels the spirals of a resistance frame mounted at the back of the panel. Two large terminals are provided at the bottom of the panel are for the cables carrying the current to the rail, and two smaller terminals for the milli-voltmeter leads.

PARLIAMENTARY INTELLIGENCE.

The following petitions have been lodged against bills originating in the House of Lords. The petitions against bills commencing in the House of Commons were given in our last issue.

Administrative County of London and District Electric Power Supply Bill.—Southall-Norwood Urban District Council, Paddington Borough Council, Richmond Corporation, Richmond (Surrey) Electric Light & Power Co., London & North-Western Railway Co., Erith Urban District Council, City of Westminster, Woodford Urban District Council, Westminster Electric Supply Corpn., Southwark Borough Council, Kingston-on-Thames Gas Co., Bermondsey Borough Council, Camberwell Borough Council, Deptford Borough Council, Lewisham Borough Council, Chelsea Borough Council, Stepney Borough Council, South Metropolitan Electric Light & Power Co., Bromley Urban District Council, Gravesend Urban District Council, Beckenham Urban District Council, Bexley Urban District Council, Chislehurst Urban District Council, Dartford Urban District Council, Dartford Gas Co., Hackney Borough Council, Hanwell Urban District Council, Leyton Urban District Council, Essex County Council, Great Eastern Railway Co., Maldens and Coombe Urban District Council, Wanstead Urban District Council, East Ham Corporation, Ilford Urban District Council, Metropolitan District Railway Co., Underground Electric Railways Co. of London, Whitechapel & Bow Railway Co., Barnes Urban District Council, Thames Conservancy, Ealing Corporation, Lambeth Borough Council, Hampton Urban District Council, Wandsworth Borough Council, West Ham Corporation, Croydon Corporation, Teddington Urban District Council, Wimbledon Urban District Council, Brentford Urban District Council, Chiswick Urban District Council, Twickenham Gas Light & Coke Co., Barking Urban District Council, Metropolitan Water Board, City of London Corporation, Central Electric Supply Co., County of London Electric Supply Co., London County Council, London United Tramways Co., Great Northern, Piccadilly & Brompton and other railway companies, Heston and Isleworth Urban District Council, Bromley Rural District Council, Croydon Rural District Council, Hampstead, Battersea, Fulham, Hammersmith, Poplar, St. Pancras, Stoke Newington, Woolwich, Islington and Marylebone Borough Councils, South Metropolitan Tramways & Lighting Co., Kingston-on-Thames Corporation, Kent Electric Power Co., Kent Electric Power Synd., North Metropolitan Electric Supply Co., Uxbridge & District Electric Supply Co., City of London Electric Lighting Co. and promoters of East London and Lower Thames Electric Power Bill, Kensington & Knightsbridge & Notting Hill Electric Lighting Companies, Grays Thurrock Urban District Council and companies supplying electrical energy in the Administrative County of London.

Blackpool Improvement Bill.—Blackpool, St. Anne's & Lytham Tramways Co., Lancashire & Yorkshire Railway Co., London & North-Western Railway Co.

Central Electric Supply Co.'s Bill.—Paddington Borough Council, London & North-Western Railway Co., City of Westminster, London Electric Supply Corpn., Kensington & Knightsbridge Electric Lighting Co., Notting Hill Electric Lighting Co., Brompton & Kensington Electric Supply Co., Chelsea Borough Council, City of London Corporation, London County Council, Great Northern, Piccadilly & Brompton and other railway companies, Hampstead, St Pancras and Marylebone Borough Councils, promoters of Administrative County of London and District Electric Power Bill.

Charing Cross & Strand Electricity Supply Co.'s Bill.—South London Electric Supply Corpn., Great Northern and other railway companies, City of Westminster, Woodford Urban District Council, London Electric Supply Corpn., Stepney Borough Council, Hackney Borough Council, Westminster Electric Supply Corpn., Hornsey Borough Council, Leyton Urban District Council, Essex County Council, East Ham Corporation, Ilford Urban District Council, Thames Conservancy, Lambeth Borough Council, Whitechapel & Bow Railway Co., West Ham Corporation, Barking Urban District Council, Walthamstow Urban District Council, City of London Corporation, County of London Electric Supply Co., St. James & Pall Mall Electric Light Co., London County Council, Tottenham Urban District Council, Edmonton Urban District Council, Southgate Urban District Council, Islington, Poplar, Shoreditch and Stoke Newington Borough Councils promoters of the Administrative County of London and District Electric Power Bill, Wood Green Urban District Council, City of London Electric Lighting Co., and promoters of the East London and Lower Thames Electric Power Bill, North Metropolitan Electric Power Co.

City of London Electric Lighting Co.'s Bill.—South London Electric Supply Corpn., Great Northern and other railway companies, Erith Urban District Council, Southwark Borough Council, London Electric Supply Corpn., Camberwell Borough Council, Lewisham Borough Council, Deptford Borough Council, South Metropolitan Electric Light & Power Co., Bromley Urban District Council, Gravesend Urban District Council, Beckenham Urban District Council, Bexley Urban District Council, Dartford Urban District Council, Dartford Gas Co., Chislehurst Urban District Council, Westminster Electric Supply Corpn., Thames Conservancy, Lambeth Borough Council, West Ham Corporation, City of London Corporation, County of London Electric Supply Co., London County Council, Baker-street & Waterloo Railway Co., Great Northern, Piccadilly & Brompton Railway Co., Bromley Rural District Council, Bermondsey, Battersea and Woolwich Borough Councils, Kent Electric Power Co., Kent Electric Power Syndicate, Promoters of Administrative County of London and District Electric Power Bill.

County of London Electric Supply Co.'s Bill.—South London Electric Supply Corpn., Great Western and other railway companies, City of Westminster, Southwark Borough Council, London Electric Supply Corpn., Chelsea Electricity Supply Co., Westminster Electric Supply Corpn., Lambeth Borough Council, Thames Conservancy, Wandsworth Borough Council, Croydon Corporation, Metropolitan Water Board, City of London Corporation, London County Council, Great Northern Piccadilly & Brompton Railway Co., Tottenham Urban District Council, Camberwell, Battersea, Deptford, Lewisham and Shoreditch Borough Councils, Promoters of the Administrative County of London & District Electric Power Co., Lea Conservancy, North Metropolitan Electric Power Supply Co., City of London Electric Lighting Co., and promoters of East London and Lower Thames Electric Power Bill.

East London and Lower Thames Electric Power Bill.—South London Electric Supply Corpn., Great Northern and other railway companies, Woodford Urban District Council, London Electric Supply Corpn., Bermondsey Borough Council, London, Tilbury & Southend Railway Co., Stepney Borough Council, South Metropolitan Electric Light & Power Co., Hackney Borough Council, Wanstead Urban District Council, East Ham Corporation, Ilford Urban District Council, Essex County Council, Whitechapel & Bow Railway Co., Thames Conservancy, West Ham Corporation, Barking Urban District Council, Metropolitan Water Board, Greenwich, Deptford, Woolwich and Poplar Borough Councils, City of London Corporation, County of London Electric Supply Co., London County Council, promoters of the Administrative County of London & District Electric Power Co., Grays Thurrock Urban District Council, North Metropolitan Electric Power Supply Co., Charing Cross & Strand Electricity Supply Corporation.

Hastings Tramways Bill.—Hastings Corporation, Bexhill Water & Gas Co., Bexhill Corporation.

Metropolitan Electric Supply Co. (Acton) Bill.—Willesden Urban District Council, Middlesex County Council, Metropolitan Water Board, Promoters of the Administrative County of London & District Electric Power Co.

Metropolitan Electric Supply (Extension of Powers) Bill.—Southall-Norwood Urban District Council, Paddington Borough Council, London & North-Western Railway Co., City of Westminster, Kensington & Knightsbridge Electric Lighting Co., Notting Hill Electric Lighting Co., Brompton & Kensington Electric Supply Co., London Electric Supply Corpn., Chiswick Urban District Council, Feltham Urban District Council, Staines Urban District Council, Twickenham Urban District Council, South London Electric Supply Corpn., Hanwell Urban District Council, Westminster Electric Supply Corpn., Brentford Gas Co., Underground Electric Railways Co. of London, Metropolitan District Railway Co., Ealing Corporation, Thames Conservancy, Lambeth Borough Council, Hampton Urban District Council, West Ham Corporation, Teddington Urban District Council, Brentford Urban District Council, County of London Electric Supply Co., London County Council, Fulham, Hammersmith, Hampstead, St. Pancras and Marylebone Borough Councils, Heston and Isleworth Urban District Council, St. James & Pall Mall Electric Light Co., promoters of the Administrative County of London and District Electric Power Bill, Uxbridge & District Electric Supply Co., City of London Corporation.

Metropolitan Railway Co.'s Bill.—Chelsea Electricity Supply Co., Westminster Electric Supply Corpn., North Metropolitan Electric Power Supply Co., the Electric Lighting Companies of London.

Mexborough and Swinton Tramways Bill.—Swinton Urban District Council, Rotherham Corporation, Mexborough Urban District Council.

North Metropolitan Electric Power Supply Co.'s Bill.—Great Northern and other railway companies, City of Westminster, Westminster Electric Supply Corpn., Hackney Borough Council, Hornsey Borough Council, West Ham Corporation, City of London Corporation, County of London Electric Supply Co., London County Council, Great Northern, Brompton & Piccadilly Railway Co., Charing Cross, Euston & Hampstead Railway Co., Tottenham Urban District Council, Islington and Shoreditch Borough Councils, Edmonton Urban District Council, Southgate Urban District Council, Wood Green Urban District Council, promoters of the Administrative County of London & District Electric Power Co., Charing Cross & Strand Electricity Supply Co.

Oldham and Saddleworth Tramways Bill.—National Telephone Co.

Southend and Colchester Light Railways Bill.—Great Eastern Railway Co., Southend Corporation, Maldon Rural District Council.

South Lancashire Electric Tramway Co.'s Bill.—Lancashire Electric Power Co., Warrington Corporation, Worsley District Council, St. Helen's Corporation.

Wellingborough and District Tramroads and Electricity Supply Bill.—Finedon Urban District Council, Bedfordshire County Council, Northamptonshire County Council, Thrapston Rural District Council.

The following bills were read a second time in the House of Lords on Tuesday:—Administrative County of London & District Electric Power, Blackpool Improvement, East London & Lower Thames Electric Power, Hythe Corporation, Nottingham Corporation.

ELECTRICITY IN MINES.

In the House of Commons on Thursday last week Mr. JOHN ELLIS asked the Secretary of State for the Home Department whether the rules respecting the use of electricity in and about coal mines had been settled and published; and, in that case, in what Parliamentary Paper could a copy be found.

Mr. AKERS-DOUGLAS, in a printed reply, said that these rules had been settled with the owners' association and approved by the men's representatives. They were not yet in force, as they had to be proposed, by statute, to each colliery owner individually; but the notices of proposal, some thousands in number, would all have been despatched within the next few days, and the rules would, in each case, come into force, if not objected to, within 20 days from the receipt of the notice. The rules as settled had not yet been made public, but he would be happy to send Mr. Ellis a copy if he desired it.*

WIRELESS TELEGRAPHY.

In the House of Commons on Thursday last week Major SEELY asked the President of the Board of Trade whether the installation of wireless telegraphy for life-saving purposes on the East Goodwin, South Goodwin, Gull, Tongue, Sunk, and Cross-Sand lightships, as to which arrangements were in progress in June, 1903, had yet been completed; and if not, at what date the work was likely to be finished.

Mr. GERALD BALFOUR, in a printed reply, said the necessary legal agreement between the Board of Trade, Trinity House, and the Marconi Wireless Telegraphy Co., with the assent of the Admiralty and the Post Office, had not yet been completed. The legal and administrative difficulties had been great, as it was necessary to deal with questions affecting wireless telegraphy in this country by legislation, and to safeguard the rights of the Post Office. He was in hopes, however, that the completion of the agreement would not be long delayed, and when completed he saw no reason to doubt that the actual work of installation would proceed expeditiously.

THE PACIFIC CABLE.

In the House of Commons on Thursday last week, in answer to Mr. Gibson Bowles,

The CHANCELLOR OF THE EXCHEQUER said that the amount borrowed for capital expenditure on the Pacific Cable was being repaid by a terminable annuity provided in the vote for telegraph subsidies and Pacific cable (Civil Service Estimates, Class V., 5). The colonial shares of the expenditure were recovered from the colonial governments after the close of each financial year. The first instalment of the annuity for the repayment of the borrowed capital was included in the vote for 1903-4, and the colonial share had been received in the present financial year.

LEGAL INTELLIGENCE.

Jandus Arc Lamp & Electric Light Co. (Ltd.) v. the Arc Lamp (Ltd.)

This case again came before Mr. Justice Kekewich on Monday, the earlier hearings having been reported in *The Electrician* of Jan. 20 and Feb. 17.

Prof. J. D. Cormack, Mr. J. Swinburne and Mr. Adam gave further evidence as to various experiments made by plaintiffs.

Mr. GRAY, in summing up the defendants' case, submitted that size, diameter or capacity had nothing whatever to do with the life of the carbon. On the evidence of Mr. Swinburne alone he argued that the experiments proved conclusively that nothing whatever could be concluded so far as plaintiffs' experiments were concerned even to prove a prima facie case, that size had anything to do with the life of the carbon. Experiments of this kind could not possibly be conducted except over a long period of time and after a great deal of repetition.

His LORDSHIP: In my opinion, the experiments would be no safe guide, and I do not mean to regard them at all.

Mr. GRAY said the onus was upon the plaintiffs to prove that size was a feature of any importance, and they had failed to do so. Plaintiffs had proved nothing except that tightness was of importance, and that point defendants admitted. With regard to anticipations, counsel submitted that there was no more complete or comprehensive direction to prevent air getting into the globe than was contained in Beardsley. The Beardsley specification was an absolute anticipation so far as the life of the carbon was concerned. As to the question of utility, counsel said somewhat visionary evidence had been given as to the sale of the Howard patent. It had been said that the Howard patent was responsible for a revolution in electric arc lighting. The Jandus Co. sold a considerable number of lamps made under the Jandus patent in 1895, and it was not till 1896, three years after the date of the Howard patent, that they acquired that patent. Upon the evidence, they acquired it, not because it was a wonderful epoch-making patent, but because there was a claim for an inner and an outer globe.

His LORDSHIP said the evidence of Mr. Dugald Clerk was that the Jandus Co. acquired the Howard patent because it was thought that they were infringing it.

The learned Counsel, proceeding, said plaintiffs had never told his Lordship what particular point appeared in the Howard patent that did not appear in the Jandus patent. He submitted that, upon the evidence, no lamp made according to the true Howard's specification had ever been put upon the market. As to the question of subject matter, counsel submitted that there never had been a case decided in the Courts in which a mere alteration of size had been held to be subject matter for a patent.

His LORDSHIP said that, with reference to that part of the Howard patent with which they were concerned, he proposed to hold that what Howard claimed to have invented was a lamp enclosed in a small envelope, practically airtight, but yet allowing escape of gases at the top; that Howard attained what he claimed—namely, an increase in the life of the carbon—and, further, that the invention had been commercially useful and had not been anticipated. He wished to hear the plaintiffs' counsel in reply on the question of subject matter.

Mr. FLETCHER MOULTON argued that change of size might be a most important practical step towards revolutionising or altering widely the general practice. There was no enclosed lamp before the date of this patent. Now all the best lighting effects were by enclosed lamps. The learned counsel quoted a number of authorities in support of his contention that there was proper subject matter.

His Lordship reserved judgment.

Tilling Limited v. Dick, Kerr & Co. (Ltd.)

Mr. Justice Warrington on Saturday gave judgment in this action, in which plaintiffs sued defendants for damage caused to their omnibuses by certain obstructions placed by defendants in the highways. (The case was reported in our last issue, pp. 720 and 721.) His Lordship found, as a fact, that negligence was not proved against defendants. London County Council, prior to 1900, purchased under statutory powers the South London tramways, and by the London Tramways Electric Power Act, 1900, substituted electrical for horse traction. The 6th section empowered the Council to place, lay down, construct and maintain on, in, under or over the surface of any street, and to attach to any house and building such posts, conductors, wires, cables and apparatus, and to make and maintain such openings and ways in or under the surface of any street as may be necessary or convenient for such electrical working, and to reconstruct or make such alterations of the tramways and to execute all works on or in connection therewith, in, over or under the streets or roads in which the same are laid as may be necessary for adapting the same to be so worked. The special acts of the London Tramways Co. and the General Tramways Act provided that the uppermost surface of the rail should be on a level with the surface of the street and that rights of the public to pass over or along the streets should not be abridged save as in the acts provided. For the purpose of converting tramways the Council made a contract with defendants by which the latter undertook the work described therein, and in the specification annexed at a certain price. The specification provided, amongst other things, that the contract should include the provision and maintenance of all temporary lines, turn-outs and cross-over roads to be used during reconstruction. The contract and specification contained provisions casting upon the defendants the duty of observing the provisions of the statutes and the responsibility for all damage caused by interference with traffic or otherwise. Clause 13 of the specification, or that part of it which was material, was as follows: "The reconstruction, unless specially otherwise ordered by the engineer or his representative, is to be carried out on one track only over each section opened at one time. The contractors shall provide all flush or raised temporary junctions and termini, diverting horse traffic so that it can be carried from both the up and down services on the track which is in process of reconstruction, and they are to lay flush or raised temporary lines as required between the turn-outs, or if so ordered by the engineer or his representative to ensure that the process of excavation and removal of sewers, pipes, wires, &c., or the general process of reconstruction shall interfere as little as possible with the regular tramway services along, or crossing, the road. At the trial a portion of the Romney-road, opposite the Royal Naval College, was taken as an example of what had been done by defendants for maintaining the traffic on a double line of rails and with the desire at the same time to interfere as little as possible with the ordinary traffic; the defendants laid between kerb on one side of the road and the permanent tramway a line of rails, at the same time closing altogether the other half of the road. The half which was open to traffic was thus occupied by one of the two permanent lines and by the temporary line. The temporary line was constructed on rails with a bevel on either side from the ground to a height of 2in. or thereabouts, and with a groove in the top to take the flange of the wheel. The uppermost surface of the rails was, therefore, not on a level with, but was above, the surface of the street. At intervals there were clamps and nuts projecting above the surface of the raised rails. At the two ends of each section so dealt with, called a turn-out, a junction was made between the temporary line and the permanent tramway. He found, as a fact, that the rails were an obstruction to the highway and caused damage to plaintiffs' omnibuses. There was evidence, which he accepted, that it would have caused great public inconvenience to interrupt the service of the cars, and that less real interference to ordinary traffic was caused by the construction of the turn-outs than by carrying on a tram service on a single line with cross-overs at intervals. The first question was, Were the acts of defendants authorised by the statute? It was clear that the acts of defendants would be a cause of action to plaintiffs unless they were so authorised; and further, that if the acts in question were authorised expressly or by necessary implication, defendants would be excused, although the doing of them might occasion a nuisance, public or private. It was contended that the works constructed by defendants were works necessary for adapting the tramways to be worked by electricity, and were therefore authorised by sec. 6. He could not adopt defendants' contention. In his opinion the works they had constructed were not necessary for adapting the tramways to be worked by electricity, but were necessary (if at all) for maintaining the tramcar service uninterrupted. Works for this purpose were, in his judgment, not covered by the act, and defendants were accordingly not protected by it. Then as to the action being barred by the Public Authorities Protection Act, 1893. In the absence of authority, he should have been prepared to hold that contractors undertaking work for their own profit were not within the protection of an act passed, as this was, for the protection of persons acting in the execution of statutory and other public duties. When the facts of the case were considered it was clear that this action did not fall at all within that act. The damage done to the road in question was done by certain contractors, and those contractors were not the servants or agents of a corporation in doing that damage. The contractors were simply persons who contracted to deliver certain stone and material within the limits of the Council's area. In his opinion, therefore, plaintiffs were entitled to the relief they asked. It was agreed that the damages were to be ascertained by some form of reference. Defendants must pay the costs up to and including judgment. He proposed, therefore, to make a declaration that plaintiffs were entitled to recover damages in respect of the matters complained of, and to refer it to the official referee to ascertain the amount of such damages. The plaintiffs were also entitled to costs up to judgment, the subsequent costs to be dealt with by the referee.

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* The new rules will be found on page 756 of this issue.

A stay of execution was granted pending an appeal, and it was agreed to stay the reference to the official referee until after the hearing of the appeal if notice of appeal were given within 14 days.

Corporation of Norwich v. Norwich Electric Tramways Co.

Yesterday (Thursday) this case came before the Court of Appeal (Lords Justices Vaughan Williams, Romer and Stirling) on the appeal of the company against a judgment of Mr. Justice Phillimore (reported in our issue for July 15).

Plaintiff corporation sought to recover £53 odd paid by them for repair of roads said to have been damaged by defendant company's tramways, and both parties sought a declaration of their rights under the Norwich Tramways Act, 1897. This act incorporated provisions in the General Tramways Act, under which the company had to keep in good repair and to the satisfaction of the local road authority, (1) so much of the road as lay between the road lines of the tramway, (2) if there were two tramways belonging to the company within 4ft. of each other the portion of the road between the two tramways, and (3) so much of the roadway as extended 18in. beyond the rails on each side of any such tramway. If the company failed to comply the Corporation might, after seven days' notice, open and break up the road and do the necessary works at the expense of the company with interest at 5 per cent. The act also provided that whenever the road authority, the Corporation in this case, altered the level of any road on which the tramline was laid the company should at the same time alter its rails to level them with the altered surface of the road. If this was not done and the lines became a danger to public traffic, a penalty of £5. 10s. could be imposed. It was further provided that where there was a less space than 3ft. between the footpath and the tramway rails, the company should pave and maintain the road. It was shown that in some cases the tramways were laid in granite setts in macadam roads and at the point where the macadam became worn lower than the granite a hollow was formed into which the wheels of vehicles sank and water accumulated, making the macadam rotten and soft. The Corporation had repaired these hollows, the company denying responsibility on the ground that the surface of the macadam was bad, and the whole of it was in need of repair. Mr. Justice Phillimore found that while the macadam might have been in better repair, in the greater number of cases it was in sufficiently good repair. The sub-section was difficult to construe, but on the whole he thought that the fact that macadam wore away more quickly than granite had been considered in the legislation that had been carried out, and that it was intended to throw upon the tramway companies as a condition of the privileges given them, the duty of maintaining the even contour of the road by a proper junction of the two surfaces. He therefore gave judgment for the Corporation for £53 with 5 per cent. interest. He also made a declaration in favour of the Corporation. (See *The Electrician*, July 15, 1904, p. 532.)

Mr. DANCKWERTS, K.C., for appellants, now said there were two questions which arose in the case, one of which unhappily was not raised in the Court below, but he was bound to call the attention of the Court to it. That was whether the High Court had any jurisdiction in the matter whatever. The other point was as to the construction of a provision in the private Act of Parliament with regard to the extent of the liability of the company for whom he appeared. It had been held that questions arising under the section between a body like the Corporation and a body like the company should be referred to and decided by a referee appointed by the Board of Trade, and that the Court had no jurisdiction. The action was brought to recover money expended by the Corporation in alleged or disputed default, and the company to do certain repairs, and for a general declaration as to the extent of the company's liability to repair. Mr. Justice Phillimore made a declaration, and that question was a very important one because it not only took away from the referee appointed by the Board of Trade in this case the very questions which, under the act, were to be referred to him, but it took away his jurisdiction in other cases. The money matter was trifling, the important part was the declaration Under the General Tramway Act the tramway company, whenever it laid a tramway, was obliged to repair the road and maintain the roadway with such materials, &c., as the road authority required, and to the satisfaction of the road authority; that was, they were obliged to maintain the roadway between the rails and 18in. on each side of the rails, and where there was a double line of tramway the space between the rails as well. In this Act of Parliament the 4ft. limit had been done away with, and in certain narrow streets the company was bound to maintain the whole width of the street. In addition the company was bound to lay the rails so that the upper surface of the rail was not above the level of the surface of the roadway. The company had to maintain the roadway with such materials as the local authority required and to its satisfaction. There was a section in the act which said that if the company failed to maintain and keep in repair the junction between the surface of the Corporation's part of the roadway and the tramway company's part certain consequences would follow. The question was what was the meaning of the word "junction."

Lord Justice ROMER: They seem to have foreseen the difficulty. You may look after your foot of the road and get it nice and perfect and the Corporation may look after theirs, and so far as it is looked at by itself it cannot be complained of. But through wearing down there may be a difference in level at the junctions. They cannot both do the necessary work because they would interfere with each other. It must be put on someone, and they say it must be put on you.

Mr. DANCKWERTS said if it was merely the maintenance of the junctions he should not object, but the Corporation went a good deal beyond that. The Corporation sought to construe the act solely with regard to macadam, and said the company must maintain the surface of the macadam for the necessary distance in order to keep a level contour.

Lord Justice VAUGHAN WILLIAMS: I think Mr. Justice Phillimore's judgment means that the obligation on the company is to maintain the contour of the road.

Mr. DANCKWERTS: They have, in fact, mended their macadam part of the road, and sought to charge us with the cost.

Lord Justice VAUGHAN WILLIAMS: I should have thought an engineer was the very person to say whether in a particular instance it was necessary to do that.

Lord Justice ROMER thought it was particularly a case which should have been taken to the Board of Trade. The question was whether, as that course had not been adopted, the jurisdiction of the Court had been ousted.

Lood Justice VAUGHAN WILLIAMS: If you had been a private individual instead of a company there would have been no necessity for an action at all. Whenever a Corporation and a company come in conflict, I do not know whose fault it is, but at once an abundant stream of unnecessary expense commences to flow.

Mr. DANKWERTS: The reason is because the surveyor of the Corporation tries to throw upon the tramway company as much as he can of the repairs.

In answer to a question from the Bench, Mr. McMORRAN, K.C., for the Corporation, said all the Corporation contended was that the company was bound to see that there was not an actual dip at the line of junction."

Mr. DANKWERTS said that was not what the Corporation had claimed, and produced a photograph showing work done for which the Corporation claimed payment of the entire cost.

It was again suggested from the Bench that the matter should be brought before the Board of Trade, and Mr. Dankwerts said he would make an offer. The amount in dispute was a small one, which the company would be willing to pay without prejudice to the general question, and set aside all that had happened in the Court below. There were some roads about which the Corporation had given notice, and the company had asked for arbitration with the Board of Trade, and if it was possible in that case they could get legitimately before the Court, the arbitrator stating his award in the form of a special case.

Mr. McMORRAN was unable to accept the offer. They would have to throw away everything they had done and would not get any further forward.

Later, however, it was arranged that the hearing should be adjourned until decision had been given in the House of Lords in the case of Joseph Crossfield & Sons (Ltd.) v. Manchester Ship Canal Co. on the point of jurisdiction, with liberty to either party to apply to restore the appeal.

Kay v. British Westinghouse Co.

In the Court of Appeal on Friday (before the Master of the Rolls and Lords Justices Mathew and Cozens-Hardy) defendant company asked for judgment, or, alternatively, for a new trial of the action, which was heard before Mr. Justice Jelf and a special jury at Manchester Assizes in July, and reported in our issue of July 15

Mr DICKENS, K.C., for appellants, said the action was brought by a workman for damages in respect of injuries caused by his falling against a part of the electric lighting apparatus of the company's works at Trafford Park and getting burnt by the current. Plaintiff's case was that defendants had been guilty of negligence, and that they had committed a breach of duty under the Workshops and Factory Acts by reason of not having fenced in alleged dangerous parts of the machinery of the factory namely, the switch in question. Alternatively, plaintiff said defendants were guilty of negligence in not supplying safe and efficient plant for the carrying on of their business. In defence it was pleaded that the switch in question was not machinery, either within the ordinary meaning of the word or within the meaning of the Factory Acts, and, secondly, that if there was negligence it was not the negligence of defendants, but that of a fellow servant of the plaintiff—namely, the general manager of the factory. On the point, under the Factory Acts, the learned judge at the trial expressed the opinion that the switch in question was not a part of the machinery, and reserved his decision. He, however, left the question of common law negligence to the jury, who returned a verdict for plaintiff, with £850 damages. The ground of the present appeal was that the learned judge misdirected the jury—in the first place, by telling them that defendants were liable for the negligence of their servant, and, secondly, by holding that the defence of common employment set up was not an answer to the claim, notwithstanding the fact that the whole management of the factory was left in the hands of the manager. He (counsel) submitted that the jury found that it was dangerous to have the switches uncovered, but the question here was whether the defendants were responsible for their not being covered in. He submitted that the defence of common employment was a good defence against the claim at common law. It was proved at the trial that the whole management of the factory was handed over to the general manager, that the switches in question were put up at his orders without the knowledge of the directors, and that the work of covering them in was being carried out by an employé of the company. It was quite clear as a matter of law that the manager of a company was the fellow servant of an ordinary employé of the company, and counsel's submission was that the negligence, if any, was the negligence of a fellow servant, and that, therefore, the company was not liable. As to the suggestion that this was not efficient machinery, supposing, of course, that it was, in fact, machinery, his point was that it only became dangerous by reason of its position. Had it been 7ft. from the ground instead of 5ft. the accident would not have happened. Defendants had complied with all the obligations cast upon them by law; they had provided an experienced and fully qualified man to take their place.

Lord Justice **MATHEW**: Do you say that because they employed an experienced man as manager that is enough to exonerate them from liability?

Mr. **DICKENS**: If we employ an experienced man, and we supply all proper and necessary materials, I submit that we have fulfilled our legal obligations. He submitted that the switch was not machinery which the company was under a statutory obligation to fence. A mere switch had no connection with the machinery of the factory, and was used in the same way and exactly for the same purpose as the tap to a gas bracket.

THE MASTER OF THE ROLLS, in giving judgment, said that, apart from the alleged misdirection of the Judge, there was abundant evidence in justifying the jury in coming to the conclusion they did. There was ample evidence to show that the system of live electric wires, unguarded, was defective, and it was proved that this fact was brought to the knowledge of the directors. The mischief which had caused the accident had attracted the notice of the inspector, who caused formal notice to be served upon the company, and Mr Westinghouse, one of the directors, must have seen the switches unguarded when going through the place. He was a specially skilled person, and therefore one who would have been acute in observing the fault which had been brought to the notice of the board by the inspector. The evidence submitted to the jury was sufficient to saddle the company with the obligation of dealing at once with the mischief and possible danger from these live points. As regarded the question of whether the switches were machinery within the meaning of the Factory Acts, it was not necessary to decide the point, and he desired to reserve his opinion upon it. It was enough for him to say that on the main point there was no reason to complain either of the summing up of the learned judge or of the verdict of the jury.

Lords Justices Mathew and Cozens-Hardy concurred, and the appeal was dismissed with costs.

A stay of execution with a view to taking the case to the House of Lords was refused.

Neale v. East Ham Council.

In the King's Bench Division on Tuesday, before Mr. Justice Ridley and a special jury, plaintiff sued East Ham District Council, to recover damages for personal injuries, alleged to have been caused by defendants' negligence. Defendants denied the injuries and the negligence, and pleaded "inevitable accident."

It appeared that on Sept. 13, 1903, plaintiff was seated on the top of one of defendant's tramcars, and as the car was proceeding the trolley wire snapped, a portion of it flew back, and (according to plaintiff) struck him on the head, burning his cap and giving him an electric shock, while almost at the same moment the iron arm jumped back and struck him. From that time he alleged his health had gone from bad to worse, his right eye having been rendered useless, so that he was unable to carry on his trade, and he had been attacked by locomotor ataxy. One of the statutory rules under which defendants had constructed their tramway system provided that every carriage should be so constructed as to provide for the safety of passengers and for their protection from the apparatus used for drawing or propelling the carriage. Some of their tramcars had a covering over the outside passengers, but the one in question had not; and plaintiff urged that if the covering had been there the accident could not have happened. It was submitted for plaintiff that the mere happening of the accident constituted evidence of negligence.

For the defence it was urged that the material employed (the wire) was the best that could be got, that it was tested before being put up, and was examined once a week. Further, that plaintiff's claim, assuming he had been struck as alleged, was an extravagant one.

Mr. Justice **RIDLEY**, in summing up, said that it was a question of importance whether a council, setting up a system of tramways of this kind, were responsible for the breaking of a wire. The same principle was applicable to the case as to other cases of the kind—namely, that the Council were not insurers, but were liable for damage caused by want of such reasonable care as was necessary in view of the nature of the means of propulsion employed. The jury could not say that the absence of a roof was negligence, for there were many tramcars running without *roofs*. The point to be considered by the jury was whether there had been a proper examination of the wire before and after it was put up. There was an inspection once a week, but that would not meet the case of an internal flaw in the metal, which it was impossible to obviate or detect.

The jury found for defendants, and judgment was entered accordingly.

Spaull v. Johnson and Others.

Mr Justice Warrington, in the Chancery Division on Monday, heard an action in which plaintiff, a partnership negotiator and general business agent, sought to recover commission for introducing investors for a certain patent for wireless telegraphy and telephony and for specific performance of a clause in an agreement vesting in plaintiff one-tenth of the world's rights in the invention. Plaintiff alleged that in pursuance of the terms of the agreement, he introduced Dr. Richardson and Mr. Holt. The agreement was signed by Mr Johnson for the Torophoric Syndicate, in which plaintiff suggested all the defendants were included. The statement of claim alleged that Johnson accepted certain moneys from the gentlemen introduced by plaintiff, and he claimed an account.

Defendant **JOHNSON** pleaded that the agreement was only to hold good for seven days and that he did not agree to its terms on behalf of the other defendants. He further pleaded that, under the circumstances, the provisions were wholly unreasonable, and that specific performance should be refused on the ground of hardship. The other defendants denied that they had any part in the agreement, one of them adding that the Torophoric Syndicate was not a registered company and had no legal existence, but was merely a pseudonym invented by Johnson.

His **LORDSHIP** found that plaintiff had not carried out his agreement, the foundation of which was the introduction of £500, and there must be judgment for defendants with costs.

Overhead Wires in the City of London.

The National Telephone Co. were summoned at the Guildhall (London) under the London Overhead Wires Act, for having a wire across a main thoroughfare not duly supervised and maintained. In support of the summons it was stated that this was the first case in the City under the Act. On Dec. 9 last, this particular wire was found hanging loose, in a rusty condition, apparently brought down by the high wind. It had done no harm, but as it weighed 26lb., and fell from a height of 60ft., the result, it was urged, would have been disastrous had anyone been passing at the time. The wire was not in use and had apparently been forgotten.

Mr R. **GODDARD**, for the company, said his clients took very considerable pains to see after their wires and it was eloquent testimony to their care that this was the first case that had ever been in any court in the metropolis. There was no laxity. Every precaution was taken, and they employed an army of "fault-finders" to detect any faults in the wires. Any system, however perfect, would break down at times.

The Alderman Sir J. Knill imposed a penalty of £5, with £2 2s. costs.

National Telephone Co. v. Brooker.

At Tunbridge Wells last week, before Judge Emden, plaintiffs claimed £4. 5s. 4d. for the use of the telephone and party-line fees.

Mr. S. J. **SMITH**, the company's district manager at Maidstone, said he signed an agreement with defendant for a telephone connection in 1903, defendant paying his first instalment in June, 1903. After that he was in arrears, 12s. 8d. in January, and was disconnected in February, 1904, due notice being given. No letters of complaint were received from defendant as to any defect in the service.

For defendant it was urged that there had been a defective service. There were, he said, many occasions when he could not ring up.

Defendant having given evidence, his **HONOUR** asked why the plaintiff company, having disconnected the service in February, claimed up to May. Surely the disconnection in February was a termination of the contract?

After long legal argument on the point whether the disconnection of the service by the company really terminated the contract between them and their customers, his Honour held that even if no defective service had been established, the company, by disconnecting defendant's service in February, had terminated the contract as between the company and the customer. The claim would not therefore be allowed, and the action would be dismissed.

Leave to appeal was refused unless the company paid costs. For the company it was stated that the question of an appeal would be mentioned at the next sitting of the Court, and his **HONOUR** said the question of costs would be considered when the application for leave to appeal was renewed.

Pacific Cable.—In our "Parliamentary Intelligence" will be found record of a question put by Mr. Gibson Bowles to the Government on Thursday last as to whether the Colonies had yet paid their contribution of £1,400,000 to the capital cost of the Pacific Cable. The reply of the Chancellor of the Exchequer will be found duly set out. Mr. Gibson Bowles' question was made the subject of an instructive (because accurate) review of the Pacific cable situation which appeared in the London "Morning Leader" of the 17th inst. In this review facts and figures are marshalled which we recommend to the notice of all who may take an interest in the question of the position of the Pacific Cable, as an example of State-aided competition with private enterprise.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An electrical engineer is required by the Government of British Honduras. The duties will comprise the erection and supervision of telegraphic and telephonic lines and apparatus, electric lighting works, &c. Salary $1,500 (American) per annum, with travelling allowance. Engagement for three years. Applications will be received by the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., up to March 7. See also an advertisement for further particulars.

The directors of the Great Western Railway Co. require an electrical engineer for traction and lighting. Salary £600 per annum. Applications to secretary (Mr. G. K. Mills), Paddington Station, London, W., by 27th inst.

Yorkshire Electric Power Co., Central Bank Chambers, Leeds, require a costs clerk, with practical knowledge of storekeeping and general office routine of an electric power company. See advertisement.

Carlisle Electricity committee require a mains superintendent. Applications by 28th inst.

On Wednesday Battersea (London) Council appointed Mr. W. A. Kenun, hitherto chief assistant electrical engineer, to the position of borough electrical engineer, in succession to Mr. H. R. Forbes Mackay. The three candidates from whom the appointment was made were Messrs. W. A. Kenun, A. H. Foyster (Edinburgh) and John McMillan (Falkirk).

Mr. C. F. Butler, A.M.I.E.E., managing engineer to the Hertford power station of the North Metropolitan Electric Power Supply Co., has been promoted to a similar position at the Wellingborough power station of the County of Northampton Electric Power and Traction Co.

Mr. W. W. Alston, second engineer-in-charge at Bermondsey, has been appointed chief assistant engineer at West Bromwich, and Mr. H. B. Shutes, third engineer-in-charge, has been promoted to the vacancy.

Mr. Ernest F. Cox, assistant electrical engineer at Hamilton, has been appointed resident electrical engineer at Wishaw.

Electrical Standardising, Testing and Training Institution.—Prof. C. A. Carus Wilson will commence a course of lectures to the senior students on March 6, on "Direct Current Motor Construction."

Ashton-under-Lyne.—The charges for current to continuously running motors have been reduced as follows:—First 250 units per quarter, 1½d.; second 250, 1¼d.; next 500, 1d.; over 1,000, 0·9d.

Bath.—The Corporation decided on Tuesday to apply for sanction to borrow £7,000 for additional electrical plant, and £8,000 for extensions of mains.

Brighton.—At the meeting of the Corporation last Wednesday the mayor (Ald. F. Blaker, J.P.) referred to the litigation with Messrs. Macartney, McElroy & Co. over the tramway contract.

He said that although they had saved only a very small sum comparatively, it was something like £2,000 or £3,000 more than they would have done if they had fought the matter out to the bitter end.

The Town Clerk then read counsels' Opinion advising the settlement. The £17,500 proposed in settlement of everything was, in counsels' opinion, substantially better than the consequences of an adverse decision, and they therefore advised its acceptance, and, on behalf of the Corporation, had consented to judgment for that amount.

The following statement was then read by the Town Clerk:—

Original judgment debt	£14,634	4	7
Interest	1,387	0	0
Costs as between party and party	3,800	0	0
	£19,823	4	7
There would still have remained in dispute the claim (£1,330. 1s. 10d.) and the counter-claim (£832. 18s. 1d.). The Corporation had been advised to pay	594	18	7
Total	£20,418	3	2

Plaintiffs had agreed to accept £2,918. 3s. 2d. in settlement of certain items, making the sum in settlement £17,500. The Town Clerk said this did not include the costs.

Bermondsey (London).—On Tuesday the Electric Lighting committee submitted the details estimated in connection with the proposed supply of electric current to Surrey Commercial Dock Co. The surplus income over expenditure was estimated at £114. 14s. 2d. per annum. The estimates were approved by the Council.

London County Council have notified the Borough Councils with reference to the offer of the latter to supply current for lighting the schools in the district, that with regard to the existing schools the County Council were unable to incur the cost of installation. The offer would, however, be borne in mind in the event of new schools being erected in the district.

Bognor.—The question of the revocation of the Council's electric lighting order, 1899, has been deferred for six months.

Buncrana (Ireland).—Mr. Louis J. Lawless, of Dublin, is putting down electric lighting plant for Mr. Thomas Swan, of Buncrana, Donegal. The scheme provides for the supply of electricity for public and private lighting, and the generating plant will consist of three Leffel water wheels, each capable of developing 50 B.H.P. under 60ft. head, and there will also be a 70 B.H.P. gas engine and suction producer as reserve. The capacity of the station will be equal to about 4,600 8 c.p. lamps, and the streets will be lighted by Nernst lamps.

Chobham.—The Parish Council have decided to adhere to their resolve to oppose the Woking Electric Supply Co.'s application for a provisional electric lighting order for Chobham unless the co. undertake to light the village electrically in two years.

Coaling Hoists.—Large docks are being erected at Clydebank, and a notable feature will be the coaling cranes. The largest crane of this class in Glasgow at present is situated at Princes Dock, and is capable of lifting 25 tons. Those to be erected at Clydebank will have a lifting capacity of 32 tons. Four of these hoists are to be erected, and it is claimed that, beside being the largest and most powerful in the country, they will also possess the distinction of being the first to be driven by electricity.

Croydon.—The Council have withdrawn the scheme for the construction of tramways to Upper Norwood.

Dartford.—The Council have decided by eight votes to seven to proceed with their tramway scheme.

Devonport.—At the meeting of the Electric Power committee last week a sub-committee was appointed to deal with the question of extending the electric lighting mains to Stoke. A letter was received from the Admiralty asking for an estimate of the cost of lighting the eastern part of the Royal Albert Hospital by electricity, and this was referred to the sub-committee.

The Local Government Board wrote intimating that they could not allow repayment of the loan recently sanctioned for extending the electricity works for a longer period than 21 years.

Dundee.—The city electrical engineer (Mr. H. Richardson) reports that during the present winter the lighting load of the electricity works has increased by 900 H.P., and that if this rate of increase continues a new station must be erected. Mr. Richardson estimates that about £3,000 per annum would be saved if a site for a station could be obtained near the railway and river.

The Works committee have agreed to the placing underground of the National Telephone Co.'s wires in the town.

Dundee-Broughty Ferry Tramways.—The promoter of the Broughty-Ferry Tramways (Mr. G. Balfour) has lodged with Dundee Council £1,000 as security for the construction of the tramway from Dundee to Broughty and Monifieth. Construction work will be commenced within three months.

Dunfermline.—The Council have decided to apply for a provisional electric lighting order to enable them to become authorised distributors of electricity to be supplied in bulk by the Fife Electric Power Co.

Last week the Finance committee reported that, with regard to the fee of 60 guineas charged by Mr. J. Alex. Bell (city electrical engineer of Aberdeen) for his report on the proposed electricity scheme for the burgh, they thought it excessive, and had offered 40 guineas.

Mr. Robertson said it was undignified for the Council to dispute with professional men who had advised them. If nothing was settled beforehand, he thought the best plan was to pay up.

Provost MacBeth said the committee sympathised with Mr. Robertson's views, but 60 guineas was an excessive charge. While they wished to deal fairly and generously with anyone who did skilled work for them, they had a right to object to what they might consider an overcharge. Mr. W. B. Sayers had only charged 25 guineas for his report.

The Council then approved the committee's action.

Ealing.—The accounts of the Electricity department for the nine months ended December show a small profit, notwithstanding a reduction of 1d. per unit in charge for current. The Council will participate in the Shoreditch scheme for opposing the London electric power bills.

Egremont.—The Council's electric lighting order, obtained in 1900, has been extended for 12 months.

Electric Lighting in Belgium.—The Belgian State Railways will shortly be inviting tenders for the installation of electric light in the South Station at Antwerp.

Electric Tramways in Surrey.—Plans of the London United Tramways for the tramways along the main roads in the borough of Kingston-on-Thames and the urban districts of Esher, the Dittons, the Maldens and Coombe, Surbiton and Wimbledon and Croydon have been modified to meet the Council's requirements, and the company propose to commence the work of construction at an early date. Kingston Bridge will be widened to enable the company to lay a double-track tramway over the bridge.

Electricity in Printing Works.—At a meeting of the "Financial Times" (Ltd.) on Friday the managing director (Mr. F. M. Bridgewater) said that for some time the directors had had under consideration the desirability of substituting electric generating and motor plant for the steam power they now had at their printing works. That was an operation of very considerable magnitude, and they had made very painstaking investigations into the results obtained by firms who had adopted electric driving power to see what they could learn from them. They were fully persuaded that the change was one which was extremely desirable and which they would be glad to make forthwith. It would, if adopted, necessarily involve considerable capital expenditure, but the saving, which they had every right to expect, was so considerable as to amply compensate for the outlay.

Elland.—During 1904 private consumers connected to the mains increased from 27 to 97, while the equivalent 8 c.p. lamps connected increased from 2,858 to 5,350 and the horse-power of motors connected from 7 to 72. 46,054 units were sold.

Exhibitions.—There is an interesting electrical exhibition being held at Bexhill, Sussex, and a particular feature is made of electric heating and cooking. A complete kitchen is installed, and luncheons and dinners are prepared and served daily at popular prices. Bexhill Council are arranging that the electricity department shall hire out cooking utensils, and this step seems to promise well, as much interest is taken by the public in the display. Yesterday (Thursday) Earl De La Warr (the mayor) and a large party of engineers and others from neighbouring towns met and partook of an electrically-cooked luncheon. Mr. W. T. Le Feuvre, borough electrical engineer of Bexhill, is to be congratulated upon the success of the exhibition, and upon the fine display made under the auspices of the electricity department of a large variety of electrical plant, apparatus and accessories. The exhibition remains open until to-morrow (Saturday).

An exhibition of electric light fittings, electric motors, heating and cooking apparatus, &c., promoted by the Urban Electric Supply Co., was formally opened at Grantham on Thursday last. The proceeds will be in aid of the funds of Grantham Hospital.

Fatality.—A fatality occurred on the North-Eastern Railway near Backworth Junction on Monday At the inquest on Wednesday the jury returned a verdict that deceased was electrocuted while trespassing on the line.

Gravesend.—The application of the Council for a provisional order for Northfleet will be opposed by Northfleet Council, Gravesend and Milton Gas and Water Companies, Northfleet & Greenhithe Gas Co., the Associated Portland Cement Manufacturers (Ltd.), South Eastern & Chatham Railway Co., and the Gravesend & Northfleet Electric Tramway Co.

Hackney (London).—The profits of the electricity undertaking for the last financial year (£5,478. 16s. 8d.) have been invested in the purchase of Metropolitan Water Stock to provide a reserve.

Hammersmith (London).—Tenders are shortly to be invited for boiler-house extension. The Council have authorised the electrical engineer (Mr. G. G. Bell) to prepare a scheme for lighting Netherwood-road by arc lamps.

The Finance and Electricity (Joint) committee reported that they had considered the report of the district auditor upon the audit of the accounts of the Borough Council for the year ended March 31 last, which stated that "the cost of providing the electric lamps and pillars is treated as part of the capital expenditure of the electricity undertaking. It would appear to be the correct method to treat that expenditure as a charge upon the general rate fund, whether it be capital or revenue expenditure, and to base the charge for current upon that fact." They were of opinion that that view of the auditor was correct, and in order to carry it into effect it would be necessary to make some alteration in the existing arrangements with regard to the charging of capital expenditure in respect of lamps and pillars, and to the charge per lamp made by the electricity department. After considering a report of the electrical engineer (Mr. Bell) upon the matter, the committee were of opinion that a reduction from £22 10s. to £20 per lamp per annum would meet the case, and they recommended accordingly. The report and recommendations were adopted.

Hanley.—Last week the Electric Lighting committee reported that for the past year the gross profit was £6,892, out of which £2,562 had been paid for interest, £2,522 for sinking fund and redemption charges, and £649 to reserve and depreciation account, leaving net profit £1,159. Sinking fund and redemption accounts now stand at £18,835. The committee recommended that £1,150 be paid to credit of district fund, and £204 be carried forward.

Ald. Coates said the electricity works had not been so profitable as they could have wished, but they had not done amiss considering the large expenditure on repairs and other matters. The works had cost £1,000 more than last year, but they were still able to pay £1,100 towards the reduction of rates.

Horsham.—The Council have decided to apply for sanction to a loan of £4,500 for electric lighting extensions, including £400 for "free" wiring.

Horsforth.—Yorkshire Electric Power Co. recently offered to supply electricity in bulk to the Council. The company stipulate for a guaranteed minimum consumption of 30,000 units per annum. The Council are circularising the ratepayers on the subject.

Huntingdon.—Messrs. A. Rutter, Sons & Lloyd, of Cambridge, offer to take a transfer of the Council's electric lighting order. The Council have engaged Mr. F. J. Warden-Stevens, at a fee of 15 guineas, to report upon the matter.

Inverness.—The Corporation have agreed to the North of Scotland Electric Light & Power Co. erecting and maintaining some electric lamps for experiments in public lighting.

Italy—A concession has been granted to the Leghorn Tramways Co. for the construction and working of an electric tramway in the city of Leghorn.

The Roman Tramways & Omnibus Co. have been authorised to convert their present system of animal-drawn tramways between the Piazza del Popolo and Ponte Milvio to electric traction.

Lancaster.—A formal inspection of the electricity works was recently made by members of the Corporation, and on the same evening the members of the Astronomical and Scientific Society, the Science classes at the Storey Institute and a number of townspeople visited the works. Some particulars were given by the electrical engineer (Mr. W. A. Tester) of the history of the undertaking, the capacity of the plant, &c. Demonstrations were also given with the Cooper-Hewitt mercury vapour lamp, the Dowsing radiator, and Tesla's high-frequency and Röntgen-ray experiments were also made.

Leyton.—The charge for electric current for power has been reduced to 2d. per unit.

Light Railways.—An enquiry was held last week into the application of Bath Electric Tramways (Ltd.) for an order authorising lines through Westgate-street, Bath, and from Weston to Newton-street, Loe. The Corporation had objected to a portion of the proposed extensions, but tendered no evidence. The Commissioners said they were against the company for the objected portion, having regard to the absence of the Corporation's approval, but were favourable to the remaining portion of the route.

The Light Railway Commissioners recently held an inquiry into the application of the British Power Co. (Ltd.) for an order to authorise the construction of an electric tramway through Newark, with branch lines to Balderton and Farndon. Ratepayers and others gave evidence in favour of the scheme, and the Commissioners decided to grant the order, with the exception of a section from Devon Bridge to Farndon.

An inquiry has also been held into the application of the Middlesex County Council for an order for extensions of their system,

Liversedge.—The Council object to the transfer of the British Electric Traction Co.'s local undertaking to the Yorkshire (Woollen District) Electric Tramways (Ltd.) on the ground that the former have not constructed the Hightown and Cleckheaton line as agreed with the Council.

London County Council.—At Tuesday's meeting £2,000 was loaned to the Metropolitan Asylum District Managers for the electric lighting of Belmont Asylum.

Proposed London Power Schemes.—A long report was presented by the Parliamentary committee with reference to the various bills being promoted this year for supplying electricity for power in the County of London. The committee asked for the Council's approval in the course they had taken in opposing the bills. The report stated that the committee have instructed the chief officers to submit detailed reports dealing with the whole question, and have invited the Highways committee to appoint representatives to confer with them on the subject. In the committee's opinion, the powers sought are such as to constitute a serious menace to existing and future municipal electrical supply undertakings, and they are fully persuaded that the magnitude of the proposals, the overlapping powers sought and the general reversal of the conditions now applying to London leave the Council no alternative but to oppose the bills.

Mr. Stuart Sankey said he agreed the Council should petition against the bills so as to secure a locus standi; but there was a suggestion that the Council should itself generate electric energy. This would involve large capital expenditure and be a dangerous extension of municipal trading. The report was taken back for a week to allow it to be discussed.

Tramway Motors v. 'Buses.—Mr. Phillimore asked if the attention of the chairman of the Highways committtee had been called to the article in *The Electrician* as to the working cost of motor 'buses.

Mr. E. Collins asked if Mr. Baker's attention had been called to the letter in *The Times* from Mr. Scott Montagu warning the Council against the extension of the tramway system, in view of the rapid extension of the motor 'bus system.

Mr. Baker (chairman of the committee) said his attention had been called to the article in *The Electrician* of Feb. 17, and it was the best reply he could possibly give to Mr. Collins. It was a very able report, and went into the cost of 'buses as compared with tramways. Mr. Baker quoted a considerable portion of the article, and said he did not think they need fear any serious opposition to the tramways from motor 'buses.

Replying to other questions, Mr. Baker said the Garratt-lane tramway electrification would be undertaken at once, and the committee would report at an early date on the electrification of the Deptford lines. They knew positively that at present their lines were too light to take motors. They had been to the motor exhibition at Olympia, and there was nothing there which would do for their lines.

Mansfield.—The charge for current for lighting has been reduced from 7d. and 2d. to 7d. and 1d., and for power from 6d. and 1d. to 4d. and 1d.

Marylebone (London).—At last week's meeting of the Borough Council the estimates for the year showed on electricity revenue account a deficiency of £6,050 due to preliminary expenses, and it was proposed to carry this forward until the undertaking was in working order, as well as a further estimated deficiency of £6,000 for the ensuing six months.

Municipal Telephony.—At the meeting of Brighton Town Council last week the Telephone committee reported that

There was at present in hand about £3,000 in respect of certain works included in Mr. A. R. Bennett's estimate which had not yet been carried out. That sum would be required for the particular works for which it was sanctioned, and was, therefore, not available for additional works in contemplation. With regard to extensions in Hove, the committee recommended that application be made for sanction to borrow for 25 years £11,616. 11s. 8d.

The Chairman (Councillor Lintott) said he was confident that the financial position of the telephone undertaking was in every way sound. He asked the Council not to be influenced by reports they had seen in the papers, for those reports were a series of contradictory, inaccurate and misleading statements intended for no other purpose than to prejudice the minds of ratepayers and members of Council against the Corporation telephone service. They had a total of 1,725 instruments fixed at present. The business was rapidly growing, so much so that since he had been chairman of the committee (three months) they had added upwards of 200 instruments. They had a switchboard of which they were proud, and which had a capacity of upwards of 2,000 subscribers. He denied that the Brighton switchboard was of the same pattern as that at Glasgow. Just now they were making a profit of between £80 and £100 per month, and that was increasing gradually and surely as the months went by. The financial position of the undertaking was safe and they were doing well. At present there were 100 subscribers waiting to come on to the system, and it was imperative that they should make all necessary arrangements. The accountant had certified that there was a net profit of £115 from April last to Dec. 31. He hoped that when he brought up a balance-sheet at the end of 12 months it would record a profit of between £300 and £400. He believed the building of the switchboard, which cost more than Mr. Bennett estimated, would prove a blessing in disguise. If their business increased as fast as it had in the past they would very soon want another board, and they had the necessary accommodation. The power plant was giving every satisfaction. As regarded the Hove extensions, they had practically used all the wires, and subscribers were waiting to come on the service.

Councilor Saunders expressed surprise that money was wanted. On Oct. 20, Ald. Carden told the Council that only £33,000 of the telephone loan had been expended at that date.

Councilor Sone said he did not complain of the present chairman of the Telephone committee, but of the past chairman (Ald. Carden), in spending sums of money without even the knowledge of his own committee. The committee were led to believe that they had sufficient money in hand, but now it suddenly dawned upon them that they had not sufficient to meet their requirements. The cost of their 1,700 odd lines had worked out at £35 or £36 per line instead of £20 16s., as estimated. The profit spoken of was problematical. If they had placed a proper amount to depreciation the profit would have been swept away, and there would have been a loss. How was it they had thrown over Mr. Bennett and substituted Mr. Barnes as their adviser in the matter? He moved an amendment that the expenditure be omitted from the report. Councillor Toxer seconded this, but it was rejected by a large majority

Councillor Black said that during the first months of the undertaking the committee had a heavy loss, the deficit up to the end of March being £1,700. That gradually declined, until at the end of the year they had a profit of £115, and in January alone the profit was £80, while the prospect for February and subsequent months was even better.

Ald. Carden was confident they would get over 2,000 instruments working within a close approximate sum of the estimate, and that Mr. Bennett's figures were as accurate as could be expected. There would be a little increased cost, but that would be owing to the fact that the Council divided the work up into two portions. They were making a minimum profit of £80 a month, and he was satisfied that the balance-sheet at the end of the year would show a substantial balance. They were in possession of an extremely sound financial undertaking and a telephone system that was a credit to the town.

Ald. Reeves admitted that whereas in 1900 he was paying £13 for his telephone and had communication with 1,100 other subscribers, to-day he was paying ten guineas and was in direct communication with 4,000. If there was anything in a telephone service as a convenience for public, private and commercial life he was now getting, through the competition in Brighton, four times the value he formerly had. The argument that there were a large number of ratepayers who derived no benefit was a short sighted one.

Councillor Lintott replied to the discussion, and the report was adopted by 33 votes to 4. He then moved the adoption of the Telephone committee's minutes, which recommended that application be made to Hove Corporation to lay telephone ducts in various streets, and this was also approved.

Newfoundland Telegraph Award.—The award has now been given in the arbitration between Mr. Reid and the Newfoundland Government in regard to the former's claim under the Telegraph Arbitrating Clause for $3,488,000. The award gives Mr. Reid $1,503,100, with interest at 3 per cent. from Oct. 1903.

Paddington (London).—The Council on Tuesday accepted the offer of the Metropolitan Electric Supply Co. to contribute £500 to the cost of a new footbridge at Ranelagh, provided they are given rights to carry mains across.

Perth.—The Council recently authorised the contractors for the reconstruction of the tramways to use Norwegian instead of Welsh setts.

Pontypridd.—The official inspection of the electric tramways took place on Friday last, and it is anticipated that the public service will be inaugurated on March 6.

Poplar (London)—Five 7½ ampere arcs are to be erected for lighting the Recreation Ground at an estimated cost of £314.

Portsmouth.—The differences between the promoters of the Portsmouth & Hayling Light Railway and the Corporation in regard to the construction of the line have been overcome.

Provisional Order Revocation.—The Board of Trade have revoked the East Retford Electric Lighting Order, 1899.

Rawtenstall.—Application has been made to the Board of Trade for an extension of two years for carrying out the terms of the electric lighting order 1899.

Richmond (Surrey).—The Richmond (Surrey) Electric Light & Power Co. have been asked by the Council to submit estimates of the cost of public lighting.

Shipley (Yorks.).—The Leeds section of the Institution of Electrical Engineers paid a visit to the electricity works of the Council on Saturday. Mr. R. Lindley (chairman of Shipley Electricity committee) and Mr. S. D. Schofield (resident engineer) conducted the party over the works.

Shoreham.—The Council recently resolved to join with Southwick and Portslade Councils in obtaining a provisional electric lighting order.

Solihull (Birmingham).—A committee has been appointed to make a canvass of the district to ascertain the amount of support likely to be accorded an electric lighting scheme.

Southend-on-Sea.—The gross profit on the electricity undertaking for the past year was £3,808. After meeting interest and sinking fund charges, £358 has been voted to relief of rates.

The gross profit on the tramways was £2,718, but after meeting statutory payments there was a deficit of £602.

Spain.—The Bilbao-Santander Railway Co. are, it is announced, about to adopt electric power in operating the line from Bilbao to Las Arenas. It is also stated that an electric railway is to be built between Sans and Coll-Blanch. For particulars regarding this latter work address Diréccion-General de Obras Publicas, Madrid.

The lines of tramways between Carthagena and San Antonio, Abad, Dolores, Barris, Peral and Santa Lucia are to be converted to electric traction by the owners, the Carthagena Tramways Co.

Stirling.—The Council have decided not to acquire the undertaking of the tramway company, but facilities will be given for the conversion of the lines to electric traction.

Stoke Newington (London).—The Metropolitan Water Board have granted the Council a tenancy at will of a piece of land at the south-east corner of the filtering station at Green Lanes for the erection of a transforming station.

Stretford.—The charge for electric current for lighting has been reduced from 6d. to 4½d. per unit.

Sunderland.—For the past year the income of the tramways department was £65,002, an increase of £1,984 on 1903. The gross profit was £24,521. Last year £1,000 was paid in relief of rates, but this year nothing will be paid over, it is stated, for this purpose, as losses have occurred on two sections of the tramways route and the Seaside-lane section at Roker.

Swansea.—On Tuesday the Streets committee decided to obtain a report as to the advisability of lighting the route of the new tramways electrically.

Train Lighting by Electricity.—It is announced that for some time the Belgian Government workshops at Verviers have been engaged in the construction of a locomotive equipped with generating machinery and accumulators for the lighting of a complete train of several cars. We understand that an experimental trip is shortly to be made between Verviers and Brussels.

Tramway Parcel Scheme.—Manchester Tramways committee have prepared a scheme for carrying parcels on their tramways:—

The committee have drawn up a scale of charges, inclusive of charge for delivery, for two areas, the "inside" and the "outside." The "inside" area will include the whole of Manchester and Salford and part of Stretford. The "outside" area will include the suburbs around the district thus outlined and within the tramways circuit. Parcels will be despatched to all parts covered by the scheme at intervals of not more than 15 min. The scheme will probably be put into operation next month. Charges for the inside area will be:—Not exceeding 14lb. 2d., 28lb. 3d., 56lb. 4d., 112lb. 6d. For the outside area:—Not exceeding 14lb. 3d., 28lb. 4d., 56lb. 6d., 112lb. 8d.

Uruguay.—On behalf of a local syndicate, Mr. A. Beisso has offered to purchase the Uruguayan Government's Monte Video electricity works for £200,000. The Cia. Alemana Transatlantica de Electricidad is also said to be negotiating for the purchase of this undertaking.

Village Lighting.—Backworth and Earsdon are now lighted electrically by current supplied by the Backworth Coal Co. For public lighting there are 112 16 c.p. lamps fitted up by the Northern Electrical Engineering Co., which is locally (N. Shields) represented by Mr. T. Harrison.

Walsall.—The accounts of the Electricity department for the year ended December, 1904, have been issued, and show capital expenditure of £86,405. 16s. 2d., or an increase of £7,832. 16s. 9d. for the year.

Receipts were £12,109. 5s. 4d., including £5,888. 13s. 7d. for current supplied for private lighting, £5,190. 10s. 2d. for traction and £564. 4s. 10d. for power (less discounts £225. 18s. 3d.), £503 for public lighting and £188. 15s. for meter rentals. Working expenses totalled to £6,792. 4s. 7d., leaving £5,317. 0s. 9d. After paying interest and providing for sinking fund, &c., and instalment of loan from tramway department, the net profit was £1,060. 11s. 7d. 1,628,728 units were generated, of which 423,192 were supplied to private consumers, 707,654 to the tramways, and 34,392 to public lamps. The total maximum supply demanded was 754kw.

Walthamstow.—Sanction has been obtained to the expenditure of £27,387 for extensions of the electricity undertaking, and £16,739 for excess expenditure.

West Cumberland Tramways.—Whitehaven, Workington, Maryport and Cleator Moor Councils have decided to oppose the West Cumberland Tramways Bill unless the extension of time for commencement of work for which the bill provides is reduced from two years to one year.

Westminster.—The Works committee of the City Council have requested the electric light companies and others having statutory powers to construct surface boxes in the streets, to surround all which are or may be fixed in macadamised roads with three rings of granite cubes set on concrete.

Wilmslow.—The Council have sealed an agreement with the Alderley & Wilmslow Electric Supply (Ltd.) for the public lighting of Wilmslow. The work of laying cables will be commenced at once.

Windsor Castle.—His Majesty on Tuesday journeyed by motor car from London to Windsor Castle, and after travelling through the grounds, inspected a trench dug for the reception of the cable which the Western Electric Co. is about to lay for the electric lighting of portions of the Castle.

Workhouse Lighting.—Stourbridge Guardians have obtained estimates for gas and electric lighting at the workhouse. The first cost for gas is £2,139 and for electricity at £2,700. The charge for gas is to be 2s. per 1,000ft., minimum consumption 3,000,000ft. per annum, and for electric current 3d. per unit. The Building committee are to obtain further information.

Electro-Harmonic Society.—A ladies' night concert will be held this (Friday) evening in the King's Hall, Holborn Restaurant, London, W.C., commencing at eight o'clock.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1905 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date (to Feb. 22), and the Directorial Division of the new volume has been corrected up to February 11th, 1905. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. The number of large sheet Tables, &c., has been increased, and the 1905 Edition of this indispensable work is offered as the most complete book of the kind ever published.

Among the chief features of the Handbook Division are Notes of the Year on Electric Traction and Electric Power, Turbine Notes, Electric Lamp Notes, Wireless Telegraph Notes (very full), Parliamentary Summary, Legal Decisions, and a complete set of all the chief documents used by Government Departments affecting the Electrical Industry (including the new "Special Mining Rules," issued Feb. 22).

TENDERS INVITED.

Manchester Tramways committee invite tenders for the supply of materials and various stores for their tramways department, including armatures, controllers, fuses, switches, etc., pinion and gear wheels, arc and incandescent lamps, bells, bell fittings and cells, switchboards, tubing, insulating and armature repairing material, armature and field coils, cable, copper, brass and steel wire, overhead equipment material, spare parts for feeder boxes, globes, lamp glasses, etc., porcelain and brown ware insulators, rubber goloshes and gloves, lamps and lamp fittings, car furniture, brassware, trolley heads, bolts, screws, washers, etc. Further particulars are given in an advertisement. Specifications, etc. from the general manager of the Corporation Tramways (Mr. J. M. McElroy). Tenders, addressed to chairman of committee, 55, Piccadilly, Manchester, by 10 a.m. March 6th.

Manchester Corporation also require tenders by 10 a.m., March 6 for laying underground telephone pipes.

Edinburgh Corporation invite tenders for supply of stores for their electricity department for one year from May 15, including arc lamp carbons, cast-iron pavement and road boxes, electricity meters, house service fuse boxes, earthenware troughing for laying cables on the solid system, bitumen and arc lamp globes. Specifications from the chief engineer (Mr. F. A. Newington), 5, Dewar-place, Edinburgh. Tenders to the town clerk (Mr. Thomas Hunter, W.S.) by March 13. See also an advertisement.

Plymouth Corporation invite tenders for supply of stores for the 12 months ending March 31, 1906, including electricity meters, transformers and cables (paper insulated). Specifications from the borough electrical engineer (Mr. E. G. Okell), to whom tenders by March 18. See also advertisement.

Londonderry Corporation invite tenders for supply of materials for the electricity department for one year commencing April 1, 1905, including carbons, meters and demand indicators. Forms of tender, &c., from the chief engineer (Mr. R. V. Macrory). Tenders to the town clerk (Mr. F. Henry Miller), Guildhall, Londonderry, before noon March 6. See also advertisement.

Torquay Electric Lighting committee invite tenders for the supply of 1,200 to 1,500 tons of smokeless thro' steam coal. Specifications from the town clerk (Mr. Frederick S. Hex), Town Hall, Torquay, to whom tenders by noon March 20. See also an advertisement.

Gloucester Electricity Supply Committee invite tenders for supply and erection of plant at the electricity works, including 3 Lancashire boilers and accessories, one 600kw. generating set and accessories, electrically-driven surface condensing plant to deal with 30,000 pounds of steam per hour, steam, exhaust, feed, drain, condensing water and sundry pipes, valves, &c., and an electrically driven boiler feed pump. Specifications, &c., from the Town Clerk (Mr. G. Sheffield Blakeway), to whom tenders by 1 p.m. March 16. See also an advertisement.

The *Great Central Railway Co.* invite tenders for various stores and materials during the 12 months ending April 30th, 1906, including electric light and telegraph materials, wire, oils, signal materials, screws, sundry tools, glass, carriage and wagon fittings, hardware, iron, india rubber, asbestos, etc. Patterns can be seen from February 27 to March 6 inclusive on application to the Storekeeper (Mr. A. W. Longden), Cornwall-street, Openshaw. Specifications, &c., from the Secretary (Mr. Oliver S. Holt), London-road Station, Manchester, to whom tenders by 10 a.m. March 7. An advertisement contains further particulars.

The directors of the *Great Western Railway Co.* invite tenders for supply, delivery and erection of plant at their electricity generating station at Park Royal and proposed sub-stations and distribution centres, including high tension three-phase direct-current switchboards and battery boosters at Park Royal; three-phase static transformers and high and low-tension switchboards at various sub-stations and lighting distribution centres; and high and low-tension, three-phase direct-current switchboards at Royal Oak, Shepherd's Bush and Old Oak in sub-stations (*a*) three-phase switchboards, (*b*) direct-current switchboards, and (*c*) six motor-driven boosters in connection with storage batteries at Royal Oak and Shepherd's Bush sub-stations). Tenders to the secretary, Paddington Station, London, W., by March 13.

Newport (Mon.) Electricity and Tramway committee invite tenders for a 300kw. continuous-current high-speed tramway generator and a 200kw. continuous-current high-speed steam balancer (engines of enclosed type), one (straight tube) water-tube boiler and superheater, one multiple switchboard, extensions to switchboard gallery; also for the supply of general stores, including general ironmongery, lamps, carbons, greases, chemicals, paints, engine room and electrical stores, &c. Tenders to town clerk by first post March 6.

Stoke Newington (London) Council invite tenders for supply, delivery and erection of sub-station plant and mains, including transformers, three-phase motor generators, boosters, &c., extra h.t. and three-wire l.t. switchboards, storage battery and l.t. distribution mains. Tenders (addressed Electric Lighting committee) to the Town Hall, Stoke Newington, N., by 4 p.m. March 8.

Wimbledon District Council invite tenders for supply of stores during the year ending March 31, 1906, including engine-room stores, cables, joint boxes and jointing materials, transformers, meters, oils, incandescent electric lamps, carbons and accessories, and iron castings. Tenders to Chairman of General Purposes committee, 12, Queen's-road, Wimbledon, before noon March 4.

Shoreditch (London) Borough Council invite tenders for stores for one year from April 1 next, including electric cables and sundries, gas pipe and fittings, engineers' stores, glass, &c., for street lanterns, smiths' and plumbers' work, timber, &c. Tenders to town clerk (Dr. H. Mansfield Robinson), before 3 p.m. March 14.

Ilford Urban District Countil invite tenders for supply during year ending March 31, 1906, of Welsh coal, electricity meters and demand indicators, cables, incandescent lamps, arc lamp carbons and house service fuse boxes. Tenders to Chairman of Council, Town Hall, Ilford, by 27th inst.

Ilford District Council also want tenders by 27th inst. for 12 months' supply of tramcar accessories, &c. Forms of tender from tramways manager, Ley-street, Ilford.

Lowestoft Corporation invite tenders for supply and erection of one water-tube boiler with superheater, brickwork settings and accessories, together with the necessary pipework. Tenders to town clerk by 5 p.m. March 9.

King's Lynn Corporation invite tenders for one 200kw. steam dynamo, condenser, steam and other pipes. Tenders to town clerk (Mr. J. W. Woolstencroft), Town Hall, King's Lynn, before noon 28th inst.

Glasgow Corporation require tenders by March 1 for electric passenger and warehouse lifts in buildings at the corner of Nelson and Bell-streets. Forms of tender, &c., from Messrs. Thomson and Sandilands, 241, West George-street, Glasgow.

London County Council require tenders by 10 a.m. March 7 for 12 months' supply of electric light sundries, iron pipes, lead, glass, belting, packing, &c., to their various asylums.

Great Yarmouth Corporation invite tenders for supply and delivery of two water-tube boilers and a 300kw. steam alternator. Tenders to Town Hall by noon March 1.

Fulham (London) Borough Council invite tenders for the supply of electrical stores for the year ended March 31, 1906. Tenders (on printed forms) to the Town Hall, Fulham, by 4 p.m. March 15.

Hull Electric Lighting committee invite tenders for supply, &c., of mains and cables for 12 months. Tenders to chairman of committee, Town Hall, Hull, by noon March 1.

Willesden District Council require tenders by 4 p.m. of 28th inst. for maintenance of Council's telephones and wires for one or three years.

Leeds Corporation invite tenders for rotary convertors, transformers, high and low-tension switchboards, &c., for the equipment of two sub-stations. Tenders by March 14.

Salford Electricity committee invite tenders by March 4 for alterations to two storage batteries.

Croydon Corporation want tenders by 11 a.m. 28th inst. for 12 months' supply of coal to the electricity works.

Southwark (London) Council require tenders by 4 p.m. March 1 for electric lighting and heating at the new museum.

TENDERS RECEIVED AND ACCEPTED.

Hammersmith (London) Council have received the following tenders for cables for extensions.

A Williamson, Western Electric Co. (*accepted*)	£1,570	3	0
W. T. Glover & Co.	1,312	2	6
St. Helens Cable Co.	1,297	19	5
Siemens Brothers & Co.	1,222	10	0
Electrical Co.	1,196	11	4
British Insulated & Helsby Cables	1,195	10	0
W. T. Henley's Co.	1,168	10	0
Callender's Co.	1,155	10	0

Poplar (London) Electricity committee has accepted the tender of the Stirling Boiler Co. for an additional boiler, &c., at £1,950. Babcock & Wilcox also tendered at £2,112. For a pump (tandem-compound type) capable of discharging 10,000 gallons per hour, the tender of G. & J. Weir was accepted at £245. Joseph Evans & Co. tendered (beam-compound type) at £255, Clarke, Chapman & Co. (tandem-compound) at £250 and Pulsometer Engineering Co. (compound) at £145.

Marylebone (London) Council have accepted the tender of the Electrical Power Storage Co. for supply and erection of a storage battery at £2,418, with £88 per annum for maintenance; also that of C. A. Parsons & Co. for construction of stairways, flooring and grating of engine room for £2,962.

Dick, Kerr & Co. have secured the contract for permanent way work in connection with the extension of Rothesay tramways to Ettrick Bay (Bute) at £15,707, the work to be completed within two months. The overhead equipment will be carried out by Rothesay Tramways Co.

Neath Corporation have accepted the tender of the British Westinghouse Co. for wattmeters, and that of Evershed & Vignoles for a "Megger" testing set (arranged for 250 volts and reading up to 20 megohms).

Rochdale Corporation have accepted the tender of the British Thomson-Houston Co. for supply and erection of high-tension three-phase switch gear and extensions to low-tension continuous-current switchboards.

A. H. Marshall & Co.'s estimate of £2,203 for wiring certain of the tramway car sheds has been accepted by London County Council by £550 for the provision of incandescent electric lamps instead of arc lamps at the New Cross and Camberwell car sheds.

Carlisle Town Council have accepted the offer of the Tudor Accumulator Co. for the supply of a battery of 256 type L. D. 13 cells, at £725, payable by three instalments, with £55 per annum for maintenance for 10 years, payable half-yearly.

Perth Town Council are recommended to accept the tender of R. W. Blackwell & Co. for construction of the permanent way and overhead equipment of the Dunkeld-road tramway route.

J. G. White & Co. (Ltd.) have secured the contract for the conversion of Lacroze Bros' Buenos Ayres rural tramway to electric traction.

Battersea (London) Council have placed an order with Babcock & Wilcox for three water-tube boilers, with chain grate stokers, for £3,600.

Bermondsey (London) Council have accepted an offer by Messrs. Brown & Son to maintain the artesian well and pump in connection with the generating station in working order for £25 per annum.

London County Council on Tuesday accepted the tender of the Jas. Keith & Blackman Co. for two electric motors for the ventilating apparatus at Deal-street School, Whitechapel.

Bury (Lancs.) Joint Hospital Board have accepted the tender of Ashworth & Parker for an engine for the electric lighting installation.

Messrs. Johnson & Phillips have secured the contract from the Admiralty for two d.-c. dynamos for Sheerness dockyard.

BUSINESS NOTICES.

Messrs. D. H. Bonnella & Son (Ltd), 58-60, Mortimer-street, London, W., ask us to make the following announcement:—

"Our attention has been called by several of our friends to a circular emanating from a firm who have recently commenced business under a name similar to that of our company. As it is calculated to mislead, we take this opportunity of informing you that the firm in question has no connection with us whatever, and that our business is being carried on under the same personal management and at the same addresses as heretofore."

Messrs. Howard Marryat and Harry Alexander Place (trading as Marryat & Place), electrical engineers, 28, Hatton-garden, London, E.C., have dissolved partnership. Debts by Mr. Marryat.

Messrs. John Bontch and Colin Bell Heaviside, electrical and mechanical engineers, 14, Neville-street, Newcastle-on-Tyne, have dissolved partnership. Debts by Mr. Bontch.

Messrs. Geo. Edwd. Vint and Maurice Edgar Moss Vint (the latter has traded at Rusholme-road, Manchester, as an electrical engineer) have dissolved partnership.

Messrs. Geo. Brearley, Joseph Horrox, and James Bertram Horrox, mechanical and electrical engineers, 90, Back George-st., Manchester, have dissolved partnership. Debts by J. & J. B. Horrox, who continue as Horrox & Co.

BANKRUPTCIES, LIQUIDATIONS, &c.

The National Electric Traction Co. (Ltd.) is to be wound up voluntarily. Mr. L. Morse, 79, Queen-street, London, E.C., is liquidator.

A meeting will be held on March 20, at 8 and 9, Great James-street, Bedford-row, London, W.C., to receive an account of the winding-up of the Electro Institute (Ltd.).

The discharge of Dr. Frederic Hungerford Bowman, electrical engineer, 39, Victoria-street, London, S.W., is suspended for three years.

A first and final dividend of 4½d. is payable at 117, St. Mary-street, Cardiff, in the bankruptcy of Thos. Williams, electrical engineer, 54, Bridge-street, Llandaff, lately residing at Cardiff.

Mr. A. F. Whinney, 82, Old Jewry, London, E.C. (with a committee of inspection) has been appointed liquidator of the Sir Hiram Maxim Electrical & Engineering Co. (Ltd.).

Claims against the Electrical Fittings Co. (Ltd.) must be sent by March 31 to Mr. J. D. Pattullo, 65, London Wall, London, E.C.

A meeting will be held on March 24 at Albion-chbrs., Bristol, to receive an account of the winding up of the Bath Electric Mfg. Co., Ltd.

Plant, &c., for Sale.—Messrs. White Bros., engineers, High-street, Stratford, London, E., have some electric lighting plant for sale, including a pair of Ruston-Proctor compound horizontal engines, Crompton dynamo, loco-type boiler, portable Marshall engine, &c. See also advertisement.

A 80 H.P. Babcock-Wilcox boiler is advertised for sale in another column. Applications to Messrs. Tebbitt's, Latona-road, Old Kent-road, London, S.E.

Accumulators for Sale.—Offers are invited by King's Norton Guardians for purchase and removal of some storage cells, with glass boxes, insulators, &c. Further particulars are given in an advertisement, and the accumulators may be seen on application to the steward, Infirmary, Selly Oak, near Birmingham. Tenders to the clerk to Guardians (Mr. R. J. Curtis), Guildhall-buildings, Stephenson-street, Birmingham, by March 6.

Premises for Sale, &c.—Messrs. Furber, surveyors, valuers and auctioneers, 3, Warwick-court, Gray's Inn, London, W.C., will offer for sale at the Mart, Tokenhouse-yard, London, on March 2 at 2 p.m., a substantial building, No. 158, Farringdon-road, comprising a warehouse and factory, of which particulars will be found in an advertisement elsewhere. These premises were formerly in the occupation of Messrs. Ely Bros., the well-known ammunition manufacturers, who have now erected new works at Edmonton, where the Farringdon-road branch of the business will be carried on.

Messrs. Stimson & Son, 3, Moorgate-street, E.C., and 2, New Kent-road, S.E., London, have extensive factory premises (close to Vauxhall and Nine Elms, with frontage to the main road) to let. See advertisement.

A ground floor, area 2,700 super. ft., equipped with electric power, and suitable for general engineering, is to let. Applications to Messrs. Marshall & Co., Campbell Works, Stoke Newington, London, N. See advertisement.

Some premises at Latona road, Old Kent-road, London, S.E., are to be sold or let. See advertisement.

A corner warehouse near London Bridge station (total area 21,000ft.), with two cranes, lift, electric light, &c., is to be let or sold; also a freehold new factory on the canal, Old Kent-road. Apply to Trustee, 2, Crediton-road, West Hampstead, N.W. See advertisement.

"Cheap Steam"—A pamphlet is issued bearing this title and dealing with the well-known automatic stokers manufactured by Ed. Bennis & Co., of Little Hulton, Bolton. Besides making the stoker which bears their name, this firm design, build and instal complete forced-draught furnaces, gas producers for steel and iron works, steam or electrically-driven coal and ash elevating and conveying plant, band conveyors, picking tables, cable conveyors, cable railways, automatic coal weighing and recording machinery, and many other machines, besides accessory plant and apparatus. The Bennis stoker needs no description here, but it is interesting to observe that there has recently been added to the system a compressed air bar, into which air is pressed by the aid of a minute steam blast in each bar separately. It is thrown with great force into the fire, thus combining all the benefits of mechanical firing with forced draught of the best type. In the latter portion of the pamphlet tables are given of figures obtained at tests, and these show excellent results. At a test at the works of the Butterley Iron Co. the coal used with the Bennis stoker could not be burnt when hand fired. Its value at the pit is given as only 1s. per ton. In spite of this, however, 6·33lb. of water were evaporated per pound of coal, as compared with 4·82lb. of water per pound of coal at 2s. 6d. per ton, when the latter was hand fired. Thus, the comparative costs of fuel required to evaporate 1,000 gallons of water were 8½d. for the cheap coal used in conjunction with the Bennis stoker, and 2s. 3½d. for the better coal when hand fired. Included also in the pamphlet are some useful tables and data relating to the properties of saturated steam, imperfect combustion losses, and the weight of water.

Speed Indicators.—Messrs. Staunton & Co., Blythe-street, Bethnal Green, London, E., send us particulars of the "Staunton" speed indicator for tramcars. This indicator registers the total number of miles travelled by the car, the rate of speed at any moment, and (automatically) the maximum speed reached during each 110 yards. The indicator can be made to register high speeds over other distances.

Photo-Engraving.—Many of our readers are interested in the subject of photo-process engraving, and may like to know that in the "British Journal of Photography," there is now included "Photo-Mechanical Notes," in which the various processes of reproducing engravings, &c., are dealt with.

Export Merchant Shippers Directory.—Manufacturers and suppliers of electrical goods for export will gather some useful information from the selected list of shippers and agents in the chief towns of the United Kingdom which has been prepared by Messrs. Dean & Son, 160A, Fleet-street, London, E.C., and is just published. This is the fortieth annual issue of the "Export Merchant Shippers of Great Britain and Ireland," and every portion of the book has been carefully revised, and special attention given to an index to the class of goods shipped by the firms whose names are listed. A work which has for so long secured a favourable reception from shippers and merchants may be safely recommended.

Catalogues, &c.—We have received from the Electrical Corpn., 85, Gracechurch-street, London, E.C., copy of a new catalogue of the "Pluto" system of electric heating, &c. In the accompanying illustrations Fig. 1 shows the "Balmoral" design of heater. This has an art metal body, pierced over-panel, cathedral glass, and has two switches and a small lamp. Dimensions 39in. by 24in. by 13in. Fig. 2 is the "Buckingham" design, of similar make, 31in. by 28in. by 11in., and Fig. 3 the "Windsor" design, in antique hammered copper studded with cut crystal jewels, and fitted with two switches and two small lamps. Height 30in., diameter 20in.

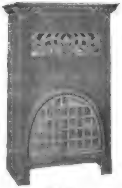


FIG. 1.

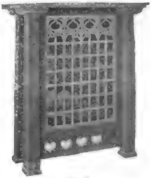


FIG. 2.

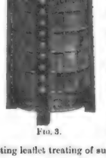
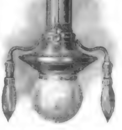


FIG. 3.

Messrs. W. T. Glover & Co. have ready a new catalogue the feature of which is a second grade cable termed "non-association" rubber cable. Judging from the samples we have received, this class of cable should be serviceable in those cases where the best class of rubber insulation is not specified.

Messrs. Arnold Goodwin & Son, Sumner-street, London, S.E., have ready some new sheet lists of pulleys and shafting, hangers, brackets, self-oiling and swivel fittings, &c., and an interesting leaflet treating of suspended liftways.

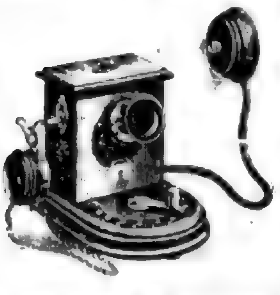
The A.E.G. English Mfg. Co., 4 and 5, New Compton-street, London, W.C., have ready a new Nernst lamp list in which the various types of this lamp are illustrated and described. The "Express" (large) type Nernst lamp, which gives light immediately the current is switched on, is shown in the illustration. The glow lamps shown are switched off automatically when the filament of the large lamp is alight.



Condensing plant is the subject of a new circular published by the Mirrlees Watson Co., Glasgow. The surface condensing plant supplied by the firm to Glasgow Corporation for the tramway power station of Pinxton is illustrated, as well as a number of separate pieces of machinery. Several horizontal dry air pumps are also shown. There is also ready a circular relating to surface condensing plant installed at a flax mill at Calcutta on the River Hoogly.

The Armorduct Mfg. Co., of 6, Farringdon-avenue, London, E.C., have prepared a cost book of Armorduct wires, cables and conduit accessories. The book is issued in pocket form, contains 276 pages of printed matter, and a diary for 1905.

A new pamphlet has been prepared by Aron Electricity Meter (Ltd.) illustrating and describing the Aron alternating-current motor meter and giving instructions for fixing and starting.



The General Electric Co. have issued a small booklet illustrating special lines of battery-ringing telephones, &c., which have been designed to meet the demand for cheap indoor and short-distance instruments. Particulars are given also of accessories suitable for use with the instruments illustrated. A comprehensive set of diagrams of connections is included. The illustration herewith shows an intercommunication battery set to stand on desk or table. The company notify that they have arranged to place at the disposal of their customers, free of charge, the service of a large staff of expert telephone engineers to give advice respecting telephone installations.

A new sheet of distributing boards is issued by Ernest F. Moy (Ltd.), of Camden Town, London, N.W.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Feb. 15 to 21, with the ports of destination:—

Africa—Alexandria, £261; Cape Town, £464 (including £72 telegraph material); Delagoa Bay, £376; Durban, £408 (including £203 telegraph material); East London, £248 (including £108 telegraph material); Mombasa, £17; Port Elizabeth, £145 (including £9 telegraph material); Suez, £103. *Argentina*—Buenos Ayres, £488 (including £334 telegraph material and apparatus). ***Australasia***—Adelaide, £209; Auckland, £118; Fremantle, £67; Hobart, £28; Melbourne, £410 (including £340 telegraph wire); Perth, £220; Sydney, £191; Wellington, £208. *Azores*, £97 (telegraph apparatus). *Belgium*—Osten, £25. *Brazil*—Pernambuco, £217 (telegraph material). *Ceylon*—Colombo, £642. *Channel Islands*—£20 (telegraph material). *Chili*—Iquique, £30. *China*—Canton, £155 (telegraph cable). *France*—Paris, £101. *Germany*—Cologne, £10; Hamburg, £352 (including £125 telegraph material). *Gibraltar*—£45,072 (including £44,640 telegraph cable). ***Holland***—Amsterdam, £85, Rotterdam, £21. *Hong Kong*, £167. *India*—Bombay, £349 (including £170 telegraph material); Calcutta, £1,239; Karachi, £10; Madras, £218. *Japan*—Moji, £236; Yokohama, £1,179. *Philippines*—Manila, £1,370 (submarine cable). *Straits Settlements*—Penang, £66; Singapore, £13. *Turkey*—Salonika, £10 (telegraph material). *U.S.A.*—New York, £14; Philadelphia, £17. Total £54,298, against £16,698 in the corresponding week last year (Feb. 17 to 23).

COMPANIES' MEETINGS AND REPORTS.

Charing Cross and Strand Electricity Supply Corpn. (Ltd.)

The annual ordinary general meeting was held on Wednesday, Mr. W. F. FLADGATE (Chairman of the Board) presiding.

The SECRETARY (Mr. E. Wilmot Seale, F.C.I.S.), read the notice convening the meeting.

The CHAIRMAN then said: Gentlemen, this is the eighth year that I have had the pleasure of meeting the shareholders, and during that time our progress has been very great indeed. I find that when first I had the honour of representing you as your Chairman that the total number of lights which we were supplying was only a little more than the additions which we have made during the past year, and that will show you the rate of progress at which we have been going. The increase last year in the whole of our districts was 132,700 lamps, and this is, as far as I know, a record by any company, except the record which we established of our company in the year 1903 of 146,710 lamps. Our grand total in all our districts is at present 710,744, and the result of that figure is that we are now, I think, the fourth company in London in point of supply. Of this increase in lights, 73,722 have been added in our West End districts. That is a very large number, and is the highest we have yet acquired in any one year, and it brings our grand total to 409,663 in the West End. We have during the year completed the building of the new station in the Green Park, which will enable us to extend our operations. We have been also able to complete, and not only to complete, but to prove to be satisfactory, the dual supply for theatres and other buildings which, under the advice of our engineer, we organised some little time back. That system was at first somewhat called in question, but I am glad to say that we were first able to satisfy the arbitrator appointed to consider the requirements of London County Council at Drury Lane Theatre, and subsequently to satisfy the authorities of the County Council themselves, that our supply was, in fact and in truth, a dual supply sufficient to comply with their requirements. In dealing with the accounts I may point out that we have £100,000 more share capital to deal with than last year, and that our loan capital is increased by £40,000, interest on which has to be provided. The balance on capital account of £237,411 is a sum which has been spent by us in the City, and upon which I shall have some remarks to make later on. The revenue account is more satisfactory than it was last year. One of the most important items is the expenditure on coal. In our case the only fair way of estimating what the consumption of coal is is to consider what the actual cost of coal is for the whole undertaking, and I am glad to inform you that the cost of coal per Board of Trade unit is nearly one-tenth of a penny less than it was last year. There is a saving on oil, waste, &c., the figure this year being £755, against £1,801 last year. The purchase of current in bulk has increased, and for two reasons. First, the more economical working of our stations, and, secondly, that there has been a greater demand for current in the West End. The sum of £11,000 has been written to depreciation account, as against £10,000 last year, and we think that this is a sufficient amount, having regard to the fact that we keep our plant in as good order as we possibly can, no less than £9,000 being spent on repairs, &c., during the last year. On the credit side of the account it is satisfactory to note that the sales in all have increased from £110,000 last year to £122,877. The net revenue account shows a carry forward of £50,900, against £39,111 last year. Out of this net revenue it is proposed to pay a dividend of 8 per cent., the same amount as we paid last year, and to carry forward £10,223. Depreciation is increased by £11,000, and now stands at £76,000. The premium account is increased by £11,359, and the total reserve of the Company now comes to £223,377, against £202,788. These reserves now amount to no less than 23 per cent. of the actual expenditure on the West End district. It is true that these have been employed in our business; but they have been very well employed, and I for one should be sorry to deal with them otherwise than in that way. Mr. Fladgate then gave a lengthy account of the agreements entered into with the Construction Company—the Charing Cross and City Electric Co. He said: Works to the extent of upwards of £1,000,000 have been done under those contracts, and for practical purposes those works, the important works, have now been finished, and, that being so, we do not think that it is right to further continue the work of the Construction Company. It, therefore, became necessary for us to consider the proper way of closing the whole of the accounts of the Construction Company. Now, first, I am glad to say, on taking the accounts of the Construction Company, we are able to tell you this—that the effect of the trading of the Construction Company during the years that it has been in existence is that, out of the profits which have been earned by it as a Construction Company, it has been able to defray the interest on the whole of the amounts which have, from time to time, been borrowed by it of your company. The result of our arrangements in regard to this matter will be that the liabilities between the Construction Company and your Company are put an end to, and, as was originally intended by us, that the whole of the share capital of the City undertaking should, in fact, be held as an asset for the benefit of and as a feeder to your Company as a whole. The effect upon the accounts will, of course, be considerably to simplify them. The arrangement we are now proposing has been considered most carefully by counsel, and we are advised it is a proper one to enter into, and I may add that that advice is quite in accordance with the views of the Board of Trade auditor.

Now, as to the City undertaking. We are quite contented with the progress we have made. 6,968 lamps have been added during the past year, making a total of upwards of 300,000 lamps acquired during the few years we have been in business. During the year £265,000 have been spent on capital account, and the loan account increased by some £50,000. The purchase in bulk by the City undertaking of the West End undertaking is greatly decreasing, the amount having been last year only £864. Repairs have increased, of course, the sum of £1,434 having been spent in 1904, against £387 in 1903. The sales of current amounted to £78,431, as compared with £56,000 in the previous 12 months, which, I think, is a very satisfactory result. It is quite true that no depreciation has yet been charged against this account, but upwards of £4,000 has been spent on repairs, and our engineer assures us that at the present time there is no depreciation, as a matter of fact. The plant is all new and has been carefully used, and it is only now in many respects just completed. Consequently it does not seem to us at present wise or necessary to put aside anything for depreciation. The balance accordingly thus carried to net revenue amounts to £33,274, against £31,400 in the preceding year. In the previous year there was a debit balance of £779, which has been wiped off, and it has been necessary to provide interest for debenture bonds amounting to £18,800, against £14,800 in the preceding year, which has taken £4,000 from revenue account. Temporary loans are £4,900, against £2,400, which has absorbed a further £2,000. That is to say, we have had to provide an increased sum for interest of about £6,000. Notwithstanding this increase, the preference dividend, now amounting to £18,000, has been paid by the City undertaking to the extent of £10,725, left £7,374 to be borrowed from the West End undertaking under their guarantee. I would just point out that this £7,374 is not a deficit on this past year's working. The actual amount required from the West End undertaking to provide the dividend on the City undertaking preference shares in respect of the past year was only £1,550. Now, gentlemen, I think it is only necessary for me now to point out to you what is our general position. On both undertakings our capital expenditure, as appears in the accounts, is about £2,167,000. This is represented by nearly £1,000,000 spent upon 580 miles of mains, so you have there a considerable asset, and a little over £1,000,000 spent on stations, buildings and machinery. These stations include Bow, where there is plant of the best kind. Our City sub-stations are Ludgate, Fenchurch-street, Cannon-street and Beech-street, all complete and in working order; and then for our West End undertaking we have Lambeth, Short's-garden, Maiden-lane, and St. Martin's-lane, with available space for further additions at Short's-garden, while we have under consideration the question of using Maiden-lane for motor generators. It has been necessary for us to spend this large capital amount. You may say, "And when are you going to stop spending?" Well, gentlemen, if we ever actually cease spending we shall cease working, because it will be necessary for us always to spend a certain amount on capital account. Now Bow, at present, provides some 200,000 lamps for the supply of the West End in bulk, and we are supplying at the present time in the City 300,000 lamps. To bring Bow up to 800,000 lamps, that is to say, to provide for the 200,000 we use for bulk in the West End, the 300,000 we are now supplying in the City, and a further 300,000 lamps there, or, in other words, to be able to provide a supply for 600,000 City lamps from Bow, in addition to the 200,000 for the West End, would only cost us something like a further £100,000. Therefore, you will see that we can double our output for the City at a small extra capital outlay. In addition we have spare way for further mains already, and at the sub-stations we have considerable space to deal with. I now move the adoption of the report and accounts.

Mr. G. H. BROUGHAM GLASIER (vice-chairman) seconded the motion.

After a brief discussion, replied to by the Chairman, the motion was agreed to unanimously.

Resolutions were then passed for the payment of the preference and ordinary dividends recommended by the Directors; for the grant of 1,500 guineas to the Directors for their services during the year 1904; for the re-election of the retiring auditors; and approving an agreement (dated Feb. 13, 1905) between the Charing Cross and Strand Electricity Supply Corporation and the Charing Cross and City Electric Company.

In answer to a question as to whether any further capital demands for the purposes of the Company would be required, the Chairman replied that a certain amount of fresh capital would be issued, but that the Directors had not yet come to any conclusion on the subject.

At an extraordinary meeting, which followed, approval was given to the promotion of a bill to confer further powers upon the Charing Cross and Strand Electricity Supply Corporation, and a subsequent resolution approved a change in the name of the company to "The Charing Cross (West End and City) Electricity Supply Company (Limited)."

A cordial vote of thanks to the Chairman and Directors, and to the staff who had supported the Board so well, was then proposed by Mr. LAURIE, who said he was sure they were deeply indebted to Mr. Patchell and Mr. Seale, who had given a great deal of time and industry to the affairs of the company.

The CHAIRMAN, in reply, thanked Mr. Laurie for his kind remarks, and the shareholders for their hearty vote of thanks. He agreed with all that had been said and cordially joined in the expressions of gratitude to the staff who had served them so well. He would, in conclusion, quote to the meeting some words from *The Electrician*. That journal, speaking of the company, said, in its summary of the past year: "As usual the Charing Cross Company easily takes the palm for the greatest increment in connections, and it looks as though the day is not far distant when it will outstrip all the other undertakings as regards actual connections."

The proceedings then terminated.

London Electric Supply Corpn. (Ltd.)

The ordinary general meeting was held yesterday (Thursday) under the presidency of Mr. ROBERT H. BENSON.

The SECRETARY (Mr. H. C. Carter) having read the notice convening the meeting,

The CHAIRMAN, after referring with regret to the absence of Lord Crawford from the chair, said he particularly regretted his lordship's absence on this occasion as he would have wished him to be present to propose the first dividend. Still more did he regret that Lord Wantage was not present to share in this reward of their patience. But for Lord Wantage they would have all lost their money, and it was due to his courage and unselfishness, which would be fresh in the shareholders' memory, that they were in their present satisfactory position. The directors' prognostications as to the company's position had been verified almost to the letter. The salient features of the report showed that the units sold rose last year from 4,102,000 to 10,531,785, while the cost per unit sold declined from 2·39d. to 1·21d. The number of lights had increased from 219,361 to 239,542, the gross revenue from £77,190 to £118,395, and the nett revenue from £36,177 to £65,333. Their figure for the cost of current per unit sold (1·21d.) was the lowest of any London company that had so far published its accounts, and they were indebted to the staff, and especially to Mr. Partridge, their chief engineer, and those under him; to Mr. Burstall, their consulting engineer, and to Mr. Carter, their secretary, and last but not least, to their managing director, Mr. Bain, for this result. Mr. Bain and Mr. Partridge were part of the old guard who had given the best years of their lives so far to the service of the company, and Mr. Carter had been with them nearly as long. These acknowledgments were usually made as a matter of form at the completion of a meeting, but he thought the present was the proper time to acknowledge their indebtedness to the efforts of the staff. The expansion of their lighting business kept on in its old steady way. What had brought them to their present satisfactory position was the development of the demand for power in bulk. Their chief customer was the London County Council, and of course that contract could not last for ever. The contract was, he believed, satisfactory to both sides. Their position at Deptford was unique for the supply of cheap power, and they anticipated a steady increase in the general demand for current in bulk in their area. The net results of their operations for the year was to leave the company with £33,403 over, after paying the preference dividend, and they had now to decide what should be done with this sum. Their first duty was to create a reserve against contingencies, of which the chief was the antiquation of plant, and the directors proposed to place £5,000 to credit of contingencies account. Next it was proposed to add to the general reserve, for, like their neighbours, the company was liable to be bought up by the local authorities after a term of years, and their term expired in 1931 with no allowance for goodwill or earning power, so that although they had written off £227,565 in times past, had reduced the shares from £5 fully paid to only £3, they must pile up their reserves, making up this reserve to £25,000 by adding £18,540, and out of last year's revenue, there remained sufficient to pay 3 per cent. dividend on the ordinary shares and to carry forward £2,009, the same as was brought forward last year. As to capital expenditure, they expected last year to spend on new plant £50,000, and it had come out at about that figure. This year they would have to spend about £55,000. They were putting up two new stations for the supply of continuous current for power—one in Deptford, the other in Lambeth. Parliament had established the principle of one competitor and no more everywhere. They had their competitor already alongside of them in every part of their area, with the exception of the small borough of Deptford and a small corner of Lambeth. With this competition, and the liability to be bought up in 26 years, they looked to Parliament for protection against further competition. They were ready to give the public in their area all the power they wanted at competitive prices, and were determined to defend themselves against any invaders of the area which Parliament had given them for a term of years for the benefit of the public and of themselves. In the next session of Parliament they were called upon to defend themselves not only from the attacks of an invader from the North, but also against poaching by their fellow electric lighting companies in London. This latter form of competition was dangerous, as dissension among the London companies was other people's opportunity. But he thought they had less reason to be anxious than some of their neighbours. For the purposes of any contest that might be necessary they had the satisfaction of knowing that they had a strong cash position and also unused capital powers easily available. He moved the adoption of the report and accounts and the payment of the dividends recommended therein.

Sir WILLIAM H. PREECE, K.C.B., F.R.S., seconded the motion.

Mr MAKINS asked how the sum set apart for depreciation would be treated by the purchasing authority.

Mr. DRUCKER urged that to make themselves strong financially their reserve fund should be invested outside the company's business.

A SHAREHOLDER asked how much of the additional capital which the chairman had intimated was to be spent was likely to be required for the supply of electric current to the County Council, whose contract they would probably lose in about a year and a half.

The CHAIRMAN, in reply, said: The capital expenditure for London County Council was all made last year, and I do not anticipate there will be any further expenditure on that account. The £55,000 which I said we might spend is for the development of the business generally. As to the reserve of the company being invested in the company's business, I think we are right in so investing it. The purchasing authority has the power to buy us up without any allowance for goodwill or earning power, as I have said, but we have to spend money all the time on the business in order that we may return to you at least £3 per share whenever the purchasing authority comes in. We are getting a higher rate of interest than if we invested it in outside securities.

The MANAGING DIRECTOR (Mr. R. Stewart Bain) said: It has been the custom for me to give you details of our capital expenditure. Of the £49,000 odd spent during the past year rather more than £20,000 was for the completion of our new condensing plant, £6,000 for new engines, £1,000 for sundry new plant in connection with those engines and condensing plant, and over £12,000 for new mains. We have completed a new trunk main route, which gives us a second string to our bow in case of necessity. With regard to the average price received per unit sold, this still shows a decrease, due to the increase in the power supplied at a very low rate. Leaving out of consideration our contract with the London County Council, the average price has decreased from 4·502d. to 4·134d., and owing to increased competition this decrease is likely to continue. But the cost per unit sold also shows a decrease of no less than 50 per cent.—from 2·39d. to 1·21d. I would like to emphasise the chairman's remarks as to the great debt we are under to our engineering staff, which is certainly second to none in London. Our principal saving in cost is again in coal, which has been at the rate of 21 per cent. In 1903 every unit of current we sold took 7·89lb. of coal, while in 1904 it only took 6·26lb. The cost of the coal decreased from 0·79d. per unit sold to 0·51d., and this very large saving is due chiefly to our being able to burn lower-priced coal, owing to the new condensing plant and new boilers. The increase in the efficiency of our system is shown by the percentage of units sold to units generated, which was 87·077 per cent. in 1904. Even without the London County Council power units the increase is still very satisfactory. Prospects for the present year are distinctly favourable, as units sold and lamp connections already show considerable increases.

The resolution was then carried unanimously.

The retiring directors, Sir W. H. Preece and Mr. R. Stewart Bain, were then re-elected, as were the retiring auditors, and a cordial vote of thanks to the chairman, the directors, and the staff brought the proceedings to a close.

Chelsea Electricity Supply Co. (Ltd).

The annual ordinary general meeting was held on Wednesday under the presidency of Mr. J. IRVING COURTENAY.

The CHAIRMAN, after referring feelingly to the death of Maj.-Gen. C. E. Webber, one of the original directors of the company, said it was satisfactory to be able to report further improvement in the company's position. They were paying ½ per cent. more than last year, making 6 per cent. for the year. The capital expenditure of £10,829 was small, and was largely due to the change in pressure. The total working costs were practically the same, notwithstanding that there had been a considerable increase in the amount spent on maintenance of plant. Their engineer (Mr. Percy Still) deemed it prudent to make a special overhauling of all the plant during the year, and their entire system of mains had received particular attention, a large sum having been spent on this work. The increase in output had been satisfactory, there having been a considerable increase in supply for motive power, heating, and for charging batteries of electric carriages, &c. The number of equivalent 8 c.p. lamps added during the year was 15,424, which, although not quite so good as in 1903, was about the average for several years past. The total of these connections at Dec. 31 last was 210,659. The equipment of their station at Alpha-place has been completed, and there was now no further room for additional plant in that building. To cope with a prospective increase in demand it had been necessary to provide an extension, and they had acquired land adjoining the station for this purpose, and here they would erect a new generating station adjoining the Alpha-place station. This work would be carried out during the current year, and the equipment of the works would follow gradually. The alteration in their system of supply which had been carried out during the past two years had led to a marked improvement in the efficiency of their distribution. The work of altering their mains and machinery to render them suitable for use for the higher pressure was of a somewhat difficult nature, as it had to be carried out without any interference of the service to the public. The cost had been considerable, but now the great bulk of this expenditure had been incurred, and they hoped to derive substantial advantage from the alterations carried out. The total number of units sold during the year was 3,212,412, or 473,060 more than last year, and the units sold per lamp 15·25, against 14·05. He moved the adoption of the report and accounts and payment of the dividends recommended therein.

Mr. G. N. MARTEN seconded the motion.

In reply to a question, the CHAIRMAN said the opposition on the part of some of the founders' shareholders had been withdrawn so far as the House of Commons was concerned

The motion was then adopted unanimously, and the retiring director and auditors were re-elected.

At an extraordinary meeting which followed, a resolution confirming that passed at the meeting of shareholders on Feb. 1 was duly approved.

At an extraordinary meeting of the founders' shareholders which followed, a resolution was passed confirming that agreed to on Feb. 1.

Mr. CALLENDER, as an ordinary shareholder, as well as a founders' shareholder, then proposed a vote of thanks to the Chairman, the Directors and the staff.

Mr. BARBER seconded, and expressed the opinion that the Board had done a great deal in pulling the Company out of what might have been a difficult position.

The resolution was carried by acclamation.

The CHAIRMAN, in thanking the shareholders for this expression of opinion, also returned thanks on behalf of the engineering staff and the staff of the secretary's department. He said there had been a great deal of work in connection with the founders' shares question, a great many technicalities had had to be dealt with, and the work had been throughout well done.

The proceedings then terminated.

Westminster Electric Supply Corpn. (Ltd).

The ordinary general meeting was held on Wednesday, Mr. Boulnois, M.P. (in the absence of Lord Suffield through illness, presiding.

The SECRETARY (Mr. Frank Iago) read the notice convening the meeting.

The CHAIRMAN said: Gentlemen, I think you will agree with the directors that the report for the past year is of a highly satisfactory character. We have increased the equivalent of 8 c.p. lamps by some 50,000 during the past year, and that brings up the total number to 711,679, and applications continue to come in at a satisfactory rate. The station of the Central Electric Supply Co. at St. John's Wood has been working well during the year, and has supplied a large amount of current to this company at a considerably lower rate than in the previous year. Our new transformer station at Duke-street is not yet completed, but arrangements have been made for a part of the supply to be available for the engineers, and operations are now going on there, and have been since the latter part of last year. The shareholders will not, I think, complain of the dividend which we propose should be declared. I feel sure that all men of business among the shareholders will agree that it is a wise thing to keep a substantial balance in hand. We have already, from the commencement of the year, lowered the price of current somewhat, and we believe that that will ultimately lead to more business. I have little more to say with regard to the report, but I want to sound a note of alarm. I do not wish to frighten the shareholders, but I think they should understand that a bill has been lodged in Parliament which is called the Administrative County of London District Electric Power Bill. It is a high sounding title, and its object is to supply the whole of London with current for power purposes. I think it is hard that such an attempt should be made upon the companies in London who have borne the heat and burden of the day, and who have had considerable trouble, and spent enormous sums of money, in bringing their systems to perfection and supplying the public with the commodity at a reasonable charge. We have been placed from the first under obligations and restrictions by Parliament. This new company, if the bill should be passed in its present form, will be under no statutory restrictions with regard to the time in which they will be able to supply power. We shall, in the shareholders' interests, oppose this bill on every point and do our utmost to bring about its defeat. By the irony of fate, we have now on our side the London County Council and the municipalities who are also suppliers of electricity, and, with the aid of the other electric lighting companies in London, we ought to be able to prevent what I venture to say would be a great injustice to us. As far as I am aware the whole of the London companies, with one exception, are opposing this bill. There are 77 petitions against the bill. I now move the adoption of the report and accounts.

The motion was seconded by Mr. HAYES FISHER, M.P., and carried unanimously.

Resolutions approving the payment of the dividend at the rate of 15 per cent. per annum for the half-year to Dec. 31, and re-electing the retiring directors, having been approved, a hearty vote of thanks to the chairman, directors and staff terminated the proceedings.

BAKER STREET & WATERLOO RAILWAY CO.—At the meeting last week the chairman (Mr. T. J. Hare) announced that satisfactory progress was being made with the works. Between the Elephant and Castle and Baker street the running tunnels had been driven throughout. All the station tunnels were through, except the down tunnel at Elephant and Castle. Half the permanent way had been laid. The running tunnels for the Paddington section had been driven as far as Harewood-avenue and the permanent way laid. Arrangements for the interchange subway with Marylebone station of the Great Central Railway had been completed. The work of ventilation, secondary lighting and signalling was well advanced, and the high-tension cables to the substations on the company's line were nearly completed. Eighteen trains of six cars each, also trucks, motors and controlling apparatus, were all on order, and delivery should commence in May.

CROSSLEY BROS. (LTD.)—The report for 1904 states that there has been a satisfactory year's trading in all departments. The amount for disposal is £101,954. The directors propose a further dividend at the rate of 12 per cent. per annum on the ordinary shares (making 11 per cent. for year), leaving £19,051 to carry forward.

EDWARDS AIR PUMP SYND. (LTD.)—The report for 1904 states that royalty income amounted to £9,489, compared with £7,493 for 1903. Expenditure was £3,700, an increase of £572. During the year 1,046 pumps were booked, 626 for land installations and 420 for use with marine engines. A large number of pumps have been fitted in connection with turbines. The British Admiralty have adopted the Edwards pump for all electric lighting and power plants with which the Government dockyards in various parts of the empire are being equipped. The pump has been adopted for more than 200 of the principal electric lighting and traction stations in Great Britain and the United States. A further dividend of 10 per cent. is proposed, making 15 per cent. for the year.

GIANT'S CAUSEWAY & PORTRUSH ELECTRIC TRAMWAY CO. (LTD).—At the meeting last week the chairman (Mr. J. S. Moore, D.L.) moved the adoption of the directors' report, which stated that there was a large increase in the receipts, compared with the previous year (from £3,376. 17s. 1d. to £3,636. 18s. 4d.), while the increase in passengers carried during the year was from 108,154 to 119,876. The net profit for the year was £1,479. 1s. 9d., against £1,241. 14s. 8d. in 1903, £1,263. 2s. in 1902, and £1,059. 14s. 11d. in 1901. The number of miles run by electricity were 28,489, against 22,954 in 1903, and the number of miles run by steam were 5,803, against 7,560 in 1903, making the total number of miles run last year 34,292 against 30,514 in 1903. That result had arisen from the successful working of the new overhead electric system, which provided greater power and more rapid means of transit than did the old system. The engineer (Mr. W. A. Traill, C.E.) reported that the permanent way, engines, rolling stock and electrical plant had been maintained in an efficient condition during the year. The number of miles run by electricity had increased from 22,954 in 1903 to 28,489 in 1904, run at a working cost of a little over 3¾d. per mile. The number of miles run by steam had been still further reduced from 7,560 in 1903 to 5,803 in 1904, but at an increased cost. The increased electric mileage and diminished steam mileage had given most favourable results, and if steam haulage could be done away with and electricity alone be used the result would be still more favourable; a larger generator and two extra electric cars would almost be sufficient to accomplish that end. The two new turbines had given excellent results in increased power from the same height of fall. With practically the same train services and the same rolling stock, at least 30 per cent. more passengers could have been carried last year, and, instead of there having been an increase of 11,722 passengers, an increase of at least 36,000 could easily have been had if the weather in the two summer months had not been so bad.

GREAT NORTHERN RAILWAY CO.—At the recent meeting the chairman (Lord Allerton) said that during the half-year £41,000 was expended by that company on the Great Northern and City and the Great Northern Piccadilly and Brompton tube lines. In connection with the opening of the Great Northern and City Railway there was no doubt that had led to a large increase in the number of passengers carried by the Great Northern. It was estimated that during the half-year they carried in the suburban district nearly 800,000 more passengers, and he had no doubt the increase in traffic would shortly catch up the loss involved by the reduction in fares which had had to be made. In Yorkshire, however, they had carried about 200,000 less passengers and in Nottinghamshire about 70,000 less, owing to electric tramway competition.

HART ACCUMULATOR CO. (LTD.)—The directors' report to Dec. 31, 1904, states that the profit for the year is £5,813. 0s. 4d., and the balance from last year £5,737 10s. 8d. After deducting preference dividend (£137. 17s. 8d.) the balance is £11,412. 13s. 4d., and the directors recommend an ordinary dividend of 12½ per cent., leaving £6,412 13s. 4d. to be carried forward. The company's buildings, plant, tools, &c., have been augmented by £4,261. 17s. 1d. which has been charged to capital, and due depreciation has been made. The maintenance of works, plant, &c., has been well kept up (at a cost of £799. 13s. 11d.) out of revenue.

IMPERIAL TRAMWAYS CO. (LTD.)—The directors' report for year ended Dec. 31 states that the gross receipts from the Middlesbrough, Stockton and Thornaby electric tramways was £51,097., and the number of passengers carried 9,818,349, compared with £49,963. 7s. 7d. and 9,576,125 in preceding year. The net profit was £16,564 14s. 9d. Under the company's 1904 Act power is given to construct a line of tramway (4 miles 4·70 chains), commencing at the termination of the existing system in Middlesbrough and running through North Ormesby, South Bank, Grangetown and Eston. Those tramways, with the exception of ¾ mile, are not purchasable by the local authorities until 1929, and then only on the terms of paying the fair market value as a going concern, instead of the terms laid down in the Tramways Act, 1870. The act also authorises the conversion from single to double track of a portion of the company's existing line in Thornaby. In connection with the act the company have entered into an agreement with Thornaby Corporation under which the latter have undertaken not to exercise any rights of purchase with regard to existing lines until the expiration of 21 years from their authorisation, viz., in 1918. Under the company's 1897 Order power was given to the local authorities, provided they all combined, to acquire the undertaking in 7 or 14 years, although on terms more advantageous to the company. The effect, therefore, of the new agreement with Thornaby is to render that alternative provision inoperative. The company's interest in the London United Tramways has been slightly increased during the year and there is a corresponding increase in the dividends, which amount to £21,135. The company's available balance is £41,655. 15s. 3d., and after payment of interest for the year and interim dividends (£26,168. 4s. 7d.), it is proposed to pay the balance as follows: preference dividend (£5,700), a final dividend at 10 per cent. per annum (making 9 per cent. for the year) on the ordinary capital, less tax, and to carry forward £287. 10s. 8d.

LANARKSHIRE TRAMWAYS CO.—The report for the half-year ended Dec. 31 states the receipts were £18,315 and expenses £9,705. £2,500 has been placed to depreciation and £1,527 written off. A dividend at the rate of 5 per cent. per annum for the half year is declared. Capital expenditure during the half-year was £11,836, which has been expended mainly on the power station, 10 new cars and permanent way. Ten new cars were put in service in July last.

LONDON UNITED TRAMWAYS (1901) (LTD.)—The report of the directors for 1904 states that the gross receipts amounted to £296,235. 11s. 2d., and expenses to £176,188. 5s. 10d., leaving (with balance forward) a net revenue of £120,834. 8s. 5d. After payment of interest and preference dividend there remains £42,087. 8s. 3d. An interim dividend was paid in August, leaving £23,805. 7s. 2d. It is proposed to pay a final dividend on the ordinary shares, making 6 per cent. for the year (less tax), to place £5,000 to reserve and to carry forward £563. 11s. 3d. The gross receipts show an increase of £15,993. 15s. 1d. and the operating expenses a decrease of £203. 6s. 9d., notwithstanding a larger mileage open. The total number of passengers carried was 48,126,727, an increase of 2,833,254. Preparations are in progress for the construction of the authorised tramways in Kingston, Surbiton, the Maldens and Wimbledon, and between Brentford and Hanwell. These Surrey lines will connect with the London County Council electric tramways at Tooting, and over Kingston Bridge with the company's tramways in Middlesex and London.

NATIONAL ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting the chairman (Mr. J. Booth) said notwithstanding the depression in trade in Preston and the bright weather in the autumn, the receipts for current amounted to £21,037, against £19,462 the previous year. Rates and taxes had increased from £873 to £1,776, against which they had appealed. The 4 per cent. preference dividend for the year and a dividend of 5s. per share on the ordinary shares for the half-year (making 8s. for the year), and £2. 14s. 3d. per share on the founders' shares were declared.

NATIONAL TELEPHONE CO. (LTD.)—The report of the directors for the half-year ended Dec. 31 last shows that the income accrued in respect of the business for this period amounted to £1,033,705. 17s. 5d., compared with £941,259. 14s. 11d. for the corresponding period of 1903, an increase of £92,446. 2s. 6d. Working expenses were £591,635. 16s. 11d., compared with £527,284. 5s., an increase of £64,351. 11s. 11d. The net result (after deducting Post Office royalties, £95,195. 3s. 2d.) is a profit balance of £346,874. 17s. 4d., compared with £327,739. 2s. for the same period of 1903, or an increase of £19,135. 15s. 4d. The rentals carried forward for unexpired terms of running contracts amount to £889,577. 14s. 1d., compared with £827,163. 19s. 10d., an increase of £62,413. 14s. 3d. Out of the available balance of £247,057. 16s. the board recommend the payment for the half year of the due dividends on preference and preferred stock, and at the rate of 5 per cent. per annum on the deferred stock, less tax in all cases. £115,000 is transferred to reserve and £10,141. 2s. 8d. carried forward. £402,101 0s. 8d. has been expended on capital account during the half year in the erection of 18,625 additional exchange and private stations and in the construction of underground works. The directors state that, after protracted negotiations, they have arrived at an agreement with the Postmaster-General for the sale to him on Dec. 31, 1911, of the undertaking of the company, the agreement being subject to the approval of Parliament. [This agreement is set out on another page of this issue.]

NEWCASTLE & DISTRICT ELECTRIC LIGHTING CO. (LTD.)—At the meeting on Tuesday the chairman (Mr. J. D. Milburn) moved the adoption of the report set out in our last issue. The amount of profit, he said, did not compare so favourably, but that was owing chiefly to the withdrawal of the business of the North-Eastern Railway, from whom they had received £6,000 or £7,000 per annum. But having lost that business, they sought to replace it. They had developed and were developing into a full-fledged power company, and were able to deal with large users of power, and give them as favourable terms as they could get anywhere. In 1890 they began with a dividend of 2 per cent., and if they considered the period since then as 14½ years, there had been an average dividend of 7·137 per cent. Their new power station was in working order, and they hoped in the coming year to get a benefit in revenue. They had now to credit of reserve £20,816. 19s. 6d., and had written off depreciation £7,500, which put the company in a more satisfactory position than it had been for some time past.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The directors' report for 1904 states that the total units sold during the year amounted to 17,132,153 compared with 9,033,625 in the previous year; 14,000,000 were sold for power and the remainder for lighting. The profits (including £1,069. 0s. 8d. from 1903) amount to £62,539. 8s. 7d. out of which interest absorbed £14,256. 19s. 10d., interim dividends £14,278. 7s. 6d., and balance of extra cost in connection with the electrical undertaking purchased from the Walker & Wallsend Union Gas Co. £1,500, leaving available £32,504. 1s. 3d. The directors now recommend payment of the balance preference dividend, 5½ per cent. on the ordinary shares, making 8 per cent. for the year and absorbing £24,405. 0s. 10d., and a dividend of 3½ per cent. on the ordinary shares allotted in connection with the purchase of the Walker & Wallsend Union Gas Co.'s electricity undertaking (making 6 per cent. as per agreement) and requiring £1,226. 11s. 6d., £6,000 is written off to depreciation, and £872. 8s. 11d. is carried forward. During the latter half of 1904 the North Eastern Railway Co. was regularly supplied with electric energy for traction as well as for power and lighting. The depreciation account now amounts to £131,000. Expenditure on capital account during the year has been £124,242. The company has had allotted to them 10,000 £1 fully paid shares in the Priestman Power Co. (Ltd.), representing one half of total share capital of that company. The Priestman Co.'s generating station at Blaydon Burn is now supplying current and the development of the business generally in that district is being pushed forward. An agreement has been entered into with the Northern Counties Electricity Supply Co. (Ltd.) by which the working and developing of the districts of Whitley, Monkseaton, Earsdon and Seghill, covered by provisional orders granted to that company, have been transferred to this company. The shareholders will be asked at the forthcoming meeting to confirm a provisional agreement entered into for the purchase of the whole of the shares issued by the County of Durham Electrical Power Distribution Co. (Ltd.).

NORTH METOPOLITAN TRAMWAYS CO.—At the meeting on Wednesday the chairman (Mr. G. Richardson) said there was no doubt motor omnibuses would adversely affect horse-drawn vehicles. The time was coming when street locomotion would be altered, but so far as the company was concerned the point that would affect them was when they would be able to get a suitable motor car which would run upon their rails.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—Mr. F. H. Thornton, J.P., stated at the meeting last week that the equivalent of 6,576 8 c.p. in lamps and motors were connected during 1904, bringing the total to 47,431 8 c.p. Motors increased from 251½ h.p. to 351½ h.p., of which 210 h.p. were hired out by the company. Consumers had increased from 704 to 801. The extension of the mains to Dallington has been justified by results. An important purchase of land was made during the year, with a view to future needs, and substantial additions have been made to the plant. The provisional order extending the area of supply to the whole of the county borough, and to various parishes, was confirmed by Parliament. On April 30 last, Northampton Council offered £100,000 for the company's undertaking, payment was, however, to be deferred and there were other impracticable conditions, so the directors did not feel called upon to convene a meeting to consider such proposals. £1,750 is now added to depreciation, besides £50 written off motors. Some old plant has been sold, and the loss written off. There is £1,746 available for dividends, and it is proposed to pay a dividend at the rate of 5½ per cent. per annum for the half year on the ordinary shares, making 5 per cent. for the year.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO. (LTD.)—The directors' report for the year ended Dec. 31, 1904, states the balance is £16,574. 16s. 3d., or, with £5,219. 19s. 1d. from previous year, £21,794. 15s. 4d. Deducting £6,323. 18s. 6d. for interest and £1,750 for interim preference dividend, there remains £13,720. 16s. 10d. The directors propose to pay the final preference dividend (£2,439. 6s. 8d.), to place £2,250 to depreciation, to write £824. 19s. 11d. off "Change-over system in Greenwich" account, to reduce preliminary expenses by £1,500, and to carry forward £6,706. 10s. 3d. At the end of 1904 the equivalent of 108,391 8 c.p. lamps (including Crystal Palace undertaking from June 16) was connected, against 60,540 in 1903, the number of consumers being 2,555, against 1,734. The undertaking of the Crystal Palace Co. was taken over on June 16th last; and the number of lamps added by this inclusion was 29,572. The change of system from direct to alternating current in the new area should be completed before the end of 1905. Beckenham Council have served notice on the company, exercising their statutory right to purchase a small portion of the new area. The purchase price is being adjusted.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—The 41st annual report of the directors states that the accounts for the past year show a net profit of £48,825. 15s. 11d. after charging interest on debentures. To this sum is added £120,484. 17s. 3d. brought forward, making £169,309. 13s. 2d. From this is deducted the interim dividend of 5 per cent. (£22,410), leaving £146,899. 13s. 2d. to be dealt with. The directors propose to distribute £1. 4s. per share absorbing £44,820, being at the rate of 10 per cent., and making a total dividend for the year of £1. 16s. per share, or 15 per cent., tax free, leaving £102,079. 13s. 2d. to be carried forward. Various lengths of cable have been manufactured, and sundry cable repairing operations have been carried out, but work generally has not been on so extensive a scale as during the past few years. The company's factories at Greenwich and Wharf-road have been well and properly maintained. Advantage has been taken of the slackness of work

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Feb. 18	1,071	+ 27	36	53,048	+ 5,702
Airdrie	,, 10	302	− 4	6	1,169	− 4
Ayr Corporation	,, 18	175	+ 16	40	12,064	+ 585
Barnsley	,, 10	115	+ 1	6	850	+ 28
Barrow	,, 10	167	+ 17	6	1,027	+ 17
Bath Electric Trams, Ltd.	,, 18	547	+ 16	7	3,788	+ 465
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 19	971	+ 21	...	...	...
Birmingham Corporation	,, 18	169	...	7	18,289	...
*Birmingham & Mid.	,, 10	1,788	+ 267	6	9,628	+ 968
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 16	303	+ 29	46	45,602	+ 6,110
Blackpool and Fleetwood	,, 18	157	+ 8	7	1,769	− 28
Blackp'l, St. Anne's & Lytham	,, 16	142	− 2	16	2,010	...
Bolton Corporation	,, 11	1,680	+ 8	37	66,161	+ 461
Bournemouth Corporation	,, 16	295	+ 37	‡46	49,269	+ 2,183
Bradford Corporation	,, 18	3,881	+ 264	44	208,495	+ 19,545
Brighton Corporation	,, 19	760	+ 49	46	45,660	+ 3,628
Brisbane Tramways	...	...	...	...	...	...
Bristol Trams & Carriage	,, 17	4,461	+ 169	2	8,951	+ 105
Buenos Ayres & Belgrano	...	...	...	...	...	...
Buenos Ayres Elec. Trams	...	...	...	...	...	...
Burnley Corporation	,, 18	964	+ 97	21	7,318	+ 3,022
Burton Corporation	,, 19	202	+ 2	¶46	15,722	...
Calcutta Tramways Co.	,, 18	a39,068	+ a1,083	7	a285,953	+ a30,106
Camborne-Redruth	,, 20	87	− 11	16	1,680	− 218
Cardiff Corporation	,, 15	1,848	+ 44	46	93,578	+ 2,018
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 18	7,192	+ 96	7	50,201	+ 1,063
Chatham & Dist. Lt. Rys.	,, 16	579	+ 67	7	3,863	+ 880
*City of Birm'gh'm Tram Co.	,, 10	5,584	+ 118	6	30,360	+ 585
City & South London Rly.	,, 19	2,816	− 351	8	24,217	− 1,545
Colchester Corporation	,, 16	157	...	8	409	...
Cork Electric Trams Co.	,, 16	460	+ 63	7	2,772	+ 22
Darwen Corporation	...	...	...	...	...	...
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 10	446	− 12	6	2,657	− 18
Dover Corporation	,, 18	169	+ 7	47	10,211	− 170
Dublin & Lucan Railway	,, 17	92	+ 8	7	648	+ 7
Dublin Southern District	,, 17	759	+ 99	7	30,364	+ 467
Dublin United	,, 17	3,595	+ 8			
Dudley—Stourbridge	,, 10	715	+ 58	6	4,170	+ 38
Dundee Corporation	,, 15	776	+ 8	¶18	32,633	+ 594
East Ham Council	,, 18	651	+ 51	46	32,548	+ 1,798
Gateshead & Dist. Trams	,, 10	558	+ 20	6	3,007	+ 81
Glasgow Corporation	,, 18	13,912	+ 1,074	†86	540,651	+ 26,550
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 10	191	− 25	6	1,064	− 111
Gt. Northern & City Rly.	,, 18	1,623	...	7	11,349	...
Greenock & Port Glasgow	,, 10	491	+ 42	6	2,948	+ 274
**Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 10	255	+ 12	6	1,326	− 19
Huddersfield	,, 15	1,198	+ 75	46	67,331	+ 3,950
Hull Corporation	,, 18	2,060	+ 78	46	110,660	+ 10,378
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	,, 15	101	− 17	10	2,163	− 351
Ipswich Corporation	,, 18	539	+ 14	40	21,857	—
Isle of Thanet Co.	,, 19	241	+ 8	20	5,706	+ 77
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	,, 18	91	− 1	6	521	− 2
Kirkcaldy Corporation	,, 18	198	+ 7	...	...	...
Lanarkshire Trams Co.	,, 18	684	+ 107	7	4,399	+ 371
Leeds Corporation	,, 18	5,991	+ 436	48	204,750	+ 15,397
Leicester Corporation	,, 18	1,782	...	7	12,055	...
Liverpool Corporation	,, 11	10,080	+ 559	6	58,887	+ 1,631
Liverpool Overhead Rly.	,, 19	1,440	− 31	8	11,778	− 414
*London County Council	,, 11	11,264	+ 3,201	§15	575,479	+ 128,691
Lowestoft	,, 18	118	− 14	7	763	...
Maidstone Corporation	,, 16	96	...	31	4,158	...
Manchester Corporation	,, 18	11,670	+ 1,095	46	569,926	+ 25,669
Mersey Railway	,, 18	1,625	+ 154	7	11,909	+ 818
Merthyr	,, 10	178	− 14	6	969	− 89
*Metropolitan Elec. Trams	,, 10	2,020	+ 943	6	11,066	+ 4,658
Middleton	,, 10	272	+ 25	6	1,457	+ 117
Nelson Corporation	,, 18	107	+ 18	47	4,459	+ 1,364
Newcastle-on-Tyne Corp.	,, 18	3,514	+ 8	7	24,718	+ 348
Newport (Mon.)	,, 18	481	+ 48	20	10,105	+ 1,846
Oldham, Ashton & Hyde	,, 10	491	+ 3	6	2,791	+ 8
Oldham Corporation	,, 19	1,361	+ 296	47	59,017	+ 4,401
Perth (W. A.) Elec. Trams	,, 17	1,459	+ 127	7	10,884	+ 819
Peterborough	,, 10	106	− 12	6	678	− 45
Poole and District	,, 10	214	+ 3	6	1,231	− 21
Portsmouth Corporation	,, 18	1,362	+ 20	§46	87,170	+ 6,467
Potteries	,, 10	1,662	− 22	6	9,358	+ 258
Reading Corporation	,, 16	545	− 13	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 10	46	+ 7	6	200	+ 21
Salford Corporation	,, 20	3,646	+ 178	45	166,024	+ 9,160
Sheerness	,, 8	25	+ 5	6	273	− 41
Sheffield Corporation	,, 19	4,888	+ 106	§47	218,412	+ 8,707
Southampton Corporation	,, 18	791	− 86	46	44,261	− 2,579
Southend Corporation	,, 18	228	+ 7	46	15,925	+ 1,591
Southport Tramways	,, 10	284	+ 15	8	1,274	− 13
S. Staffordshire Trams	,, 10	677	− 50	6	3,657	− 317
Stockport Corporation	,, 17	429	+ 14	46	25,061	+ 3,436
Sunderland Corporation	,, 19	1,079	+ 15	47	57,963	+ 1,472
Swansea Trams	,, 10	456	− 55	6	2,576	− 11
Taunton Trams	,, 10	40	− 9	6	239	− 40
Tynemouth and District	,, 10	179	− 31	6	962	− 183
Tyneside Trams Co.	,, 15	358	+ 45	7	2,140	+ 256
Wallasey District Council	,, 18	631	+ 63	§46	34,199	+ 2,332
Walsall	,, 19	433	...	7	3,049	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 16	1,079	...	51	49,446	...
Weston-super-Mare	,, 8	25	+ 5	6	117	+ 21
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 10	361	+ 29	6	1,917	+ 81
Worcester	,, 10	262	− 10	6	1,439	+ 654
Wrexham	,, 10	104	+ 6	6	536	− 28
Yorkshire Woollen District	,, 10	576	+ 26	6	3,161	+ 348

(a) These comparisons are with the corresponding period last year. † Minus 8 days. ‡ Minus 2 days § Plus 2 days. ¶ Plus 3 days. ** Fortnight. * Partly electrical.

to rebuild a portion of the factory at Greenwich, and to introduce improvements there which will add to the efficiency of the works. The company's steamships are in good and thorough repair. The directors have contracted for the building of a new cable steamer. She was launched in the Tyne on Nov. 22, and is named the "Cambria."

The transfer books will be closed from 20th to 28th inst. inclusive, preparatory to payment of the dividend on the 20th inst.

TOPSHAM ELECTRIC LIGHT CO. (LTD.)—At the meeting last week it was stated that since the formation of the company the number of lights supplied to customers had trebled. There was reasonable promise of a dividend at the end of the first year. Mr. H. Gould is secretary and manager of the company.

CITY NOTES.

MEMORANDA (Feb. 23).—Bank rate 3 per cent. (since April 21, 1904). Price of silver 27⅞d. per oz. Consols 90⅜—90½ for money, 90⅞—90¹⁵⁄₁₆ for account; 2½ per cent. annuities 89¾—90¼. Consols Pay Day, March 1. Stocks and Shares Continuation Days, March 13 and 28; Ticket Days, March 14; Pay Days, Feb. 24 and March 15; Mining Share Carry-over Days, March 10 and 27.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units delivered to consumers during the four weeks ended Jan. 27 was 199,288, compared with 124,324 in the corresponding four weeks of the preceding year.

CHATHAM & DISTRICT LIGHT RAILWAYS CO.—A dividend of 3 per cent. for the half-year ended Dec. 31 is announced. The receipts were £16,381 and the expenses £10,029.

MUNICIPAL ISSUE.—Belfast Corporation are inviting applications for £1,000,000 3½ per cent. redeemable stock at 98 to provide capital for the conversion of the tramways to electric traction, &c.

PERSONAL.—Mr. J. S. Harmood Banner, a director of the British Insulated and Helsby Cables (Ltd.), the Electric Supply Co. of Victoria, the Electric Supply Co. of Western Australia, the Midland Electric Corporation for Power Distribution, &c., was returned by a very substantial majority as member of Parliament for Everton at the bye-election which took place on Wednesday.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend (payable March 25) of 3s. per share (at the rate of 6 per cent. per annum), tax free, for the quarter ended Dec. 31 last. The transfer books will be closed from March 18 to 24 inclusive.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—Subject to audit, the directors recommend a dividend for the year to Dec. 31, 1904, on the ordinary shares of 15 per cent. (less tax), including interim dividend of 5 per cent. paid Sept. 1.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., Feb. 22.	Rate per cent. yielded.	Dividend Due.	Business, week to Feb. 22 High est.	Low est.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
1	2/0	Anglo-Argentine Ord. shares	8¼—8½	5 10 7	Ap, Oc	8⅜	8¼
1	2/6	Do. 6% Cum. Pref.	1⅛—1¼	4 5 1	—	6⅛	[illegible]
St.	6%	Do. Permanent 6% Deb. Stock	140 —145	4 3 11	—	..	..
St.	6%	Auckland Elec. Trams 5% Deb. (red.)	104 —106	4 15 8	—	06	[illegible]
10	6%	Barcelona Tramways Ord.	11½—12½	2 9 0	—	12½	12
10	6/0	Do. 6% Cum. Pref.	9½—10	6 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	96 —100	4 10 0	—	..	..
100	5%	Do. 5 per Cent. Debs.	99 —102	4 18 1	—	..	..
1	..	Brisbane Electric Trams. Invest. Ord.	1¼—1¾	..	..	..	..
5	5/6	Do. 6 per Cent. Cum. Pref.	4¼—4¾	5 17 8	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	94 —96	4 11 10	..	96	..
St.	6%	British Columbia Elec. Rlwy Def. Ord.	102 —106	5 14 4	—	104½	103½
St.	5%	Do. Pref. Ord. Stock	100 —103	4 17 2	—	102	101½
10	5/0	Do. 5% Cum. Perp. Pref.	10 —10½	4 10 11	—	10½	..
6	4½%	Do. 4½ per Cent. 1st Mort. Dbs	[illegible]	4 5 9	..	[illegible]	[illegible]
100	4½%	Do. Vancouver Power Debs.	97 —102	4 8 3	..	..	..
5	1/6	Buenos Ayres and Belgrano Ord.	3¾—4	5 12 6	—	4	3⅞
5	5/0	Do. 5 per Cent. "A" Cm. Pref	4¾—5¼	5 2 2	—	..	..
5	2/0	Do. "B"	5¾—5⅞	5 9 1	—	5⅝	5⅝
St.	5%	Do. 5 per Cent. Debs.	107 —109	4 11 8	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	102 —105	4 15 3	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	94 —97	5 3 1	..	..	..
1	3/0	Calcutta Tramways	1⅝—1¾	3 13 8	—	1⅝	1¾
100	4½%	Do. 4½% 1st Deb. Stock (red.)	100 —103	4 8 4	—	100½	..
1	0/6	Cape Electric Tram Shares	1⅛—1⅜	2 14 0	..	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt Deb. (red.)	102 —104	4 16 1	..	102½	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	101 —103	4 17 3	Ja, Jul	..	..
100	5%	Montreal St. Ry. St'g 5% Mort. Debs. (1908)	102 —105	4 15 3	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 —105	4 5 9	..	..	..
St.	5%	Perth (W.A.) Elec. Trams 1st Mt. Deb. Stk.	103 —105	4 15 3	..	..	..
		ELECTRICITY SUPPLY.					
5	3/0	Calcutta Electric Supply Ord.	9 —9½	3 10 3	—	9½	9¼
St.	5%	Elec. Ltg. & Trac. Co. of Aust. 5% Debs.	86 —91	5 9 11	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	—	—	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	⅞—1⅛	..	—	1	..
1	..	Rand Electric	1 —1⅛	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	100 —102	4 8 9	Ap, Oc	101	00

* In calculating the yield, allowance has been made for accrued interest but not for redemption.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Feb. 22.	Rate per Cent. Yield. £ s. d.	Dividend Due.	Business Week to Feb. 22. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
1	..	Bath Elec. Trams Pref. Ord.	⅞–1⅛	..	..	..	..
1	1½d.	Do. 5% Cum. Pref.	1¼–1⅜	4 16 1	—	..	..
St.	..	Do. 4½ 1st Mort. Deb. Stock (red.)	100 –102	..	..	101	100
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	96 – 98	..	..	98	97½
10	8%	Bristol Tramways and Carriage Ord.	19 –20	4 0 0	Feb, Aug	..	..
10	6%	Do. Cum. Pref. (fully paid)	10 –10½	5 16 2	—	..	..
St.	4%	Do. 4 per Cent. Debs.	106 –108	3 14 0	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	9½–9¾	6 2 11	..	9⅝	9½
10	6/0	† Do. 6 per Cent. Cum. Pref.	10⅝–11⅛	5 7 10	Feb, Aug	11⅛	11
St.	6/0	Do. 5 per Cent. Perpetual Debs	120 –122	4 2 0	—	121½	121
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	97 –99	4 10 11	—	98½	97½
St.	4%	†Central London Ordinary Stock	98 –99	4 5 1	June, Dec	99½	98½
St.	4%	† Do. 4 per Cent. Pref. Stock	101 –103	3 17 8	—	101½	100½
St.	4%	† Do. Deferred Stock	81 –83	3 16 5	—	82	..
100	4%	Do. 4 per Cent. Debs.	110 –112	3 11 5	—	111	..
5	2/6	City of Birmingham Trams 5% Cm. Prf.	4¾–5¼	4 17 6	..	5⅛	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	101 –104	3 17 5	..	..	..
St.	1½%	†City and South London Rly. Con. Ord.	40½–41½	4 18 11	Feb, Aug	41½	40½
St.	5%	† Do. 5 per Cent. Perp. Pref. (1891)	120 –123	4 1 4	Feb, Aug	121½	..
St.	5%	† Do. (1896)	118 –121	4 2 8	..	..	..
St.	5%	† Do. (1901)	115 –118	4 4 9	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	107 –109	3 13 5	May, Nov	108½	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13 –14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15½–16½	3 12 9	—	..	..
10	4 0	†Gt. Northern & City Rly. Prf. Ord. (4%)	6 –6½	3 12 0	—	6¼	6⅛
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8½–9½	..	..	..	..
10	10%	‡ Imperial Tramways Ord	19 –20	5 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	15 –15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	111½–112½	4 0 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½–4¼	5 13 4	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 –92	4 7 0	—	90½	89½
10	1½%	Liverpool Overhead Railway Ord	3½–3¾	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 –10½	4 16 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10 –10½	4 15 3	..	10⅜	10¼
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 –105	3 16 2	..	104	..
St.	..	Mersey Con. Ord. Stock	4 –7	..	..	..	..
St.	—	Do. 3 per Cent. Perp. Pref.	10 –13	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅝–¾	..	—	..	..
1	0/6	† Do. 5% Cum. Pref.	⅞–1⅛	5 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock	104 –106	4 5 0	—	104½	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½–1½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	8½–9	5 11 2	..	..	..
10	5 0	† Do. 5 per Cent. Cum. Pref.	9¼–9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 –102	4 7 5	—	..	..
1	—	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	—	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London	98 –99	5 2 0	..	98½	98¼
St.	3⅛%	†Waterloo and City Ord.	92 –94	3 6 5	June, Dec	—	—
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 –102	4 0 0	Jan, July	..	..
10	..	Amazon Telegraph	1½–2½	..	Jn, Dec ..	2	1¾
St.	17/6	†Anglo-American	59 –61	4 10 1	F,My,Ag,N	..	..
St.	35/0	† Do. Preferred	106 –108	5 1 10	F,My,Ag,N	106½	106¼
St.	2/0	Do. Deferred	13½–14½	..	F,My,Ag,N	14⅛	13⅞
100	$2	Commercial Cable Capital Stock	170 –190	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	96 –98	4 1 8	Jn,Ap,Jy,O	98	97
10	5/0	Cuba Submarine Ord.	8½–9½	5 5 0	Feb, Aug	8¾	..
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 1	Feb, Aug	17½	17
5	2/0	Direct Spanish Ord.	2¾–3¼	6 11 9	April, Oct	2⅞	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8 –8½	6 1 3	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	100%–102%	4 10 0	Jan, July	..	..
20	8/0	Direct United States Cable	10½–11½	4 12 2	Ja,Ap,Jy,O	11⅛	11⅛
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 –102	4 7 7	Jn, Dec ..	..	..
St.	26/0	Eastern Ordinary	140 –142	4 17 9	Ja,Ap,Jy,O	142	136½
St.	17/6	Do. 3½ per Cent. Pref. Stock	88 –90	3 17 9	Ja,Ap,Jy,O	89½	88½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 6	May, Nov	107½	106
10	2/6	Eastern Extension	11¾–12¼	4 15 10	Ja,Ap,Jy,O	12⅛	12
St.	4%	Do. 4 per Cent. Deb. Stock	104 –106	3 15 7	Feb, Aug	105½	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1900	100 –102	3 18 6	Feb, Aug	100½	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%–103%	3 17 8	May, Nov	..	..
10	6/0	Great Northern (of Copenhagen)	30½–31½	4 18 6	Jan, July	31¼	30
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100 –102	4 8 3	June, Dec	..	..
25	12/6	Indo-European	46 –48	5 4 2	May, Nov	47½	47½
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	98 –101	3 19 2	June, Dec	..	—
10	4/0	West African Telegraph Shares	7½–7¾	6 9 2	..	..	..
7½	..	West Coast of America	⅝–⅞	..	—	..	..
100	4%	Do. 4 per Cent. Debs.	99 –101	3 19 2	Jan, July	..	..
20	—	West India and Panama	1⅛–1⅝	..	May, Nov	1	..
10	7/0	Do. 6% 1st Pref. ex 7 on act. of arrears	8½–9	7 4 6	May, Nov	9	8¾
10	—	Do. 6 per Cent. 2nd Pref.	8½–9	..	May, Nov	8¾	8
100	5%	* Do. 5 per Cent. Debs.	102 –104	4 16 3	Jan, July	104	..
10	8/0	Western Telegraph	12½–14	6 0 0	Mr,Jn,O,D	12¾	12½
100	5%	* Do. 5% Debs. (2nd Series, 1900)	101 –103	4 17 1	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	102 –104	3 16 11	—	102½	..
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	6¼–6¾	5 5 7	August ..	6½	..
1	0/7½	Monte Video Telephone Ord.	⅞–1⅛	2 11 9	—	..	..
St.	6%	National Co. Pref. Stock	110½–111½	5 7 7	—	111	109½
St.	6%	Do. Def. Stock	105 –107	4 13 5	..	111	106½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 –14	4 8 9	Feb, Aug	13⅝	13½
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12 –13	4 12 4	Feb, Aug	12⅝	12½
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½ –5¾	4 10 11	Feb, Aug	5⅝	5½
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 –100	3 11 5	June, Dec	98½	98¼
St.	4%	Do 4 per Cent. Deb. Stock (red.)	103 –105	3 16 2	..	104½	103¾
..	24/0	Do. Do. Prov. Certs. all paid	103 –105	3 16 2	..	103½	..
1	0/7½	Oriental	1⅛–1¼	5 7 3	April, Oct	..	—
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛–1¼	4 11 5	..	..	..
St.	20/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101 –104	..	..	102½	102¼
5	2/6	United River Plate	7½–7¾	5 8 3	July	7⅝	7½
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 17 9	June, Dec	..	..
St.	6%	* Do. 5 per Cent. Deb. Stock (red.)	106 –108	4 12 6	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	2/0	Elec. & Gen. Investment 5% Cum. Pref.	4¼–4¾	5 17 1	—	..	..
10	2/6	Globe Telegraph and Trust	10½–11½	5 2 4	Ja,Ap,Jy,O	10½	10¼
10	3/0	Do. 6 per Cent. Pref.	13½–14½	4 4 11	Ja,Ap,Jy,O	14½	13½
100	6%	Submarine Cables Trust (Cert.)	113 –116	4 15 3	April, Oct	..	..

Share.	Last Dividend	Name.	Price Wed., Feb. 22.	Rate per Cent. Yield. £ s. d.	Dividend Due	Business Week to Feb. 22. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½–12¾	6 5 6	..	12½	..
10	4/6	† Do. 4½ per Cent. Cum. Pref	9½–10	4 10 0	..	9¾	..
10	6/0	† Do. 6% Cum. Second Pref.	11 –12	5 0 0	—	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104 –106	4 4 10	—	105	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5¼–5¾	3 9 7	—	..	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 0	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½–11	4 10 11	—	..	..
5	3/6	Do. 7 per Cent. Pref.	10½–10¾	3 5 1	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105 –108	3 14 1	—	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8 –8½	4 14 3	Feb, Aug	8⅛	..
5	2/3	† Do. 4½ per Cent. Pref.	5½–5¾	3 17 0	Feb, Aug	5⅝	..
St.	4%	Do. 4% Deb. Stock (red.)	102 –104	3 16 11	..	103½	103
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾–5⅛	4 4 9	—	5	..
5	2/3	Do. Do. (1903)	4¾–5⅛	4 4 9	..	5⅛	..
5	2/3	Chelsea Electric Supply Ord.	6¾–7¼	4 0 3	March ..	7	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108 –110	4 1 10	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	15½–16	3 16 11	Feb, Aug	15⅞	15¾
10	6/0	Do. 6 per Cent. Cum. Pref.	13½–14	4 5 9	Jan, July	13⅞	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	125 –127	3 18 8	Jn, Dec ..	126	..
St.	4½%	Do 4½% 2nd Deb. Stock (red.)	103 –105	4 5 9	..	104½	103½
10	4/0	County of London Elec. Supply Ord.	9½–9¾	4 2 1	..	9⅝	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 –12½	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	108 –111	4 1 1	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	102 –104	4 6 7	..	103½	103
5	2/0	Folkestone Electricity Supply Co. Ord.	5½–6	4 11 9	—	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 –104	4 6 7	—	..	—
5	3/6	Hove Electric Lighting Ord.	7½–8	5 5 3	—	—	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	100 –102	4 8 9	..	..	..
5	[illegible]	Kensington & Knightsbridge Ord	13 –13½	4 8 11	..	..	..
5	6%	Do. 6 per Cent. 1st Pref	6¾–7	4 5 9	Jan, July	—	—
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 –104	3 17 3	—	..	..
5	..	London Electric Supply Ord.	2¼–2¾	..	—	2½	2⅜
5	3/0	Do. 6 per Cent. Pref.	6 –6¼	4 18 0	..	5⅞	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	98 –100	4 0 0	Mr,Jn,S,D	98½	..
10	9/0	Metropolitan Electric Sup. Ord.	18½–18¾	4 18 3	April, Oct	19	18½
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼–5¾	3 18 3	Jan, July	5⅝	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 –115	3 18 3	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 –98	3 11 3	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	97 –100	4 10 0	..	98½	97½
10	5%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	13 –13½	3 3 5	Feb, Aug	..	..
5	8%	Newcastle Elec. Supply Ord.	8¼–8¾	4 13 2	Feb, Aug	..	..
5	6%	Do. 5 per Cent. Non. Cum. Pref.	6¼–6¾	3 17 10	Feb, Aug	..	..
1	3%	Northern Counties Elec. Sup. 17/- paid	15/6–16/9	3 6 0	Mar, Sep	..	..
10	6/0	Notting Hill Electric Ord.	14½–15½	4 0 0	March....	15	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	102 –104	3 17 0	..	102½	..
5	2/6	Oxford Electric Ord.	6¼–6¾	5 0 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 –100	4 0 0	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	13½–14½	5 0 0	Feb, Aug	14⅛	..
5	7/6	Do. 7 per Cent. Pref.	8¾–9	3 17 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98 –100	3 10 0	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¾–3¼	6 3 1	—	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	79 –82	4 16 5	..	80	79½
5	3/0	South London Electric Supply Ord.	4¼–4¾	3 3 7	—	4½	..
1	..	South Metrop'n Elec. Lt. & Power Ord.	¾–1	..	—	..	..
1	0/8½	Do. 7% Cum. Pref.	1¼–1⅜	4 15 4	—	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. Accum.)	107 –110	4 2 3	—	..	..
5	2/6	Urban Electric Supply Ord.	5 –5½	4 17 6	—	5¼	..
5	2/6	Do. 5% Cum. Pref.	5¼–5½	4 16 3	..	5⅜	..
St.	..	Do. 4½% 1st Mort. Deb.	105 –107	—	..	106½	..
5	6/6	Westminster Electric Supply Ord.	12½–12¾	5 1 9	Mar, Sept	12⅝	12½
5	2/6	Do. 5 per Cent. Cum. Pref.	6¼–6¾	3 16 6	—	6⅜	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	¾–⅞	5 6 6	..	..	..
1	6d.	Aron Elec. Meter 6% Cum. Pref.	⅞–1⅛	..	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5¾–6¼	6 3 8	July, Feb	6	..
5	3/0	Do. 6 per Cent. Pref.	5¾–6¼	5 4 4	Jan, July	6⅛	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 –104	4 6 6	..	101	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 –103	4 10 6	—	..	..
5	3/0	British Westinghouse 6% Pref.	5½–5¾	..	—	5⅝	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	87 –89	4 9 11	..	..	..
2	..	Brush Electrical Engineering	½–¾	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¾–1⅞	6 17 2	Mar, Sept	1¾	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	95 –97	4 12 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	79 –82	5 9 9	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	10½–11	5 13 5	Jan, July	10⅝	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½–5¾	4 9 10	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	105 –107	4 4 0	Nov, May	..	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1⅞–2	4 9 5	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	94 –96	4 13 9	..	..	..
1	0/1½	Chadburn's (Ship) Telegraph Ord.	¾–1⅛	3 17 6	..	..	..
2	1/6	Crompton and Co. (Nos. 1 to 54,000)	2¼–2½	3 3 4	Jan, July	2⅜	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	93 –95	5 2 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	7¾–8¼	6 1 3	Sept	8¼	..
5	3/0	Do. 6% Cum. Pref.	6¼–6½	4 13 0	Sept	6⅜	..
St.	4½%	Do. 4½% Deb. Stock	105–107	4 4 0	..	106½	..
5	—	Edison & Swan United ("A" Sh.) (£3 pd.)	½–⅞	..	Feb, Aug	—	..
5	..	Do. (£5 paid)	1 –1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 –82	4 17 3	June, Dec	80	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79 –84	6 0 0	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	6½–6¾	6 12 0	H'lf-yearly	6⅝	..
5	3/0	Do. 6 per Cent. Cum. Pref.	6 –6¼	4 16 0	..	6⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106 –108	4 3 3	..	..	..
2	1/7½	Electric Construction Co.	1¼–1½	6 8 0	July	..	..
2	2/0½	Do. 7 per Cent. Cum. Pref.	2¼–2½	5 12 3	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 –99	4 0 10	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	—	..	—
10	5/0	General Electric (1900) 5% Cum. Pref.	9½–10	5 0 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91 –96	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	12½–13	6 7 3	Feb, Aug	12¾	..
5	2/3	Do. 4½ per Cent. Pref.	5½–5¾	4 3 11	Feb, Aug	5⅝	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	111 –113	3 19 7	Feb, Aug	112	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	17½–18½	5 17 8	Feb, Aug	18⅛	18
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 –103	3 17 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11 –11½	4 7 0	Mar, Sept	..	..
12	17/6	Telegraph Construction & Mainten'ce.	36 –37	6 7 3	Mar, July	36	35½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	102 –104	3 16 11	Jan, July	..	..
5	—	Willans and Robinson Ord.	1½–1¾	—	Apr, Oct	1⅝	1½
5	—	Do. 6 per Cent. Cum. Pref.	3 –4	—	Apr, Oct	3½	..
..	4%	Do. 4 per Cent. 1st Mort. Debs.	77 –82	4 17 7	May Nov	81	80

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

Two or three single-phase traction systems have been built and experimented with in the United States during the last couple of years, but it is claimed that the "electrified" portion of the Indianapolis–Cincinnati Railway, a description of which appears in this issue, is the first American single-phase railway to work under commercial conditions. In point of fact this traction system can hardly be compared with the heavy suburban lines in this country; it corresponds rather to those of our light railways, which are not tramways pure and simple. Although the greater part of the line is built on its own way, a considerable length passes over public roads like a tramway, and the fares are collected on the car; but, on the other hand, it is stated that the speeds to be achieved approximate those of express trains on steam-operated lines. It may reasonably be doubted, however, whether the proposed high speeds of 50 or 60 miles an hour can be safely maintained on a track using 70lb.-rails only.

It is interesting to note that three-phase current is generated at the power house at 2,300 volts, and is then transformed by stationary transformers to two-phase current at 33,000 volts, at which pressure current is conveyed to the sub-stations, where the voltage is reduced to a pressure of 3,300 volts for the trolley wire. The two phases are kept entirely distinct, and the quantity of copper in the high-tension transmission line is fairly high for this reason, while on the other hand something is saved in the cost of the three-phase generators as compared with single-phase or two-phase machines. In the special circumstances the combination of a three-phase generator, transformers arranged on the Scott system, two-phase four-wire transmission, and single-phase transformers at the sub-stations, may be the most economical. In the majority of cases, however, it seems probable that a simple single-phase system throughout will generally be preferred in spite of the extra cost of the plant and mains. The catenary suspension adopted for the overhead equipment, it will be noticed, differs in detail to some extent from the now familiar Continental design, especially in connection with the manner of supporting the steel cable.

◆

THE special conditions of the Waterloo and City Railway are rather favourable for obtaining quantitative information as to the amount of power required on tube lines. The absence of intermediate stations, and consequent regularity of the service, the fact that all passengers are carried the same distance, and the small distribution losses simplify the consideration of the figures abstracted from the log sheets which give, almost without qualification, pure engineering results, though it is true that the somewhat sharp curves have to be allowed for. Therefore Mr. HERBERT JONES's Paper (concluded in this issue) on the working results of this railway possesses a special value as forming a kind of standard which will supplement Mr. MACMAHON's classic Papers, without in any way displacing them.

◆

THE traffic conditions are not favourable to high economy, especially as regards the power supply, and in the circumstances the costs of 0·919d. per unit generated are creditable. The traffic conditions, which are most graphically expressed by the curves, have been well met by the use of four-car and single-car trains during the heavy and light load-hours respectively, with the result that the train-load factor is kept up to a very satisfactory level, and the working expenses are less than 48 per cent. of the receipts. These are excellent results, comparing very favourably with other lines, although, as pointed out above, comparisons are difficult. It will be noticed that Mr. JONES has been compelled to adopt the unit of "train-ton-mile" instead of the orthodox "train-mile," and has also used the passenger-mile unit. That 2¼ train-ton-miles are run for every passenger mile is a striking fact. Mr. JONES' experiences with rigid bonds, direct motor control, and some other points are suggestive and useful, but open up debateable matter. The illustrations to the Paper in the form of curves are not its least valuable part.

THE *Daily Mail* of the 25th ult. published a letter from Mr. W. G. TOWLER, of the London Municipal Society, apropos of the article published in *The Electrician* of February 17th on "Tramways *v.* Motor 'Buses." He questions the costs per car-mile for tramway working, bringing in support the London County Council estimates, which show working costs of 8·11d. and 8d. per car-mile for the years 1902-3 and 1903-4 respectively. These figures are of no value as indicating the working costs when the London County Council lines attain a steady state and are driven from their own station. The transition stage through which the lines have been passing for the last three years is not yet over, and the working costs whilst it endures must be abnormally high. The purchase of power from three different sources, and the temporary distribution arrangements thereby entailed, make the expenditure on this item very high. Without official information, we can only surmise that it is in excess of 1·5d. per car-mile, whilst the supply from the Council's own station will probably cost one third of that amount, judging from the experience of Glasgow and the few other towns where the tramway system approximates in magnitude to that of the London County Council. It will not surprise us if the working expenses of the conduit lines exceed the 6d. per car-mile derived from experience with overhead lines; but on the other hand there is every probability that the traffic receipts per car-mile and per route-mile will be so much in excess of any existing British examples, that the comparison between the commercial results of the motor omnibus and the tramway car in London will be still more favourable to the latter than that deduced from present experience.

A NOTICE of the perfected Murray printing telegraph appears in to-day's issue. The improvements as described by the inventor would appear to have made of this system a practical and useful addition to the various systems of modern telegraphy. It will possibly take a large place in replacing present methods of fast Wheatstone automatic work. It hardly, however, appears as yet capable of doing so where the extreme limit of speed of which the Wheatstone system is capable, is taken advantage of; or, at any rate, where this utmost limit is necessary.

THE Murray system enables the telegraph message to be presented to the public in page form with no necessity for skilled manipulation other than that of preparing the transmitting slip with the aid of a keyboard analagous to that of a typewriter. This feature, however, is not novel, but the particular means which enables the system to do its work at a comparatively high rate of speed and with safety is distinctly new. The message is not printed direct, but is produced in perforations on a "slip" at the receiving end; and herein lies the significant feature of the invention, because the perforating devices respond much more rapidly to received impulses from the line than printing devices, and therefore the line gets cleared quickly, while, if necessary, more than one printing apparatus may be employed to translate the received "slip." It is not unreasonable to hope that this feature is capable of still further development in the way of rapidity, and that a degree of speed commensurate with fast Wheatstone working may yet be attained.

THE chief item of interest in the course of the discussion on Mr. ADDENBROOKE'S Paper, at the Institution of Electrical Engineers last week, was the ruling by the chairman that it was not in order for members taking part in the discussion to read their remarks. We believe that it is the first time that Mr. W. H. PATCHELL, who is one of the junior vice-presidents, has taken the chair at a meeting of the Institution, but his firm action in this matter is to be commended, and may well be imitated by future chairmen. Although there is actually nothing in the rules of the Institution that definitely forbids members from reading the remarks they contribute to discussions, the president for the evening has a right to exercise his discretion as to the manner in which debates are conducted. Those members who have something to contribute, but are too nervous, as speakers, to do so in the ordinary course, should either send in their remarks in writing to the secretary, or, if what they have to say is important enough for immediate publication, they will find that we are frequently willing to extend to them the hospitality of our columns.

THERE is great activity in the development of the incandescent lamp just now. We recently gave an account of the Siemens & Halske metallic wire lamp, and we now have further particulars as to Welsbach's osmium incandescent. Such materials as osmium and tantalum are so unpromising from a manufacturing point of view that we are agreeably astounded to find anyone has patience to use them successfully.

As regards osmium, the first thing is to catch your osmium; the next is to make it into fine wire. It is brittle and not ductile, so it has to be got into wire by special methods; and these do not lend themselves to the manufacture of wires thin enough to make high pressure lamps. Lamps have now been made up to 110 volts, however. It was very difficult 20 years ago to make good 110-volt, 16-candle, carbon incandescent lamps; now they are made for 200 volts and 3 candles; so it is quite likely metal wire lamps will eventually be made for 200 volts and small powers. The softness of the hot osmium wire is a serious drawback all the same.

THERE are many statements in Herr BLAU'S Paper that are not easily accepted. The idea that a small black carbon filament must be hotter because it gives the same light as a larger bright surface has been frequently questioned. The other side of the question is that the carbon is a better emitter, and at a given temperature gives out more radiation of all wav lengths than a bright surface, the proportion of each kind of ray being the same. As far as we know there is no proof that at the same temperature a "black" body gives a smaller percentage of rays of high frequency. At any rate this is at present a matter of doubt, and Herr BLAU enunciates his views as if they were admitted facts.

THE statement, made by Prof. WEDDING in the discussion, that the blackening of a lamp bulb does not stop the light will not appeal to the consumer, even though it may be supported by some experimental data obtained in the laboratory. The man who has the temerity to doubt the professional verdict will ask: What is the "blackness" of a bulb but its power of stopping transmitted light? Surely a blackened lamp looks black when held up between you and the window because the blackness stops the light? Perhaps some of our British professors can throw more light on this question, and also on the temperature question already mentioned, which has lain dormant for some time.

THE judgment in the enclosed arc lamp patent case, which we publish in another column of this issue, will be read with interest by the makers of enclosed arc lamps, for it upholds the validity of the master patent owned by the Jandus Company. As it is almost a foregone conclusion that there will be an appeal from the decision of Mr. Justice KEKEWICH, we will make no comment on the case at the present juncture, but we will call attention, in passing, to the Judge's significant remarks with regard to the reading of amended patents and on experiments made in connection with patent actions.

Manchester Students' Section of the Institution.—The annual dinner of the Manchester Students' Section of the Institution of Electrical Engineers will be held at the Grand Hotel, Aytoun-street, on Saturday, March 18th, at 6:30 p.m.

Lighthouse Communication.—Up to the end of March, 1904, a sum of £3,874 was spent out of the General Lighthouse Fund for the purpose of establishing electrical communication with lighthouses and light vessels. A Parliamentary Paper has just been issued dealing with this matter.

New Atlantic Cable.—The *London Gazette* for February 24th contains a notice to the effect that the Commercial Cable Co. have applied to the Board of Trade for a licence to land and maintain at Waterville, co. Kerry, a cable to be laid from Canso, Nova Scotia. Objections must be lodged before March 22.

Trials on the Inner Circle.—The Metropolitan Railway Co. have been making trials over the portion of the Inner Circle owned by them, and which they have converted for working by electric traction. This portion is from Notting Hill Gate to Aldgate, via King's Cross, and a train of six coaches was successfully run over this section on Tuesday.

Lancashire and Yorkshire Railway.—The interruption of traffic which occurred on the Liverpool and Southport Railway last week was not due to any defect in the electrical plant. One of the corridor coaches of a steam-driven train left the metals and blocked the line for several hours, necessitating a discontinuance of the electric service as well as the steam service.

Royal Society.—Among the Papers down for reading yesterday were the following: "On the Radio-active Minerals," by the Hon R. J. Strutt, communicated by Lord Rayleigh, F.R.S.; "Atmospheric Electricity in High Latitudes," by G. C. Simpson, communicated by Prof. A. Schuster, F.R.S.; "On the Electric Resistance to the Motion of a Charged Sphere in Free Space or in a Field of Force," by G. W. Walker, communicated by Prof. A. E. H. Love, F.R.S.

Cable Interruptions and Repairs.

	Date of Interruption.		Date of Repair.
Cayenne—Pinheiros	**Aug. 13, 1902**	..	—
Belesi-Issa (Yemen)—Camaran	**Oct. 22, 1903**	..	—
Tarifa—Tangier	**Jan. 18, 1904**	..	—
Cayenne—Paramaribo	**July 13, 1904**	..	—
Marmaritza-Rhodes	Jan. 30, 1905	..	Mar. 1, 1905
Jamaica—Colon	Jan. 10, 1905	..	—
Martinique—Paramaribo	Feb. 14, 1905	..	Feb. 24, 1905
Gibraltar—Tangier..........	Feb. 20, 1905	..	—
Oran—Tangiers	Feb. 24, 1905	..	
England—Channel Islands ..	Feb. 28, 1905	..	—

Institution of Electrical Engineers.—The following is the provisional programme of the session to the end of April, as announced at the meeting on Feb. 23rd:—March 9th, Dr. R. T. Glazebrook's report to the Engineering Standards Committee on "Temperature Curves on Field Coils of Electric Machines"; Mr. R. Goldschmidt's Paper on "Temperature Curves and the Rating of Machinery"; March 23rd, discussion on the above Papers; April 6th, Mr. W. Duddell's report on "The International Electrical Congress at St. Louis," and discussion on Electromagnetic Units and Standards"; April 13, Mr. F. Creedy's Paper on "The Alternating-current Series Motor," and discussion; April 27th, Mr. H. Laws Webb's Paper on "Telephone Traffic"; Mr. A. R. Bennett's Paper on "A New Telephone Switch System," and discussion of both Papers.

Electrical Equipment of the New U.S Battleships.—The electrical generating equipment of the United States battleships "Mississippi" and "Idaho," now building, will consist of eight 100-kw. 125-volt units, disposed in two separate and independent dynamo rooms. The two 12in. gun turrets and four 8in. gun turrets will be operated electrically by the Ward-Leonard system, and the ammunition hoists for the turret and smaller guns will also be operated electrically. Electrically-operated conveyors will be installed to transfer ammunition from handling rooms to hoists. All blowers, excepting those for forced draft, will be operated by electric motors, and there will be 23 blowers for compartment ventilation. All boat cranes and deck hoists will be run by electric motors. A very complete system of telephones, call bells, buzzers, gongs, annunciators, engine and steering telegraphs, revolution and rudder indicators will be installed.

Central Technical College Old Students' Association.—The seventh annual dinner of the Central Technical College Old Students' Association was held at the Trocadero Restaurant, Piccadilly, on Wednesday last week. About 60 Old Centralians were present, the guests including Sir William Crookes, F.R.S., and Dr. Hartog, the Academic Registrar of London University. The chairman, Prof. W. E. Ayrton, F.R.S., in proposing the toast of "The Association," laid special emphasis on the need of former students keeping in touch with the College, and drew attention to the importance of organising an employment agency in connection with the Association. Mr. J. W. Donaldson gave expression to the opinions formed by him as the result of three years practical experience in works in America and Canada comparing American and English methods; the same theme was dealt with by subsequent speakers. The Association now numbers 450 members; it is hoped to bring this up to 500 during the year. The honorary secretary is Dr. E. F. Armstrong, 55, Granville-park, Lewisham, London, S.E.

Engineering Standards Committee.—A report has just been issued by the Engineering Standards Committee on the experimental work which has been carried out for that committee at the National Physical Laboratory on the temperature rise in the field coils of electrical machinery. The work has been carried out by Mr. E. H. Rayner under Dr. Glazebrook's direction, and is the first step in the completion of a research, the results of which cannot fail to be of lasting importance to manufacturers of electrical plant. The report above referred to is to form the basis of a Paper to be read before the Institution of Electrical Engineers, one of the supporting bodies of the Engineering Standards Committee. A preface to the report has been written by Sir William Preece, K.C.B., Chairman of the Electrical Plant Committee of the Engineering Standards Committee, and gives some interesting particulars of the circumstances which led to the carrying out of this valuable work. The report may be obtained at the offices of the Committee, 28, Victoria-street, Westminster, or by applying to the publishers, Messrs. Crosby Lockwood & Son, 7, Stationers' Hall-court, E.C.

Municipal Tramway Undertakings.—A second conference of representatives of municipal tramways was held at the Westminster Palace Hotel on Tuesday to consider the clauses in several bills promoted in Parliament this session by railway companies asking for powers to run motor omnibuses. It will be remembered that at the previous conference (see *The Electrician*, February 17th, p. 695) it was suggested that the running of these omnibuses by the railway companies should be limited to carrying passengers to and from the stations of the companies only. This attitude was maintained at the conference on Tuesday. Another question considered was the erection of guard wires over trolley wires for protection against falling telegraph and telephone wires. The conference protested against the present state of the law, which is that if a tramway promoter has already erected his wires, and the Postmaster-General subsequently desires to erect a telegraph wire over the trolley wire, the tramway promoter is called upon by the Board of Trade to erect guard wires at his own expense. It was decided to ask the Board of Trade to receive a deputation on this matter.

Obituary.—We have to announce the death of Lord Morley, Chairman of Committees of the House of Lords. To many of our readers, Lord Morley's connection with the electrical industry will, no doubt, be difficult to trace, but those with knowledge of Parliamentary procedure will be in no such difficulty. As Lord Chairman of Committees it was his duty to scrutinise every private bill promoted in Parliament, and it will at once be seen that his familiarity with the industry was by no means unreal. There have been numerous instances during his long tenure of the office of the painstaking and conscientious manner in which he has carried out this task, for many an unprecedented proposal in both opposed and unopposed bills has been vetoed by him as being against the public interest. During last session, owing to Lord Morley's unfortunate illness, Lord Balfour of Burleigh took over the duties of Lord Chairman temporarily, and our Parliamentary columns testified to a continuance of Lord Morley's policy with such beneficial results that it can only be hoped that Lord Morley's permanent successor, Lord Onslow, will also adopt his methods.

We regret to record the death on the 1st instant, at his residence, Edenthorpe, Meads, Eastbourne, of Mr. Dodwell Kingsford, for many years assistant secretary of the Telegraph Construction and Maintenance Co. Mr. Kingsford retired about 18 months ago, and had settled down at Eastbourne. He was a great linguist and book lover, and in these accomplishments found congenial occupation. He was well known and highly esteemed by a large circle of friends in the telegraph world.

Electric Driving in Cotton Mills.—What is claimed to be the first spinning mill in England built from the outset to be driven electrically is being erected by the Acme Spinning Co. of Pendlebury, near Manchester. It will contain 41,000 mules and 34,000 ring spindles, as well as the usual preparation machinery. It will consist of six storeys and is to be equipped throughout with the most up-to-date appliances known. Supply is to be given by the Lancashire Electric Power Co. Three-phase current at 10,000 volts will be taken into a special fireproof transformer chamber, and the supply to the motors will be at 400 volts three-phase, while four-wire three-phase distribution at 230 volts will be used for lighting. As turbines are used for driving the dynamos at the power company's generating station, a very perfect drive should be obtained on the spindles, which, of course, is a matter of vast importance in the spinning industry, for not only is increased production thus obtained, but the product itself is also improved in quality. Exactly how much improvement there will be as a consequence is one of the most important questions of the whole subject, the steam engine makers insisting that with their most modern plant no cyclic irregularity occurs. As, however, this new mill is being built side by side with a steam-driven mill of the same proportions and under the same management, a very useful comparison will be instituted.

A New Dynamo Brush.—The *Elektrotechnische Zeitschrift* of February 16th contains the description of a bronze-carbon brush which is said to act as well as a pure carbon brush and at the same time materially reduces the C^2R losses in and under the brushes. These brushes are made of graphite powder, the graphite particles being individually coated first with copper and then with zinc by a "secret" process. The graphite thus treated is then hydraulically pressed into the required shape, and any hardness may be obtained by applying the proper pressure. Then the brushes are heated to such a degree that the copper unites with the zinc and forms a bronze. It is stated that, since the final product contains some 20 per cent. of graphite, the brushes are self-lubricating. Comparative tests on a 110-volt dynamo, it is claimed, have shown that for a current density of 5 amperes per square cm., and at commutator speeds of 12ft., 24ft., 36ft. and 48ft. per second, the C^2R losses were 0·5, 0·7, 0·9 and 1·5 watts per square cm., the corresponding figures for good carbon brushes being 5·2, 6·1, 7·6 and 10·0. For a current density of 10 amperes per square cm., and at the same speeds, the losses were 1·6, 2, 2·6 and 3·6 watts per square cm., as compared with 10, 13·3, 20·2 and 32, which the makers (the Svenska Dynamoborstfabrik of Stockholm) state would be the corresponding losses with ordinary carbon brushes.

The Submarine Disaster.—The Admiralty inquiry into cause of the explosions in Submarine A5 in Cork Harbour on February 16th was resumed on February 23rd. After evidence had been given the officer presiding stated his findings. He came to the conclusion that the pressure produced by the explosion was only a few pounds per foot, and that the explosion itself had been due to the presence of petrol vapour in the air, the petrol having leaked from a badly-packed gland in one of the filling pumps. The sparking of the motor brushes supplied the necessary ignition to the mixture and the explosion occurred. He had examined the starting controller and found that the act of starting the main motor was one that could not be done accidentally. Three operations were necessary: (1) Switching on the fields, (2) removing the locking button pressing down the handle, (3) revolving a wheel, for which both hands were required. The motors were started with a view to revolving the engine, and such an action was in flagrant violation of the regulations laid down. After the first explosion petrol continued to leak from the pump gland, and burning canvas, ignited by the first explosion, provided ignition for the second. Finally, he expressed appreciation of the action of the officers and men of H.M.S. "Hazard" who went to the rescue and boarded A5, which was on fire, while there were 7 tons of petrol in her tanks.

Another Fire at a London Telephone Exchange.—At about two o'clock on Tuesday morning another disastrous fire broke out at one of the National Telephone Co.'s London exchanges. The work which is being carried out on the Inner Circle Railway has necessitated some alteration in the telephone cables laid in these tunnels. The cables are being removed from their old positions and placed in metal casings similar to those used by the District Railway Co. itself for its feeders. In carrying out this work the cables are not disconnected from the exchange in order to avoid the disorganisation of the service. It appears that on Tuesday morning the Metropolitan District Railway Co. were carrying out some tests on their line, and the conductor rails were charged. One of the telephone cables referred to was in contact with one of the rails, and an arc occurred which melted the lead sheathing of the cable and connected the wires in it to the live rail. The heavy current was carried through the wires to the test room of the Bank Exchange and the cable distributing room at Oxford-court, and caused fires in both these places. The switchboard itself at the Bank Exchange, however, was not damaged in any way. The room at Oxford-court is a distributing room for a large number of junction lines, and as a result of the accident no less than 1,800 junction lines have been put out of service, and 6,000 exchange and private circuits have also been interrupted. This necessitates the rebuilding of the test room and distributing room, and will involve the jointing, tapping out, re-numbering, and labelling of 150 cables. Between 400 and 500 men are engaged on this work night and day, and the company hopes that the service will be partially restored some time next week.

Opening of the Bridlington Electricity Works. The electric lighting station at Bridlington, Yorkshire, was opened yesterday. Although a Provisional Order was obtained by the Corporation as far back as 1900, little was done to carry out the scheme until 1903, when tenders were invited and provisionally accepted. Work was commenced in earnest a little over a year ago—viz., in January, 1904. Two Clayton Lancashire boilers, 30ft. × 7ft. 6in., fitted with economisers, supply steam at 135lb. per square inch to two generating sets, each consisting of a 160 H.P., double-acting, Allen vertical compound-enclosed engine, running at 475 revs. per min. and driving directly a Johnson and Phillips continuous-current dynamo. At present the steam engines are working non-condensing. An E.P.S. storage battery is provided, and the switchboard was supplied by Messrs. Johnson and Phillips. The length of feeders and distributing mains, which are of the Anchor Cable Co.'s make, aggregates about 30 miles, the distribution being on the 2 × 220 volt, three-wire system. Street lighting is carried out by 410 incandescent lamps supplied by the British Prism Globe Electrical Co. and 32 arc lamps, the switching on and off being done from the station by electrically-operated long-range switches fixed at different parts of the town. The consulting engineers were Messrs. F. H. Medhurst, Page & Lloyd, and Mr. Arthur J. Beckett is the borough electrical engineer.

Annual Dinner of the Post Office Engineering Department.—The second annual dinner of the Engineering Department of the General Post Office was held on Friday, February 24th, in the Victoria Hall, Hotel Cecil, Mr. J. Gavey, C.B., engineer-in-chief, presiding. The guests of the evening included Mr. H. Babington-Smith, C.S.I., secretary, Mr. J. C. Lamb, C.B., C.M.G., Mr. J. Ardron, Mr. A. F. King, Sir Robert Hunter, Mr. S. C. Hooley, I.S.O., Mr. J. C. Badcock, C.B., Capt. R. H. H. Boys, R.E., D.S.O., Dr. Walmsley, Mr. A. M. J. Ogilvie, Mr. J. W. Willmot, Mr. W. Bosomworth, Mr. G. Morgan, Mr. A. W. Heaviside, I.S.O., and Mr. W. J. Etheridge, the company numbering about 200.

Mr. J. C. LAMB, in the absence of Lord Stanley, proposed the "Engineering Department" in the course of which he complimented the Department upon the distinguished men who had been connected with it. He did not suppose that he would have the pleasure of being present at another of those functions, and he therefore wished them a hearty farewell.

Mr. J. GAVEY, in responding, briefly reviewed what had been done during the year. The progress of the Post Office, both telegraphically and telephonically, appeared to be very satisfactory. The Telegraph Administration of the General Post Office had always done everything to foster and encourage progress. In the course of the last year or two a number of experimental trials of the most advanced type of telegraph apparatus had been carried out. They had, in addition, forwarded that great work of the underground telegraphs to the North, and at the present time the lines might be said to be complete to Carlisle and to be on the verge of completion to Glasgow. In other words, during the last few years, something like 30,000 miles of underground wire had been laid to make absolutely free from all climatic disturbances the great trunk line service of the country. Funds for this purpose had been provided for next year, so that a continuance of this progress for one year at least was absolutely sure. In the matter of the extension of the London telephone service he was glad to say that very solid and very steady progress had been made. It was in February, 1902, that the first London exchange was opened with 250 subscribers. On February 22nd, 1905, 25,138 stations had been joined up. In the case of the trunk line service continued growth was to be recorded. In 1897, shortly after the Post Office had acquired the trunk lines, there were 47,855 miles of trunk line in use. At the end of the last financial year there were 102,752 miles erected, and the Post Office was steadily erecting from 7,000 to 8,000 miles of trunk wires every year. Dealing with the agreement between the Post Office and the National Telephone Co., Mr. Gavey reminded his audience that the final acquisition of the company would take place in 1911. As an old war-horse, who sniffed the battle from afar, personally he might have wished to have had his little share in that great transfer, but the fates and the wisdom of their chiefs had decided otherwise. So far, however, as the younger men that he saw around him were concerned, he should like to offer a word of suggestion and a word of advice. He had a settled conviction that we were only on the threshold of this very great enterprise. The magnitude of the work that would have to be carried out in future years was perhaps only appreciated by a few. As an illustration of this, he referred to the abnormal growth of telephones in the United States within the last few years. In New York in 1898 there were 26,031 telephone exchange stations. At the end of the year 1904 that 26,000 had increased to 140,000 stations in New York, and New York proper was not the greater New York including Brooklyn and New Jersey. It was a little bit of an island 10 miles long by about 3 miles broad, with a population of about two millions. Again, taking the report of the American Bell Telephone Co., he found that in 1899 throughout the United States they had 165,000 subscribers' stations. In 1904, after an interval of five years, they had 1,325,000 stations. In this country the rapid growth of the telephone was of comparatively recent date, and the problems which would have to be solved in the future increased in magnitude as the square of the number of subscribers and not as the numbers themselves. In the year 1911 it would not be a question of intercommunication between 100,000 subscribers, it would be a question of intercommunication between a quarter of a million, with probably the possibility of having to provide intercommunication between half a million 10 years later. It meant that they would have to apply the highest technical and scientific knowledge that it was possible for men to obtain in order to do this work in a satisfactory and an economical manner; they would, before the transfer took place, have to fit themselves, by keeping abreast with all the technical knowledge of the age, to take the position which it would be necessary for them to occupy when that great transfer took place. There was now in preparation at headquarters a species of technical summary of the theoretical principles on which telephony was based and the lines on which the work ought to be done in the future. With the consent of their chiefs, he proposed to have this printed and issued shortly, and he invited their careful attention to it, not by any means as a complete work, but rather as an index, a sort of direction post, pointing out the various paths in which they should carry out their investigations.

The toast of "The Visitors" was given by Mr. J. W. Woods, superintending engineer of the Metropolitan Central District, and responded to by Mr. H. Babington-Smith.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) **FRIDAY, March 3rd.**

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at Westminster Palace Hotel. Paper to be read: "Possible Improvements in Locomotive Practice," by W. Longland.

ROYAL INSTITUTION.

9 p.m. Evening discourse: "Recent Advances in Wireless Telegraphy," by G. Marconi.

SATURDAY, March 4th.

GLASGOW TECHNICAL COLLEGE SCIENTIFIC SOCIETY.

7:30 p.m. Meeting at 38, Bath-street. Paper to be read: "Steam Generators and their Failures," by G. Ness.

MONDAY, March 6th.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting at the Royal United Service Institution, Whitehall. Paper to be read: "The Transport Possibilities of our Inland Navigable Waterways," by B. H. Thwaite.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture IV.: "Internal Combustion Engines," by Dugald Clerk.

FARADAY SOCIETY.

8:15 p.m. Meeting at the Institution of Electrical Engineers, 92, Victoria-street, Westminster. Paper to be read: "Recent Developments in Electric Smelting in Connection with Iron and Steel," by F. W. Harbord. The Annual General Meeting will be held at 7:30 p.m.

TUESDAY, March 7th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be further discussed: "Surface-Condensing Plants and the Value of the Vacuum Produced," by R. W. Allen.

THURSDAY, March 9th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Report on Experiments carried out at the National Physical Laboratory: (1) "On the Effect of Heat on the Electrical and Mechanical Properties of Dielectrics"; (2) "On the Temperature Distribution in the Interior of Field Coils," presented by Dr. R. T. Glazebrook, F.R.S. The following Paper will also be read: "On Temperature Curves and the Rating of Electrical Machinery," by R. Goldschmidt.

INSTITUTION OF ELECTRICAL ENGINEERS: DUBLIN LOCAL SECTION.

8 p.m. Ordinary Meeting at the Royal College of Science. Paper to be read: "Lightning Conductors," by P. H. Stewart.

FRIDAY, March 10th.

RUGBY ENGINEERING SOCIETY.

8 p.m. Meeting in the Benn Buildings, High-street, Rugby, when Mr. J. T. Milton will deliver the second of his course of lectures on "The Minute Structure of Metals."

PHYSICAL SOCIETY.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "On the Stresses in the Earth's Crust before and after the sinking of a Bore-hole," by Dr. C. Chree, F.R.S. (2) "On the Lateral Vibration of Bars of Uniform and Varying Sectional Area," by J. Morrow. (3) "On Direct-reading Resistance Thermometers, with an Appendix on Composite Thermocouples," by A. Campbell.

ROYAL INSTITUTION.

9 p.m. Evening Discourse:—"The Structure of the Atom," by Prof. J. J. Thomson, F.R.S.

SATURDAY, March 11th.

ROYAL INSTITUTION.

3.0 p.m. Afternoon Lecture I.:—"Electrical Properties of Radioactive Substances," by Prof. J. J. Thomson, F.R.S.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7:30 p.m. Meeting at the Colonnade Hotel, New-street, Birmingham. Paper to be read: "Electric Lifting Machinery," by E. C. R. Marks.

THE MURRAY TYPE-PRINTING TELEGRAPH.

Since a description of this system first appeared in *The Electrician* about three years ago, the apparatus has undergone some modification and improvement. Its perfected form was described by the inventor in a Paper read before the Institution of Electrical Engineers last week. A reference to the former description will enable the general principles to be understood (*The Electrician*, Vol. XLVIII. p. 86), and it is only proposed here to notice some later modifications which have been made in the system.

Briefly, the system is one in which there is a considerable advance towards the ideal of rapid type-printing telegraphy, and also towards that of a more completely automatic transmission of messages. All this is achieved by means of very beautiful mechanism, and although there is an appearance of complexity it will be found to be of really simple nature, especially considering the necessarily multifarious devices involved in printing telegraphy.

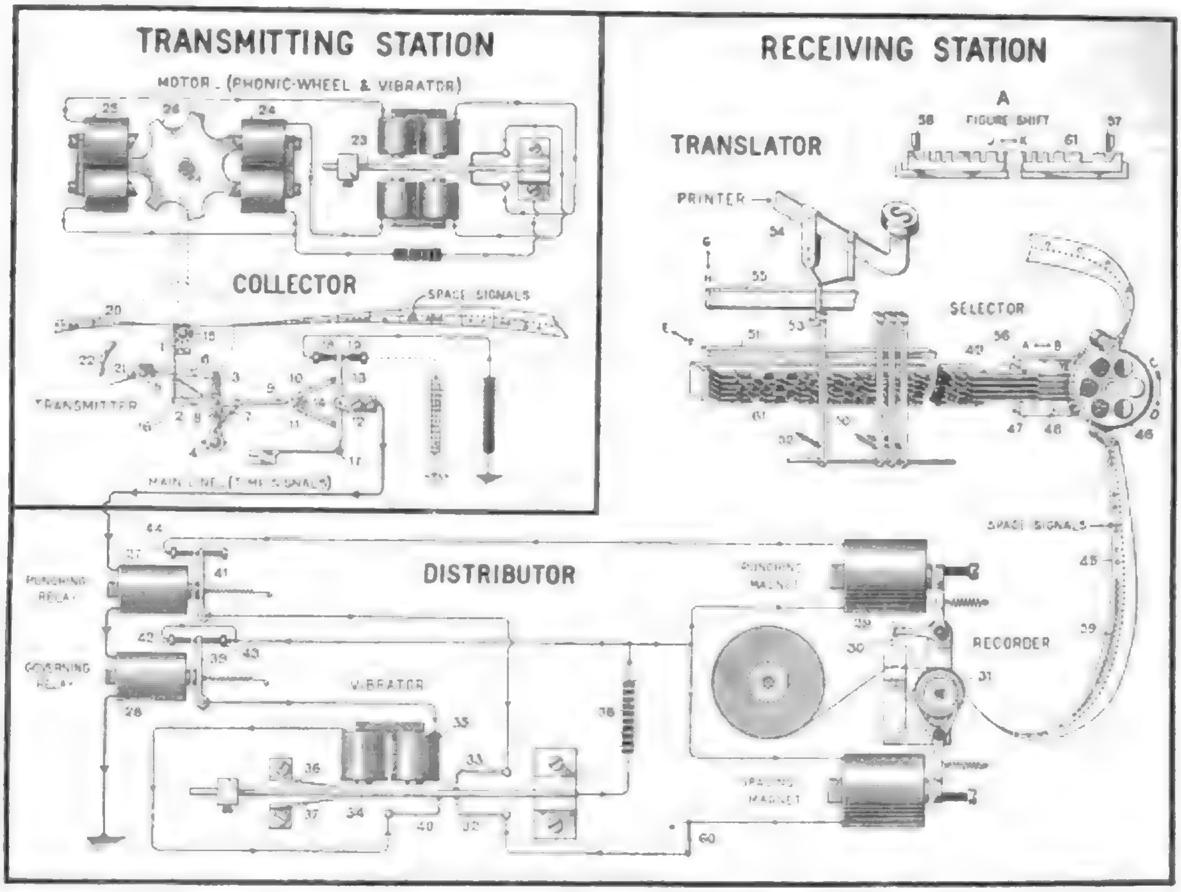
TRANSMITTING STATION
MOTOR _ (PHONIC-WHEEL & VIBRATOR)
25
26
24
23
COLLECTOR
SPACE SIGNALS
20
19
1
22
21
6
3
10
18
13
5
9
TRANSMITTER
14
16
2
8
7
11
12
4
17
MAIN LINE _ (TIME SIGNALS)
RECEIVING STATION
A
58
FIGURE SHIFT
57
TRANSLATOR
J → K
61
PRINTER
54
G
H
55
SELECTOR
E
51
53
56
49
A → B
C
D
47
48
46
52
50
SPACE SIGNALS
45
44
27
41
DISTRIBUTOR
PUNCHING RELAY
PUNCHING MAGNET
42
43
39
29
RECORDER
30
GOVERNING RELAY
31
28
VIBRATOR
35
38
36
33
37
34
40
32
SPACING MAGNET
60

Fig. 1.—General Diagram of Murray Automatic Printing Telegraph System.

The message is prepared on a paper band or "slip" by perforations analogous to that of the well-known Wheatstone system. The machine necessary for this is controlled by a keyboard, so that the operation of preparing the slip is the same as that of manipulating an ordinary typewriter. This operation is the only one involving skill in the whole system; the subsequent stages of transmission are purely automatic until the message is ready for its addressed envelope.

The prepared "slip" is next run through a transmitter somewhat after the Wheatstone type. The transmitted signals, however, are received not as an inked record, but in the form of a slip punched out precisely similarly to that which sent the signals through the line from the sending end. This received slip is then taken and run through an apparatus which controls the mechanism of a typewriter of an ordinary kind. The passage of the slip through this selector, which forms an adjunct to the typewriter, results in a message printed in successive lines in typewriter fashion ready for the recipient.

Two features of the system lend themselves to rapidity of transmission, and this last is very important in any system which will have to compete with the fast automatic work of the Wheatstone system. The first of these is more incidental than inherent in this system. This feature is the selection of a special alphabet designed to give the greatest possible economy in number of permutations of the transmitted current impulses. A tabulated statement of the alphabet will be found in the article above referred to, where a comparison is made with the Baudot alphabet, which it closely resembles in principle.

The other feature conducing to rapidity is the fact that the transmitted signals are not hampered by inertia of moving parts, which is so troublesome an obstacle to speed in most systems where the signals directly control the printing mechanism. In this system the current impulses from the

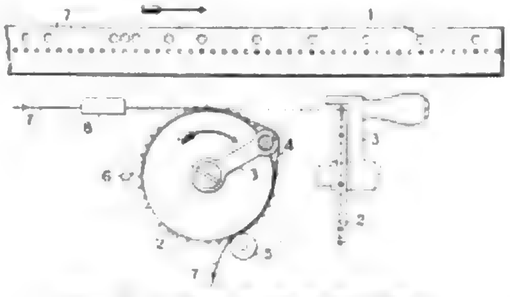
7
1
7
8
6
4
1
3
2
2
7
5

Fig. 2.—Method of Securing Unison.

line have merely to control the reciprocation of a light perforating punch with the magnet armature which works it. The results in rapid action obtained by Mr. Murray with his punching devices at the receiving end are very surprising.

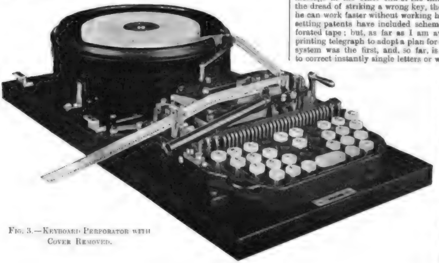

Fig. 3.—Keyboard Perforator with Cover Removed.

The following extracts from Mr. Murray's Paper, if read in conjunction with a reference to the previously-published description in *The Electrician*, will make the later modifications clear.

While describing the tape, an important point in regard to automatic printing telegraphs may be explained. So far as commercial telegrams are concerned, a serious objection to direct-transmitting page-printing telegraphs is that errors show up badly in the printed message, and operators have to work slowly and carefully to avoid making mistakes. Telegraph operators are remarkably accurate, but, in spite of the best care and skill, errors are frequent. Anyone who is accustomed to using a typewriter knows how difficult it is to write a page of typewritten matter without striking at least one or two wrong letters. In four cases out of five there is consciousness of the error as soon as it is made, and steps can be taken to correct it. In tape printing telegraphs, like the Hughes and Baudot, the errors and the succeeding corrections can be cut out of the tape before it is pasted on to the telegraph blank, and there is then nothing to disfigure the telegram, and make the recipient uneasy about its accuracy. With a direct-transmitting page-printing telegraph this cannot be done. A wrong key depressed is an error printed at the other end of the line, and the correction following only magnifies the blot. All automatic systems of telegraphic transmission in which there is preparation of the message beforehand, possess the potentiality of correcting an error before transmission. In the Wheatstone automatic system, for instance, this process is known as a "rub-out." When an operator at a Wheatstone puncher makes a mistake he can pull the tape back and punch it full of holes, thereby obliterating the mistake. In this case the mistake is represented by a series of dots on the received tape, and the transcribing clerk passes over it. In automatic telegraph systems, in which a printing machine takes the place of the receiving operator, it is a comparatively simple matter to arrange that the printer shall imitate the action of the operator by remaining inactive when dots only are coming over the line. In this way no trace of the error appears in the printed message. This, for instance, is done in the Buckingham system. In the Buckingham system, however, as with Morse, the groups of letter signals on the transmitting tape are of varying length. It is consequently not possible to pull back the transmitting tape letter by letter in the keyboard perforator. It has to be adjusted by hand, or pulled back unit by unit, a process necessarily involving some loss of time, and many corrections in this way would materially reduce the output of the operator. In the Buckingham system, also, it is necessary to rub out everything as far as the end of the previous line. Hence, to correct a single letter a whole line may have to be rubbed out. With automatic systems like the Murray, using an alphabet in which the letter signals are all of the same length, the transmitting tape, while being prepared in the keyboard perforator, can be pulled back instantly letter by letter by depressing a lever. If an operator strikes a wrong key, all he has to do to rectify his error is to strike the back-spacing lever, the letter-shift key, and the desired letter—the work of a moment. A word of six letters can be blotted out in this way in a few seconds, and no trace of the correction, not even a blank space, will appear in the printed message at the other end of the line. This relieves the operator from the dread of striking a wrong key, the strain on his attention is less, and he can work faster without working harder. One or two automatic type-setting patents have included schemes for correcting errors in the perforated tape; but, as far as I am aware, the Buckingham was the first printing telegraph to adopt a plan for invisible correction, and the Murray system was the first, and, so far, is the only system having the power to correct instantly single letters or words.

The correction is made by striking the letter-shift key (Caps.). This punches five holes in a letter space, and so blots out all other permutations which may have been previously punched. At the other end of the line this signal leaves the printer unaffected, its function being to shift the action of the printer from figures to letters. The signal may be repeated half a dozen times, so as to blot out a whole word, and there will be no trace of the error in the printed message.

Making the transmitting and receiving slips identical is one of the recent improvements. Not only does this conduce to simplicity and uniformity, but it has a more direct practical value in actual working. The received slip can be utilised, if required, for retransmission on another line, an advantage that may be found of great use in some circumstances.

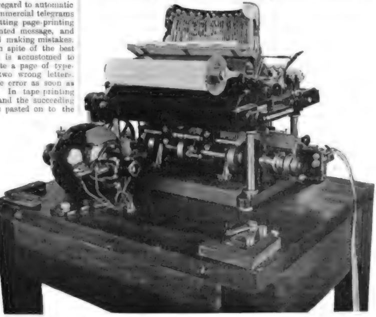

Fig. 4.—Murray Printer Complete with Typewriter.

The following extract, while describing the new transmitter, will at the same time make the alteration in the perforations of the transmitting slip quite clear. Also one or two unique features will appeal to those familiar with the various types of transmitters in common use.

As there is only one row of message holes in the tape, the Murray transmitter, in its improved form, is a considerable departure from the Wheatstone model. In the Wheatstone the signals depend on the relative positions of message holes arranged in two rows. In the new Murray transmitter the signals depend on the relative positions of perforated and non-perforated units of tape. The mechanism is shown in Fig. 1 (collector). The tape and the transmitter together form the collector. There is the usual Wheatstone star-wheel 15 to feed the tape forward by means of the central row of holes, rack-and-pinion fashion; but in place of the two small upright rods used in the Wheatstone for entering the holes in the tape, there is a single rod 1. This rod is pivoted at one end of a horizontal thrust-lever 2. This thrust-lever is in its turn pivoted near its middle on a vertical lever 3, oscillating on the centre 4. This vertical lever is kept oscillating steadily by a small eccentric wheel 5 and connecting rod 6, of the same kind as that employed in the Wheatstone transmitter. The thrust-lever 2 has a tooth 7 on its under side, which rests against a pin 8 in the vertical lever 3. The result of the oscillations of the vertical lever 3 is to cause the horizontal thrust-lever 2 to oscillate also. The free end 9 of this thrust-lever is placed close to the two free ends of two converging thrust-bars 10 and 11, which are pivoted one on each side of the pivot 12, of an ordinary Wheatstone contact lever 13. These converging thrust-bars are lightly pressed against a friction roller 14 by two small steel wire springs. The usual Wheatstone jockey roller 17 ensures the contact lever 13 making firm contact and remaining either on contact 18 or on contact 19.

When the machine is in operation, and tape perforated with a message is being fed through in the ordinary Wheatstone manner, the small steel rod 1 reciprocates regularly against the paper tape 20, as may be seen from the dotted arc 16 described from the centre 4. It makes one reciprocation for each unit of the tape, the eccentric wheel 5 making 10 revolutions for one revolution of the star-wheel 15, the spindles of the two wheels being connected by 10-to-1 gearing, as shown by the large dotted circle. If there is a message hole in the tape, the tip of the rod enters the hole and the complete motion of the rod is unobstructed. This permits the thrust lever 2 to move as if it were one piece with the vertical lever 3, and the oscillation causes its free end to strike the free end of the lower thrust-bar 11, connected with the contact lever below the pivot 12. This throws the contact lever over on to the marking contact 18. If at the next oscillation the small upright rod again enters a hole in the tape, the same action is repeated, but the contact lever being already against the marking contact, and held there by the jockey roller 17, no change is made in its position, and marking current continues to be sent out to line. No further repetition of message-holes in the paper tape makes any change in the position of the contact lever; but if a non-perforated unit of tape intervenes, then the small rod 1 is obstructed by the tape, and the oscillation of the vertical lever 3 causes the rod 1 to depress its end of the thrust-lever 2, thereby raising the other end 9 of the thrust-lever, which then, in the course of the oscillation, strikes the upper thrust-bar 10. This throws the contact lever over on to the spacing contact 19, thereby breaking the marking current and throwing spacing current into the line. If in the next oscillation another non-perforated unit of tape intervenes, the same action is repeated, but as the contact lever is already resting on the spacing contact, no change in its position takes place, and spacing current continues to be sent out until a perforation occurs in the tape. This, by the action already explained, throws the contact lever over again on to the marking contact. It is always the first of a series of perforated units or the first of a series of non-perforated units of tape that operates to throw the contact lever over from one contact to the other. By this means the space signals punched in the tape are converted into time signals of the real Baudot alphabet.

There are a number of details connected with the transmitter, but the only one worth mentioning is the method of getting rid of bias — that is to say, the method of ensuring that the positive and negative half-waves or units shall be both of the same length. In the Wheatstone transmitter, bias is shown by the galvanometer needle inclining to the right or left according as the positive or the negative half-waves are longer, when reversals are sent. The contacts are then adjusted till the bias ceases to show on the galvanometer. The best that can be said for this arrangement is that it is rough and ready. In the Murray transmitter a more precise and scientific method is used. The eccentric wheel 5, Fig. 1, makes one complete revolution for each half-wave, positive or negative. A small steel pointer 21 is inserted in the eccentric wheel, and on the frame of the machine there is a short scale 22. If the transmitter is driven very slowly by hand the galvanometer needle will be observed to come to zero at the moment when the positive or the negative contact is broken. If the pointer points to the same division on the scale for a positive break as for a negative break, then there is no bias, and the positive half-wave is the same length as the negative half-wave. If, on the other hand, the pointer is alternately in advance and in retard for each half-wave or unit, then bias exists, and the contacts have to be adjusted till it disappears. As each half-wave or unit is equal in length to the circumference of the circle described by the tip of the pointer 21 it will be seen that bias is not only shown on a magnified scale, but is exactly measured. Absence of bias—that is to say, correct timing of the signals, is important in all systems of machine telegraphy, including even such simple apparatus as the Wheatstone automatic, and the indicator just described leaves nothing to be desired as far as the Murray system is concerned.

The La Cour phonic wheel motor that drives the transmitter is clearly shown in the general diagram. 23 is a vibrating reed, which sends electrical impulses alternately to the two motor magnets 24 and 25, and these keep the notched armature 26 in steady rotation. This armature 26 drives the star-wheel 15 and eccentric wheel 5. The arrangement is in reality an electrical pendulum with the action reversed, the pendulum driving the escapement wheel, the two magnets being the two pallets of the escapement which pull the escapement wheel 26 round step by step, though the inertia of the wheel is sufficient to ensure uniform motion. The vibrating reed being isochronous in the acoustical sense, the speed of the motor is the same for all amplitudes of vibration. That is to say, variation of current strength has no effect on the speed of the motor. The speed is remarkably uniform, and the motor is ideal for the purpose and gives no trouble.

This single-line transmitter has several advantages over the Wheatstone instrument, the chief one being that there is a direct thrust against the contact lever from the driving mechanism, independent of the strength of the paper tape. Hence this thrust can be made strong in order to give very firm contacts.

An interesting point is the method of securing unison. In the Murray system the question of unison is removed from the line to the tape. As with the Wheatstone recorder tape, it is a question of correctly dividing up the signals on the tape. With the five-unit alphabet each letter occupies five units, or ⅝in. on the tape. Hence, to divide up the signals properly we have to start at the right unit and then measure five units at a time. The star-wheel 46 does the measuring, and all that is necessary is to place the tape properly on the star-wheel. To enable this to be done with facility, each batch of messages begins with four or five space signals, as shown in Fig. 2 at 1. The space signal is a perforation in the third-unit position. In the star wheel 2 it will be noticed that every fifth tooth is omitted and the vacant tooth positions blackened. The tape 7 is inserted in the machine so that the space holes 1 come opposite the missing teeth of the star wheel which show up black through every fifth central hole in the tape, as shown for the sake of illustration by the blackened centre holes in the tape opposite the space signals 1. The tape is then in unison. In the event of it not being in unison, it can be put in step by rotating the small unison arm 3. This bags up the tape as shown at 4, and advances the tape on the star wheel to the extent of one unit. A maximum of four and an average of two revolutions of the unison arm 3 brings the tape into step. The roller 5 is spring-pressed, so that it gives way and permits arm 3 to pass. The unison arm, when not in use, is held locked in the dotted position by the spring tooth 6. 8 is a guide for the tape. The missing teeth in the star wheel and the space signals show at a glance at the beginning of a message whether the tape is in step. If a line interruption causes the unison to fail in the middle of a message, two or three revolutions of the unison arm by the attendant set all right again. This does not often happen, however, as a line interruption must be complete for at least seven letters before the unison can be affected. Momentary interruptions do not disturb it. Apart from occasional line interruptions, the receiving mechanism perforates the tape with surprising accuracy. On short circuit it will run for hours without making a single false perforation.

An improvement is indicated in Fig. 1 at 54. This shows the method by which the selecting mechanism which pulls down each key-lever in its due turn can yet be readily detached, leaving only the lever 53 fixed to the key of the typewriter, and thus permitting the typewriter itself to be readily removed without involving derangement of any of the various parts. It is further to be noticed that the paper is now fed by means of a motor instead of the original hand crank, an arrangement which will no doubt be appreciated by the attendant whose duty will be to attend to the printing of the messages.

THE SELECTION OF ELECTRIC CABLES.*

BY L. B. ATKINSON AND C. J. BEAVER.

(*Continued from page 746.*)

The matter of testing paper for admixture with the woody classes of fibre is quite simple to anybody with an elementary knowledge of the microscope. The preparation merely consists in extracting the insulating material with a solvent such as benzol, boiling the paper in a weak alkaline solution, washing with water and teasing out the fibres with needles, and mounting in the usual way in glycerine, or in a special reagent which by its differential action on various fibres colours them distinctively according to the class to which they belong, thus aiding the identification described below.

Fig. 6 shows esparto. It will be seen that the fibres are generally smooth, cylindrical and uniform in diameter, the central canal is very small. On examining the paper containing the esparto under the microscope it will be found to contain, in addition to the fibres, a certain number of serrated cuticular cells which are very characteristic.

Fig. 7 shows straw. The chief features of the fibre are generally similar to those of esparto. The pulp will also contain a number of serrated cuticular cells, which, as a rule, are of more varied shapes and dimensions than those of esparto. A further distinctive feature of straw pulp is the presence in it of a number of lozenge-shaped cells derived from the pithy matter attached to the inside of the stem. The form and size of the serrated cells will vary according to the kind of straw, but the general character of them is always similar.

Fig. 8 shows chemical wood. The fibres are broad, flattened and smooth, with truncated ends, and are characterised by the presence of numerous pitted vessels in the fibres.

Fig. 9 shows mechanical wood. The fibres are similar to those of chemical, but seldom appear in their entirety, owing to the severity of the mechanical process which they have undergone. The pitted vessels are frequently even more marked than in the case of chemical wood pulp.

Fig. 10 shows manilla. The fibres are smooth and regular, and have a wide central canal, though this is sometimes not very distinctly marked. They are entirely free from any of the characteristics noted in the case of the above-mentioned fibres, such as pitted vessels or serrated cuticular cells.

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* "Some Points on the Selection of Electric Cables," read before the Manchester Local Section of the Institution of Electrical Engineers on Jan. 31. Slightly abridged.

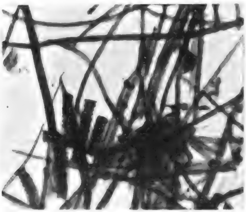

FIG. 6.

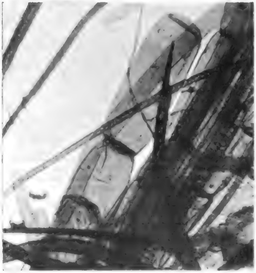

FIG. 7.

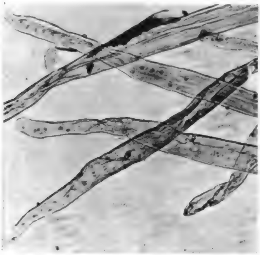

FIG. 8.

It will thus be seen that the characteristic forms of the fibres to be specially avoided are very definite and easy to identify.

The impregnating compounds used by different firms vary considerably. From an electrical point of view they should be designed to have the highest possible dielectric strength and specific insulation; the specific inductive capacity should approach as nearly as possible to that of the fibrous material. As regards consistency, it should be plastic but not fluid. Usually engineers specify that it should have no tendency to drain away from the cable, and some specify a test to ensure this, consisting of cutting a piece of cable from a length and suspending it vertically for a certain time at a stated temperature and observing whether any "bleeding" occurs from the lower end. A compound that will so "bleed" after 24 hours' suspension at, say, 70° F., will tend to drain away from the cable at junction boxes or on inclines, and we have heard of a case of a cable suspended in a pit shaft, where the draining took place to a sufficient extent to burst the lead covering of the cable at the bottom of the shaft. Electrical deterioration must follow such bleeding to some extent; for instance, by forming layers of high specific inductive capacity, and thereby increasing the dielectric stress in parts of the cable.

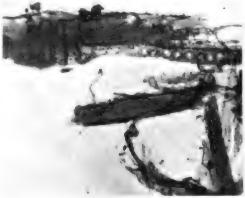

FIG. 9.

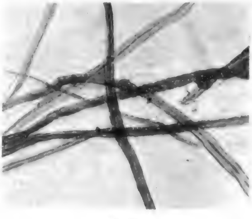

FIG. 10

As the final insulating property of these dielectrics depends on the exclusion of moisture, the lead envelope is very important. In theory, of course, the thinnest covering would suffice; practice, however, has enabled a certain thickness to be arrived at, which provides in addition for protection against damage in handling and external corrosion. Such thicknesses have been embodied in tables drawn up by a committee of the Cable Makers' Association, and later reconsidered and accepted by the joint committee of the various engineering societies, which has been sitting on the question of standardisation. The thicknesses are shown for various diameters of cable in Fig. 11.

These thicknesses must be taken as minimum thicknesses; in certain conditions of soil and surroundings it is advisable to increase them.

The lead is put on such cables in a plastic state by hydraulic pressure. This is an operation requiring such care to avoid minute cracks or damage from particles of oxide being forced in with the lead, that there are engineers who still advocate the older system of drawing the cable into a lead pipe which has already been tested by water pressure, or of putting on double sheaths of lead. Messrs. W. T. Glover & Co., Ltd., have, however, met the question by the use of hydraulic pressure up to 100lb. per square inch applied externally after the cable is finished. Such pressure invariably detects a fault if such exist in the lead. The ordinary tank test is practically useless, and it may take many months or even years for water to enter the very fine seams which such faults occasion, but eventually it will do so.

Causes of corrosion due to impurities in lead, causing local galvanic action, are very rare. The total proportion of impurity shown by analysis of practically any brand of new soft English pig lead will not average more than 0·5 per cent. The only accidental impurity likely to get into the lead is oxide of lead, but the chances of this are very remote, owing to improvements in the design of the melting pot arrangements.

Galvanic action between lead and adjacent metal is also seldom met with, though one or two bad cases have come under our notice in concentric cables in which the lead has been applied directly over the outer conductor, and galvanic action has been set up between the tinned copper wires and the lead in presence of atmospheric moisture. The lead coverings were corroded through in about two years.

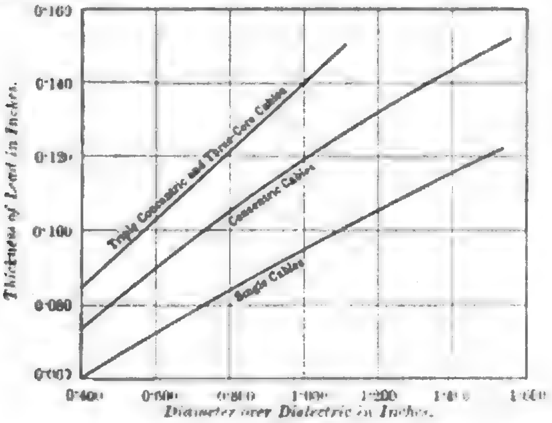

Fig. 11.

Corrosion by chemical action is fairly common, and may occur in certain soils or where organic acids are produced as the result of the decomposition of wood or vegetable matter, or where cables are laid through made-up ground, especially where ashes or clinkers are abundant. Most pit waters have an appreciably corrosive effect on lead, some being extremely severe in their action, though we have known several cases where the water has been wrongfully blamed for damage really due to electrolysis.

Electrolysis is by far the most serious form of lead corrosion. Taking the word electrolysis in its broad sense—(*i.e.*, as the electrochemical action due to the passage—via an electrolyte—of current to or from the lead, which is in turn due to difference of potential between the lead and its surroundings from any cause), it is also the most common form, though this is not usually appreciated.

So much has been heard for years past of the electrolytic corrosion of water and gas mains where electric tramways have been installed in various towns, that there is a tendency to disregard the fact that it may occur under conducive conditions even in isolated house wiring installations where lead-covered wires are used, neither tramway nor heavy lighting cables being near. The effect of the existence of a difference of potential between the lead covering of a wire or cable and its surroundings, depends on the degree of difference of potential, the current density in the electrolyte and the character of the electrolyte, *i.e.*, its conductivity, decomposition products, &c.

The character of the corrosion may vary from small holes which gradually penetrate the lead covering, converting the lead into various oxides of lead, and only make themselves apparent when the rubber dielectric becomes oxidised to a sufficient extent to break down, or the paper dielectric sufficiently exposed to absorb moisture and fail (which may take many months) to very extensive action and a high degree of oxidation (where there is a free and continuous supply of the electrolytic medium and a small difference of potential) or a limited amount of general corrosion, followed soon by fusion (where the supply of the electrolytic medium is small or not continuous, and the difference of potential is comparatively high).

To give instances of these varied conditions, and the varied character of the corrosion resulting from them, we may state in a general way that the first described result is most common in small and medium-size lead-covered cables laid or fixed in wood casing (as occurs sometimes in large isolated installations) or in conduits which are fairly dry or which do not actually have water running through them. The lead covering in such cases is only in intimate contact with the wood casing or conduit intermittently, and the corrosion naturally takes place chiefly at such places which are the paths of least resistance. If such corroded points are carefully examined at various stages of the corrosion it will usually be found that a cone-shaped hole is eaten away and that the lead is converted into oxides, the various colours characterising the degrees of oxidation being clearly distinguishable, the extreme outer layer becoming converted into the white carbonate by exposure to the moist atmosphere. In rubber cables the rubber usually fails quickly when the lead is finally penetrated, owing to oxidation of the rubber; but in the case of paper cables, if undisturbed, the oxides into which the lead is converted will keep out atmospheric moisture for, possibly, years, and the effect of the liberated oxygen on the paper (if made of pure Manilla only and well impregnated) will be negligible.

The second described action (where there is a continual supply of the electrolyte and small P.D.) chiefly occurs in conduits where water is continually trickling through; and in such cases the degree of oxidation is high and fairly uniform throughout the thickness and along the surface of the lead. The corrosion is practically confined to the bottom of the cable. The P.D. being low, and the surface exposed to the electrolytic medium being large, the current density will be very small, and therefore the final failure of the cable may take a year or two. The slowness of the action and the fact that the surface affected is more or less continuously covered with the electrolytic medium, accounts for the high degree of oxidation and the comparative absence of carbonate on the surface in such cases.

The third case, where a limited amount of corrosion is followed by fusion of the lead, generally occurs on large networks carrying heavy currents or on electric tramway and railway systems, where bonds may be fused by heavy leakage currents resulting from a short-circuit, whereby the lead coverings of cables may be raised to a P.D. of, say, 10 to 20 volts. There may, under such circumstances, of course, be immediate breakdowns of other lead-covered cables, but in some cases the whole of the resultant damage may not be at once ascertained, and the consequent leakage currents may go on for some time, causing corrosion wherever lead coverings are even only partially exposed. (For instance, in the case of cables laid on the solid system imperfectly, or where the ends emerge into manholes, &c.) Supposing in such a case the electrolytic medium to be entirely decomposed and dried up by the passage of heavy leakage current (obviously at a high current density) sparking from the lead and fusion of the same may easily ensue.

It is not proposed here to touch further on the diagnosis of breakdowns due to lead corrosion. Enough has been written to indicate the extreme care necessary to avoid conditions which tend to produce lead faults, and incidentally to indicate that the use of lead-covered cables on large networks carrying heavy currents will probably be limited in the future, or that elaborate and costly precautions will have to be taken. It is obvious that bonding and earthing judiciously and sufficiently is the remedy for electrolytic faults, but in the first class of electrolytic faults, roughly and generally described above, bonding is frequently neglected. In the second class it is worthy of note that bonding and earthing, even if in accordance with Board of Trade regulations, is probably not a sufficient protection to prevent lead corrosion under the conditions referred to. In the third class it is fairly common for conditions to arise under which bonding and earthing arrangements, designed with a lage margin of safety, are unavailing; and where very large currents return by earth paths as the result of breakdowns, it is almost impossible to forecast or predetermine what will happen on various parts of the network.

As a preventive measure against leakages of current from conductor to lead covering at connections in paper cables, where sealing boxes or terminals are difficult to fix, a waterproof non-fibrous sealing tape, such as Glover's Guttaroid tape, should be used, the tape being lapped over the trim from thimble to lead covering. Pure rubber, or even proofed tape, is often used on small cables by contractors, but is of little use under damp conditions, as either will absorb moisture in course of time, apart from the fact that they do not form a homogeneous covering. Instead of a covering of lead, a waterproof envelope of non-metallic material may be provided. Such cables are made by Messrs. W. T. Glover & Co. under the name of Paper Leadless, and are covered with a compound called Guttaroid, which is of the same class as those described under V.B. cables, but chosen more with a view to its waterproofing than its dielectric qualities.

(*To be concluded.*)

THE INDIANAPOLIS-CINCINNATI SINGLE-PHASE RAILWAY.

The first electric railway in America to put a single phase traction system into regular commercial use is that of the Indianapolis & Cincinnati Traction Co. This company has adopted the Westinghouse single-phase railway system, and the first car equipped was put in service on December 30th last; on January 21st a regular service was opened between Rushville and Morristown, two points 16 miles apart.

The Indianapolis & Cincinnati Traction Co. was organised for the purpose of building a double-track through line from Indianapolis to Cincinnati. At present the line has been constructed between Indianapolis and Rushville, a distance of 41 miles, and a through service between these towns has been established. In all the smaller towns a private right of way has been obtained, and the road is not constructed upon streets or highways except in cities or towns of such size as to make it necessary. A double track has been laid in the city of Rushville and on all highways. On the private right of way, however, only one line has been laid, as a second track can be more conveniently put down later when a sufficient portion of the road is in operation to require double track. The track is laid with 70lb. "T" rails connected with Weber rail joints, and bonded with No. 4-0 10in. copper bonds with $\frac{7}{8}$in. terminals under the plates. Cross bonds are put in every $\frac{1}{2}$ mile and long bonds under all special work. All poles are of white cedar, those for the centre trolley construction being 40ft. long with 7in. tops. The side poles for the high-tension lines are 50ft. long with 7in. tops, and all poles are set 6ft. in the ground. Along streets where it is only necessary to support the span wires on one side, 30ft. poles are used, while on the other side, where the high-tension line runs, the poles vary in height from 40ft. to 60ft., so as to carry the feed wires above the trees. The trolley wire is suspended along the private right of way from poles 100ft. apart, with a bracket made of angle iron looped at the end, so as to carry a large flat porcelain insulator, from the top of which is run a $\frac{7}{16}$in. steel strand cable (Fig. 1). The No. 3-0 grooved copper trolley wire is carried 8in. under this cable, to which it is attached every 10ft. with specially made steel clamps. The substantial insulators are not likely to break, but if they should the steel cable would remain suspended from the top of the bracket. The trolley wire is suspended 18ft. above the top of the rail. Where the tracks are in the streets the trolley is suspended from span wires.

Transformer stations are about 10 or 12 miles apart, and the single-phase current is transmitted from the power house to each of these stations by two No. 4 wires at 33,000 volts, 25 ∼ per second, and is reduced and fed into the trolley at a potential of 3,300 volts. As the wires make a complete circuit, and permit, therefore, the placing of the circuit-breakers and switches at the central power house, attendants at the transformer stations are to be dispensed with. The high-tension lines are carried on a separate line of poles set near the edge of the right of way.

The railway system is provided with two telephone lines, one of which is used exclusively by the train despatcher, the other line being used for general purposes. Each car is provided with a telephone, by means of which the conductor can talk with the train despatcher at fixed points. Jack boxes are placed on the poles at intervals of 2,000ft. The four telephone wires are carried by porcelain insulators on cross arms near the top of the trolley poles, and are thus far removed from the high-tension lines. They are transposed every 500ft.

Within the city of Indianapolis, for a distance of approximately 3 miles, the cars will be run over already existing lines, and will be operated by continuous current at 550 volts. Within the city of Rushville they will be operated by alternating current at the same potential. The power station from which it is intended subsequently to operate the entire road is at Rushville.

Three transformer stations have been erected between Indianapolis and Rushville. The transformer houses measure but 21ft. by 23ft. The foundations are of concrete; the walls are of brick laid in cement mortar, and the floors for both the first and second storeys are of concrete upon steel beams. The roof is built upon concrete base. Doors and windows are provided with steel shutters, and the whole structure is made thoroughly fireproof. In each of the transformer stations there are at present two 300kw. oil-insulated step-down transformers, 33,000 to 3,300 volts. Space has been provided for an additional transformer of the same capacity. On the second floor of each transformer station there are the lightning arresters and disconnecting switches. No automatic switches of any type are to be found in these stations.

In the power house there are two 300kw. transformers, wound for 3,300 volts primary and 550 volts secondary.

The boiler room of the Rushville power station occupies one side of the building, and is at present equipped with three 300 H.P. B. & W. boilers. Natural gas is now being used for fuel, but provision is made for the burning of coal, if at any time the supply of gas becomes insufficient. The engine room occupies the other side of the building, and is separated into two parts by a heavy brick partition. In the main room are two generator units, which consist of a 500kw. Westinghouse revolving field alternator, 25 ∼ per second, direct-connected to a 700 H.P. Corliss type cross-compound condensing engine. Engines and generators are designed for an overload capacity of 50 per cent. Each engine is equipped with an independent jet condenser. Two pairs of 250kw. air-cooled transformers are arranged to change the current which comes from the generator at 2,300 volts, three-phase, to 33,000 volts, two-phase, for transmission to the transformer stations along the line. There are two exciters; one is driven by an induction motor while the other is coupled to a Westinghouse compound steam engine. The main 'bus bars are located in the basement and are supported upon a masonry structure and separated by barriers of alberine stone.

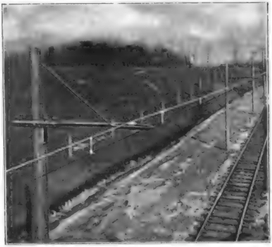

Fig. 1.—Catenary Overhead Construction.

At present there are 10 passenger cars, each measuring 55ft. over all, and divided into three compartments. The first compartment is 9ft. 10in. long, and is intended to carry baggage. It is provided with doors opening on either side. Space for the motorman is provided in front of the baggage compartment, from which it is separated by a strong railing made of pipe. Next to the baggage compartment comes a smoking compartment for 16 passengers. The third compartment accommodates 38 passengers.

Each truck is equipped with two 75 H.P. single-phase Westinghouse motors, and the cars are operated on the Westinghouse unit switch system of multiple control. The motors are controlled by the rheostatic system, and may be operated on either alternating or continuous current. Both straight and automatic air brakes are provided on each car, the straight being used when the cars are run singly, the automatic system when the cars are run in trains. The motors on the present car equipment are geared for a maximum speed of 45 miles per hour and an average speed of 30 miles per hour. Each car is equipped with two trolleys, one of the Union standard type, with trolley wheel, to be used when operating from the continuous-current lines in Indianapolis, or from the low-voltage alternating-current lines in Rushville; the second trolley is of the bow, high-speed type, designed for 3,300 volts.

A number of special cars are also to be put into service, which will be equipped with four 150 H.P. motors, designed to run the train at a schedule speed of 50 or 60 miles per hour. An average fare of 1½ cents per mile is charged for passengers, the road being divided into 5-cent sections; no fare less than 5 cents is charged for any ride. A school children's ticket is issued, good for use one hour before or after school hours. A mileage or sectional ticket is also issued at a reduced rate, giving 160 5-cent rides for $7, a reduction of 12 per cent. from the ordinary fare. No other tickets are sold and cash fares are collected on the car.

This contains the necessary apparatus for lighting and heating the car and also the air-compressor motor with its governor. It is taken from the line by a second transformer. This circuit is not connected with the motor circuit.

The motor circuit begins with an auto-transformer of special design connected between the trolley wire and the ground. This transformer is fixed underneath the car, and is so arranged that the current of air created by the motion of the car circulates through it, thus keeping it cool. At a point approximately 230 volts from the ground a circuit is led from this auto-transformer through the secondary of the induction regulator, and another tap, approximately 650 volts from the ground, is led through the primary of the regulator. The exact wiring of this arrangement may be seen in Fig. 2 and the diagrammatic arrangement in Fig. 3, which is somewhat modified for greater clearness.

Between the auto-transformer and the trolley is placed the circuit-breaker, which also acts as a main switch, and not only automatically opens the circuit when an overload occurs, but also whenever it is desired to cut off the current from the car. This circuit-breaker is held in place by a compressed air cylinder working against a powerful spring. When the air is allowed to escape the spring opens the breaker. The admission or release of air from the pneumatic cylinder is controlled by means of magnetic valves.

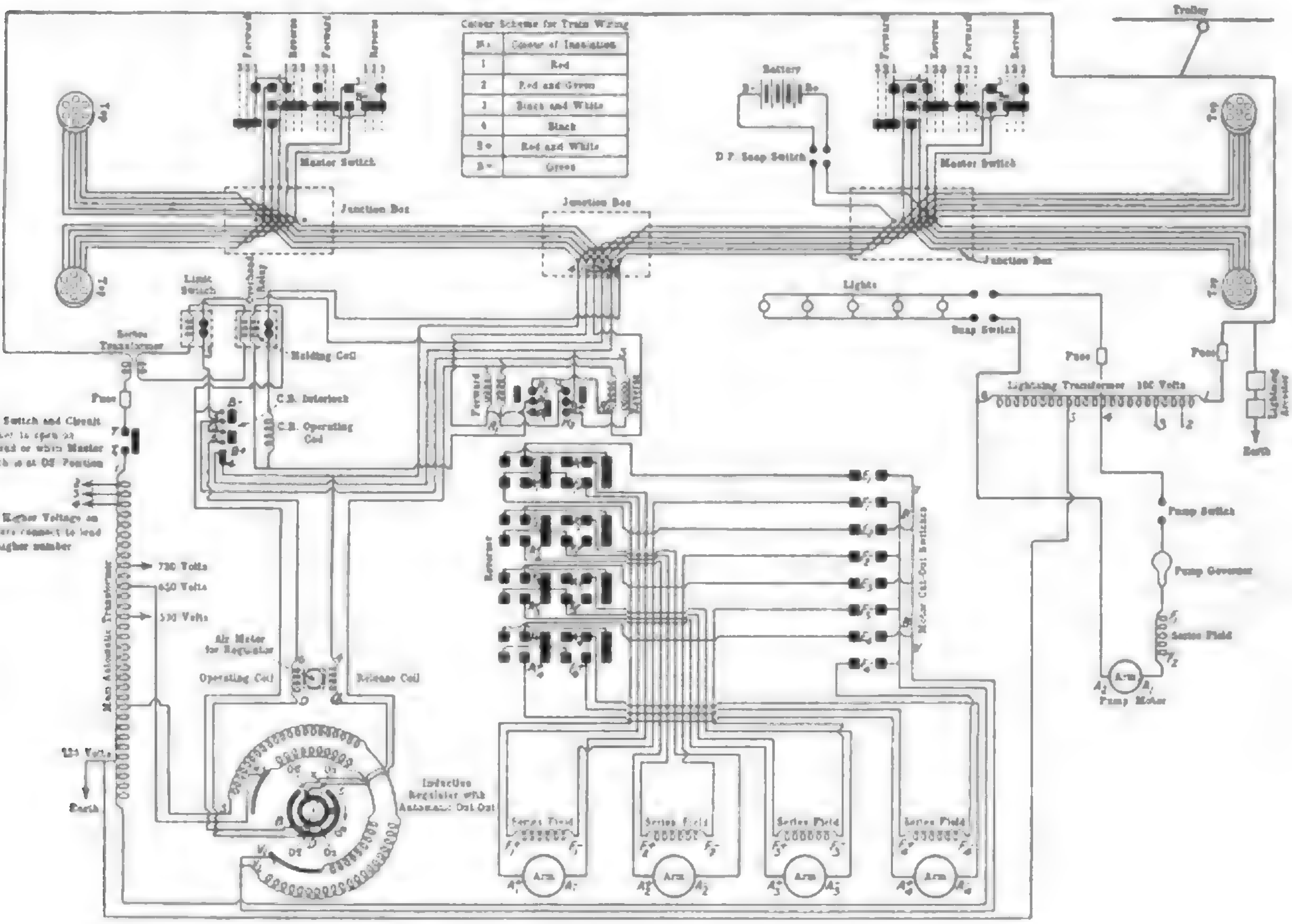
Colour Scheme for Train Wiring
No. | Colour of Insulation
1 | Red
2 | Red and Green
3 | Black and White
4 | Black
B+ | Red and White
B− | Green
Forward
Reverse
Forward
Reverse
Master Switch
Junction Box
Junction Box
Tap
Tap
Limit Switch
Overload Relay
Series Transformer
Holding Coil
Fuse
C.B. Interlock
C.B. Operating Coil
Main Switch and Circuit Breaker is open at overload or when Master switch is at Off Position
For Higher Voltage on Motors connect to lead of higher number
730 Volts
650 Volts
530 Volts
Main Automatic Transformer
Air Motor for Regulator
Operating Coil
Release Coil
230 Volts
Earth
Induction Regulator with Automatic Cut Out
Reverser
Motor Cut-Out Switches
Series Field
Series Field
Series Field
Series Field
Arm
Arm
Arm
Arm
Trolley
Battery
D.P. Snap Switch
Master Switch
Junction Box
Lights
Snap Switch
Fuse
Fuse
Lighting Transformer 100 Volts
Lightning Arrester
Earth
Pump Switch
Pump Governor
Series Field
Arm
Pump Motor

FIG. 2.—WIRING DIAGRAM OF CAR EQUIPMENT.

For some two years previous to the equipment of the traction system just described, the Westinghouse Co. had been running an experimental car with single-phase motors almost daily on the inter-works railway between East Pittsburg and Wilmerding, and systems of regulation and control suited to various operating conditions were devised. Referring to Fig. 2, there are three electric circuits upon each car, as follows: (1) The motor circuit. In this circuit there are placed the circuit-breaker, main transformer, induction regulator, reverser, motor cut-out switches and motors. (2) The auxiliary control circuit. An electro-pneumatic system of control is used, the various parts being operated by compressed air controlled by magnet valves. Current for the magnet valves is obtained from a 14-volt storage battery placed under the seat of the car. The fact that the control circuit is independent of the line and can be used whether the trolley is in use or not is also an advantage. (3) The lighting and heating circuit.

The voltage applied to the motors and consequently the speed of the car is governed by the induction regulator. This is in effect a transformer with its primary core and winding movable with respect to the secondary. It is operated by means of a small pneumatic motor controlled by electro-magnetic valves, and may be turned so that its voltage either opposes or aids that of the auto-transformer by any amount within the capacity of the regulator. In the "off" position the full voltage of the regulator is opposed to the 230-volt circuit of the auto-transformer, thus giving a low voltage for starting the motors. At the "full-on" position the entire voltage of the regulator is added to that of the 230 volt circuit of the auto-transformer, giving the proper voltage for full-speed running. A diagram of the regulator circuit is shown in Fig. 4.

The reverser, as its name implies, changes the connections of the motor armatures with reference to their fields, so that the car may be run either forward or backward. The reverser is operated by means of two pneumatic cylinders, one throwing it forward and the other backward. Air is admitted to either cylinder when desired by means of a magnetic valve. The motor cut-out switches consist of a double-pole switch for each motor, all mounted together and enclosed in a suitable iron case. In case of damage to any motor, the injured motor can be cut off entirely from the circuit, and the car then operated with the remaining motors. As the motor voltage is independent of the trolley voltage, a standard of 250 volts has been adopted, irrespective of the voltage of the trolley.

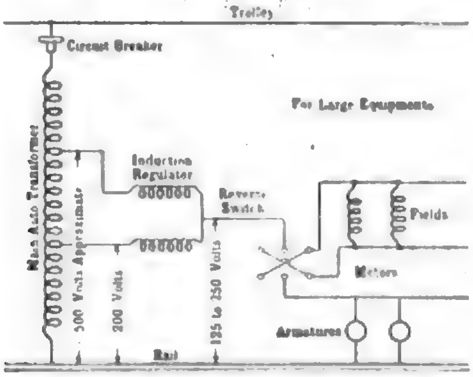

FIG. 3.—DIAGRAM OF MOTOR CIRCUIT.

The operation of the various magnet valves which regulate the movement of each of the above pieces of apparatus is controlled by means of a master switch located on the platform of the car. There are but three positions for the handle of the master switch for operating the car in a forward direction, and three corresponding positions for backing. To increase the speed after starting the handle is thrown to the third notch, which closes the circuit to one of the magnet valves controlling the pneumatic motor which drives the induction regulator, and air is thus admitted to the air motor. The regulator is then turned, gradually raising the voltage at the terminals of the motors. If the handle of the master switch is left on the third position, the regulator will advance to the "full-on" position, where it will be automatically stopped. If it is desired to operate the car at anything less than full speed, the handle of the master switch may be brought back to the second position and the regulator will at once stop and remain stationary. Under such circumstances, if the handle is again moved to the third position, the regulator will advance and increase the voltage at the motors, and consequently the speed of the car. If the handle is moved back to the first position the regulator will return toward the minimum position, lowering the voltage on the motors, thus lowering the speed of the car. If at any time it is desired to cut off the current, the handle of the master switch may be returned to the "off" position, in which case the circuit-breaker will open at once, thus cutting off the current immediately. After the circuit breaker has been opened the regulator will return toward the minimum position and the circuit breaker having once been opened cannot be closed again until the regulator has reached the position of minimum voltage. The circuits leading to the circuit-breaker and reverser are so interconnected that the circuit-breaker cannot be closed until the reverser has first been thrown, nor can the reverser be moved unless the circuit-breaker is open. The arrangement described can be adopted for multiple control by the addition of leads, connection boxes and "jumpers" for forming a continuous-control circuit over the different cars, no other change being necessary.

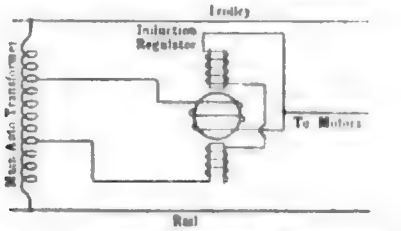

FIG. 4.—INDUCTION REGULATOR CONNECTIONS.

The lighting and heating circuit is operated from a small auto-transformer similar in design to the one in the motor circuit. From this transformer are supplied the lights in the car, the heating circuits—if any—and the small motor for operating the air compressor. The latter may be controlled by an automatic governor or by the hand switches which are conveniently located. Where the voltage of the line is 1,000 or less, connection between the car and the trolley wire is established by means of a trolley of the ordinary type. For higher voltages, a trolley of the bow type, especially designed for the purpose, is used. This is raised and lowered by compressed air under the control of the motorman, and any danger from shock in handling is thus avoided. The two levers at each side are so arranged that when the pneumatic pressure is removed the trolley lies flat upon the top of the car. When the air is applied the result is first to raise the upper section to a certain angle, and then to lift the entire trolley to the running position. The main spring keeps the trolley upright, but permits it to give under pressure. When the direction of the car is reversed the upper portion of the trolley is slanted in the opposite direction. The side springs in the levers, which support the upper portion of the trolley, adjust it for variations in the height of the wire, and the trolley is thus kept in contact with it and a continuous unbroken current results. With ordinary variations the position of the lower portion of the trolley remains unchanged, the fluctuations affecting only the lighter upper section and insuring a sensitive action. The chief advantages given by the trolley are the substitution of pneumatic for hand control, with the consequent elimination of all danger from grounding through the hand rope; a continuous contact with the trolley wire and the impossibility of the trolley slipping off the wire and damaging the overhead structure.

At each support the trolley wire is attached at a point alternately 12in. to right and left of the centre of the track, so that it is staggered, and the contact between it and the trolley varies from one side to the other and thus under-wear at any point is prevented.

Some particulars with regard to the Westinghouse motor were also given by Mr. H. L. Risley in the course of a Paper, entitled "Description of some Plant Inspected during a Recent Visit to the States," read before the Newcastle Local Section of the Institution of Electrical Engineers on January 16th.

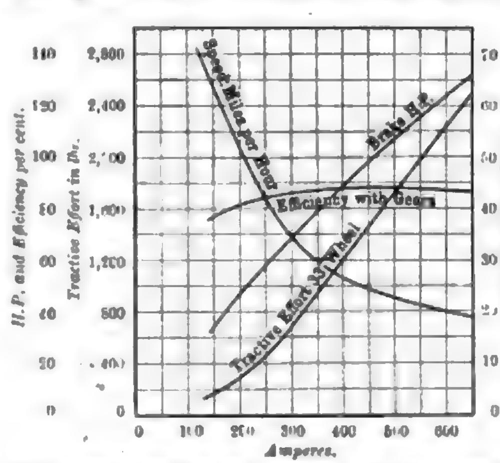

FIG. 5.—PERFORMANCE CURVES. No. 91. WESTINGHOUSE A.C. RAILWAY MOTOR. 200 VOLTS. 3,000 ∼. GEAR RATIO, 20 TO 62.

The field coils of the single-phase motors are wound with copper strip bent on edge and insulated. The field coils are connected permanently in series. A drum type core with open slots is wound with machine-formed coils of copper strip connected in multiple. The coils are held in place by a retaining wedge of hard fibre, which fits in grooves punched in the armature teeth. There are no band wires over the core. The motor is wound for 225 volts and a frequency of 25 cycles or less. At normal voltage and full load the speed is 700 revs. per min. Characteristic curves are shown in Fig. 5. The frame of the alternating-current railway motor is of cast steel, but the entire magnetic part of the field (poles and yoke) is laminated. The poles are shorter than those of the direct-current motor, and carry only a very few turns of heavy strip winding. The armature is in all essentials similar to that of the direct-current motor, having much the same general dimensions, and being fitted with the same commutator. Instead, however, of only two brush arms, the lower voltage, and consequently larger current motors of the alternating-current type, require one set of carbon brushes per pole. The armature and field coils are connected in series precisely as in the direct-current motor, but there is an auxiliary field in addition, which is also placed in series with the main field and armature.

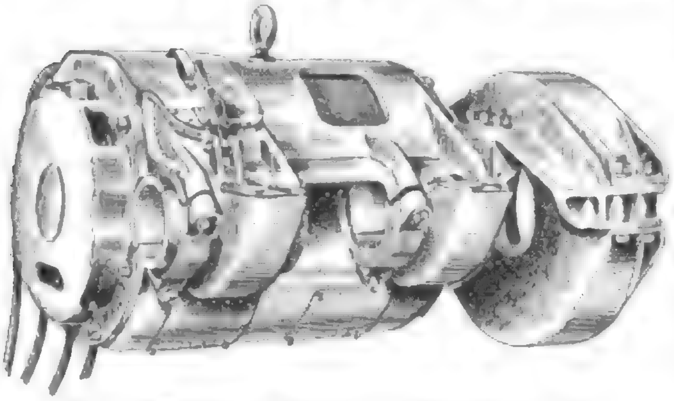

Fig. 6.—Westinghouse Single-phase Motor used on the Indianapolis–Cincinnati.

SURFACE CONDENSING PLANTS AND THE VALUE OF THE VACUUM PRODUCED.*

BY R. W. ALLEN.

The Paper opened with a statement of the various factors involved in the production of vacua, and the installation of condensing apparatus in power and lighting stations as applied to central stations for electricity supply. General questions which arise where the introduction of a condensing plant is under consideration in connection with an existing electric generating station were referred to; and the standardisation of condensing plants was suggested with a view to greater uniformity in design, and in sizes of various capacities, as well as economy. Increased interest is now being evinced among engineers in the subject of the condensation of steam, owing to the introduction of the steam turbine; and the difficulty of obtaining reliable information on the subject led the author to carry out certain experiments, whose results are given in the Paper.

Surface-condensing plants only are dealt with, and two series of experimental results are given, designated as "Series A" and "Series B." The results of Series A are from a condensing-plant attached to a generating station, consisting of three steam-driven generator sets of 365kw. total capacity, the generators being chosen as nearly as possible to run at their respective full loads, as the demand varied; those of Series B are from a specially-designed experimental plant capable of dealing with 3,000lb. of steam per hour, constructed and run under conditions approximating very closely to those pertaining to surface condensers directly connected with steam turbines.

A brief description of the construction of the surface condensers follows, and also the results of experiments made for determining the frictional loss of head in condenser-tubes in relation to the flow of circulating water through them. The use of reciprocating and centrifugal pumps for the circulating water is dealt with. An arrangement introduced by the author, whereby the lower rows of tubes of a surface condenser are submerged in the water of condensation, is described: experiments show that a gain in vacuum results from its use. The use of steam-driven and electrically-driven air and circulating pumps is mentioned, and special reference is made to the Edwards air pump and to the importance of water-seals on the air-pump discharge valves, and all fittings on the air-pump or condenser. As a check on the satisfactory working of the plant, the author adopted the practice of calculating what he terms the "vacuum efficiency," namely, the ratio of the actual vacuum obtained to that theoretically possible in a space filled with water vapour only, at the temperature of the condenser.

The trials of series A are then fully described. The amount of steam dealt with by this condenser varied between 4,500lb. and 7,000lb. per hour. All circulating and condensation water and all fuel used were carefully measured. Two tables of data are given, one referring to one generator set only at work with a load-factor ranging from 88 to 95 per cent., the other to two generator sets at work with a combined load-factor ranging from 72 to 75 per cent. The range of vacua used was from 5in. to 25in. of mercury. Two diagrams, plotted from the data in these tables, show the relation between the vacuum and each of the following items:—

1. The temperature of air-pump discharge.
2. The steam consumed by the condensing plant engine.
3. Indicated horse-power of the condensing-plant engine.
4. Circulating water used per pound of steam condensed.
5. Steam per kilowatt-hour.
6. Coal per kilowatt-hour.

The unaccounted-for water-losses in the whole cycle of operations amounted to 4·5 to 7·5 per cent. of the total water evaporated by the boilers, even when every care was taken to reduce this loss to a minimum.

Particulars are also given of the capital outlay and working costs of the plants, and comparison is made with non-condensing conditions, showing a gain in favour of condensing.

The trials of Series B differed essentially from those of Series A in bearing particularly upon the higher vacua required for steam turbines, and involving the following items:—

1. The area of tube surface of the condenser.
2. The effect of the temperature of steam entering the condenser upon the vacuum produced.
3. The possible vacuum efficiency and its relation to air leakage into the plant.
4. The heat taken up by the circulating water during transit through the tubes.
5. The volumetric capacity of the air pump per pound of steam condensed per unit of time.

The load dealt with by this plant varied between 1,500lb. and 3,000lb. of steam per hour, and the temperature of the circulating water supply ranged from 65° to 85° F. The vacuum obtained ranged from 26½ in. to over 28½ in. of mercury, and the vacuum-efficiency obtained during the test was 98·5 to 99 per cent. Diagrams given in the Paper show the relation between the vacuum and the quantity of circulating water per pound of steam condensed per hour, for various amounts of steam in the same condenser; while the Tables give other information bearing on the subject.

The author then gave illustrations of existing installations of various kinds where such higher vacua are used; and the paper concluded with a description of the vacuum-gauges in use, and of the kinds which were found to be most serviceable, accurate and simple in construction, for the class of work under investigation.

Cement covered Wood Poles for Telegraphs.—According to Mr. M. Kastler, in the *Schweizerische Elektrotechnische Zeitschrift*, wooden poles—completely covered with a 1¼in. to 2in. layer of cement—have been tried and experimented with for the last three years. During this time they have proved entirely satisfactory, and it is hoped that they will be as durable as well-kept iron poles, over which they have the advantage of cheapness. The wooden pole is first surrounded by a wire netting supported from the pole by suitable iron brackets and iron bars. After this has been done the whole of the pole is covered with cement to the thickness mentioned. Such cement-covered wooden poles, in lengths of 39ft., 42⅔ft. and 46ft., have recently been employed by the Zurich electricity works. Before adoption some tests were made on a pole 12 metres (39ft. 4in.) long, having a diameter of 7·9in. at the top and 12·4in. at the base. The length of pole embedded in the ground was 1·6 metres (5ft. 3in.), and the pole was subjected to a pull at a point 10·2 metres (33ft. 5in.) above the ground, the force being gradually increased until the pole broke. This took place when the pull reached 1,068kg. (2,370lb.), and it was observed that the deflections were very nearly proportional to the force applied up to the moment of breakage. For a force of 838kg. (1,860lb.), for instance, the deflection was 89cm. (2ft. 11in.).

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* Abstract of a Paper read before the Institution of Civil Engineers on Tuesday.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Dimensions of Electric Quantity.—By a curious mathematical artifice, V. Fischer endeavours to make out a case for putting the dimensions of electric quantity simply equal to those of mass—viz., M. Starting from the fact that the mass required to exert upon 1 gramme at a distance of 1cm. a gravitational attraction of 1 dyne is 15 million grammes, he brings this number into relation with the values found for the ratio e/m, which range from 11 million to 19 million. He puts the Newtonian law of gravitation into the form

$$P=\frac{1}{\epsilon}\,\frac{m'm''}{r^2},$$

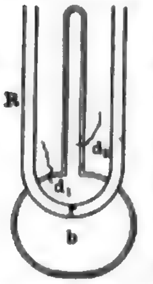
and Coulomb's law of electrostatic attraction into the form

$$P=\frac{1}{\epsilon}\,\frac{e'e''}{r^2}.$$

Putting $1/\epsilon=1$ as in the electrostatic system, he gets $e/m=1{\cdot}5\times10^7$, which resembles the value found for the same ratio in the electromagnetic system of units. He defines the "electric gramme" as 15 million ordinary grammes.

[V. FISCHER, *Physikalische Zeitschrift*, February 15, 1905.]

Control of Thermo-couples.—In measuring temperatures by means of thermo-couples it is necessary to keep one junction at a constant temperature, which may be called the fundamental temperature. This is usually that of melting ice. Now various circumstances may occur which raise the actual temperature of the junction above that of the melting body. When that occurs, special arrangements must be made to bring the junction back to the fundamental temperature, but the difficulty lies in ascertaining whether that has occurred or not. F. W. Adler has therefore devised an apparatus which indicates when the constant junction has deviated from the fundamental temperature. It consists of a thermometer whose bulb *b* is filled with mercury. A tube, R, containing the thermo-couple is fused into and through the bulb, and the junction is placed at *r*. A platinum wire, d_1, is fused into the bulb in contact with the mercury, and another, d_2, is fused into the stem at a height depending upon the accuracy aimed at. When the instrument is properly charged, the mercury will reach d_2 as soon as the temperature exceeds a certain amount, and this contact can be employed in connection with any current indicator to warn the observer.



[F. W. ADLER, *Annalen der Physik*, No. 15, 1904.]

Transparent Iron Films.—It is easy to obtain transparent iron films by the ionoplastic method, in which the iron is deposited by cathode disintegration, but in attempting to measure the thickness of such films serious difficulties are encountered. The method of iodisation, though applicable to silver and copper, does not work well with iron, and the conversion of the iron into oxide does not make exact measurements possible, owing to the inconstant composition of the oxide. An accurate method consists, according to L. Houllevigue, in dissolving the iron film in aqua regia and comparing the colouration of the solution with that of a standard solution of a known ferric salt. This, again, has the disadvantage of destroying the film whose thickness is to be measured. The author has, therefore, worked out a purely optical method, in which the error does not exceed 25 per cent. The method consists in measuring the transparency of the film in a Lummer-Brodhun photometer. Since the light transmitted by the film is grey it absorbs all rays equally, and the absorption is proportional to the thickness. The coefficient connecting the absorption and the thickness is determined by the colorimetric method mentioned above as involving the destruction of the film. Thus the author found for a film of 0·024 milligrammes per square centimetre a thickness of $39\mu\mu$ and a transparency of 0·114. With a film of 0·056 milligramme per square centimetre, the thickness was $72\mu\mu$ and the transparency 0·0093; this transparency is, however, subject to a correction for reflection.

[L. HOULLEVIGUE, *Comptes Rendus*, February 13, 1905.]

Dielectric Hysteresis.—C. E. Guye and P. Denso have made some measurements of the heat developed in paraffin when subjected to the action of a rotating electric field, which complete the series of facts necessary to establish the existence of dielectric hysteresis is a quantitative manner. The apparatus consisted of four metallic armatures arranged in a square and embedded in paraffin. Between these four armatures a rotating electric field was produced whose circular character could be minutely verified. The heat disengaged was measured by means of an iron-constantan thermo-couple whose hot junction was placed in the centre of the rotating field, while the cold junction was placed in a similar apparatus unconnected with a source of electricity. The results show that for the same frequency the energy disengaged in the form of heat is proportional to the square of the pressure, as in the case of slow alternating fields. For the same pressure, the power consumed and converted into heat is proportional to the frequency. The ratio between the power absorbed in the rotating field and that absorbed in the alternating field, both having equal pressure and frequency, is about 2·56.

[GUYE and DENSO, *Comptes Rendus*, February 13, 1905.]

Alternate-Current Electrolysis.—A. Brochet and J. Petit have succeeded in analysing certain organic acids by means of an alternating current, and have observed a high efficiency of the alternating current. They used a test tube containing about 150 cubic cm. of solution, and ribbons of platinum as electrodes, the mean current density being 1 ampere per square centimetre. The solutions used included solutions of the formates of potassium and barium, and acetic and oxalic acids. With the potassium formate, the results are extremely variable, and the electrodes are rapidly covered with a light deposit of carbon. The efficiency rapidly diminishes, and it is necessary to make the measurements quickly, and to calcine the electrodes after each experiment. The carbon obtained does not adhere to the electrodes, but spreads through the liquid and gradually falls to the bottom. The gas developed is nearly pure hydrogen, with a very slight admixture of oxygen and carbonic acid. The efficiency is 80 to 90 per cent. The barium formate gives about 65 cubic cm. per minute of a mixture of hydrogen and carbonic acid, the efficiency being about 75 per cent. There is practically no oxide of carbon disengaged. The analysis is in every way similar to direct-current analysis.

[BROCHET and PETIT, *Comptes Rendus*, February 13, 1905.]

The Solar Constant.—A. Hansky has determined the constant of the sun's radiation in the course of some actinometric measurements made on the summit of Mont Blanc under particularly favourable conditions. The solar constant has been given values which show a steady increase at each successive observation. Thus Pouillet gave it as 1·763, Violle as 2·54, Crova as 2·83, Langley as 3·068 and Angström as 4·0. The author is convinced that the last value is considerably too high. He makes out that it lies between 3 and 3·5 calories, but that it is certainly higher than Langley's value.

[A. HANSKY, *Comptes Rendus*, February 13, 1905.]

Gravitation.—A. Föppl has endeavoured to discover any effect that rapid motion may have upon the transmission of gravitational attraction. For this purpose he suspended a weight within a few millimetres of a flywheel 50cm. in diameter, which weighed ½cwt. and could be given a tangential velocity of 60 metres per second. The flywheel was cased in tinned iron in order to prevent the effect of air vibrations and air currents. The author obtained a deflection, apparently due to increased attraction, and amounting to a few thousandths of a millimetre. He is, however, convinced that this result is due to observational errors, though he is unable to account for them, especially since the deflection does not increase when the vibration of the supports increases. He repeated the experiment with a torsion balance enclosed in a cardboard box, and then obtained no perceptible deflection. He points out, however, that his experimental means were somewhat inadequate.

[A. FÖPPL, *Physikalische Zeitschrift*, February 15, 1905.]

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ELECTRICITY SUPPLY IN PARIS.

The electric lighting of Paris—La Ville Lumière—has always been in a peculiar position of instability. While in London the purchase by the Local Authorities of the electricity supply undertakings owned by the various Companies will take place in 1931, the City of Paris, being governed by a Municipal Council far more socialistic than our much-reviled London County Council, might have been in a position to turn out four of its six Electric Lighting Companies in April, 1907, and the other two in August and December, 1908, respectively. We use advisedly the colloquial but expressive phrase "turn out" and the dubious "might have been," for, although the majority of the Companies' licences will cease in two years' time, and their distributing networks will become the property of the city, the Municipal Council has so far made no provision for taking over the supply itself—in fact, the Council has not even made up its mind yet how it shall act in the matter. The terms of the Companies' concessions were somewhat complicated, but we believe we are right in saying that, when these concessions expire, the mains that are laid in the streets will become the absolute property of the Council, while no arrangement whatever has been made as to a compulsory transfer of the generating stations, the service wires or the meters. The Council may buy these at their fair market value, it is true, but only on the condition that they pay for the mains also instead of acquiring them gratuitously. During the last few years of their concessions, needless to say, the Companies are not over active in extending their systems or in reducing the prices charged for the supply of electrical energy, and complaints have been numerous.

The first step towards a solution of the difficulty has been the presentation of a report by a technical committee appointed to consider the question. This report, which has just been issued, considers the question from the point of view of what will be the best system of supply in Paris without taking account, in the first instance, of the stations now in operation there. It is estimated that works will be required in the near future of a capacity of 80,000kw. This the Committee propose should be provided in units of 5,000kw. placed in three generating stations. Steam turbines are preferred to gas engines for good reasons which are specified, and so as as to have an ample supply of condensing water for these the works are to be situated on the banks of the Seine. Three-phase generation at 8,000 to 12,000 volts is recommended, and two-phase and continuous-current three-wire distribution at 110 volts. In recommending a declared pressure of 110 volts rather than 220 volts, the Committee have been influenced by the fact that lamps for the former pressure are more economical (they have made tests demonstrating a 20 per cent. higher average efficiency under like conditions), by the disadvantage of the higher pressure in the case of arc lamp circuits, and last, but not least, by the existence of the 110-volt networks, the possession of which, as we have already stated, will eventually devolve upon the Council. These considerations outweighed the greater general economy of the 220-volt system.

It may be mentioned in passing that the existing Companies have a variety of systems of generation and distribution. Although 110 volts is, we believe, the declared pressure in all cases, there are two-wire, three-wire and five-wire continuous-current networks, fed directly or through sub-stations, single-phase systems with transformers to a large extent in the houses, and a certain amount of two and three-phase generation. It has been incorrectly stated in some French journals that the extent of the demand in Paris is twice as great as in London. This is far from being the case. As has already been mentioned, a capacity of 80,000kw. is deemed to be sufficient provision for the whole needs of Paris during the next few years: the capacity of the generating stations within the County of London was 156,252kw. on January 1st last. Later on in the report it is estimated that 52,500,000kw.-hours would be sold annually: in London during 1903 about 110,000,000 units were sold.

In the system outlined in the Committee's report, continuous current is recommended for the central districts which are the densest, and two-phase current in the thinner ones. The latter is chosen in spite of its greater cost in comparison with a four-wire three-phase system, on account of the greater ease in balancing and the simplicity in the arrangement of the circuits. A three-wire three-phase system is not even considered, all the calculations being based on a declared lamp pressure of 110 volts—as in the case of the continuous-current network. Motor generators are given the preference to rotary converters, and the frequency is fixed at 50∼ per second.

The estimates in the report are interesting, although they are not very detailed. They are based on a capacity of 70,000kw. The cost of the generating station is taken at £20 per kilowatt, sub-stations £6 per kilowatt, and network £28 per kilowatt (excluding service wires and meters), the total being rounded off, with allowance for miscellaneous expenses, to £4,000,000. Renewal fund is reckoned at a 10 years' rate for boilers, 15 for machinery and 35 for networks, corresponding altogether to 3·35 per cent. per annum. With an estimated output of 52,500,000 units this works out to 0·58d. per unit. The works costs are estimated as follows: fuel 0·47d. per unit, wages 0·41d., repairs and general expenses 0·30d., total 1·18d. Management charges are estimated at 0·30d., so that the total, including also 6 per cent. as interest and sinking fund (1·10d. per unit), and the 0·58d. per unit for renewals, comes out at 3·16d. per unit. It will be noticed that there is a substantial renewal fund in addition to a full allowance for sinking fund. On the basis of this 3·16d. per unit the question of tariff is considered, and this section of the report is one of the longest. A differential system of charging is chosen, with a first price for the first 400 hours per annum of 5d. per unit (52·5 c.), after which 1·05d. per unit (11 c.) is to be charged. But these 400 hours are not the first 400 hours of maximum demand, nor are they estimated on the actual kilowattage of consuming devices installed; they are the first 400 hours' use of the *nominal rating of the meter*. If the consumer has a 2kw. meter, his first 800 units per annum are charged at the higher rate, and the remainder at the lower rate. The system has, at all events, the merit of being novel, and over three pages of the report are devoted to proving that it is equitable and rational.

The conclusion of the report is inconclusive. Apparently it has not been within the province of the technical committee to suggest any solution of the deadlock that has arisen between the Municipal Council and the companies. It is estimated that five years would be required to realise the programme on the basis of a "tabula rasa." But, to avoid discontinuity in supply, use must be made for some years of the existing material owned by the Companies. In four years' time, it is estimated, two of the new generating stations could be built, the main feeders laid, the network in the industrial districts completed and about one-half of the central network. This includes one year for drawing up the specifications and letting the contracts. Another two years, making six in all, would see the completion of the central part of the network, and then the remainder of the scheme would be gradually carried out. Electrical engineers in this country will follow the successive developments with interest.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign book.)

The Becquerel Rays and the Properties of Radium. By the Hon. R. J. Strutt. (London: Edward Arnold.) 8s. 6d.

In this work the author gives a clear and connected account of the phenomena of radio-activity, freed as much as possible from technicalities and mathematical reasoning. After a brief review of the phenomena accompanying electric conduction in high vacua, a short history is given of the discovery of the radio-activity of the elements uranium, thorium, radium, actinium and polonium. The properties of the radiations from, and the accompanying changes in, these elements are then dealt with in detail. The last chapter contains a short account of the electrical theory of the nature of matter.

In Appendix B the theory of the deflection of cathode rays by an electrostatic or magnetic field is developed in an easy and ingenious manner. It should be pointed out, however, that the theory of a moving charge here given is of rather misleading simplicity.

There are several misprints. For instance, on page 87, line nine from the bottom of the page, "greater" should be "less"; on page 90, in lines eight and nine from the bottom, "dense" and "light" should be interchanged.

The author is to be congratulated on his very successful attempt to produce a popular and at the same time scientific book on this interesting subject. It should be especially useful to young students whose knowledge of electricity is not very deep.

A Short Introduction to the Theory of Electrolytic Dissociation. By J. G. Gregory. (London: Longmans, Green & Co.) 1905. 2s. 6d.

This little book is lucidly written, and will therefore be well received by students who desire to study the theory of electrolytic dissociation. We are not, however, quite sure that these students will purchase this book, because we are inclined to think that they would be more likely to buy a work on physical chemistry. In such a work they will probably find as much as they want, or at any rate think they want, about electrolytic dissociation, beside which in one and the same book they will find numerous other things dealing with physical chemistry in general. In making these remarks we are not depreciating the book which lies before us, but we are doubtful as to the wisdom of publishing so many volumes upon detached portions of chemical science. Only a few years ago works on physical chemistry were almost unknown in this country, now they are springing up on every side.

Mr. Gregory certainly makes out a very good case for the theory of electrolytic dissociation. A little more space might have been devoted to osmotic pressure and the lowering of the freezing point by dissolved substances. One of the most useful and suggestive parts of the book is where the author employs the ionisation theory to explain certain analytical processes—such, for example, as the reason why zinc sulphide is precipitated in the presence of an alkali acetate and only imperfectly from its combinations with the mineral acids. The book is to be heartily recommended as a clearly expressed contribution to the literature upon the subject. There is, however, one serious omission: there is no index.

Annual Report of the Smithsonian Institution for 1903. (Washington: Government Printing Office.)

In the general appendix to this report are reprinted some of the most important Papers on pure science which have been read before various learned societies. Among them are the following: "Radium," by Prof. E. Curie, at the Royal Institution on Feb. 13, 1904; "Experiments in Radio-activity and the production of Helium from Radium," by Sir Wm. Ramsay and Mr. F. Soddy, at the Royal Society on July 28, 1903; "The N-Rays of M. Blondlot," by C. G. Abbot, abstracted from the *Comptes Rendus*; "Modern Views of Matter," Romanes Lecture, delivered by Sir Oliver Lodge at Oxford, June 12, 1903; "Modern Views of Matter," address by Sir Wm. Crookes to the Congress of Applied Chemistry at Berlin, June 5, 1903; and "Terrestrial Magnetism in its Relation to Geography," address by Capt. Creak to Section E of the British Association, 1903.

Second Stage Magnetism and Elecricity. By R. WALLACE STEWART, D.Sc. (London: W. B. Clive.) 3s. 6d. 2nd edition.

Following the lines of the author's "higher text-book" on the same subject, the present volume is divided into three parts: electrostatics, magnetism and current electricity. The same scheme of treatment has been adopted, but the "second stage" book is, of course, less advanced. No words are wasted on long unnecessary explanations, and the author refrains from advancing any pet theories of his own—if he has any. The numerical exercises set are excellent, and we can recommend the book to candidates for the second stage Board of Education examination.

Die Wechselstromtechnik. By E. ARNOLD and J. L. LA COUR. Vol I., Theorie der Wechselströme und Transformatoren. By J. L. la Cour. 12m. Vol. II., Die Transformatoren. By E. Arnold und J. L. la Cour. 12m. Vol. III., Die Wicklungen der Wechselstrommaschinen. By E. Arnold. 12m. Vol. IV., Die synchronen Wechselstrommaschinen. By E. Arnold and J. L. la Cour. 20m. (Berlin; Julius Springer.)

In this work, of which four volumes have appeared whilst a fifth is in preparation, the authors have set themselves the task of setting forth in minute detail the theory of alternating-current phenomena in general and of alternating-current machinery in particular. There are, in addition, some chapters and passages of a more practical turn, but the theoretical part predominates. For a proper understanding of the volumes the reader should already possess a sound knowledge of alternating-current phenomena and their representation by graphical means, and he must also be well versed in higher mathematics. Nor is this all. To derive the greatest benefit, he should be imbued with a keen critical spirit, able to distinguish the important from the unimportant, the good from the indifferent; for this is a distinct fault of the book, possessed in common with a large number of German publications, that the authors have mostly contented themselves with merely enumerating methods, arrangements and facts, without critically discussing their pros and cons, or their particular field of application. This is particularly unfortunate in Vol. III., which deals with the windings of alternating-current machines. A very large number of possible windings are here passed in review, but it is generally left to the student to puzzle out when and where a particular winding will give best results. It cannot be said that the book affords lively reading: theories, equations and diagrams follow each other in monotonous procession without any break, save in a few instances, in the form of, say, a stirring criticism or an interesting example. The work breathes the atmosphere of the college room, and the commercial aspect of the problems to be solved is not sufficiently considered. On the other hand, considered from the theoretical point of view, the present publication is one of the most complete we know.

The foregoing remarks refer to the work as a whole, and we will now proceed to deal as concisely as possible with the contents of the various volumes. The first volume opens with a short chapter on electric and electromagnetic principles. Herr la Cour introduces the conception of both lines of force and tubes of force; sine curves and their representation by vectors are then discussed, and a few pages are devoted to the application of the method of complex quantities—popularised by Steinmetz—to the representation of sine functions. All questions relating to the strength, phase relationship, &c., of current and pressure in alternating-current circuits possessing self-induction, capacity, or combinations of the two, are then solved, the means being both analytical and graphical. The end of the first half of the book is brought to a close by the description of various electric instruments, including the oscillograph. The second part of this volume gives an exhaustive theory of the single-phase and polyphase transformer and winds up with a mathematical treatise on power transmission.

Vol. II. is devoted entirely to transformers. Its theoretical part is largely a repetition of what was said on the same subject in Vol. I., but it is distinguished from the first volume by the application of the theory to practical cases, by the description of a number of transformers for special purposes (voltage regulators and choking coils), and by the addition of a large number of good illustrations and tables relating to actual designs by renowned firms. There is a clever chapter on the methods of testing transformers; the erection of transformers is briefly alluded to; instrument transformers are described, and various ways of changing two-phase transmission to three-phase transmission and so on are enumerated. In view of the increased importance which is being attached to alternating-current systems of traction, the chapter dealing with the application of "sucking" transformers—which perform analogous duties to the track boosters in continuous-current systems—to alternating-current railways will be read with interest.

Vol. III. deals with all manner of windings for alternating-current machines, and it is perhaps this volume which is of greatest interest to dynamo designers. Many of the windings are derived methodically from others, or are, again, combinations of others, and we doubt very much whether the majority of the windings proposed have ever been tried. This is, perhaps, the reason why the author is reluctant, as has been mentioned above, to assign to the different windings their precise sphere of utility. Chapters VIII. and X. deal with insulating materials and the mechanical arrangement and construction of windings, respectively. They are very complete and of much practical value.

Vol. IV., more than 800 pages in length, contains the most comprehensive theoretical and descriptive account of synchronous machines we know of, and it may safely be said that the engineer who has mastered the contents of this bulky book will be able to solve any problems relating to the subject with very fair accuracy. For the computation of the dispersion-coefficient the authors give three methods. The first is an elaborate calculation based on the data of the machine, and applicable only when the magnets are of simple form; the second method is an approximate one, and makes use of several empirical constants, while in the third case the authors mention the limits of dispersion-coefficients for normal machines. In the latter case the extreme upper and lower limits are given as 1·15 and 1·35. We venture to think that it would have been advisable to verify the more elaborate method on a number of actual machines, so that the reader could judge for himself in how far it gives more accurate results than the simpler ones. Rotaries, inverted rotaries and double-current generators are dealt with at length. As an appendix to the book there are a dozen folded sheets containing very good detail drawings of a number of alternators, synchronous motors, converters and motor generators.

In conclusion we may recommend the book without hesitation to those electrical engineers who revel in complicated problems relating to alternating-current circuits and machinery. The practical engineer and dynamo designer will benefit chiefly by the figures and drawings of machines of approved design and by the various chapters and pages which deal with the calculation, arrangement and design of details, although he will also find profitable reading in some of the theoretical portions of the book.

The volumes are well printed and profusely illustrated.

ELECTRICITY METERS.*

BY C. H. W. GERHARDI.

(Continued from page 744.)

CONTINUOUS-CURRENT METERS.

It will be noticed that all the alternating-current meters which have been described have been watt-hour meters, whether they be for the measurement of energy supplied to inductive or non-inductive circuits, and so far as the author is aware there have been but few examples of alternating-current ampere-hour meters—among which may be mentioned the Ferranti, Ferranti-Wright and Schallenberger—which have seen any extensive service. With continuous-current meters, however, it is different: the great majority of those meters which are suitable for continuous-current circuits *only*, are ampere-hour meters. There is, moreover, a greater difference between the meters of different makes, some depending on electrolysis and differing among themselves considerably, whilst those of the motor type may be divided into two classes —*i.e.*, the mercury motor class, and the commutator class. The permanent magnet plays even a greater part in the continuous-current motor meters than in those suitable exclusively for alternating-current, for in a great many instances it becomes an important member of the motor as well as of the brake.

The Acme Continuous-current† meter is a watt-hour meter of the motor type, possessing some novel features of construction. Fig. 38 illustrates the meter with its cover removed. The mechanism is mounted on a zinc base on which a cover of insulating material fits tightly. The main spindle carries an armature composed of an astatically-arranged iron core, magnetised by a stationary shunt coil. By employing such an armature it is claimed that a large torque is obtained with almost complete independence of external magnetic fields, and also that the hysteresis errors are so small as to be practically inappreciable. By using an iron armature no commutator is required on the main spindle, but a contact device for changing the direction of the current in the shunt coil (to reverse the polarity of the iron armature twice in each revolution) is mounted on a separate spindle. Sparking is reduced to a minimum by the introduction of a non-inductive resistance (in circuit with which is a small electro-magnet) in parallel with the armature coil, this auxiliary resistance being short-circuited except during the period of commutation. The point of reversal of the armature is a dead point, but a torque sufficient to carry the rotating part over this dead point is obtained by means of the electro-magnet referred to above acting on an auxiliary armature during the period of reversal. Acceleration above the desired speed is prevented by the usual magnetic brake.

Referring to Fig. 39, which is a diagrammatic view of the meter, the main spindle 3 carries the iron armature 6, whose pole-pieces 7 and 8 rotate respectively outside and inside the main coils 10, 11. The current in the shunt coil 9, which excites the armature, is reversed twice in each revolution by the commutator. The brushes 2 are connected with the stationary armature coil and the current is led to the segments by the contact blades 4 and 5, which bear on the ends of the commutator spindle. On the same spindle a disc is mounted having a number of pins round its periphery corresponding to the number of commutator segments. Opposite these pins two semi-circular discs, 13, 14, are mounted on the main spindle in such a position that they engage with the pins and turn the commutator the distance of one segment per half-revolution of the main spindle. The electro-magnet 16 acts on the auxiliary armature 17, and thus causes the torque, which carries the main spindle over the dead point. This electro-

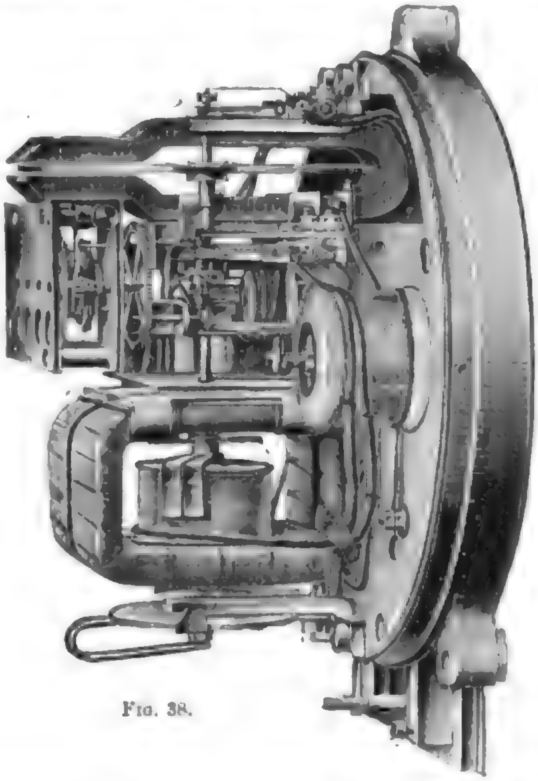

FIG. 38.

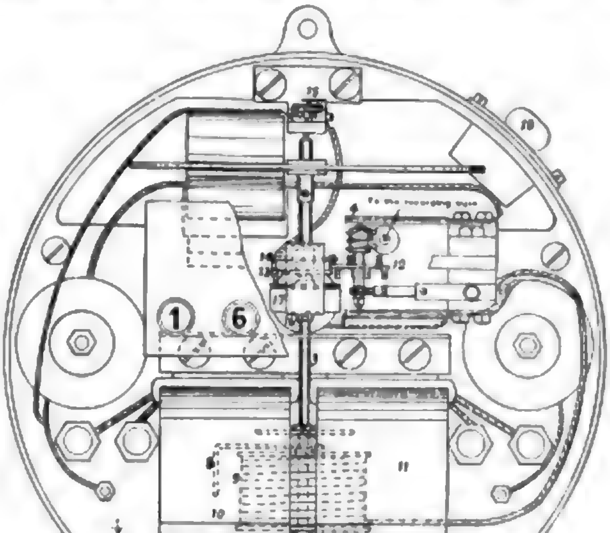

FIG. 39.

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* From a forthcoming book to be published by "The Electrician" Printing and Publishing Co. All rights are reserved.

† As in the previous section, the meters are described in alphabetical order.

magnet is brought into action by the contact device 15 fixed on the top end of the main spindle. The additional impulse comes into operation during about $\frac{1}{16}$th of a revolution, so that the contact friction due to the commutator is reduced to about $\frac{1}{8}$th of that in meters whose brushes are constantly in contact. Further, as during the change from segment to segment an additional torque is produced, the friction caused by the changing has not to be overcome by the driving torque. A worm on the commutator spindle drives the recording mechanism.

The shunt loss is stated to be about two watts, whilst the pressure drop at full load varies from 1·2 volts in the three-ampere meter to 0·8 volts in a meter of 50-amperes capacity. The author has not had an opportunity of testing this meter, which, in order to do away with the simple commutator, common to most continuous-current watt-hour meters, is rendered somewhat complicated.

The Bastian Meter.—The Bastian meter is an electrolytic meter, and perhaps the simplest in construction of any. It is in reality a voltameter, through which the whole current to be metered passes decomposing water into its two component gases, which are allowed to escape. The drop in level of the remaining electrolyte is taken as a measure of the ampere-hours (or Board of Trade units at a declared pressure) supplied to the consumer. In the older type, two platinum electrodes are suspended by the conducting leads in the bulb at the bottom of a long glass tube, the top of which is open. The bore of this tube is made as even as possible throughout its length, and the leads are enclosed in two vulcanite tubes screwed into a square vulcanite framing, which forms a mechanical protection to the platinum electrodes enclosed by it. A scale graduated in Board of Trade units at a definite voltage is fixed in front of the tube in such a manner that the level of the electrolyte can be easily read. The glass vessel is fastened in a cast-iron or tinned sheet case, having a door in front, in which is a long window enabling the height of the column of liquid to be seen from the outside. The leads from the electrodes are connected to terminals at either side of the case. The electrolyte is a dilute solution of sulphuric acid and water (a quantity equal to about 6 drachms of water is sufficient sulphuric acid for 5 and 10-ampere meters). As only the water is decomposed, it is only necessary to refill the tube with water. In order to prevent evaporation, which would naturally cause an error, paraffin oil is poured on the top of the electrolyte.

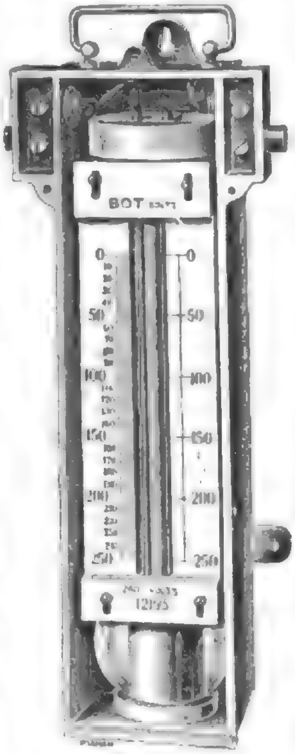

FIG. 40.

One of the chief objections to this meter is its large pressure drop, which is always more than 1·5 volts, due to the back E.M.F. An additional drop due to the resistance of the electrolyte brings the total drop up to 3 volts at full load on a 5-ampere meter. The drop is variable and depends slightly on the volume of liquid remaining, the maximum drop being at the zero (or top) end of the scale. Another objection is that the tube requires refilling periodically with water, the period depending on the consumption, which may vary considerably in different houses. If left too long all record of the consumption is lost. Each time the meter is refilled the record is lost and may lead to dispute between the consumer and supplier. The scale is held in position by screws passing through slotted holes, so that on refilling the final adjustment of the zero mark to the level of the liquid can be made by altering the height of the scale. The reading should be taken from the top of the water and not from the top of the oil. The calibration of the scale is conveniently checked by filling the tube up to the bottom mark (or maximum reading) with water, then by means of a burette, calibrated in cubic centimeters pour in quantities of water corresponding to those which would be decomposed by a definite number of units at the voltage on which the meter is to run. The following table gives the quantity of water decomposed by 10 Board of Trade units at different voltages.

C. cm. of water.	Voltage.	C. cm. of water.	Voltage.
34·64	100	15·76	220
31·5	110	15·1	230
23·1	150	14·4	240
17·3	200	13·85	250

The type "N" meter of this make is very similar in design to that just described. The electrodes, however, instead of being of platinum are of nickel, and they are immersed in an alkaline electrolyte which, it is claimed, has no action on the electrodes. The substitution of nickel for platinum enables the electrodes to be much larger at a reasonable cost, and, consequently, the drop due to resistance is reduced. The author has not had much experience with these meters, but has noticed that on the decomposition of the liquid the tube is left coated with a dirty deposit.

Fig. 40 illustrates an "N" type meter in which, it may be mentioned, the terminals have also been improved. The leads are now pushed through bushed holes in the case to brass binding posts, sulphured in the two compartments, one on each side of the meter. In this way all danger of ignition of the gases given off by a small spark in the terminal is avoided.

This meter is open to the same objections as the former as regards loss of reading and refilling—against which may be balanced its extreme simplicity, its straight line law, and the small chance of its getting out of order, provided that it is properly attended to, that is to say, regularly refilled before the reading is lost. Its accuracy depends on the accuracy with which the scale is calibrated, together with that with which the last reading before refilling is taken, and on the setting to zero correctly. The reading becomes difficult if the meter is bubbling much at the time of refilling, in which case it almost becomes necessary to have the lights off.

(*To be continued.*

THE VALUE OF OVERHEAD MAINS FOR ELECTRIC DISTRIBUTION IN THE UNITED KINGDOM.

The following is an abstract of the discussion on the Paper on overhead mains read by Mr. G. L. Addenbrooke before the Institution of Electrical Engineers on February 9th. We published the Paper in our issues for February 10th and 17th.

Mr. J. GAVEY thought the Paper had come at an appropriate time, and hoped that the result would be that local authorities and other bodies and individuals who opposed so strongly the erection of overhead wires throughout the United Kingdom would be induced to take a more liberal view of the requirements of the electrical industry. Before dealing with the wayleave question, he would like to ask one or two questions on the Paper. One of them was with regard to the varying cost of the erection of wires of the same type to provide for carrying varying voltages. Was this extra cost due to the additional precautions that had to be taken in carrying high-pressure wires across roads, where naturally some precaution would have to be taken to protect the public? In a thickly-populated country like the United Kingdom, where roads were crossed, the wires would have to be either taken underground or left overhead and enclosed in cages or lattice carriers. He would also like to know if the costs quoted included wayleaves, which, as a rule, although they were payable annually, would have to be capitalised. When erecting long lengths of overhead wires across private property it was possible that now and then a dispute would arise with the landowner and the wires had to be diverted. This was an item which came under the head of maintenance, but it must be provided for. Another point was whether three wires would suffice to maintain a continuous and uninterrupted service day and night, year in and year out? Members of the Institution who took part in the Italian visit would probably remember the great installation of the Edison Company at Milan, where they transmitted about 13,000 H.P. a distance of some 20 miles by overhead mains. But there they had 18 wires provided in six groups of three, nine wires being on either side of the poles. He was told by Mr. Semenza that normally the energy was transmitted over all the 18 wires, but to effect repairs and carry out alterations the energy was switched over to nine wires on one side of the poles, the other nine being left absolutely free and available for repairs. Contingencies would arise which would cause faults, such as the breakage of insulators, the piercing of insulators by the high pressures, &c., and provision must be made for effecting these repairs. On the matter of underground mains, it was stated in the Paper that to increase the number of conductors it was necessary to repeat the original expenditure. But it was usual to lay spare ducts when laying down the original mains, into which additional conductors could be drawn from time to time as the need arose. The most important of the highways in England already carried telegraph and telephone wires. Three-phase transmission on open wires caused a great deal of inductive disturbance, both electrostatic and electromagnetic. When in Italy he ascertained that along the Valtellina railway the disturbance was so great to the telegraph and telephone wires that in order to avoid doubling them throughout the whole length of the line they had to establish repeaters at each end of the line at some considerable cost. He admitted that in this particular instance the conductors which carried the high-pressure energy and also the feeding conductors were erected so unsymmetrically that nothing but extreme disturbance could have been expected. On the line from Milan to Lake Maggiore, however, the transmission conductors were erected in a far more symmetrical manner. They were equally spaced throughout, and, moreover, the precaution had been taken of revolving the conductors in the same manner as telephone conductors were revolved, so that the disturbances on the neighbouring telegraph and telephone wires were reduced to a minimum. But all the same he was afraid that if overhead power mains were carried along our main roads in the immediate neighbourhood of telegraph and telephone wires considerable disturbance would arise. By negotiating private wayleaves the line would be freer from accidental disturbances due to interference from mischievous people. It would also be freer from trees and the consequent damage from falling boughs. There was another point which might not be known. In carrying overhead wire across cultivated ground in smoky neighbourhoods it was well to avoid localities in which luxuriant vegetation existed, because the smoky acids acting on the copper generated salts, which the rain washed down on to the vegetation beneath, and it was rather destructive to the vegetation. Thirty-five years ago, when the State acquired the telegraphs every man objected to a pole in his neighbourhood. After a time this objection quieted down, but he was sorry to say that during the last few years there had been an extraordinary recrudescence of the obstruction to the erection of open wires. Local authorities, private individuals and all those who thought they had an interest in the matter had assumed that in all cases wires could be and should be placed underground. They paid no regard whatever to the cost involved. If they were told that under certain conditions it was impossible to lay underground wires —for instance, in the case of a long trunk line—they quietly assumed that they were not being told the truth, and they opposed without the slightest consideration of the questions of cost or efficiency. He only hoped Mr. Addenbrooke would succeed in removing some of these objections and he was sure that everyone interested in the progress of electrical work would join him in that wish.

Mr. R. S. PORTHEIM said the Paper was particularly interesting to him because his firm was intimately associated with the North Wales Electric Power scheme which depended in its very essence upon the use of overhead wires. With underground cables, that scheme would be commercially absolutely impossible. This was the first instance in this country in which a power company had been started on a scale of any magnitude with free powers as far as their act was concerned as to the use of overhead wires, provisional only on the Board of Trade consent. The energy would be transmitted by overhead wires at 10,000 volts along public roads, and the total power to be transmitted from the water power station at Snowdon would be 10,000 H.P. Some 60 miles of mains were now being completed. The total cost of the overhead wires in the North Wales scheme, having three or four feeders to a radius of 40 miles from the power station, was under £40,000, and the same cost in underground cables would have been nearer £150,000. With regard to the erection of these wires, they had found the Board of Trade exceedingly courteous and very reasonable indeed considering it was a pioneer installation. A railway was also being constructed by the North Wales Power Company, the 10,000-volt feeders for which would run parallel to the trolley, and the only stipulation made by the Board of Trade was that the feeders for the railways should be two pole lengths distance from the trolley. The Board was of the opinion that unless this were done, if a high-tension feeder broke the lives of the passengers in the train would be endangered. On the Valtellina railway, in spite of the fact that it had run for over two years and there were 20,000 volts on the same poles as the trolley wire, there had not been one single accident of any kind. In the North Wales scheme it was found better to give a few pounds for private rights of way than to run the mains over the public roadway. For a small consideration the Welsh farmer did not seem to object to having poles over his ground. It was better than running the risk of trouble with the Post Office through interference with the telegraph and telephone wires. As regards crossing public roads the Board of Trade had given the North Wales Company permission to do this at 10,000 volts, and no trouble was anticipated.

Mr. C. P. SPARKS took exception to the tone of the author's reference to the Board of Trade in his Paper. Together with every other nation we started to distribute electrical energy in this country with overhead wires. The act of 1882 required the express consent of the local authority before they could be used. Owing to the fact, however, that the conditions of the 1882 act were very stringent, many undertakings were started without any Parliamentary powers at all, and the earliest transmissions were by overhead wires. In 1888 an amendment of the 1882 act was made, and by sec. 4 the Board of Trade was empowered to require that the use of any overhead wires should be discontinued. If they were of the opinion that they were unsafe to the public or interfered with the Post Office they could call upon the undertakers to remove them. Up to that period the work had been principally in towns, and a good deal had been done in London by overhead wires. The Board of Trade, not for the reason that the work was badly done or that it was specially dangerous, prohibited their use in towns, and he thought this was a perfectly justifiable action in London or any similar big city. But the real veto to the use of overhead wires outside towns had not been the Board of Trade at all, but the local authorities. Under the act of 1888 the local authorities alone had the veto. Then we came to the power bills referred to by Mr. Portheim, and in most cases the local authorities' veto was removed and the Board of Trade could be called upon if the promoters thought the consent was unreasonably withheld. In his opinion, the power people had until recently ignored the extreme importance of low distributing capital cost. Now came a Paper by Mr. Addenbrooke throwing the whole blame on the Board of Trade; it was not quite fair. It had been suggested before Parliamentary committees and in the papers that possibly the interests of powerful people in the shape of cable makers had had something to do with this matter and really this was quite obvious. Wayleaves were the great difficulty; there was no doubt about that, for it was quite possible that after having obtained wayleaves over two-thirds of the route, the remaining one-third would ask such exorbitant terms that the whole scheme would fall through. The solution of the matter was to work along the main roads, avoiding, if possible, the routes chosen by the Post Office. He had some experience in the matter having been connected with the Grosvenor Gallery station in 1885 and 1886. Recently, also, he had erected overhead mains for 3,000 volts the pole route being 8½ miles, conductors 17 miles, radiating 14 miles from the centre to supply four collieries in one case and six in another. The poles were on private property and had to cross public roads, a railway company three times, and the Post Office wires many times. In all cases he negotiated without difficulty, and the requirements of the Post Office and other bodies were easily met. Referring once more to the Paper, would Mr. Addenbrooke give the basis of his calculations in the comparative tables which was said to be "On the basis of 1 per cent. loss per mile"? Was that energy loss or pressure loss? If the latter, it might affect the calculations to a considerable extent.

Mr. H. M. KENSIT said he had recently negotiated for two pole lines of 9 and 3 miles in length respectively, and from the time this had occupied it seemed that it was necessary to allow at least six to eight months for negotiation even for short lines. The law of arbitration in Italy concerning this matter was very interesting, and a law of this kind in Great Britain would be of immense service. In connection with some of the work which he had had in hand he had been asked whether he had compulsory powers, and on replying in the negative the landlords had absolutely refused even to consider the matter. It might be argued that the telephone companies got on all right without an arbitration law, and why could not the power companies, but the fact that the Board of Trade would not allow a high-tension transmission line along the highways, and was opposed to their erection along the pathways made the obtaining of wayleaves by agreement a very different proposition to a telephonic line on the roadway. That poles were a nuisance in a cultivated field could not be denied, and their erection would not be met by a rent of 1s. per pole per annum, which was the price paid for telephone and telegraph poles set in the hedges. The price might be anything up to 20s.

Mr. W. H. PATCHELL, who was in the chair in the absence of the president, here interrupted Mr. Kensit, who was reading a written statement, and informed him that such a proceeding was against the rules of procedure, but that the Institution would be very pleased to print anything he cared to send in to the secretary.

Mr. A. BLOEMENDAL, on the question of wayleaves, mentioned a small case in which he had been interested which tended to show the views that some engineers held about the dangers connected with overhead mains. A power plant was being put down in the Black Country, the system being 500 volts continuous, and in connection with it there was a lighting installation at 105 volts for a private house 500yds. away from the central station. This lighting wire had to cross a private telephone wire and ran parallel to it for some distance, but he anticipated no trouble from this. When he had put the wires up, the telephone company insisted that they should either be taken down or be replaced by rubber-insulated cables, although he offered to put the ordinary nets between the two systems and also to insert at the end of the telephone system the ordinary protective fuses which had been used in Continental practice so largely. The bare wires were accordingly replaced with rubber-insulated cables, but as a matter of fact the covered wires would offer no real protection, as after a short exposure the rubber covering corroded. Another case came under his notice a short while ago. He was asked to report on the conversion to electric driving of the machinery in five pits belonging to a colliery company. He suggested erecting one central station at the central pit and using 3,000 or 4,000 volts transmission to the others by overhead wires. Unfortunately the "powers that be" refused to allow the overhead wires to pass through one or two villages and the scheme had to be abandoned, as underground cables would have made the cost prohibitive. He had been engaged during the past few years in carrying out a great many high-tension plants on the North Bohemian coalfields, and it was the usual practice there for companies owning more than one pit to erect one generating station and transmit energy by overhead wires to the others at 10,000 or 12,000 volts. The only thing the authorities required was that when crossing roads the high-tension wires should have a network underneath in case of breakage, and that where telegraph and telephone wires were crossed, the instruments lying at the end of the piece which was being crossed should be protected by the well-known telephone or telegraph fuses. On the question of the breakage of overhead wires, when he visited an overhead wire installation he made it a point to inquire from the managers as to the breakages that occurred. He had visited installations in Italy, Switzerland, South France, Austria, &c., and for a number of years he had never come across a single case of breakage that had involved any damage to life or property. He only knew of one case in which a breakdown had occurred, and this was upon an 11,000-volt installation in Northern Hungary during a most severe snowstorm and gale. His practice was to put an earthed copper loop on each insulator, so that when a breakage occurred the wire was short-circuited and consequently was harmless. Another plant which he designed, and which had been running for two years, was a 21,000-volt transmission plant in Styria which carried current for 34 miles and supplied the town of Gratz for lighting, tramways and power. He specially mentioned this because there were only three wires and no reserve wires of any kind, and during the whole of this time only one single interruption had occurred, and that was through a sparrow flying into one of the lightning protectors and causing a short circuit. He had not experienced very great troubles from lightning. On the Styrian high-tension plant mentioned above he had found it entirely sufficient to use the well-known Wurdz type of lightning arrester, and in no case had the machinery been damaged through lightning, although this was a district where very heavy and severe thunderstorms occurred. At distances of ¾ mile they had placed a modified form of horn lightning arrester—viz., with the addition of magnetic blow-outs. The resonance was practically nil, and no static interrupters were in use, as would have had to be the case with underground cables; neither was there any difficulty in switching on and off, although there were a large number of transformers in use at seven or eight sub-stations. The breakage of insulators by boys and men throwing stones had been referred to in the Paper. At the Styrian installation some difficulty had been experienced at first, but instead of resorting to the police as an effective measure, they had resorted to the schoolmaster and the parson, with the result that after about a fortnight or so they had no more cases to report.

Mr. PATCHELL asked Mr. Bloemendal how he earthed the lightning arresters: was it through a resistance, and if so, what was its value? Perhaps Mr. Bloemendal would add this when revising his remarks for publication in the *Journal*?

Mr. F. POOLEY said that Mr. Addenbrooke had made out a very good case for high-tension feeders, and his first impression on reading the Paper was that the case was too favourable to overhead conductors, but after verifying the figures he now began to wonder what was to become of the poor cable makers. It would seem that they had either got to shut up shop or turn their insulating machines into stranders. However, he did not agree with Mr. Addenbrooke that the cable makers were going to lose the distributing cables. Inside towns, where most of the consumers were located, all the feeding must be by underground cables. He did not think it was likely that there would be actual house-to-house connection with overhead wires. Therefore the cable makers could look upon overhead distribution as providing a fresh field which they would not otherwise be able to touch owing to the fact that unless cheap power was available small towns would not have the electric light at all. Enough had been said upon the question of wayleaves, but some years ago he had to negotiate a wayleave for a single pole, and the tenant of the land required £10 per annum rental apart from the sum that had to be paid to the owner for legal permission to erect the pole. The fact that we used underground mains was not the reason why we were behindhand in the application of electricity in this country. It was much more due to the fact that here we have certain vested interests competing, such as gas companies. Gas existed in almost every town before the electric light was introduced, whereas abroad, in Europe and America, they built the electric light station before they built the towns, consequently they had no one to turn out. With regard to faults, he did not think they were any more likely to occur than on underground mains, and even with a larger number of faults on an overhead system there would not be anything like the same dislocation to the supply, because it did not take so long to localise and repair them. The unsightliness of overhead distribution was really a serious objection. The Post Office had had a very good example of that recently owing to a proposal to take a line through Epping Forest. The painting of creosoted poles was impossible. Once a pole was creosoted and paint put on, the result was far from pleasing, for the creosote came through, and a most disgustingly mottled appearance generally was obtained. If it were decided to put up wooden poles, it was best to use pitch pine, which could be painted any colour, and such poles cut square looked very neat, and were at the same time inexpensive, and had an equally long life.

Mr. L. GASTER asked for information regarding the comparative value of copper and aluminium for overhead power transmission.

Mr. G. L. ADDENBROOKE, replying first to Mr. Gavey, said that the tables were made up from actual estimates and tenders, and the varying costs at different pressures were very largely due to extra insulators, longer poles of greater section, and in various other ways which it was rather difficult to specify. The tables were made up for only three wires after a good deal of consideration. He had obtained in various ways a great number of statistics, and found that on a very large number of installations over very long lengths only three wires were used, and these were found sufficient for running large manufacturing establishments. If more than three were necessary after the poles were up an extra line could be put up at very little more expense than the cost of the copper and the arms. He had not taken any advantage of that as compared with cables, although it was a most material one. A practical case of the advantages of overhead transmission was the following: He was part possessor of some coal mines in South Staffordshire in the area of the Midland Electric Corpn. for Power Distribution. He applied to the company for a quotation for a supply of energy, their circuits being within ½ mile of the mine. The company offered very favourable terms for current, but said that as the cost of laying the cables would be about £100, they would require about 5 per cent. interest on that, and a guarantee in addition—which he was unable to give. If, however, ½ mile of overhead mains could have been erected to take about 100kw., which was the quantity required at 6,000 volts, the cost would have been a very small sum indeed, and should the poles and wires have to be taken away they would still represent nearly three-quarters of their original value. As regards running circuits near Post Office and other wires, of course a great deal depended upon the question of crossing. He would not weary them by going into details, but these would be found in the pamphlet to which he had already referred in his Paper. It contained an immense amount of information on all these questions of a practical character from people who had had this class of work in hand some years, and they seemed generally agreed that, by having a sufficient number of crossings, they might be pretty near neighbours without having too much disturbance. There seemed a general consensus of opinion that it is quite possible to run telephone wires on the same poles, and it was the habitual practice almost everywhere to run a telephone circuit for signalling along the same line of poles underneath the high-tension circuit, and by crossing and twisting the induction was got rid of sufficiently to allow speaking over a considerable number of miles. Mr. Portheim's remarks seemed to confirm his own opinions as to the very great value of overhead mains. But of course the country in England differed very much from that in North Wales. It might be possible that in Wales the Board of Trade was allowing wires to be carried along the main roads but in his own negotiations he had practically been told that, at present, at any rate, this could not be tolerated.

Mr. PORTHEIM said the Board of Trade had given him permission in some instances for main roads. In other instances it had been cheaper to negotiate a private wayleave.

Mr. ADDENBROOKE said he hoped that to a considerable extent this general permission might be enlarged. As we became more accustomed to overhead wires we should find there were no accidents. He had some conversation with Mr. Brown in Italy on this subject and he had asked him if he knew of any serious accidents to members of the public, and his reply was that he could not recollect a single instance although he knew of one or two in which workmen had received shocks and even been killed through attempting to work on live poles. Coming to Mr. Sparks' observations, the words he used in the Paper with reference to the Board of Trade were very carefully chosen. The permission from the Board of Trade for the use of overhead wires was obtained by himself, and he obtained this permission after he had made an appeal to the committee of the Institution, who did not then see their way to help him. He did not think anyone, therefore, was in a position to say what opposition there was and what opposition there was not, except those who had seen the actual correspondence. The electrical officers of the Board of Trade had always been ready to meet one more or less half way, or to go even further, but the resistance to granting overhead wires in any practical form came from other directions. The year before last, at his own suggestion, certain questions were asked in the House as to what the President of the Board of Trade was doing in the matter, and Mr. Balfour had replied that up to that time permission for two undertakings had been granted. He thought it might fairly be stated that these were the only two undertakings in the kingdom for which such permission had been granted, and there was a very stubborn resistance on the part of certain people at the Board of Trade. People who had applied lately had seemed to get on pretty well, but these early permissions had had a good deal to do with it. He remembered the Grosvenor Gallery system very well; it was in his charge for some time. No doubt there was a good deal to be said for taking all the early work down, but it had remained up in other countries, and what he always said on the subject was that the world had not yet been burned down. There seemed to be an idea that unless mains were laid in accordance with the way specified by the fire insurance companies there would be universal conflagration, but the insurance companies abroad did not appear to have been in bankruptcy through the class of work done there. He maintained that it was a great pity that we should be deprived of using the class of work that had stood so well for years on the Continent. Mr. Kensit had spoken on the question of wayleaves in different parts of the country. Personally, he had had a double experience, for in one case the wayleaves had been easily obtained, whilst in another there had been a tremendous difficulty. Trouble was most frequently caused by the cantankerous trustee, or the solicitor who was "on the make." Then, again, the local authorities had their say in the matter, and a great deal of the local authority opposition was due to the solicitor who was their clerk. Mr. Bloemendal's remarks were very interesting, especially the reference to the schoolmaster and the parson. The report of the American Institute of Electrical Engineers included some replies on this subject, and the following means were returned as having been tried to stop damage to the transmission lines by mischievous persons: (1) By posting warnings; (2) Offering rewards for information; (3) Having watchmen along the line; (4) Arrest and fine. And the following footnote was added: "Not much success with any of the above methods." Perhaps the hint with regard to the schoolmaster and the parson might be acted upon. With regard to cable makers, if he thought he was going to do any damage to the cable industry he would not have written the Paper. His view was that a general adoption of overhead mains would lead to such an expansion of work that very much larger quantities of cable would be required. The cable makers could just as well work on overhead mains as underground cables. He took it there would be the same profit to be earned. With regard to wooden poles painted in America, and to some extent on the Continent, they were now beginning to run very much longer spans of overhead mains. The early mains were mostly of soft copper, but by using stranded hard drawn copper it was possible to run spans up to 150 and more yards quite easily. For these lines very light steel towers, costing something like £10 each, were used. With such towers it was very easy to carry the wires 10ft. or

15ft. higher than was customary, and thus they were more out of the way. These large spans enabled one, in an enclosed country like England, to go from corner to corner of fields and so avoid planting poles in the middle. He had had very little experience with aluminium wires, but what he had just said had a bearing on this matter. With long spans they wanted a wire with very high tensile strength, and he did not think aluminium was altogether suitable. He did not certainly look upon it as a very material factor in the future of overhead mains in this country. He had been told that his views on the question of overhead wires generally were Utopian, but in order to succeed in the future one had to make a beginning. There was some precedent for asking for compulsory wayleaves, for he believed local authorities already possessed a similar power with regard to sewers in order to follow the contour of the district, and so get a regular and steady fall; but he did not know whether the two things were quite analagous. Some sort of regulation, however, would be in the interests of the country generally.

THE OSMIUM LAMP.

The following is an abridged translation of a Paper on the Osmium lamp read by Herr Fritz Blau before the Elektrotechnischer Verein of Berlin on January 24th:—

The total energy radiated by a heated body is proportional to the fourth power of the absolute temperature of the body. As the temperature increases, the percentage of the short waves emitted, as compared with those of long length radiated, increases also very rapidly; but the absolute value of this percentage varies for different bodies, being smallest in so-called "black" bodies, but comparatively high in bodies with a metallic lustre and smooth surface. Only these short waves, it need hardly be said, are observed as light. An efficient light-giving body must, therefore, withstand very high temperatures; its radiating surface, at a given efficiency, should be as large as possible; the substance of the filament should be transparent or white to minimise the effects of blackening; the surface of the filament should not become blacker or rough with use, and its resistance should increase with increasing temperature.

Osmium, generally in the form of osmium-iridium, is found in platinum ores and also in gold sand with gold and silver. It is at present usually obtained by alloying the residue which remains when platinum is dissolved in aqua regia, with metals, such as zinc, lead or tin. The osmium-iridium passes thereby into a finely-divided state, and if it is now heated in a current of oxygen it will split up into osmium tetroxide and iridium. Osmium may then be obtained by treating the osmium tetroxide with any reducing agent.

When Herr Auer von Welsbach invented the osmium lamp some six years ago, he found it impossible to draw osmium in form of wire, and he first tried the expedient of coating platinum wire with osmium and evaporating subsequently the greater part of the platinum. It was observed, however, that a platinum-osmium alloy was formed which—when containing more than 4 per cent. of platinum—began to melt when the platinum was being evaporated. In order to keep the percentage of platinum below this figure, the finished filament had to be made about five times thicker than its platinum core. As uniform platinum wire was not obtainable in thicknesses less than 0·02mm., it will readily be seen that the osmium filaments could not advantageously be made in diameters below 0·1mm. Such filaments, however, are not suitable for lamps consuming less than 1 ampere.

The next and final step was to mix most finely divided osmium with certain organic binding substances to a thick tenacious paste. This paste is forced under high pressure through a diamond or sapphire die on to a card which is moved about in such a manner that the filament is deposited in loops. After drying, the organic binding substance is carbonised by heating the filament in vacuo. This porous filament, rich in carbon, is then gradually heated to an intense incandescence by an electric current in an atmosphere containing much steam and a certain quantity of reducing gases. The carbon of the raw filament changes into carbon oxide and carbon dioxide, and after a relatively short time the filament consists of pure, or very nearly pure, osmium only, the percentage of carbon being insignificant. Although the density of the filament has greatly increased during this process, the filament is still porous and its surface is far from smooth. After trying unsuccessfully several means of connecting the filament to the platinum leads, it was found that a very satisfactory method was to fuse them together by the electric arc. Osmium is brittle when cold, but soft when heated, and for this reason the lamps as made at present are required to burn in a definite position.

When the manufacture of this lamp was taken up by the Deutsche Gasglühlicht Actiengesellschaft, the highest voltage that the lamp could stand was 27 volts. After the lamps had been perfected to burn at 37 volts, they were put on the open market. The lamp voltage was soon after brought up to 44 volts, and during the last few months a considerable number of 55 and 75-volt lamps have been sold. Quite recently 110-volt lamps have appeared.

The filament of an osmium lamp for 37 volts, 25 c.p. (Hefner units), consuming 1½ watts per candle-power, has a diameter of 0·087mm. and a length of 280mm. The radiating surface is from 3 sq. mm. to 3·2 sq. mm. per candle-power. If an ordinary glow lamp be run at 1½ watts per candle power, its radiating surface per candle-power is only 1·6 sq. mm. The carbon filament, therefore, must be both hotter and "blacker" than the osmium filament. With an increase of voltage of 10 per cent. the current increases 6·5 per cent. in the case of the osmium lamp, and 12 per cent. in the case of the carbon filament lamp. The corresponding increase in illuminating power is 40 per cent. and 80 per cent. respectively.

It is not possible to state definitely the life of an osmium lamp, but 5,000 hours have been repeatedly exceeded. Figs. 1 and 2 represent the relationship of illuminating power to time—for a 37-volt lamp and 110-volt lamp, respectively. Blackening of the bulb is very rare (observed in 10 per cent. only of the lamps investigated so far).

The surface of the lamp filament is at first somewhat rough, but it gradually becomes smoother, and this is the reason why the candle-power increases during the first 250 hours or so. Before the lamp is ready for sale, it is burned in the factory for several hours in order to bring the lamp up to an approximately steady state.

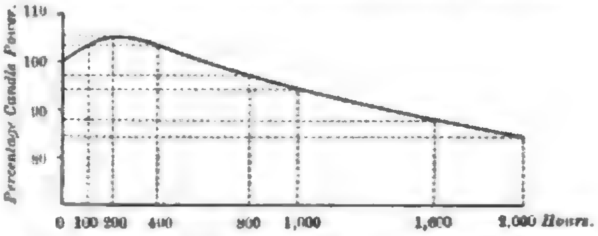

FIG. 1.—PERCENTAGE VARIATION IN CANDLE-POWER OF 37 44 VOLT AND 25 32 (HEFNER) C.P. OSMIUM LAMP.

If the lamp is run at less than 1½ watts per candle-power, the structural changes in the filament occur too rapidly for practical purposes. Nevertheless, lamps consuming 1 watt per candle power only, have been observed to burn for several hundreds of hours without decrease in light. When exposed to hard shocks, the osmium lamp filament is somewhat more liable to break than the carbon filament, but if properly packed the loss through breakages in transit is small, being only about 1½ per cent. These lamps stand the shocks of railway carriages and omnibuses very well. The osmium lamp is efficient also for very low voltages and a large number of 2-volt lamps for mines are in use in connection with portable accumulators. For a long time it was not possible to make thin filaments, but recently it has become feasible to reduce the diameter down to 0·08mm.

After the Paper had been read, Prof. Wedding mentioned some tests which pointed to the fact that the blackening of the bulb in ordinary carbon filament lamps had no marked effect in diminishing their candle-power. Amongst a large batch of ordinary 16 c.p. incandescent lamps he was testing there were four which burned 14,000 hours. During this time the illuminating power fell to 5 c.p. and 6 c.p. The original glass bulbs, which, of course were much blackened, were then replaced by fresh ones without damaging the filament. The illuminating power, however, had not benefited to any extent by the substitution, and Prof. Wedding concludes from this that the black deposit inside an incandescent lamp of the carbon type screens very little light.

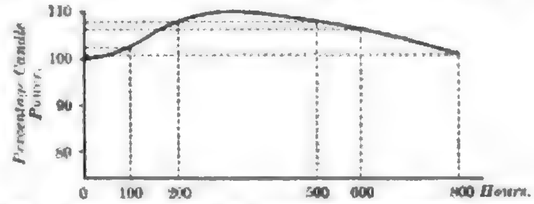

FIG. 2.—PERCENTAGE VARIATION IN CANDLE-POWER OF 110 VOLT 32 (HEFNER) C.P. OSMIUM LAMP.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Steam Pipes: Their Design and Construction." By W. H. Booth. (London: Archibald Constable & Co., Ltd.) 5s.

"Garcke's Manual of Electrical Undertakings, 1905." (London: 37 and 38, Strand.) 15s. net.

"Science Abstracts," February, 1905. Section A:—Physics. Section B:—Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

THE WATERLOO AND CITY RAILWAY.—WORKING RESULTS.*

BY HERBERT JONES.

(Concluded from page 750).

During the tests taken before and shortly after the opening of the line, it was found difficult to obtain a reliable speed curve. A tachometer was fixed in the motorman's compartment driven from one of the motor axles by means of a flexible shaft. This proved unsatisfactory, however, due to the large amount of movement between the bogie frame and car body on curves and crossings. Better results were obtained by using a stop-watch and entering the time every 100yds., the distances being taken from the lamps, which are 20yds. apart throughout the tunnels. The results were not entirely satisfactory, however, especially when plotted to a time base. The author now obtains very good results by using a recording instrument with a paper speed of 6in. per minute; the pen of the instrument marks the paper as each lamp is passed by means of a contact maker actuated by hand. The distances between the marks on the record give the speeds with considerable accuracy, at speeds up to 30 miles per hour. For higher speeds a greater speed of paper would be necessary. The speed curves in Figs. 4 and 5 were obtained in this way. The power used on a train varies not only on account of slight differences in driving, which depend on the motorman, but also according to the condition of the brake blocks and the requirements of the service which is being maintained. From some thousands of readings of meters connected up on the trains, it was found that the discrepancy between the units taken by the different motormen did not exceed 10 per cent. The average consumption per train-mile is obtained in the most reliable

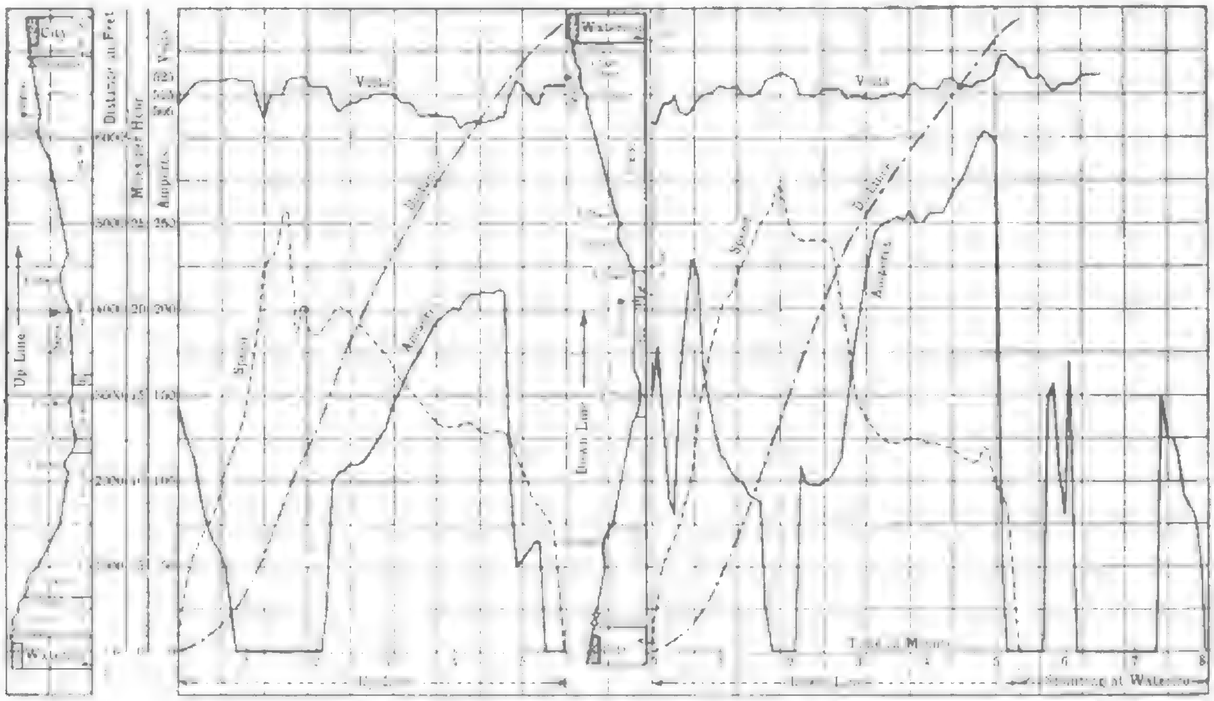

FIG. 4.—POWER CURVE. FOUR-CAR TRAIN, JUNE 3, 1904.

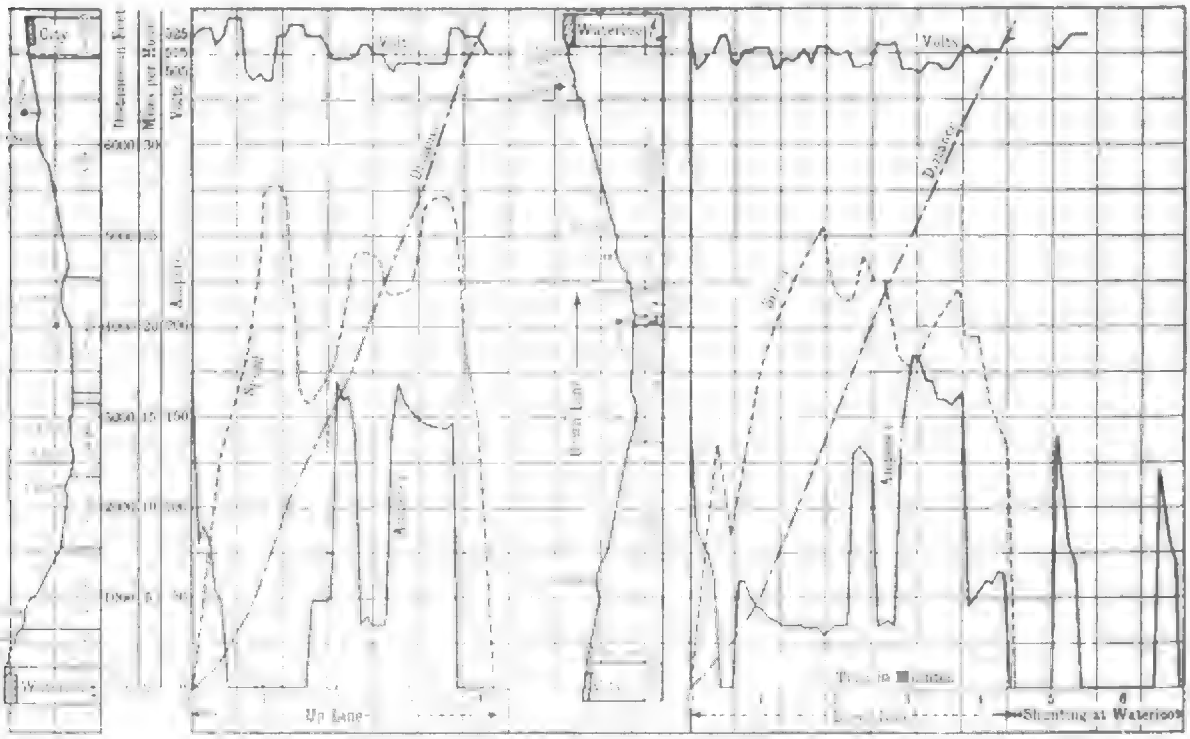

FIG. 5.—POWER CURVE. SINGLE MOTOR CAR, DECEMBER 16, 1904.

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* Abstract of a Paper read before the Tramways and Light Railways Association Feb. 23.

manner from the switchboard meters, and is given under the previous heading. The losses in distribution are less than 2 per cent. of the output, and have not been allowed for.

The results of the passenger count taken on Thursday, June 23, 1904, are plotted in Fig. 6. The passengers per hour curve was obtained by counting the number of persons entering and leaving the City station, and entering the advances of the counters at 20-minute intervals. The rise in the seating capacity curve after 10:30 p.m. is due to two four-car trains being brought from the City sidings to Waterloo as passenger trains to be examined and put ready for traffic the following morning. The train load-factor throughout the day in question is 30·6 per cent., a result which would be practically impossible but for the use of single cars at times of light traffic. Over 20,000 passengers are carried on wet or foggy days and on Saturdays in the summer; this increases the train load-factor to 38, and on rare occasions to 40 per cent. The average number of passengers carried per day during the first half of 1904 was 17,592.

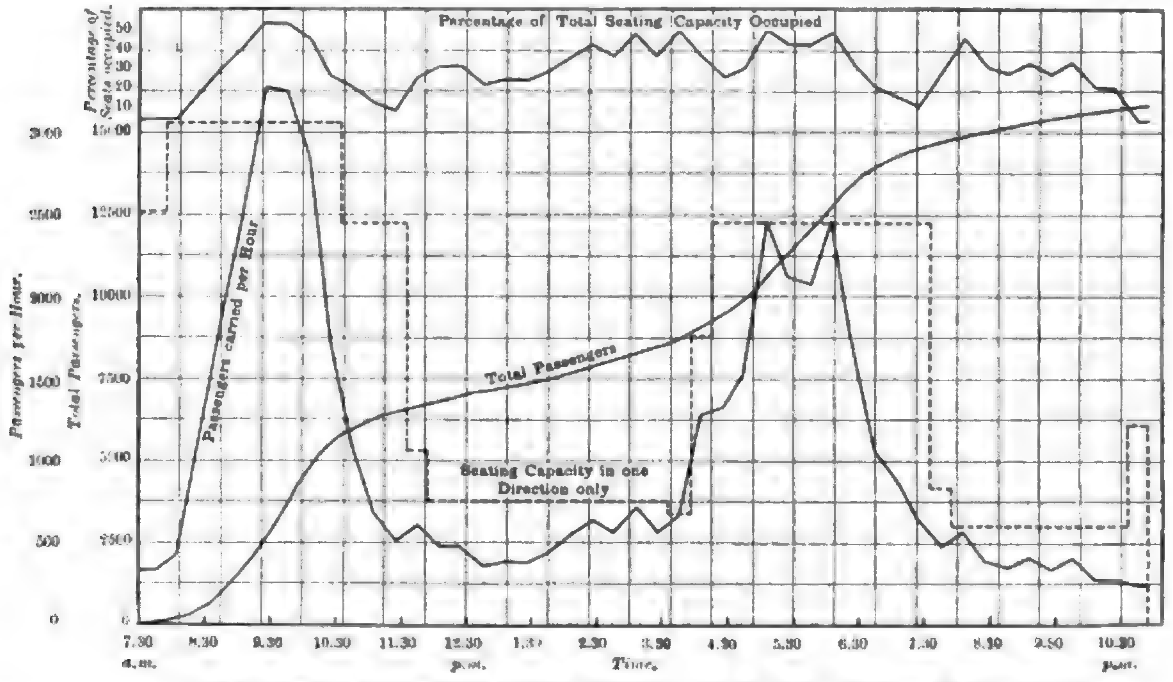

FIG. 6.—DIAGRAM OF PASSENGERS CARRIED, THURSDAY, JUNE 23, 1904. WEATHER FINE THROUGHOUT.

The following figures include all losses, such as coal used for stand-by and lighting-up purposes, and water used in the filling-up boilers and economisers after cleaning:—

Period, half-year ending June 30, 1904.

Total coal used	2,742,992lb.
Total water to boilers	24,192,900lb.
Average temperature of feed-water to boilers	172°F.
Actual evaporation per pound of coal	8·82lb.
Equivalent evaporation per pound of standard coal from and at 212°F. (excluding economiser)	9·56lb.
Total units generated	499,512
Water to boilers per unit	48·4lb.
Coal to boilers per unit	5·49lb.
Units used for traction purposes	350,570
Train ton-miles	6,023,610
Units per ton-mile (at switchboard)	0·0582
Coal used per ton-mile (at switchboard)	0·319lb.
Number of passengers carried	2,726,760
Units per passenger-mile (at switchboard)	0·0816

The time lost during the half-year in breakdowns and delays from all causes was 0·16 per cent. of the total running time, which amounts to a total delay to trains averaging about 8 minutes per week. This result is poor when compared with the corresponding half of 1903, when the figures were only 0·09 per cent., or a total delay of less than 5 minutes per week. These results are obtained under the exceptional conditions that for three hours daily all the four-car trains provided are necessary to maintain the service, so that a defect which makes it necessary to take a train over pits causes possibly four or five journeys to be missed subsequently, which is considered as equivalent to a delay of 16 or 20 minutes. Additional seating accommodation is now being provided, in order that the spare cars may be made up into a spare train. During the half-year the total number of train-miles was 92,304, of which 48,969 were four-car train-miles and 43,885 were single car train-miles

The works cost per unit generated during the half-year ending June, 1904, is given below. Management, directors and office expenses, &c., are not included, as the allocation of these charges between the several departments of a railway is a matter upon which there is considerable difference of opinion. The number of units generated was 499,512

	d.
Coal, including delivery	0·527
Water, oil and other stores	0·032
Wages, including engineer-in-charge	0·296
Repairs and maintenance	0·064
	0·919

The total receipts per ton-mile during the half-year ending June, 1904, were 0·692d., and the total expenditure 0·329d. The working expenses being at the rate of 47·55 per cent. of the receipts, a figure slightly above the average of the last three years. The following figures give the cost in pence per ton-mile in connection with the generating station, distribution system, trains and motors

Generating station's running, including wages, coal, water, oil and petty stores	0·071
Generating station, wages and materials for repairs and renewals	0·005
Distribution, wages and materials for cables, conductor rail, rail bonds and tunnel pumps	0·004
Running trains, wages and materials for motormen, examiners and cleaners	0·044
Car and motor repairs, including wages and materials for all train and motor repair work	0·020
	0·144

DISCUSSION.

Dr. ALEX. B. W. KENNEDY, in a written communication, congratulated Mr. Jones on the excellent results which had been obtained, as shown by the tests. He thought, however, that these could be much improved by the employment of batteries, and if he were designing the line over again he should most certainly put in a battery with an equalising booster

Mr. R. SMITH asked whether the sharp curves counterbalanced the good effects which might be obtained by coasting down the heavy gradients. He was surprised that the high boiler efficiency was raised by only 2 per cent. by the use of economisers, and when plenty of floor space was available for more boilers he doubted whether it would be advisable to instal economisers at all. The question as to the relative merits of the two types of conductor rail—viz., channel section and girder section—was an important one, and, personally, he thought the former was to be preferred, as it was not secured rigidly to the sleepers or insulators. With regard to the system of train control, he feared there would be serious troubles in connecting and disconnecting heavy cables when breaking up a train.

Mr. T. STEVENS said the author's statement with regard to systems of train control was misleading. The electromagnetic system was vastly superior to the electro-pneumatic, and the two ought not to appear in the same category. Direct control, such as that used by Mr. Jones, necessitated the building of special single cars, whereas the multiple-unit system did not. Hence the author's low first costs were delusive.

In his reply, Mr. **JONES** said that the gradients were of some value, but they would have been much more so if there had been no curves. Economisers were not very expensive in first cost, and the maintenance charges on them were inconsiderable. He was not so sure that the conductor rail of channel section was the right thing, after all, as they suffered so greatly from broken bonds, and this would probably not occur to so large an extent if the rail were of girder section. Experience taught him that it was better to have the armatures of the motors on the axles themselves, in spite of the fact that there was a certain amount of trouble with the windings at the commutator ends due to vibration in going over joints. He could not agree with Dr. Kennedy about the advisability of employing batteries, owing to the trouble they gave and the heavy maintenance charges which could not be avoided. Regarding the multiple-unit system of control, it was easy to split up trains on paper, but he did not think it was so easy in actual practice, and he did not know where it was done. According to the Board of Trade's newest regulations no motors were allowed in the middle of the train, and therefore the advantages of the multiple unit system disappeared. Thus, the only alternative was to run the main cables along the train.

Mr. T. **STEVENS** rose to inform the author that trains were actually split up on the Great Northern and City Railway, which was opened before the Board of Trade brought forward the new regulation about having no motors in the middle of the train.

ELECTRICAL TESTS ON THE VALTELLINA RAILWAY.

Some interesting tests, relating to the energy consumption of trains on the three-phase Valtellina railway, were communicated by Messrs. M. Novi & A. Donati to the Congress of the Italian Institution of Electrical Engineers, held in October last at Bologna. The average consumption of energy per ton-mile required by a train running between Lecco and Sondrio and between Colico and Chiavenna, ranged from 77 to 50 watt-hours, the higher figure corresponding to a train consisting of one motor car only, and the lower figure relating to a train consisting of a motor car (54 tons) and four or five trailer cars (60 to 70 tons). The starting and stopping points on these trial runs were at the same altitude. When running at a speed of 60km. (37·3 miles) per hour on the level, a single motor car required about 28·2 watt-hours per ton-mile, the corresponding figures for a train of 110 tons and 130 tons being 21·7 and 20·1 watt-hours respectively. For accelerating a train from rest to a speed of 60km. (37·3 miles) per hour, an expenditure of from 90 to 100 watt-hours is required per ton of train weight. Of this total expenditure some 42 watt-hours are required for the acceleration proper of the mass, another 18 to 23 watt-hours are required for overcoming train friction, while the balance, *i.e.*, from 30 to 35 watt-hours is expended in the starting resistances or dissipated in the copper and iron. The average time for acceleration was 130 seconds, the distance covered during that time being 1,420yds. Between Lecco and Colico, which places are 40km. (24·8 miles) apart, there are seven stopping places, and it can be calculated from the figures quoted above, that the electric energy wasted in starting resistances and iron losses averages about 9·7 watt-hours per ton-mile. This is less than one-fifth of the average total consumption per ton-mile.

It was observed that a train of 110 tons ran practically free down a gradient of 0·417 per cent., and if the gradient was steeper energy was returned to the line. When a train weighing 120 tons was coasting down an incline of 2 per cent. between Chiavenna and Samolaco at a speed of 33km. or 20·5 miles per hour (the motors being connected in cascade), an average of 45 watt-hours was returned to the line per ton-mile. On two other stretches of line, where the grades were 1·24 per cent. and 1·49 per cent., the energy returned to the line per ton-mile averaged 18·5 and 23 watt-hours respectively. In the last two cases the train speed was 62·5 km. (38·8 miles) per hour.

Measurements were also made of the total electrical energy supplied by the power station in Morbegno, and it was found that this amounted to about 11,500kw.-hours for a whole working day (from 4 o'clock in the morning to 12 o'clock at night). During this time the train mileage was 1,365, corresponding to more than 161,000 ton-miles. It is thus seen that the total consumption per ton-mile, as measured at the power station, averages 71 watt-hours. This figure includes not only the energy required to propel the trains, but covers all energy for the lighting and heating of the trains, the lighting of the stations and the driving of the repair shops at Lecco.

The following test figures refer to the new locomotives which were described in *The Electrician* of February 3, p. 636. One of these locomotives hauls regularly trains of 270 tons between Lecco and Colico at a speed of 64km. (39·7 miles) per hour. The maximum gradients between these points are of about 1 per cent., and at these places the current taken from the trolley wires amounted to from 150 to 160 amperes, the normal trolley voltage being 3,000 volts. Trains weighing 400 tons have been run over the same line at the reduced speed of 32km. (19·8 miles) per hour. On a gradient of 2 per cent. the locomotive took from 190 to 200 amperes to start a train of 250 tons.

APPLICATION OF ELECTRICITY TO INDUSTRIAL PURPOSES.[*]

BY J. F. C. SNELL.

Through the kindness of certain distinguished members of this Institution, the author is able to record the actual results of electrical stations owned by two large shipyards, one of which is being partly driven by its own steam-driven plant and partly from a town supply, these two systems being entirely separate from one another. The other example is that of a shipyard supplied from its own gas-engine-driven generating plant. In the first case, the following particulars are necessary for a proper criticism to be given of the results—viz. :—

Four boilers (marine type) 160lb. pressure ; no superheat.

Four engines, each 250 H.P. ; 1,000 total H.P. 300 revs. per min., triple expansion, condensing.

Four dynamos, each 168kw. ; 672 total kw., direct coupled to engine, compound wound, direct current, 220 to 240 volts.

104 motors supplied ; 1,895 total H.P. Motors varying from 1 H.P. to 40 H.P.

Class of work : combined shipyard and engine works.
Maximum load observed, 504kw.
Total units generated per annum, 891,655.
Load-factor, 22 per cent.
Class of coal used : smalls, 11s. per ton.
Pounds of coal per unit generated, 7·3.

The total capital outlay on this generating plant is £17,184, and the following were the working costs for 12 months—viz. :—

Labour (including 20 per cent. for working charges)	£832	14	1
Coal, 2,924 tons at 11s. per ton	1,608	11	11
Feed water at 8d. per 1,000 gallons	59	0	6
Circulating water—make up	31	19	6
Oil	58	8	5
Repairs and general stores	141	2	10
Works costs	£2,731	17	3
Depreciation at 5 per cent.	571	13	2
Interest, 4 per cent.	457	6	2
Rent, rates and taxes, taken at 33 per cent. on the item for labour	249	16	2
Total costs	£4,010	12	9

thus making a total cost per unit of 1·08d.

The second example is as follows :—

Number of gas engines, 3.
Total B.H.P., 360.
Dynamos, 3.
Total kilowatts, 225.
Belt driven, shunt wound, direct current, 230 volts.
Number of motors, 34.
397 total H.P. (Motors vary from 3½ H.P. to 44 H.P. each.)
Class of work, shipyard.
Maximum load observed, 207kw.
Total units generated during four months, 83,125.
Load-factor, 14 per cent.
Cost of gas, 1s. 6d. per 1,000 cubic ft.

During these four months the following were the ascertained costs :—

Number of units generated during the four months' test = 83,395

Town gas, 3,000,828 cubic ft. at 1s. 6d. per 1,000ft.	£225	0	10
Engine and dynamo oil	24	1	7
Waste and stores	5	9	10
Repairs	5	16	8
Water	2	0	0
Labour	84	12	1
Interest and depreciation	60	0	0
	£407	1	0

N.B.—No account allowed for supervision or general establishment charges or rating of machinery.

The cost represents 1·173d. per unit. From these two examples it will be seen that there is a variation in cost per unit from separately driven plant of respectable dimensions from 1·08d. to 1·173d. It is only fair to point out that the average vacuum in the former case is only about 15in., and that the steam pipe lead is of some length, both of which are factors which must operate against the costs ; thus the results would have been better had there been ample circulating water, and a better steam pipe range, or a moderate degree of superheat. Also, in the latter case it will be observed that the dynamos are belt-driven, which must account for probably at least 5 per cent. loss of power which would be saved by direct drive. On the other hand, the plant installed probably represents the cheapest capital expenditure on account of the higher speed of the belt-driven dynamos.

The author has always contended that in works requiring from 300,000 to, say, 1,000,000 units per annum, with a load-factor of

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[*] Abstract of Paper read before the North East Coast Institution of Engineers and Shipbuilders on Friday last.

20 to 30 per cent., the cost will be found to vary from 1·25d. to 1d. per unit; and he is of opinion that, looking at the question broadly, and taking into due account an adequate depreciation of plant and average cost of upkeep for, say, a period of 20 years, 1d. is about the lowest limit for installations of the size stated. He is aware, of course, that there are special cases in which, either through an abnormal and excellent load-factor, or through the utilisation of blast-furnace gases, the cost is materially reduced below this figure. These, however, are quite the exceptions, and he affirms without fear of contradiction that the generality of installations will be found to have costs within the limits cited.

As to the advantages of the works saving the capital expenditure, the responsibility involved in laying down their own plant, or the loss represented by the valuable space occupied; the incidental losses which result from having the machinery ready during many mornings in the year after holidays without the certainty of the men turning in, or during slack times; and the frequent special arrangements required to be made for working night shifts—all these items, which may be put to the credit of the outside power stations point of view, will be dealt with later in the Paper. Now let us turn to the other side of the question—viz., supply to works from outside sources. Whether it be a power company like the Tyneside Power Co., or a municipal works such as Sunderland, what will be said will be true of most stations, and may be considered as generally applicable to all. The first and most obvious saving is in the capital outlay per kilowatt. The following curve (Fig. 1) gives the relation of the cost per kilowatt between stations varying between 250kw. and 10,000kw.

Many independent plants do not exceed 200kw. in extent, while the two power stations referred to have actually exceeded or are nearing the higher limit. Now if, as the diagram shows, the smaller installation cost £45 per kilowatt installed (which figure includes buildings, boilers, engines, steam pipes, condensers, dynamos and switchboards completely equipped, on the one hand; or buildings and gas engines, water tanks, dynamos and switchboards completely equipped, on the other hand; and also includes, for obvious purposes of safety, spare plant representing probably some 50 per cent. of the capacity of the running plant), it is obvious that the 10,000kw. station, costing about £20 per kilowatt, can afford to spend money outside the station in laying cables and fixing transforming machinery, and yet be able to effect a considerable saving on the capital sum. It must also be equally obvious that, while a decent load factor of anything between 15 and 35 per cent. may be obtained in an independent installation, yet the combination of a dozen and, *a fortiori*, several dozen such works in one station must result in a far better load-factor, which is, in practice, found to be anything from 45 to 55 per cent. This improved load-factor at the resultant station is owing to the non-synchronism of the various maximum demands on the several works, and is known among station engineers as the "diversity factor." The author knows examples where the resultant maximum load at a generating station is only some 60 per cent. of the integrated total of the maxima. This, obviously, means that a given amount of plant installed at the power station is able to deal with a much larger total of horse-power of motors installed in various works than the same plant could possibly deal with if it were split up into a number of small independent installations. The term "load-factor," as used in this Paper, is the ratio of the actual units generated in any given time to the units which would be generated were the plant working continuously at full-load during that time.

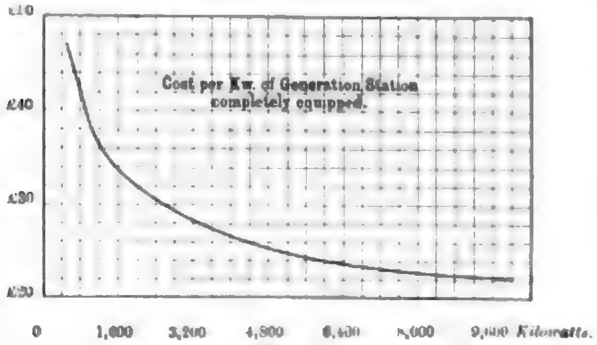


FIG. 1.

The scale of prices upon which a power station may be reasonably expected to supply current is shown in Fig 2. This scale is based upon the practical capital cost of a large power station equipped with modern appliances, and the remaining figures of fuel, stores, wages and other establishment charges, are taken from actual practical results. Fig. 3, which deals with the cost of a small local station installed for the supply of large works, demonstrates at once the influence of the capital cost upon the units generated, and the economy which can be obtained from the concentration of many such small installations in one big power station; even this does not take into account the important detail already referred to—viz., the "diversity factor." From these two diagrams it will be possible for any director of works to see the relative costs for his particular factory which will result from either the town main or his own plant. There are other economic reasons why works should, in most cases, purchase their power rather than instal a separate generating plant—viz., overtime shifts can be arranged without any trouble in the way of keeping special men for working treble shifts in the local power station; on holidays there would be no worry from having to light up boilers or start gas engines, and having the machinery ready to run and no men turning in; the manufacturer is saved the capital cost of the generating plant, and the space which the generating plant would occupy has a great value for other purposes; and, further, he has not to trouble himself about antiquation of plant or more efficient methods of generating electricity in the future. It will be granted that motors which are capable of working from 85 to 95 per cent. efficiency (according to the ratio of their load) will probably not be superseded by any more economical prime mover in the future. On the

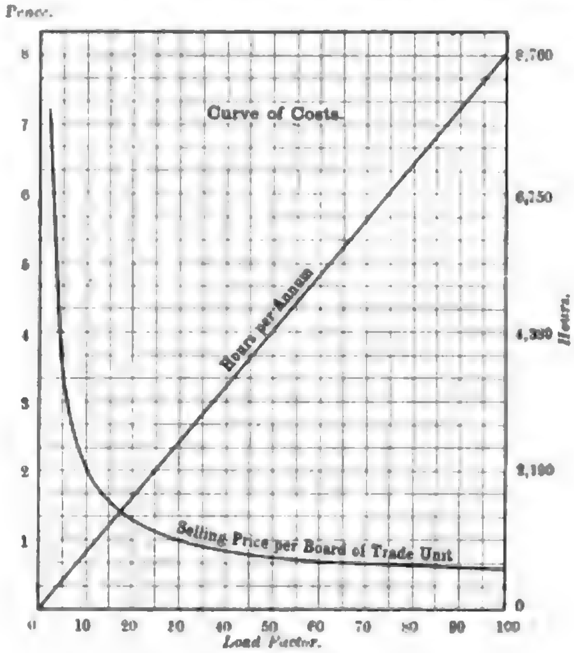


FIG. 2.

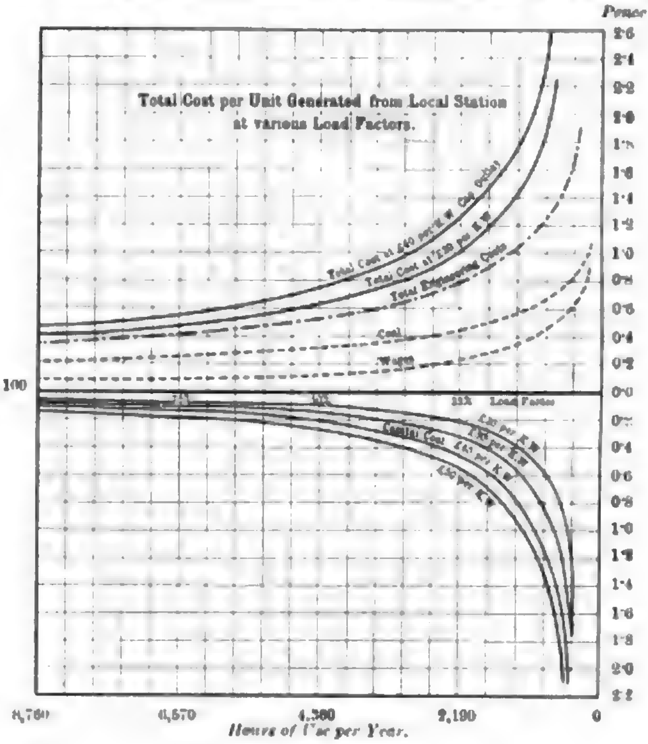


FIG. 3.

other hand, the manufacturer is entirely dependent on an outside source of supply—and the transmission cables and transforming machinery introduce a further element of breakdown, which, though amply guarded against as far as skill will allow, is a factor which cannot be negligible. It behoves a manufacturer, therefore, to see that, in becoming dependent on an outside power or supply station, the cables are duplicated, and an adequate number of reserve transformers should be insisted upon. From a comparison of Figs. 2 and 3 one gets the following results for outputs of 100,000 or more units per annum:

Load-factor. Per cent.	Units per kilowatt demanded.	Price from power supply. Pence.	Price from own local station. Pence.
15	1,314	1·5	1·75
20	1,752	1·25	1·45
25	2,190	1·125	1·25
30	2.628	1·00	1·10
35	3,066	0·875	0·95
40	3,504	0·800	0·90
50	4,380	0·75	0·75
60	5,256	0·68	0·65
70	6,132	0·66	0·58
80	7,008	0·62	0·50

The deductions to be made from the diagrams referred to show that the higher the load-factor of a particular installation the less reason is there for the purchase of power from an outside company, and the more excuse for installing one's own plant; at a load factor of 50 per cent. the costs are identical, and for load-factors above 50 per cent. the power can be more economically generated on the spot. But as this only applies to exceptional plants, such as pumping or paper mills working continuously, and does not apply to engine works and shipyards having a load-factor of under 40 per cent., the inference is that the greater number of works in this district will benefit from co-operation by becoming consumers of one general power supply.

With regard to the comparative advantages of direct-current and alternating polyphase currents, the costs and weights of motors are in favour of the three-phase type. The starting and stopping are quite as easily and as economically carried out, and the only objection which one can offer to the three-phase motor is its less easy variation in speed when compared with its direct-current competitor. It is true that 220 volts direct current is reputed to be safer than 220 volts alternating, but as fatalities have occurred in both cases, and as very many people have had dozens of shocks from both systems without harmful results, there is little to be said in favour of either one or the other in this respect. On the whole, therefore, the author is of opinion that the simple three-phase induction motor is much more likely to gain favour than even its quite simple direct current rival. In point of efficiency, the direct-current motor has the advantage at present, and is probably, from physical reasons, likely to continue to have the advantage. The efficiencies of various motors of both classes are generally as given in the following table:—

EFFICIENCIES OF ELECTRICAL MOTORS.

	Three-phase induction motor—220 v.			Direct-current motor—220 v.		
Horse p'wer of motor.	Speed.	Weight lbs.	Efficiency. Per cent.	Speed.	Weight lbs.	Efficiency. Per cent.
¼	1,375	45	67	1,600	100	67
½	1,410	80	76	1,550	150	74
1¼	1,420	100	82	1,450	180	78
2½	1,420	150	83	1,320	280	80
3½	1,425	216	86	1,280	365	82
7	1,430	340	86	1,250	560	83
9	1,430	520	87	1,100	700	84
11	965	750	86	950	1,100	84
18	965	850	88	850	1,320	85
25	965	1,050	89	750	1,570	87
30	965	1,300	89	720	2,740	89
45	720	1,700	90	640	3,240	91

Particular works must, of course, require particular application, and as the author is able to speak quite disinterestedly, he strongly advises manufacturers to pay the small additional expense incurred by the fees of a recognised electrical expert to advise them upon the application of electricity to their machines. It is lamentable to find that many of the economies which ought to be rightly obtained by the application of electricity, and by the initial expense which it necessarily incurs, are largely discounted by the absurd methods by which motors are applied to their work. In some cases lines of countershafting are retained, so as to group a number of quite large machines driven by one large motor, running often at less than half load, or, in other cases, fans originally running at 200 revs. per min. are driven electrically at a much-increased speed, and the necessarily increased power which the motors take up is a source of amazement to the manufacturer, who sometimes appears ignorant of the fact that as the speed increases, so the power required cubes. These are some of the practical mistakes which a professional consultant can and ought to be able to prevent. The judicious grouping of motors or application of single motors to special tools, and the relation of their initial capital cost to the general working expenses after their installation, is in many works a complicated problem, upon which it is submitted only one who has made a special study of such applications is competent to advise. It would be unfair to the general industries of the country if, when called upon to make the necessarily great sacrifices in scrapping their original methods of driving, and substituting a more efficient electrical motor, every care were not taken to adopt at once the most economical method in outlay, and the most efficient in practice afterwards.

The author is of opinion that 250 volts for engine works and shipyards is a sufficiently high pressure to adopt. It is a matter of common knowledge, especially with direct current, that if there be two conductors with a difference of, say, 250 volts between them, one of them (the negative) in course of time becomes approximately of the same potential as earth. A shock at 250 volts, except under very special circumstances, is not in itself dangerous, but should there be in a shipyard, for instance, an electrical winch, subject to all weathers, then a workman standing on very damp ground who grasped the naked part of the "live" cable or part of the machine would get a very severe shock, which might have even fatal results. The author would urge upon manufacturers the necessity of good materials and a complete metallic protection of the cables.

Sub-division is a very necessary factor, and it pays in large works to have a large switchboard controlling a number of individual circuits, each governing a group of tools. Tests ought to be insisted upon weekly, and the author suggests that a log book be kept in which the daily readings of the meters should be made, and which should also contain a record of the weekly tests.

Alternating currents of the same nominal pressure as direct currents have to be more carefully guarded, for whereas the virtual or mean voltage is, say, 250, the actual maximum voltage is 352 volts. Still, such liabilities can be made impossible by adopting the simple expedient of a continuous metallic covering for all cables—shielding the switches and starting gear—and earthing the motor frames. With these precautions there is not so much danger about an electrical system as there is from the belting of an ordinary countershaft. Any liability of fire is altogether removed in this way, providing that common sense is exercised in guarding each circuit at the distributing switchboard by fuses or automatic cut-outs.

There is only one more point to mention, but one by which a manufacturer starting to electrify his works can save a good deal of capital outlay. Wherever possible, it should be the aim to group the machinery and tools in such a way as to adopt three sizes of motor, and let us say, for example, 30 H.P., 15 H.P. and 5 H.P. In this way a spare armature for each type of motor will probably be found to be sufficient, and thus the capital expenditure on spares will be considerably reduced. It is quite true that a complication ensues in many cases from the variety of speeds at which tools have to be driven, but the author does not think that this is as bad as is imagined, and in special cases, rather than instal a fourth size of motor, he would be inclined to modify the speed through gearing of some kind, even at the risk of some loss in efficiency. Then, the starting switches, the switchboard panels and instruments could be made, say, of two sizes to suit the three classes of motor, and thus there will be some system instead of the too frequent and too great variety of instruments one sees installed. In a system carefully laid out, the cables can also probably be arranged to be covered by two sections. The arc lamps should be, if possible, of the same pattern, and the resistance or choking coils in connection with them should be of precisely the same pattern. Thus a very simple and easily understood system will be adopted with a resultant minimum first cost. If continuous-current dynamos be installed, the adoption of the three sizes suggested can also be probably arranged; and the same size of carbon brush (though a different number of each, of course) can be utilised, and thus only one size and style of carbon be kept in stock. It will be convenient to have a small portable blower as an auxiliary, mounted on a trolley, by means of which the motors can be thoroughly blown out from time to time. It is advisable, of course, to have a totally enclosed motor, although rather more expensive in first cost for the same temperature limit. Yet, even in this case it is advisable occasionally to have them thoroughly blown out and freed from dust. One of the greatest difficulties which manufacturers have is to ascertain the size of motor to attach to certain machines. In any case, with direct-current installations, it is always advisable to have the motors compound-wound, and in cases of intermittent work, such as with punching and shearing machines, as an extreme example, it is necessary to supplement the motor by a heavy fly-wheel. In the case of steam driven works there too many instances of such figures as ¼d. per horse-power-hour, or less, being given, which, when analysed, are soon proved to contain merely the cost of fuel and stores—not the whole of the wages, and only a vague idea of the repairs, with no provision for depreciation of plant, rating, interest on capital outlay or general superintendence.

PARLIAMENTARY INTELLIGENCE.

The following bills were read a second time during the week :—

House of Lords, Monday, Feb. 27 :—Charing Cross & Strand Electricity Supply, City of London Electric Lighting, Gosport & Fareham Tramways, Metropolitan Electric Supply (Acton), Metropolitan Electric Supply (General Powers) North Metropolitan Electric Power Supply, West Cumberland Tramways (Extension of Time).

House of Commons, Monday, Feb. 27 :—Aberdare Tramways, Accrington Corporation, Birmingham Corporation, Bolton Corporation, Bootle Corporation, Colne Corporation, Croydon Corporation, Halifax Corporation, Stockport Corporation, Swansea Corporation.

Wednesday, March 1 :—Andover Lighting and Power, Whitechapel and Bow Railway, Walton-on-Thames Electric Supply.

A bill to create a Minister of Commerce and Industry was presented in the House of Commons on Tuesday, and has been ordered to be read a second time on Monday.

The Heckmondwike Urban District Council Bill, which was referred to the Standing Orders Committee, is to be allowed to proceed.

The Wigan Corporation Bill has been allowed to proceed by the Standing Orders Committee provided the consent of the Aspull Urban District Council is obtained to the construction of the proposed tramways in that area. Failing this consent, the tramways are to be withdrawn.

The Coventry Tramways Bill, which was reported by the examiners as not having complied with Standing Orders, has been abandoned. The bill sought an extension of time for the construction of certain authorised tramways.

The London County Council (General Powers) Bill has been put down for second reading on Thursday, March 16. Sir Frederick Banbury has a motion down for the rejection of Part XV. of this bill which gives the London Borough Councils power to undertake electric wiring.

Three motions are down for moving the rejection of the proposal to carry tramways over the bridges and along Victoria Embankment when the London County Council (Tramways) Bill comes on for second reading in the House of Commons. The motions are by Mr. Whitmore, Sir Frederick Banbury and Mr. Allan Gibbs. The Bill has been put down for second reading on Tuesday next.

POST OFFICE LONDON TELEPHONE SYSTEM.

The POSTMASTER-GENERAL, in replying to Sir T. Dewar in the House of Commons on Wednesday, said that 11 Post Office telephone exchanges were open in the London area on Dec. 31 last, and the number of subscribers' telephones working in connection with them was 22,181. The amount of the annual rentals payable for the use of these instruments, and of the message fees received during the year 1904, was £156,485.

ROYAL COMMISSION ON LONDON TRAFFIC.

In the House of Commons on Wednesday,

Mr. SCHWANN asked the Secretary of State for the Home Department when the report of the Committee which has deliberated upon the street traffic of London would be laid upon the table.

Mr. AKERS-DOUGLAS, in a printed reply, said he was informed by the Royal Commission appointed to inquire into the means of locomotion and transport in London that they were now considering their report, but could not state exactly when it would be presented.

LEGAL INTELLIGENCE.

Jandus Arc Lamp & Electric Co. (Ltd.) v. Arc Lamps (Ltd.)

In the Chancery Division on Tuesday Mr. Justice Kekewich delivered his reserved judgment in this case. The action was fully reported in *The Electrician* for Jan. 20, and Feb. 17 and 24.

His Lordship said that as usual at the conclusion of the arguments in a patent case he found that the primary object was to construe the specification. That was, to ascertain from the patentee's own statements whether the monopoly which he alleged defendants to have infringed was sufficiently described and claimed. But one was met here with the preliminary question. What was the specification it was the duty of the Court to construe? The original specification had been largely amended, and the amendments had been effected merely by the erasion of certain passages and words. Amendments might be made thus or by other methods. The question was whether for construing the specification as it now stood, which was undoubtedly the instrument to be construed, he was at liberty to read and consider the erased language. Considering it as a question of principle, it admitted only one answer. The intention of the parties to a document must be ascertained from the language in which that intention was expressed, and there was no reason for treating a specification differently from other documents, whether it be regarded as a grant by the Crown or a contract between the patentee and the public. Here the amended specification was the document on which the plaintiffs were suing, and which defendants contended was either invalid or did not disclose an invention which they had infringed, and therefore, unless an exception could be established in favour of documents of this particular character, the amended specification alone could be read in order to ascertain the true construction. It was, of course, often necessary in construing one document to refer to others, and to Acts of Parliament, &c. There was, at least, one authority which supported his view (Hattersley v. Hodgson); and even if his view of the principle be incorrect, he thought sec. 18 of the Patent Act, 1883, precluded defendants from referring to the erased lines. That enactment enabled applications for leave to amend and opposition thereto to be heard by the Comptroller, with a right of appeal to the law officers, and provided by sub-sec. 8 that "no amendment shall be allowed that would make the specification or amended claim an invention substantially larger than or substantially different from the invention claimed by the specification as it stood before amendment;" and sub-sec. 9 said "leave to amend shall be conclusive as to the right of the party to make the amendment allowed, except in case of fraud, and the amendment shall in all courts and for all purposes be deemed to form part of the specification." Did not that exclude the reference to the erased lines for which defendants contended? In Moser v. Marsden the House of Lords distinctly decided that a reference to the erased parts was impossible. His next duty was to ascertain the meaning of the amended specification. It was a somewhat verbose document and shared the common defect of specifications, for notwithstanding a full description of the manufactured articles to which it referred, and of their practical operation, assisted by figures on which no question arose. There was a strange want of precision and lucidity in the language employed, and the claims were not so framed as to aptly fit the invention described. That on which special stress was laid in the description was omitted from the claims altogether. Nevertheless, the point for decision was a narrow one. The object of the alleged invention was first to increase the life of carbons in arc lamps, and secondly to improve the quality of light. With the second object he was not concerned. He was only concerned with the increased life of the carbons. That was intended to be effected by enclosing the carbons in a glass envelope carefully closed, but leaving at the top a small aperture through which the heated air in the envelope could escape, so as to prevent explosion. So far he had in his own language described that about which there was no contest, but plaintiffs said (and unless they could say so truthfully they could not maintain their action) that the glass envelope must be small, and that smallness as well as lightness was of the essence of the invention. It was reasonably clear on the evidence that a small envelope was essential to complete success, but the question was whether this was clearly stated in the specification. The figures undoubtedly pointed to a small envelope, and that might be taken in aid of the imperfect description in the letterpress; but, on the other hand, the claims contained no reference whatever to smallness, and although that was not a fatal defect, one must attribute some weight to it. It was, to say the least, strange that a patentee should omit from his claims, which were numerous, all reference whatever to an essential part of his invention. All objections and criticisms notwithstanding, he was of opinion that the patentee knew that a small envelope was essential, and that if not the sole advance, it was intended to be the main advance on previous knowledge, and that he had said this in sufficiently explicit terms. In the outset of his description of the manner in which he carried out his invention, he stated that he made the envelope "sufficiently small in size." It was an awkward expression, because sufficiently ought to be followed by language explaining for what the smallness was to be sufficient, but it was left entirely at large. Still it was a distinct indication that the envelope must be small. Further on, he said "I am enabled to make the transparent or translucent enclosing envelope 3in. or less in diameter." When describing his invention by reference to figures, he spoke of a transparent or translucent envelope preferably made of glass and not to exceed 3in., and preferably less, in horizontal diameter and of any desired length," and further on he said that the small arc-enclosing envelope prevented dissipation of the gases and maintained them at a greater degree of density than would be possible with a larger envelope. He therefore thought those passages, read in connection with the rest of the description, not merely indicated the patentee's view that a small envelope was desirable and an improvement, but stated that his invention was not complete without it. He (his Lordship) was entitled to regard the common knowledge at the date of the patent. The patentee told them that the necessity of an airtight envelope had been recognised, though all efforts to produce it had, so far as he was aware, resulted in failure, but there was no statement that the size of the envelope had received consideration, and they knew, in fact, that the value of this simple improvement had not been grasped.

Assuming that smallness was an essential part of the invention as described, there was a further question whether smallness was sufficiently defined. The patentee began by speaking vaguely of an envelope sufficiently small in size, and he afterwards spoke twice of an envelope 3in. or less in diameter. Was he to be restricted to an envelope of that size? It had been found that an envelope of a rather larger diameter produced better results, and was commercially used. One had to bear in mind the object in view—namely, to increase the life of the carbons—and what he understood the patentee to mean was that if you could employ an envelope of 3in. or less in diameter you would thereby increase the life of the carbons to the maximum possible. Then knowing, as he clearly did, that the smaller the envelope the greater was the risk of explosion, he did not mean to incur that risk to a dangerous degree. What he really understood the patentee to say was this: "Make your envelope 3in. or less in diameter if you can without destroying its utility, but at any rate make it so small that it will be useful in increasing the life of the carbons." His conclusion, therefore, was that an envelope of say, 4in. in diameter, otherwise constructed according to the specification, was sufficiently described therein and might fairly be said to be made according to plaintiff's invention. The requisition of tightness must not be left out of sight. It was insisted on in the clearest manner possible, and always with the proviso that the envelope, though practically tight, must allow a steady outflow of gases from the lamp. Perhaps the patentee did not really know why, by combined tightness and smallness, there could be attained results which had hitherto been unobtainable, but he saw that it could be done and told the public how to do it. Utility had been challenged, but there was no question that lamps constructed more or less on the lines of the Howard patent had been used and sold in large numbers, and had proved a commercial success. Defendants by imitating the plaintiffs had themselves given the strongest testimony to that conclusion. It was also said that what had proved commercially useful had not been really a lamp constructed according to the Howard patent, but one which constituted an improvement thereon and with such difference as made the two things distinct, and it was urged that the increased life of the carbons could be, and, in fact, had been, attained without following the directions of the Howard patent, and it was practically certain that no lamp constructed strictly in accordance with that patent had been in commercial use. On either side there had been conducted a number of experiments. Those experiments had been proved, and a good deal of time had been spent in examining and cross-examining witnesses who proved them. The result, to his Lordship's mind, was to show the utter futility of experiments conducted in the manner in which these experiments had been conducted. For research a man must, of course, work alone in his own laboratory, but for the purposes of evidence intended to carry weight with a tribunal concerned in determining such a question as here came up for decision, something far different was required. Although his Lordship did not for a moment suggest that on either side there had been any intention not to act fairly or to avoid discovery of the truth, it was really impossible to ascertain by cross-examination why there had been obtained first by one, and then by the other, results at variance with the experience of those by whom the particular experiment was not made. It was suggested by defendants that some experiments should be made by an independent expert. His Lordship did not see his way to directing that to be done, and reflection convinced him that it would have been useless to direct it. Experiments by an independent man, however skilled and however trustworthy, would not be satisfactory because neither party would be quite sure that the experiments had been conducted precisely with the materials and in the manner alleged to be necessary for a complete test. Perhaps an independent expert might be of assistance in watching the experiments made first by one party and then by the other and inform the court whether both classes of the experiments had been conducted with that identity of material and of all the surrounding circumstances which was essential if it was desired to test one class of experiment by another, but his Lordship was convinced that no safe conclusion could be rested on the experiments except, indeed, the one that they were inconclusive.

Turning to the other evidence on the question of utility he had already noticed that lamps had not been made, and certainly had not been commercially used, strictly according to the Howard patent. The patentee's notion that his lamps would require a lower voltage than other types of lamps had been contradicted by experience, and the methods described by him for securing the necessary tightness had given way to others which had been found more effective. It might be that in some other matters there had been a departure from the terms of the specification, and that those departures had not merely assured the success of the manufactured article, but had aided to increase that success beyond the sanguine anticipation of the patentee. Nevertheless, it seemed to his Lordship clear on the evidence that plaintiffs had constructed and largely used lamps which were in their essential character Howard lamps, and that the variations were merely accretions which, notwithstanding that they were such improvements that no one would now think of making lamps without them, yet did not destroy or reduce to a negligible quantity the essential characteristics of the Howard lamp. As to the question of infringement, there really was no doubt that the lamps manufactured by defendants were substantially identical with those manufactured by plaintiffs. There were differences of detail of course, but in what he had termed the essential characteristics of the Howard lamp they really were identical. If there were no such essential characteristics, or if the variations and improvements which experience had dictated so altered the character of the lamp that it could no longer be properly regarded as constructed according to the Howard specification, then, of course, defendants were entitled to succeed; but if his view on these subjects was right, it necessarily followed that defendants had infringed the patent vested in plaintiffs.

He would now consider the question whether the patent had been anticipated. In support of their contention that it had been anticipated, defendants put in several prior specifications, and strongly relied on more than one of them. Nevertheless, his Lordship thought it necessary to mention one only—namely, that of Beardsley, 1882. It might be that if Howard's invention was anticipated by Beardsley, it was anticipated by others also, but he was satisfied that if Beardsley's patent was no anticipation, no other was worth consideration. Beardsley, no doubt, came near to Howard, and, as admitted by Mr. Swinburne, he had the idea to which practical effect was afterwards given by Howard. He saw the value of tightness and the necessity of combining that tightness with a contracted aperture for the escape of heated gases from the enclosing envelope. But he did not see the importance of making that enclosing envelope small. Therefore, he could not be said to have anticipated Howard unless it be true that, as urged on behalf of the defendants, a competent workman might produce a Howard lamp with Beardsley's specification alone to guide him. It was admitted that no one ever did this, and the same remark was applicable to the other specifications on which defendants relied. That, of course, was not conclusive, but it was of some weight. There might be a complete and unanswerable paper specification of a patent, and if one be produced it would not avail the patentee to say that no one had ever put it in practice. But when as here it was well known that the particular object was highly desirable of attainment and that the attainment thereof would ensure commercial success, then the fact that an alleged paper anticipation—intended to attain that very object—had never been put in practice, was strongly tending to the conclusion that the alleged anticipation was not complete. But it was urged that although it had never been done a competent workman might, and readily would, produce as good a lamp as those used by plaintiffs and defendants with Beardsley's specification as his only instructions. That might be true, and indeed on the evidence he thought it must be true; but there was a fallacy in the statement when used to support the argument that Howard was anticipated by Beardsley. Since Beardsley's time there had been a large advance in common knowledge of those versed in such matters, and it by no means followed that the competent workman of 1882 could or would have produced a lamp which would come easy to the workman of to-day. The Howard patent was dated August, 1893, and the question was whether at that time, eleven years after Beardsley's patent, the latter would have enabled a competent workman to construct a lamp according to Howard's specification and with the advantages which he secured. The evidence convinced him that the advance of knowledge had not at that time been sufficient for that purpose. Beardsley did not instruct the public that a small enclosing envelope was essential to secure the desired result—that was, to increase the life of the carbons—and no one had discovered this before Howard. As to the question of subject matter, it struck his Lordship from the outset that there was a difficulty in supporting a patent for it. His conclusion on this point had been arrived at with more hesitation than on any other point. He could not help thinking that in order to support Howard's patent as regarded subject matter it was necessary to go at least as far as had ever been gone in that direction. It was true that Howard combined tightness and smallness, and that both were required to produce a lamp having the effect that he contemplated, but the necessity of tightness was thoroughly known before, and what he really discovered was the necessity of smallness. Kay v. Marshall was cited as a conclusive authority against plaintiffs, but it seemed that the real objection to that patent was that the particular mode of using the spinning machine, which was sought to be protected, was known before. Might it not fairly be said that Howard discovered means of using the enclosing envelope, the benefit of which the world had not known before, when he said that to make it really useful it must be made smaller than any which had up to then been employed? The decisions in the Edison cases were useful towards the support of the patent, for, as he understood them, they showed that the merit of Edison's invention consisted wholly in the use of a carbon thinner than anyone had used previously, and yet his patent was upheld. Plaintiffs, in his judgment, were entitled to the relief usual in such cases and the costs of the action.

Mr. TERRELL asked his Lordship for a certificate that the plaintiffs' patent had been in question, and for a certificate of breaches, and his Lordship assented.

Mr. BOUSFIELD said that the defendants would probably like to go further, and asked his Lordship to stay the operation of the injunction at any rate until the appeal was heard.

His LORDSHIP: Not the injunction against the further manufacture and sale.

Mr. BOUSFIELD said defendants were very large manufacturers of these lamps. Assuming that his Lordship's judgment was reversed in the Court of Appeal, that meant that in the meantime, if the injunction was not stayed, defendants' business would be turned upside down. His Lordship would remember that defendants had been doing this for many years without interference, and plaintiffs had not before thought it worth while to take any steps to put the matter to the test. If the operation of the injunction was not stayed, and his Lordship's judgment was reversed, the defendants would suffer a loss which could not possibly be compensated for in any way. It was usual in such cases as these, where there were serious points between plaintiffs and defendants, to stay the operation of the injunction pending an appeal.

His LORDSHIP said he could not see why a man should be enabled to continue to do wrong merely because he wished to take the opinion of the Court of Appeal and probably the House of Lords. He thought that in the great majority of cases the good sense of the parties would prevail, and some arrangement would be made for the business of the defeated party to go on, and he hoped that would be done here. He thought that was the proper thing to do in the present case. He could not, however, himself make any order to the effect asked for by Mr. Bousfield in the absence of agreement.

Breach of Agency Agreement.

In the King's Bench Division last week Mr. Justice Bray heard an action, Sanders, Rheders & Co. v. Pfluger Accumulatoren Werke A. G., Berlin, to recover damages for alleged breach of agreement, under which defendants appointed plaintiffs their sole agents in this country for 10 years for the sale of Pfluger electric accumulators.

Mr. RUFUS ISAACS, K.C., for plaintiffs, said defendants were manufacturers of a special kind of accumulator, of which the stationary was used for storing energy for lighting, and the portable, which was used in the motor vehicle trade. The business which plaintiffs had worked up in the country was of considerable value, and the ground of action was that plaintiffs were under a contract to represent defendants for 10 years from Nov. 21, 1903, subject to determination in certain events, which had not happened.

Nevertheless, defendants had put an end to the contract by notice in June, 1904, and thereby committed a breach. They had refused to employ plaintiffs any further, and his case was that his clients were entitled to damages calculated upon profits and commission which would have been earned if the contract had been carried out for the full 10 years. One question of fact his lordship would have to decide was whether there was on the part of the defendants, when they gave this notice, any bona fide intention of discontinuing being represented or carrying on business in this country, for that was the excuse alleged for the determination of the contract. He would show that in giving this notice the defendants had no idea of discontinuing a valuable business, but intended to get rid of plaintiffs in order to obtain the benefit of the work they had been doing under this and previous agreements. Plaintiffs were to receive a commission of 2½ per cent. on orders obtained for stationary batteries, and of 5 per cent. on portable batteries, with a percentage also of the net profits earned. The defendants were to have the right to determine the agreement in case they decided to entirely discontinue representation in England or in the event of a sale to a third party. In the latter case provision was made for the payment of an indemnity to plaintiffs. In reply to the notice received plaintiffs pointed out the profits that had been made on the English business, but defendants maintained their determination to discontinue representation. While this conference was going on, however, defendant issued to customers a "Notice of removal," informing plaintiffs' customers and others that, owing to great increase of business they had decided to establish a factory in Coventry, where "the largest orders" for their accumulators would be dealt with. This notice also stated that defendants were taking commodious offices in Westminster.

Mr. POLLOCK, for defendants, said the defence was that the agreement contemplated both business done by plaintiffs as defendants' agents, and also that the defendants should be entitled to do business direct, subject to plaintiffs' right to commission and a percentage of the profits. On his construction of the agreement the defendants had the power to drop the agency if they found it unprofitable, in which case plaintiffs were entitled to commission for the 10 years' but not to profit.

His LORDSHIP said the question of whether defendants really intended when they gave notice to plaintiffs to give up everything in England might become important.

After an adjournment Mr. ISAACS stated that the parties had come to terms, and that by consent judgment would be entered for the plaintiffs for £2,500, this sum to include costs, and Mr. J. C. Pfluger guaranteed payment of this sum in cash.

Mr. POLLOCK said he hoped his Lordship would permit him to say that his client (Mr. Davis) was misled in the matter, as a full disclosure was never made to him either of the circumstances or of the documents.

His LORDSHIP said he should draw that inference, and he should have awarded a sum not far short of that which had been agreed upon.

Thomas v. Mackie & Co.

Before the Court of Appeal (the Master of the Rolls and Lords Justices Mathew and Cozens-Hardy) on Tuesday defendants applied for judgment or new trial of this action, tried before Mr Justice Lawrance and a common jury, who awarded plaintiff £80, and judgment was entered for this amount with costs. The action was brought by plaintiff to recover damages for personal injuries owing to alleged negligence of a servant of defendants. Plaintiff was in the employment of a firm of brewers as lift attendant. Defendants had previously installed electric motors for working the lift, and in February, 1904, were employed to lay the wires for working the lift. After the wires had been laid and the connections made, one of defendants' wiremen, in starting the lift for the purpose of explaining to plaintiff how something was to be done on an emergency, fused the wire. A few days later the wire was repaired and the lift started to see if it worked properly, when it stuck. Plaintiff was in the pit below cleaning out some rubbish, and his case was that the lift was started without warning, but defendants said the wireman was expressly directed not to touch the machinery or put the lift in motion, and that he was to call the second engineer of the brewery when his work was finished in order that he might set the machinery in motion for testing the wires and connections, and they (defendants) contended they could not be held liable on the following grounds: (1) That the wireman in setting the machinery in motion was not acting within the scope of his employment; (2) that even if he was defendants were not guilty of negligence, as their servant gave a warning shout before setting the machinery in motion; and (3) plaintiff had been guilty of contributory negligence.

In the result their Lordships allowed the appeal, holding that the act of defendant's foreman which caused the accident was done outside the scope of his employment, and therefore not as defendants' servant. Judgment was entered for defendants with costs.

Tramway Accident.

At the Liverpool Assizes a child named Foster (through her father) was awarded £300 by a jury as damages from the New St Helens & District Tramways Co. (Ltd.) for personal injuries. On Aug. 17, 1903, she was returning from school, and while crossing the road was knocked down by a tramcar belonging to defendant company, whose negligence was alleged to consist in the excessive speed of the car, as shown by the fact that it took the driver 30yds. to pull up. Defendants denied negligence, and said the car was travelling at the ordinary speed. The accident was entirely due to the child rushing in front of the car in such a way that the driver could not see her.

ELECTRICAL EXHIBITION IN LONDON.

In connection with the proposed Electrical Exhibition to be held in London in the fall of 1905, a meeting of representatives of electricity supply undertakings was held on Monday at the Hotel Cecil, London, at the invitation of the above Association, to elect five representatives of municipal and company undertakings to sit on the executive committee of the exhibition, in company with the five manufacturers' representatives previously elected from amongst the members of the Association and five representatives from the ranks of outside manufacturers.

Mr. W. H. PATCHELL, engineer-in-chief of the Charing Cross & Strand Electricity Supply Corporation, was voted to the chair, and said it had been felt that the Institution of Electrical Engineers had not done what it ought to have done for them. The Council were asked last autumn whether they would support an electrical exhibition of the kind proposed, and, after several meetings, the Council had replied that the Institution did not see its way to extend its patronage to an electrical exhibition promoted by a single individual or group of individuals undertaking such a scheme for private gain. Four different persons received this reply, and some of those who had been on the committee of the proposed exhibition tried to move matters a stage further. Then came a letter from Mr. A. J. Fuller, who, when he heard how things stood, kindly sent to the Institution all his papers, explaining the scheme and objects of the proposed exhibition with which his name was associated. They came to the conclusion that such an exhibition depended for its success mainly upon the exhibitors, and that though they, as station engineers, did not usually come in contact with the people who buy, they thought they should help those who did. He (Mr. Patchell) got into touch, through Mr. Northcote, with the manufacturers, and this led to the Manufacturers' Association taking the matter up warmly. They had felt the pulse of the supply companies, and the directors had expressed their willingness to do what they could to assist the undertaking financially. He thought the municipal electricity departments might experience some difficulty in giving donations to the scheme owing to fear of the L.G.B., but they could, at any rate, purchase tickets and send their ratepayers to the exhibition. At a meeting at his offices of representatives of the Association and of one or two of the chief manufacturing companies who were not members, it was agreed that the time had come for an exhibition of the kind proposed, and the only remaining question was as to its scope, some thinking the time had come for a big epoch-making exhibition, whilst others thought this time had not arrived.

Mr. W. DAVENPORT (secretary of the Association) read or referred to many letters from manufacturers favouring the project, recapitulated the plan proposed to be adopted, and gave the names of many municipal electricity departments favourable to the scheme. A list was also read out of those who, although in complete accord with the project, were unable to send representatives to the meeting. Some of the municipalities preferred to hold local exhibitions, but expressed their readiness to give way in favour of the larger venture. Mr. J. F. C. Snell (Sunderland) had been deputed to express the views of the Municipal Electrical Association, and he (Mr. Davenport) understood that the Municipal Association was favourable, and he looked forward to their help. Most of the intending exhibitors were in favour of holding the show at Olympia, but that was a matter the executive committee would have to finally decide. There was no fear of competition, as the recently proposed Crystal Palace exhibition had been dropped in view of the project now under discussion. It was proposed that the exhibition should be open from September 24th to October 24th, and it could probably be extended to five weeks if found desirable. About 70 manufacturers had already agreed to support the project. He had been asked to what extent his committee looked for help, and he thought if they got £3,000 in money and in tickets purchased they would be satisfied.

Mr. C. S. NORTHCOTE (Veritys Limited) said the committee had been promised all the data of the finances of the motor-car exhibition at Olympia to serve as a guide in estimating expenses.

Mr. A. J. FULLER (Fulham) said he could see a difficulty in getting any figure passed by his committee in support of the exhibition because they would fear a surcharge. He thought, however, that out of advertising funds it might be possible for the Councils to purchase tickets.

It was then agreed that the electricity supply members of the committee should consist of three company and two municipal, the latter including a seat for the president or other nominee of the Municipal Electrical Association. The first four gentlemen (selected by ballot) were: Mr. E. Cunliffe-Owen (or other nominee of the Metropolitan Electric Supply Co.), Mr. W. H. Patchell (Charing Cross Co.), Mr. Sydney T. Dobson (St. James' and Pall Mall Co.), and Mr. S. W. Baynes (St. Pancras).

A contribution of 1s. per consumer was suggested as a basis upon which the municipalities and companies could support the scheme, but it was eventually agreed that the invitation to contribute should be in general terms.

Telephone Purchase.—The Postmaster-General will move in the House of Commons on Monday for the appointment of a Select Committee to consider the agreement for the purchase of the National Telephone Co.'s undertaking, and it is announced that the following members of the House of Commons have consented to serve:—Mr. Beckett, Sir Horatio Davies, Mr. Helme, Sir William Holland, Mr. Joseph Nolan, Sir C. Renshaw, Mr. Stuart Wortley. The Committee will have power to "send for persons, papers and records."

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An electrical engineer is required by the Government of British Honduras to erect and supervise telegraphic and telephonic lines and apparatus, electric lighting works, &c. Salary $1,500 (American) per annum, with travelling allowance. Engagement for three years. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., up to March 7.

Wakefield Corporation require a first assistant electrical engineer. Applications by 14th inst.

On Wednesday, Newcastle-on-Tyne Tramways committee reported that Mr. G. Conaty, Birmingham, had withdrawn his candidature for the position of tramways manager, and, in order that there should be more than two names to go before the Council, Mr. C. J. Spencer, of Bradford, was asked to allow his name to be submitted. The Council appointed Mr. E. Hatton, of Salford, at a salary of £700 per annum, the other candidate in the final list being Mr. Yerbury, of Sheffield.

Salford Corporation on Wednesday decided to transfer Mr. Hancock from the position of chief clerk in the tramways traffic department to that of parcels superintendent and to increase his salary from £180 to £250 per annum; to appoint Mr. J. Eades, jun. (hitherto car works manager), as rolling stock superintendent, with increase of salary from £250 to £350; and to increase the salary of Mr. W. B. Burnie, chief lecturer in electrical engineering at the municipal technical school, from £275 to £300.

Mr. Wm. Grant, tramway manager at Rotherham, has been appointed to a similar position at Ayr at a salary of £200. There were 80 applications.

West Derby Guardians, Liverpool, have appointed Mr. Henry Kilshaw electrical engineer for the infirmary.

EDUCATIONAL NOTICES.

The distribution of prizes and certificates to students of the colleges and schools under the management of the City and Guilds of London Institute took place on Saturday at the Mansion House, London, by the Lady Mayoress. The Lord Mayor presided. Mr. Alexander Siemens delivered an address to the students.

Plymouth Secondary Education sub-committee have decided to equip the Technical School with a mechanical, electrical, and engineering laboratory.

Argentina.—The "Review of the River Plate" says a strong local syndicate has been formed to construct an electric tramway between Buenos Ayres, Banfield, Temperley and Androgue.

The Cia Electricidad del Plata has acquired and will improve the electricity supply undertaking of the town of Mar del Plata.

The electric tramway between Barracas and Quilmes was opened last month. Current is supplied by the Compañia Allemana Transatlantica de Electricidad, of Buenos Ayres.

Senor Pedro Lopez, inspector-general of Argentine Government telegraphs, has retired on a pension.

Messrs. Otto Bemberg & Co.'s concession for an electric tramway between Buenos Ayres and Conchitas has been transferred to the Cia de Tramways Ciudad de Buenos Aires y Quilmes

Aston.—On Wednesday the Council decided to abolish the dual system of charging for electric current and to substitute the following rates:—Under 300 units per quarter 3¾d. per unit; between 300 and 600, 3½d.; between 600 and 1,000, 3¼d.; between 1,000 and 1,500, 3d.; between 1,500 and 2,000, 2¾d.; upwards of 2,000, 2½d.

Australasia.—The "Australian Mining Standard" says:—

Electric traversers, elevators and hoists have been erected on the Geelong (Victoria) Railway pier.

The tender of the Electric Lighting Traction Co. of Australia has been accepted for lighting King William and O'Connell-streets, Sydney, at £640 per annum.

The municipal council of Balmain, near Sydney, are recommended by a special committee to accept the offer of a company to light the borough electrically and erect and maintain a refuse destructor, the Council reserving the right to acquire the undertaking at the expiration of ten years or any subsequent ten years.

Kalgoorlie Roads Board has granted a concession to the Kalgoorlie Electric Light & Power Corp. for erecting poles and cables in the Board's territory for public and private electric lighting. The Board reserves power to terminate the contract for street lighting upon three months' notice. The charges (per month) for public lighting will be 6s. per 8 c.p. lamp, 9s. per 16 c.p., 15s. per 32 c.p. and £2. 10s. per 1,000 c.p. arc. The rates for each lamp are to be reduced by 1s. per month if more than 40 street lamps be used. The charges to private consumers for current for lighting will be: up to 500 units per month, 7d. per unit; 500 to 800 units, 6d.; over 800 units, 5d.; and for power 4d. per unit up to 300 units per month; 3½d. up to 600; and 3d. for over 600. The option will be given of a flat rate of 15s. per horse-power per month for motors above 2 H.P. Private consumers will be allowed a discount of 10 per cent. on payment for current for lighting, and 5 per cent. on power accounts paid before 10th of month.

Award.—A gold medal and special diploma was awarded the Electrical Corpn., 17, Gracechurch-street, London, E.C., and Birmingham, for their exhibit of the "Pluto" systems of heating and lighting at the recent exhibition held at Bath.

Barnstaple.—Last week the mayor (Mr. H. Barrett) gave particulars of the progress of the electricity undertaking for the 12 months ended January.

The annual expenditure was £1,958, income (including £128. 15s. 3d. for stores in hand) £3,540 8s. 7d., or a surplus of £1,582. 0s. 2d., from which was deducted £1,290. 4s. 10d. for interest and repayment of principal, leaving a net surplus of £291. 15s. 4d. There are 219 private consumers, an increase of 60 in the year. Notwithstanding the price of current was reduced from 6d. to 5d. per unit there was an increase of revenue of £1,383. 8s. 6d. The net revenue account for 1904 showed a debit of £995. 16s. 9d., but £2,578. 13s. 4d. was paid for interest and instalments of capital.

Bedford.—The Sturtevant Engineering Co. have purchased a site of 7 acres at Bedford for the erection of new works.

Bexley.—The Council have reduced the price of current supplied to motors in the daytime to 3d. per unit up to 90 units per quarter per horse-power, and 2d. per unit up to 180 units.

Birmingham.—The electric tramway service between the city and Small Heath and Yardley was commenced last week.

Bishop's Stortford.—The Council have decided to enter into negotiations with Bishop's Stortford and Stanstead Electric Lighting Co. for a transfer of the electric lighting order for which the Company are applying.

Bradford.—The Electricity committee, after considering various tenders for the supply of incandescent lamps for free distribution, have decided not to accept the lowest or any tender, but to order lamps from four of the firms tendering.

Brazil.—It is claimed for the city of San Paulo that it can boast the finest system of electric tramways in South America, and the finest water-power and generating plant to be found anywhere on the American continent outside the United States. The system is owned by Canadians and Americans.

Cardiff.—An inquiry was held on Friday into the application of the Corporation for power to borrow £87,898 for electricity supply extensions.

The town clerk (Mr. J. L. Wheatley) asked that the repayment of the loan be extended over 25 years.

The borough electrical engineer (Mr. Arthur Ellis) gave technical details of the extensions. In reply to the Inspector (Mr. H. Ross Hooper), Mr. Ellis said that his department was not indebted to the rates; in fact, it was in the position of a creditor to the extent of £1,300, and having in addition a reserve of £2,400. £250,582 had been borrowed and about £7,000 was in hand, but it was required for extensions to the continuous-current system. There would be a demand for 4,000 8 c.p. lamps for the town hall and 6,000 for the law courts.

Mr. S. Hern opposed, mainly on the ground that no depreciation had been allowed, and he contended that not less than £5,000 per annum should be set aside for that purpose.

Castleford (Yorks.)—Recently the Council appointed a special Electric Lighting committee to acquire information and report upon the subject of electricity supply.

Cleckeaton.—At the Council meeting last week it was stated that the revenue account of the electricity department from the commencement of supply showed an expenditure of £4,331. 8s. 6d., income £3,531. 16s., deficit £799. 12s. 6d.

Damascus.—Plans for an electric tramway, for electric lighting, and for other important public works have been under serious consideration by the authorities here. With regard to the electric plans for these works the following report on the subject from the U.S. Consul at Beirut will be of interest:—

A letter has lately been received from Ahmed Izzet Pacha, second secretary of the Sultan, showing that the estimated cost of this enterprise (electric light and tramway) is $260,000, and 24,000 shares are to be issued to be paid in three instalments, the first on call, the second after three months, the third after six months. His excellency had intended to pay the whole cost, but, owing to his love for his country, invites his countrymen to subscribe first. A subscription for 4,000 shares ($43,340) has been obtained through Mustafa Bey, his excellency's brother, who resides in Damascus, together with a mazbatta from the municipality of Damascus, confirmed by the administrative mejliss (council) of this province, engaging themselves to pay to the administration an annual sum of $13,000, under the title of "Eclairage de la ville de Damas." If the existing ban on electricity is soon to be abolished in Turkey, which the foregoing would seem to imply, it is earnestly recommended that Americans be on hand in Constantinople with bids for franchises and for supplies. There are as yet no electric plants in Turkey, but why should not Turkey have electric light as it now has gas light, electric street cars as it now has steam trams, telephones as it now has telegraphs!

If Americans are to be "on hand," why not Britishers?

Darby.—The market place tramway route was officialy inspected last week, and is now open for traffic.

Duty on Printed Matter into Australia.—The imposition of a duty upon printed matter posted to Australia, of which we have previously complained, has been held to apply to notices of meetings of learned and scientific societies addressed to members of these societies in Australia. This surely establishes a record of Protection run wild. The unreasonable character of such an impost seems to have struck the Commonwealth authorities, and it is satisfactory to learn that the imposition has been taken off such communications.

East Barnet.—The District Council have abandoned their negotiations with the North Metropolitan Electric Power Supply Co. for a supply of electricity.

Edinburgh Tramways.—The Council on Tuesday adopted the recommendation of the Tramways sub-committee to apply for Parliamentary powers to convert the Gilmore-place tramways from horse to electric traction, and also proposals to seek authority to construct electric tramways from Edinburgh Hydropathic to the city via Slateford and Fountainbridge; from Broughton-street to the burgh boundary at Pilrig street; and from Canonmills to Bellevue.

Electrical Exhibition.—Everything promises well for the exhibition which is being organised by the County of London Electric Supply Co., and which will be held in premises adjoining Gamage's Stores at Holborn-circus, London, E.C., from March 20 to April 5 inclusive. The districts which are served by the County of London Co. in this part of London are amongst the most important commercial and industrial centres of the great metropolis, and it is for these trade interests that the exhibition is particularly designed, with a view to illustrating graphically the suitability and adaptability of electric power to every branch of manufacturing work. Already electric driving is adopted very largely in these districts, but the County of London Co. are of opinion that an exhibition of the character which has now been decided upon will prove the means of greatly extending the use of electrical plant, apparatus and accessories. This belief is shared by over 60 manufacturing and contracting firms who have given their active support to the project. Holborn is adjacent to the great printing centre of Fleet-street, and amongst the machinery in motion will, we understand, be several examples of printing machines: tailoring and seamstress's work is also largely carried on in the district, and sewing machines and other apparatus of the kind will be shown electrically driven; the Clerkenwell district, practically devoted to the watch and clock making industry, will, of course, be specially catered for, and the general tradesman who everywhere abounds will also find his requirements attended to. In the matter of domestic appliances the exhibitors include several firms who make this branch of work a speciality. There will be, in addition, a number of exhibits of a "surprise" character, and these will serve as an additional attraction to an exhibition which, even without them, will possess many features of particular interest to the inhabitants of Holborn, Clerkenwell, the City of London, and, in fact, all the London districts, to say nothing of its attractions for visitors to London on the look out for electrical novelties.

Electricity in Mills.—At a recent meeting of the Dundee Institute of Engineers the city electrical engineer (Mr. H. Richardson) opened a discussion on electric driving in mills.

He combated the propositions that electric driving was in its experimental stage, that the cost of repairs to electrical plant was higher than in the case of mechanical energy, that the efficiency of electrical driving was lower than mechanical driving, or that electric driving could not possibly make better and steadier running than the best mechanical driving, and was only advantageous in special cases. He said there was, out of nearly 90,000 H.P. of electric motors used for driving textile mills in the United States, leaving out those where water-power was used, or where there were other advantages, about 20,000 H.P. installed in cases where it would have been equally easy to have put in the best mechanical driving. When proprietors and engineers of mills deliberately chose electric driving it was difficult to believe that they considered electric driving in its experimental state. Owing to the comparative absence of shafting, belting and gearing in electrical drives, steadiness of speed, readier facilities for observation of efficiency, which was an unknown quantity to mechanical engineers, and the consequent maximum production attained, he thought electrical transmission was to be preferred to mechanical means. Mr. Richardson also explained the advantages of electric driving in relation to cleanliness, insurance, &c. By far the greater majority of mills in Dundee had working costs which were a great drag on their owners, and however prejudiced and uncertain the latter might be as to the faith to be placed in electricity they could not afford to neglect the consideration of the question of installing electric driving either by current supplied from a station of their own or from an outside source.

In a subsequent discussion, Mr. David Scott claimed that the mill engine as it now exists is about as perfect as it possibly can be made, and said electric driving would not be advantageous for Dundee mills, especially from a financial aspect. Mr. W. G. Thomson was not opposed to the employment of electrical energy from a supply station, although the charge proposed to be made by a projected company for current supplied to the millowners in the district would mean twice the present cost of motive power. Mr. P. Murray and Mr. P. Matthews spoke in favour of mechanical driving, while Ex-Provost Scott and the chairman (Mr. D. J. Macdonald) advocated experiments in electric driving by millowners, Mr. Macdonald remarking that there were many quarters in textile mills where mechanical power could not be transmitted and where electric transmission would be an advantage.

Elland.—The first year's working of the electricity department shows total receipts £655. 0s. 10d., working expenses £442. 10s. 3d. Interest and sinking fund required £883. 5s. 2d., leaving a deficiency of £670. 14s. 7d.

Fulham (London).—At a special meeting of the Council on Wednesday the electrical engineer (Mr. Arthur J. Fuller) reported on the question of altering the present scale of charges for lighting. This scale is 5d. per unit for average consumption of 12 units per 8 c.p. lamp per annum, 4d. between 12 and 24 units, and 2d. per unit for all units above 24 units.

After considering the objections to the scale, Mr. Fuller states that it was introduced as a compromise between a flat rate and the demand indicator system. The latter was theoretically, from their point of view, a correct one, but was not practicable, as he had found from actual experience that it leads to general discontent, and, apart from expense, is a source of great trouble. If they were to adopt the demand indicator system at present, it would mean an immediate capital outlay of at least £4,500, apart from extra labour, for which, in Mr. Fuller's opinion, they would get no adequate return. Under the present scale for 1903-4, the average charge per unit worked out at 4·18d., from which it was evident that if they were to introduce a flat rate of 4d. per unit they would not be losers. Under the present scale they had a certain number of consumers who probably had been paying a trifle less than 5d. per unit, while others had been paying probably from 3d. to 4d per unit. It would, therefore, be seen that to introduce a flat rate of 4d. would probably end in difficulties with those consumers who at the end of a certain period found their lighting bills had been increased by the change. He thought they should endeavour to reduce the price to the lowest possible limit, consistent with clearing working expenses, interest and redemption charges. During the present year, at least, the electricity works had not called upon the rates to any appreciable extent, and they were paying over £13,000 as interest and redemption money over and above working expenses. From a purely business point of view, he considered the right course to adopt was to make a bold bid to get a very large number of consumers, even at the risk of facing a loss during the next financial year of (say) £1,000 or £2,000. If the price were reduced to a low flat rate they would get such an increase in customers during the year as to ensure, with a corresponding large output, a net profit in 1906-7. For the ensuing year he had included in his estimate 900,000 units at 4d. per unit, making £15,000. From the number of customers they had put on during the current year he believed the figure would quite easily be reached at the present rate of charge. He strongly recommended the adoption of an immediate reduction of the charge to a flat rate of either 3½d. or 3d. per unit.

Supplementary to the report, Mr. Fuller suggests methods for encouraging consumers to more quickly settle their accounts, as follows: (I) Stamp each account when delivered to the effect that 2½ per cent. will be allowed if the account is paid 14 days from delivery; (II) in view of proposed reduction, instead of specifying the absolute reduction, to add ¼d. per unit to account and deduct same if account be paid in 14 days; (III) to give the consumer for every £2 of his bill one new high efficiency incandescent lamp, provided account be paid within 14 days.

The Lighting committee recommended that, until otherwise ordered, the charge for supply of current for private lighting be as follows:—(*a*) 3½d. per unit, with a discount of 5 per cent. on quarterly accounts of £2 and upwards, and 7½ per cent. on quarterly accounts of £20 and upwards (such discounts to be allowed provided payment is made within 14 days of demand), and subject to a minimum charge of £2 per annum; (*b*) that such new rate of charge date back to last quarterly reading of meters; (*c*) that the alteration of charge be notified by the delivery of handbills at every house in the streets in which mains have been, or are about to be, laid, and by advertisements in the local press for a period of four weeks.

Mr. WARNER, in moving the recommendations, said the present system of charging had worked very unsatisfactorily.

The rate of discount was altered to 2½ per cent. on accounts under £2, and 5 per cent. on accounts over that amount. The recommendations were adopted.

Extensions to mains estimated to cost £314. 15s. were approved, as was the conversion of 30 gas lamps to incandescent electric lamps, at an estimated cost of £52. 10s.

Galashiels.—A canvass of the district on the question of the adoption of electric lighting has been completed, and an agreement is to be entered into with a company for the erection and maintenance of works.

Gloucester.—Mr. R. A. Chattock, of Birmingham, last week presented his report on the scheme recently drawn up by the city electrical engineer (Mr. W. J. Bache) for the extension of the electricity undertaking. General approval of the scheme is given, but certain minor modifications were suggested by Mr. Chattock. The report was adopted.

Greenock.—The Greenock & Port of Glasgow Tramways Co. have appealed against the decision of the Board of Trade awarding £602. 19s. 9d. as the proportion of profits due to Corporation, and ruling that the company have to account for two sums of £75 (set aside for maintenance) and £1,500 (for depreciation). The company contend that the Board's award is *ultra vires*.

Halifax.—A communication from the Bradford tramways manager (Mr. C. J. Spencer) suggesting the interchange of parcel traffic between Bradford and Halifax has been referred to a sub-committee for report.

Hampstead (London).—In the annual statement of the Finance committee it is pointed out that there would have been an increase of 1d. in the rates but for the fact that the Council has, for the first time, been able to transfer £4,000 from the electric lighting profits in aid of the rates.

Hanley.—For the past year the gross profit on the electricity undertaking was £6,892. 15s. 1d., of which interest absorbed £2,562. 8s. 8d., and sinking fund and redemption charges £2,522. 3s. 2d. £649 has been carried to reserve and depreciation, leaving a net profit of £1,159. 3s. 3d. The Electric Lighting committee recommended that £1,150 be paid to credit of district fund, and that £204. 2s. 2d. (including £194. 18s. 11d. from previous year) be carried forward. The recommendation was adopted.

Huddersfield.—At a recent meeting of the Corporation the Electricity committee recommended, with the view of developing the use of electricity for power, the adoption of a scheme for payment of a commission to contractors.

For the year ended Dec. 31 the income of the department was £26,723, expenditure £13,313, surplus £13,410. The net profit was £3,875, no allowance being made for depreciation. It was recommended that this, together with £2,110, taken from depreciation and contingencies fund (which would reduce it to £9,743), be transferred to the borough fund in aid of rates for 1905-6, by way of refunding the £5,985 received from the borough rate in the three years 1893-4-5. It was further recommeded that the price of current for lighting be reduced ½d. per unit from July 1.

The report was adopted.

Kersley (Lancs.)—Mr. G. E. Fletcher has been appointed consulting electrical engineer to the Council.

Leicester.—The first section of the electric tramways was opened in May last, and on Tuesday a report by the Tramways committee on the working of their department for 1904 stated that the gross receipts were £79,900 and working expenses £47,993, leaving gross profit £31,907.

Interest and sinking fund required £18,849, the net profit being £13,088. 18,394,183 passengers were carried and 1,860,479 car-miles run. The receipts per car-mile on the electric cars were 9·70d. or 0·62d. less than the receipts on the horse cars, this difference being due to passengers on the electric cars being carried a longer distance for a given fare and to some of the electric lines not having been opened until after the summer season. This difference in receipts was, however, more than counterbalanced by the low working costs of the electric cars (4·82d. per car-mile, compared with 8·25d. on the horse cars). It was proposed to place the net surplus (£13,088) to reserve.

Councillor Flint, who moved the adoption of the report, said it was hoped a system of overlapping penny stages would be introduced before Easter. The roof covers adopted on the cars were very satisfactory.

Councillor Kemp moved an amendment that the report be referred back with an instruction that the net balance should be placed to the sinking fund for the purchase of the old undertaking.

Councillor Bruce, who seconded, was not satisfied with the financial position, and thought £2,000 or so should have been taken off for depreciation on the cars. There were items of expenditure on the capital side that ought to have been charged to revenue. If that had been done, instead of showing a balance of £13,000, there would only have been a profit of about £5,000 or £6,000.

In reply Councillor Flint said the balance was not called profit in the balance-sheet. He did not consider they had made a profit they could handle except to hold in reserve to prevent them going on the rates.

The report was then unanimously adopted.

Light Railways.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation the County of Middlesex Light Railways (Extension of Time) Order, the Portmadoc, Beddgelert & South Snowdon Railway (Beddgelert Light Railway Extension) Order, and the Welshpool & Llanfair Light Railway (Further Borrowing Powers) Order. Objections by March 18.

Liverpool.—In a report prepared by the consulting engineer (Mr. A. Bromley Holmes), on the charges made for electrical energy during the past year, it is stated that for ordinary consumers in the city 3½d. per unit for lighting and 2d. for power up to 3,000 units per quarter has been charged, in excess of 3,000 units, 3d. and 1½d. respectively. For tramways 1·12d. per unit has been charged, subject to an addition of 5 per cent. for each 1s. per ton paid for coal in excess of 6s. Last year 29,333,623 units were supplied at an average price of 1·879d. For fuel 6s. 8¾d. per ton had been paid, against 6s. 11½d. The charges for interest and sinking fund per unit were increasing, and rates and taxes had increased from £10,845 in 1903 to £14,441 last year, and a still further increase of assessment was likely.

With regard to a reduction in the charge for current, Mr. Holmes states that the result of the past year's business, taken by itself, might appear to justify some reduction; but, in view of additional capital charges, the estimated increase in interest and sinking fund by £6,045, and the material rise in the price of fuel, no general reduction in charges could be prudently made. He recommends, however, that to encourage a more extensive use of electrical energy for power the price after 3,000 units per quarter should be reduced from 1½d. to 1d. per unit. Charges for electricity used for medical and other purposes, and not for lighting, should be on the power scale.

London County Council.—At Tuesday's meeting the Parliamentary Committee brought up their report dealing with the various electric power bills being promoted in this session of Parliament. The report stated that out of many suggestions which they had considered, the three most practicable seemed to be: (a) That such companies as supplied in bulk should be placed on a sliding scale of price and dividend, and that powers of purchase should be given to the Council with regard to these on lines similar to those laid down by the Electric Lighting Acts; (b) that the Council itself should be the authority for generating electricity in bulk in London; or (c) that some arrangement should be arrived at between the existing companies satisfactory to the Council and the Borough Councils, with the object of securing a supply of electricity to London consumers upon the most economical basis. They had instructed the chief officers to submit to them detailed reports dealing with the whole question, and had invited the Highways committee to appoint representatives to confer with them on the subject. In their opinion the proposals in respect of which powers were sought were such as to constitute a serious menace to existing and future municipal electrical supply undertakings, and they were fully persuaded that the magnitude of the proposals, the overlapping powers sought, and the general reversal of the conditions now applying to London left the Council no alternative but to oppose the bills. In a further report on the same subject the committee recommended that a conference be convened at the County Hall on March 6 of representatives of the City Corporation and the Borough Councils to consider these bills.

Mr. P. H. Harris doubted whether any good results would accrue from the conference. At the present time the field was much occupied by the companies and the borough councils and the suggestion that the Council should itself supply in bulk might not be a financial success. He felt the whole matter should be referred to a commission like that which inquired into the question of London locomotion. Whatever was done he trusted that the Council would not be committed to the policy of itself supplying current.

Mr. Bruce said it was generally held that the supply of electricity could be carried out more economically from a large central station.

Sir Melville Beachcroft said British electrical industry had been flagging merely because of the action or inaction of the L.C.C. He asked what the policy of the Council was. The committee apparently approved of the general principle laid down by the companies seeking power that electrical energy could be more economically produced and transmitted by means of a large undertaking over a large area. Then he found that the Parliamentary committee expressed the view that the proposals for which Parliamentary sanction were sought constituted a serious menace to the existing and future municipal electricity supply undertakings. Apparently there were four parties interested: (1) The syndicate companies, (2) the borough councils, (3) the L.C.C., and (4) the existing electric lighting companies. Then the committee suggested there should be a sliding scale of charge imposed in the bills and compulsory power of purchase, but in 1898 a Joint Committee of both Houses of Parliament recommended that there should be no compulsory power of purchase in the case of the supply companies, and the Board of Trade felt that if there was power of purchase there should be no sliding scale. If they were to have a conference of municipal authorities, why not confer also with the syndicate companies.

Mr. J. Burns, M.P., considered that the sooner the Government explained its attitude with regard to these bills the better it would be for all concerned. They had 16 borough councils and 13 private companies all supplying electricity under statutory power, and this syndicate proposed to come in with no regard to the existing undertakings. They did this on the score of cheapness of price, but he did not think the cheapness was sufficient to warrant the trespass. Many of the borough councils sold power at a cheaper price than the syndicate promised.

Mr. Stuart Sankey said if the Council sought to become a central authority for bulk supply they would come in conflict with the borough councils, to whom they had lent £3,000,000. Bulk supply must come, and it was necessary that some settled policy should be arrived at in conjunction with the councils and companies.

Dr. Napier said all Parliament would require the Council to show was that they were not standing in the way of the supply of cheap electricity to London. They might show that there were alternatives to the present bills to bring this about. There might be agreements by which the borough councils would assent to take sufficient supply in bulk from the County Council to make it a paying matter.

It was agreed to hold the conference, the date being left open.

Tramways.—The Council approved a recommendation of the Highways committee that application be made to Parliament for statutory authority for the Council, in connection with the reconstruction of its tramways, to lay down raised temporary tramway tracks and to maintain car services thereon during reconstruction.

London Electric Power Schemes.—Wednesday's "Westminster Gazette" contains a report of an interesting interview with Mr. J. Falconer, one of the promoters of the Administrative County of London Electric Power Bill, in which the advantages, &c., of a cheap electric power supply are set out.

Malta.—On the 23rd ult. the Governor inaugurated the electric tramway system.

Manchester.—At the Council meeting on Wednesday the chairman of the Electricity committee (Mr. Howarth) referred to the report of the chief electrical engineer (Mr. S. L. Pearce) on further capital expenditure and said that none of this was for extensions at the chief generating station; the money was required chiefly for extensions of mains and for sub-station equipment. In the central parts of the city the feeders were working quite up to their limit, and it would be dangerous to rely on them for the expected demand next winter. There was no room at Dickinson-street for more boilers; it was therefore proposed to introduce three generators of 500kw. each and drive them (from high-tension mains) from Stuart-street. The scheme had been carefully considered, and the committee unanimously recommended it to the Council for adoption. The minutes were approved.

Mansfield.—The Council have reduced the charge for electric current for lighting from 7d. per unit for the first hour's maximum demand and 2d. after to 7d. and 1d., and for power from 6d. and 1d. to 4d. and 1d. per unit respectively.

Municipal Telephony.—Hull Telephone committee on Tuesday reported that the total number of subscribers was between 1,900 and 2,000, and 1,200 have already been connected.

As soon as sufficient subscribers are obtained, an exchange of the Swansea Municipal telephone service will be opened at Sketty.

Municipal Tramways Association.—The managers' section of this association had a conference at Birmingham on Friday and Saturday last, Mr. Alfred Baker, manager of Birmingham Corporation tramways, presiding. Among the subjects discussed were the following:—"Overhead Equipment," introduced by Mr. J. M. McElroy; "Tramway Telephones," by Mr. A. Baker; "Local Taxation of Tramways," by Mr. F. Coutts; "Collection and Delivery of Parcels in connection with Tramway Systems," by Mr. C. J. Spencer, and "Universal Indicators for Tramway Stopping Stations," by Mr. A. R. Fearnley. During the visit the members inspected the City of Birmingham power house at Yardley.

Ormskirk.—On Tuesday the District Council decided, by seven votes to five, to adopt electricity supply and refuse destruction, estimated to cost about £20,000.

Pollokshaws.—The Board of Trade will grant the application of the Council for an electric lighting order, with power to transfer same to Glasgow Corporation.

Railway and Canal Commission.—The Hon. A. E. Gathorne-Hardy has been appointed a commissioner under the Railway and Canal Traffic Act, 1888, in place of Viscount Cobham resigned. Mr. Gathorne-Hardy will also act as chairman of the Light Railway Commission.

St. Helens.—In explaining the revised terms of the new lease of the tramways, to the local company, Ald. J. C. Gamble stated at the Council meeting on Wednesday that it had been definitely settled that on the cost of overhead equipment and capital outlay the Corporation were to receive 4 per cent., and an agreed price for current. The Council confirmed the lease.

South Shields.—The Electrical committee recommend the Council to reduce the price of electric current after the first hour's maximum demand at 7d. to 1½d. per unit, and the flat rate from 5d. to 4d. At present the rate is 7d. and 2d. The reductions to come into force on April 1.

Southwark (London).—After considering a report by the borough electrical engineer (Mr. D. M. Kinghorn) on the present system of charging for electric current, the Lighting committee recommended that from the commencement of the ensuing Midsummer quarter the following system be adopted:—

Lighting.—6d. per unit for first 1½ hours maximum demand and 1d. after, with discounts, or a flat rate of 4½d. per unit, with discounts.

Power.—3d. per unit for first hour of maximum demand and 1d. after, with discounts, or a flat rate of 2½d., with discounts.

The discounts (to be allowed to all consumers) are 2½ per cent. on quarterly bills of £50 or under; 5 per cent. between £50 and £100; 7½ per cent. between £100 and £200; and 10 per cent. over £200.

This recommendation was agreed to.

The Council have informed the London County Council of their concurrence in the desirability of providing a sinking fund for renewals and replacements of electric lighting plant, &c., during the currency of a loan, and propose that any balance standing to the credit of the undertaking at March 31 next, be appropriated to form the nucleus of such a reserve.

Stirling.—The Secretary for Scotland has sanctioned the borrowing of £41,000 for electric lighting extensions, and at the meeting of the Town Council last week it was agreed that the expense of obtaining the Stirling Electric Lighting Order (£531. 14s. 2d.) be transferred to a suspense account, to be defrayed out of revenue, spread over three years ending May 15, 1907.

The number of equivalent 8 c.p. lamps connected on Jan. 21 was 16,348, compared with 12,861 last year.

Surbiton.—At the last meeting of the Council the chairman of the Parliamentary committee (Mr. Shaw) gave some particulars of the progress of the electricity undertaking, and stated that the equivalent of 13,000 8 c.p. lamps is connected, which it was estimated would, by the end of the year, reach 17,800. It would be necessary to put down additional plant to meet this increasing demand, the estimated cost of the extensions being about £7,500.

Sunderland.—On Friday the Electricity and Lighting sub-committee considered the question of reducing the charges for electric current.

A report and estimates for the year ending March, 1906, were submitted by the borough electrical engineer (Mr. J. F. C. Snell). At existing prices the total works cost was estimated at £25,573, interest £9,928, and sinking fund £9,720, total £45,221. The estimated revenue was £49,311, leaving a net profit of £4,090. The estimated number of units generated was 5,635,622.

Sutton Coldfield.—Application has been made for sanction to a loan of £8,000 for additional generating plant, extensions of electric mains, &c.

Swindon.—An unopposed inquiry into the Council's application for sanction to a loan of £22,000 for electric lighting extensions was recently held.

Telephone Communication in Japan.—When telephone communication was first commenced in Japan about 15 years ago, the work was on the overhead system, B.W.G. No. 18 hard copper wires being used; but two years later No. 17 wires were adopted in all places except the north-eastern districts of Houshû (including Hokkaido), when it was found that owing to the frequency of snowstorms it was safer to use No. 14 zinc-coated iron wires. In 1897 a change was made at Tokyo to No. 17 silicated copper wires, as it was found that the storms seriously damaged the lighter lines. Since 1891 overhead rubber cables have been adopted for places where the network is heavy. With the commencement of the Imperial Government's expansion programme in 1896, the underground system was adopted in Tokyo, Yokohama, Osaka, Kyoto, Kobe and Nagoya for the trunk lines, and lead-covered paper cables for the others. The cables are chiefly of two kinds, one containing 100 conductors and the other 50 conductors, 20 conductors being employed in a few cases. For conduits at first only iron pipes were used, but now earthenware is also used. The whole of the iron and a portion of the earthenware conduits are imported. The lead-covered underground cables contained at first 200 conductors, but the later type have 400 conductors. In 1895 the metallic superseded the single-circuit system. For telephone poles, "sugi" timbers are used generally, though iron poles are used for the junction of cables and naked wires. The timber poles are coated with creosote or similar preparation. For a pole that does not support more than eight wires, the arms are made of "keyaki" wood. For a larger number of wires an iron arm is employed.

Wandsworth (London).—On Wednesday the Council had before them the reply of the County of London Electric Supply Co. to Council's inquiry whether the company would be prepared to hand over to the Council the Streatham area of their undertaking upon terms, or to purchase in bulk electricity generated at the Tooting dust destructor.

The company stated that the Streatham area formed the centre of the company's distributing system of supply, so that the sale of that area would sever their undertaking into two separate portions and so involve great interference with supply in the remaining areas. The situation of the generating station is so far from the Tooting dust destructor that the proposal to purchase electricity generated at the destructor appeared to be practically impossible.

The General Purposes committee recommended that the company be further approached on the subject, and this was agreed to.

West Ham.—278,714 units of electric current were sold in 1904 for lighting and 357,329 units for power, against 254,654 and 57,287 units in 1903.

The borough treasurer reports that the institution of deposit accounts has had a beneficial effect, and has been the means of safeguarding the undertaking to a considerable extent, and has deterred undesirable consumers from coming on the mains. It has been necessary to institute monthly accounts in some cases, and there is every probability of this practice becoming more general, as it is found the one way to safeguard the undertaking against loss through consumers leaving during the quarter without any trace of their whereabouts being obtainable.

The electrical engineer (Mr. W. J. Bullock) reported having been in negotiation with several arc lamp makers, and that the Electrical Co. had offered to supply and, if necessary, erect flame or other arc lamps for consumers, subject to following conditions: (1) Upon completion of installation, 25 per cent. of agreed cost to be paid and the balance spread over two years by eight quarterly instalments, (2) in consideration of Corporation collecting the quarterly payments the electricity department to retain 10 per cent. of gross amount collected, (3) in event of a consumer discontinuing supply before the expiration of the hire-purchase period, the lamps to be returned to the company and the consumer to pay at least 50 per cent. of cost of lamp and full cost of installing, (4) the company to reserve the right of refusing to supply lamps to any consumer.

On the understanding that no responsibility attaches to the Council otherwise than as collectors, these terms have been accepted, subject to a satisfactory agreement being entered into.

The electrical engineer was further authorised to negotiate on the same basis with the General Electric Co.

West Hartlepool.—An inquiry was held here last week into the application of the Council to borrow £2,200 for additional plant at the electricity works, due to increasing demand for current.

Willesden.—At the last meeting mains extensions, estimated to cost £466, 14s. 4d., were authorised.

Wimbledon.—Application has been made for sanction to a loan of £13,218 for extensions of the electricity undertaking. As a result of a report by the chief electrical engineer (Mr. H. Tomlinson-Lee) on the cost of street lighting the Council were last week recommended by the Electric Lighting committee to charge a flat rate of 2½d. per unit for all current consumed for street lighting as from April 1, and that on and after that date the incandescent street lamps be kept lighted from dusk to dawn, each alternate arc lamp being switched off at midnight. The recommendation was adopted.

Dinners.—The annual dinner of the Foremen's Association of the Brush Electrical Engineering Co. took place on 17th ult. Mr. T. Wilson presided, and in the course of the evening Mr. W. Willis was presented with a gold albert and Mr. Lake with a marble clock.

The second annual dinner of the Chelsea Electricity Supply Co.'s Cricket Club took place on 18th ult. The chief engineer of the company (Mr. Percy Still) presided.

The annual dinner of the Chelmsford detachment of the Electrical Engineers R.E. (Volunteers) took place on 18th ult. Corp. Robinson presided over a good muster.

Football Concert.—Having succeeded in establishing their supremacy at football on every occasion since the matches were established between the Robertson lamp makers and the head office staff of the General Electric Co., the lamp makers were particularly jubilant at the concert which followed the match, and which was held in the dining hall at the Brook Green Works on Saturday last. Over 500 people were present at the concert, which was, as usual with these functions, a great success. Mr. C. Wilson presided.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1905 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date (to Feb. 22), and the Directorial Division of the new volume has been corrected up to February 11th, 1905. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. The number of large sheet Tables, &c., has been increased, and the 1905 Edition of this indispensable work is offered as the most complete book of the kind ever published.

Among the chief features of the Handbook Division are Notes of the Year on Electric Traction and Electric Power, Turbine Notes, Electric Lamp Notes, Wireless Telegraph Notes (very full), Parliamentary Summary, Legal Decisions, and a complete set of all the chief documents used by Government Departments affecting the Electrical Industry (including the new "Special Mining Rules," issued Feb. 22).

TENDERS INVITED.

Plymouth Corporation invite tenders for supply of stores for the 12 months ending March 31, 1906, including electricity meters, transformers and cables (paper insulated). Specifications from the borough electrical engineer (Mr. E. G. Okell), to whom tenders by March 18. See also advertisement.

Plymouth Corporation want tenders by 18th inst. for 12 months' supply of lubricating oils, engine-waste, &c., to their electricity department.

Hoylake and West Kirby District Council invite tenders for supply and erection of one 250kw. steam alternator, with piping and accessories. Specifications, &c., from the resident electrical engineer (Mr. Hugh G. McHaffie), electricity works, Hoylake, after March 7. An advertisement contains further particulars. Tenders (addressed chairman of Electric Supply committee) before 10 a.m. March 21.

Johannesburg Council invite tenders for the supply of 30 direct-current arc lamps and 30 lanterns. Specifications, &c., from the consulting engineers, Messrs. Mordey & Dawbarn, 82, Victoria-street, Westminster, S.W., to whom tenders by noon, March 13. See also an advertisement.

The directors of the *Great Western Railway Co.* invite tenders for supply, delivery and erection of plant at their electricity generating station at Park Royal and proposed sub-stations and distribution centres, including high tension three-phase direct-current switchboards and battery boosters at Park Royal; three-phase static transformers and high and low-tension switchboards at various sub-stations and lighting distribution centres; and high and low-tension, three-phase direct-current switchboards at Royal Oak, Shepherd's Bush and Old Oak in sub-stations (*a*) three-phase switchboards, (*b*) direct-current switchboards, and (*c*) six motor-driven boosters in connection with storage batteries at Royal Oak and Shepherd's Bush sub-stations). Tenders to the secretary, Paddington Station, London, W., by March 18.

The *Great Central Railway Co.* invite tenders for various stores and materials during the 12 months ending April 30th, 1906, including electric light and telegraph materials, wire, oils, signal materials, screws, sundry tools, glass, carriage and wagon fittings, hardware, iron, india rubber, asbestos, &c. Patterns can be seen till March 6 on application to Storekeeper (Mr. A. W. Longden), Cornwall-street, Openshaw. Specifications from the Secretary (Mr. Oliver S. Holt), London-road Station, Manchester, to whom tenders by 10 a.m. March 7.

Manchester Tramways committee invite tenders for the supply of materials and various stores for their tramways department, including armatures, controllers, fuses, switches, etc., pinion and gear wheels, arc and incandescent lamps, belts, bell fittings and cells, switchboards, tubing, insulating and armature repairing material, armature and field coils, cable, copper, brass and steel wire, overhead equipment material, spare parts for feeder boxes, globes, lamp glasses, etc., porcelain and brown ware insulators, rubber goloshes and gloves, lamps and lamp fittings, car furniture, brassware, trolley heads, bolts, screws, washers, etc. Tenders to chairman of committee, 55, Piccadilly, Manchester, by 10 a.m. March 6th.

Manchester Corporation also require tenders by 10 a.m., March 6 for laying underground telephone pipes.

Gloucester Electricity Supply Committee invite tenders for supply and erection of plant at the electricity works, including 3 Lancashire boilers and accessories, one 600kw. generating set and accessories, electrically-driven surface condensing plant to deal with 30,000 pounds of steam per hour, steam, exhaust, feed, drain, condensing water and sundry pipes, valves, &c., and an electrically-driven boiler feed pump. Tenders to the town clerk by 1 p.m. March 16.

Stoke Newington (London) Council invite tenders for supply, delivery and erection of sub-station plant and mains, including transformers, three-phase motor generators, boosters, &c., extra h.t. and three-wire l.t. switchboards, storage battery and l.t. distribution mains. Tenders (addressed Electric Lighting committee) to the Town Hall, Stoke Newington, N., by 4 p.m. March 8.

Edinburgh Corporation invite tenders for supply of stores for their electricity department for one year from May 15, including arc lamp carbons, cast-iron pavement and road boxes, electricity meters, house service fuse boxes, earthenware troughing, bitumen and arc lamp globes. Tenders to town clerk (Mr. Thomas Hunter, W.S.) by March 18.

Shoreditch (London) Borough Council invite tenders for stores for one year from April 1 next, including electric cables and sundries, gas pipe and fittings, engineers' stores, glass, &c., for street lanterns, smiths' and plumbers' work, timber, &c. Tenders to town clerk (Dr. H. Mansfield Robinson), before 8 p.m. March 14.

Londonderry Corporation invite tenders for supply of materials for the electricity department for one year commencing April 1, 1905, including carbons, meters and demand indicators. Tenders to the town clerk (Mr. F. Henry Miller), Guildhall, Londonderry, before noon March 6.

Lowestoft Corporation invite tenders for supply and erection of one water-tube boiler with superheater, brickwork settings and accessories, together with the necessary pipework. Tenders to town clerk by 5 p.m. March 9.

West Ham Guardians invite tenders for installation of electric bells, telephones, and fire alarms at infirmary. Tenders, clerk, Union Workhouse, Leytonstone, N.E., by noon of Wednesday, March 8.

London County Council require tenders by 10 a.m. March 9 for cast-iron fire alarm indicators to be fixed to gas and electric lamp columns.

Wrexham Town Council invite tenders by March 10 for stores, including carbons, meters, cables, joint boxes, engine room stores and oils.

Torquay Electric Lighting committee invite tenders for 1,200 to 1,500 tons of smokeless coal. Tenders to town clerk (Mr. Frederick S. Hex) by noon March 20.

Colchester Electric Light and Power committee require tenders by March 15 for supply of castings, &c.

Bristol Electrical committee want tenders by 9th inst. for supply of washed pea nut coal, washed small coal or slack.

Darlington Corporation invite tenders by March 20 for supply of electric motors on hire-purchase basis.

Southampton Corporation invite tenders by March 11 for stores for their electric tramways department for 12 months.

Birmingham Public Works committee invite tenders by March 7 for 1,650 tons of tramway rails, with fish-plates.

Edmonton Guardians require tenders by 9 a.m. 22nd inst. for 12 months' electrical supplies.

Leeds Tramways committee require tenders by 15th inst. for 12 months' supply of electrical sundries, tools, &c.

Dublin Corporation Improvements committee want tenders by noon of 14th inst. for supply and erection of two electric motors.

The State telegraph authorities of *Norway* will receive tenders up to April 1 for the supply of 6 tons of 1·25mm. bronze wire. Tenders must be sent in through agents resident in Christiania, with whom alone the Norwegian authorities will deal. Customs duties and the preferences given to Norwegian manufacturers render the chances for a successful British tender very remote.

The *Spanish* Telegraph Department will open tenders on March 24 for the supply of 65,000 porcelain double insulators (new Spanish telegraph type), to be delivered in five equal lots at Madrid, Barcelona, Cordova, Valladolid and Saragossa. Tenders have to be sent to the Director-General of Telegraphs, 10, Calle de Carretas, Madrid. The "Madrid Gazettee" of Feb. 26 contains additional particulars.

The *Roumanian* Administration of Posts and Telegraphs invite tenders for (*a*) 14,000 large, 8,000 medium and 30,000 small porcelain insulators; (*b*) 13,000kg. silicate brass wire 3mm. diameter, and 120kg. soft copper wire 1·5mm. diameter. Tenders for (*a*) will be opened on March 16, and for (*b*) on March 29. Specifications (in French) can be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Correction.—The amount of the tender accepted by Hammersmith (London) Council for the supply of cables, which appeared in our last issue, should have been £1,057. 8s., instead of £1,570. 8s., as printed.

Lancaster Corporation have placed an order with the British Westinghouse Co. for two tramcars at £570 each.

Islington (London) Council have accepted the following tenders for annual supplies of meters, time switches, carbons, incandescent lamps, terminal boxes, arc lamp globes and general stores and sundries:—W. H. Willcox & Co., Doulton & Co., Rumney & Rumney, Sloan Electrical Co., Witty & Wyatt, Jas. Gibbs & Co., Pryke & Palmer, Alex. Duckham & Co., and Albion Clay Co.

West Ham Corporation have accepted the following tenders for annual supplies:—

British Insulated & Helsby Cables, cables and house cut-out boxes; British Thomson-Houston Co., integrating wattmeters; British Westinghouse Co., transformers; Wiggins & Rihll, stores; Foster & Co., six months' supply of coal (Mardy slack). No tender was accepted for incandescent lamps, the electrical engineer being authorised to purchase same from time to time on best terms.

Great Grimsby Town Council have accepted the tenders of Lassen & Hjort for a water purifier at £815, of Crompton & Co. for motors, and of the Keighley Electrical Engineering Co. for motor starters.

Brighton Corporation received four tenders for the supply and laying of low-tension cables. The lowest was £2,191. 6s. 8d., but the second (that of Siemens Brothers & Co.), at £2,350, is recommended for acceptance.

The order for underground cables and boxes for Belmont Asylum has been placed with Johnson & Phillips, of Old Charlton, by the contractors, Messrs. Bromley & Batstone.

Sunderland Electricity committee have accepted the tender of the Electrical Co. for switchboard panels for sub stations at 10 per cent. off schedule rates.

Leith Tramways Reconstruction sub-committee have accepted the tender of M. P. Galloway (Ltd.) for supply of tramway poles and accessories at £4,471.

Sunderland Electricity and Lighting committee recommend the acceptance of the tender of Short Bros. for a 5-ton travelling crane at £80.

Derby Corporation have accepted the tender of the Sunbeam Lamp Co. for the ensuing year's supply of incandescent lamps.

Stepney (London) Council have accepted the tender of Jessop & Appleby Bros. at £150 for an electrically-driven wall jib crane.

Walsall Education committee have accepted the tender of Ross, Price & Co. for wiring the science and art institute.

Stoke-on-Trent Council have accepted the tender of Crompton & Co. for a 22 H.P. motor at £74. 17s.

BUSINESS NOTICES.

The Union Electric Co., 151, Queen Victoria-street, London, E.C., write to inform us that the growth of the company's export business has decided them to send their Mr. C. O. Barwell for a trip through the British Colonies and round the world, the object being chiefly to ascertain the condition of the Colonial markets, to push the sale of the company's goods, and to appoint agents. Mr. Barwell is in a position to represent one or two other leading electrical firms whose interests do not conflict with those of the Union Electric Co.

The Preston representative of the Unbreakable Pulley and Mill Gearing Co., of West Gorton, Manchester (Mr. John Lucas) has removed to 76, Brackenbury-street, More Park, Preston.

The Synchronome Co., whose system of electric clocks was the only one awarded a gold medal at the St. Louis Exposition, inform us that they have sold their Australian rights to the Synchronome Co. of Australasia (Ltd.) of Brisbane. Mr. A. Knox, the managing director, who has already installed some large electrical time-circuits in Queensland with the assistance of Mr. A. G. Jackson, A.I.E.E., the technical manager, is on a visit to this country to perfect his arrangements with the manufacturers.

Mr. Arthur Peckett, of Bristol, has joined in partnership Mr. Herbert W. Umney, 46, King William-street, London, E.C., and they will carry on at the latter address the business of civil, mechanical and electrical engineers, merchants and agents, and will also represent Isaac Storey & Sons (Manchester), the Sunderland Forge & Engineering Co., Rubery & Co. (Darlaston), Pollock, Whyte & Waddel (Johnstone, N.B.), J. & O. G. Pierson (Paris).

Bray, Markham & Reiss (Ltd.), of Walthamstow, have appointed Rees & Wilson, 33, High Bridge, Newcastle-on-Tyne, their sole agents for the counties of Northumberland and Durham and the Cleveland district of Yorkshire.

The Alliance Electrical Co. have removed to 28, Grafton-street, London, W.

Monté-Callow & Co. ask us to state that they have resigned their agency for Messrs. Lionel Robinson & Co.'s specialities.

BANKRUPTCIES, LIQUIDATIONS, &c.

The trustee (Mr. C. T. Appleby, 26, Corporation-street, Birmingham) in the bankruptcy of J. F. Worthington and G. Nuttall, electrical engineers, Foundry-street, Hanley, has been released.

Bryan Donkin & Clench (Ltd.) is to be wound-up voluntarily. Mr. A. G. Webb, Chesterfield, is liquidator.

Electrical Apparatus for Sale.—Tenders are invited for the whole of the manufacturing apparatus and stock-in-trade contained on premises situate at Moresk Mills, Truro. Tenders will be received up to March 20 by the liquidator of Headley Limited (Mr. Wm. Rowe), Strand, Falmouth. See also an advertisement.

Plant, &c., for Sale.—A 80 H.P. Babcock-Wilcox boiler is advertised for sale in another column. Applications to Messrs. Tebbitt's, Latona-road, Old Kent-road, London, S.E.

Aldershot Urban District Council have for sale 24 Watson penny prepayment meters for 200-volt circuit. Further particulars from the chief electrical engineer (Mr. F. Garside), electricity works, Grosvenor-road, Aldershot. See also advertisement.

Premises for Sale, &c.—A ground floor, area 2,700 super. ft., equipped with electric power, and suitable for general engineering, is to let. Applications to Messrs. Marshall & Co., Campbell Works, Stoke Newington, London, N. See advertisement.

Some premises at Latona road, Old Kent-road, London, S.E., are to be sold or let. See advertisement.

A corner warehouse near London Bridge station (total area 21,000ft.), with two cranes, lift, electric light, &c., is to be let or sold; also a freehold new factory on the canal, Old Kent-road. Apply to Trustee, 2, Crediton-road, West Hampstead, N.W. See advertisement.

A small well-lighted self-contained factory, close to Great Queen-street, London, W.C., is advertised to be let on lease by Messrs. Thurgood & Martin, 27, Chancery-lane, W.C.

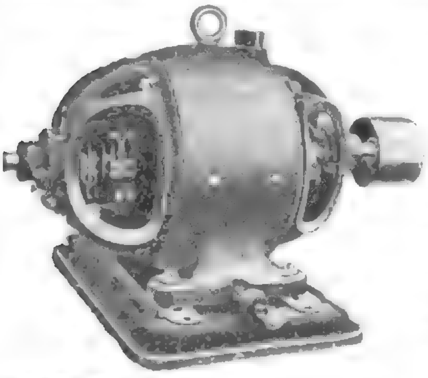
Speed Indicators.—With reference to the notices which have recently appeared in our columns concerning the patent speed indicator for motor vehicles, tramcars, &c., manufactured by Messrs. S. Smith & Son, 9, Strand, London, W.C., full particulars have now been prepared and are obtainable in pamphlet form.

Exhibitions.—In connection with the Congress of the Royal Institute of Public Health an exhibition of educational, sanitary and hygienic appliances, &c., will be held at the Polytechnic, Regent-street, London, W., from July 19 to July 25. A section will be devoted to engineering and building construction, and arrangements can be made for supply of electric current for demonstration purposes, &c. The hon. sec. of the Institute is Mr. James Cantlie, M.A., M.B.

There is a Furniture Manufacturers' and Allied Trades' Exhibition now being held at Earl's Court, London, which will remain open until the evening of March 9.

"**Garcke's Manual of Electrical Undertakings. 1905**."—The new edition of this valuable compendium of the financial operations of electrical undertakings throughout the kingdom has reached its ninth year of publication, and again gives evidence of the development of the industry. To investors in electrical securities the book should prove invaluable. It is only to be regretted that the financial particulars available in a large number of cases are so belated. This is no fault of the compilers, who have gathered together all the statistics and financial data obtainable from every source. The published price is 15s., and the publishing offices 37-38, Strand, London, W.C.

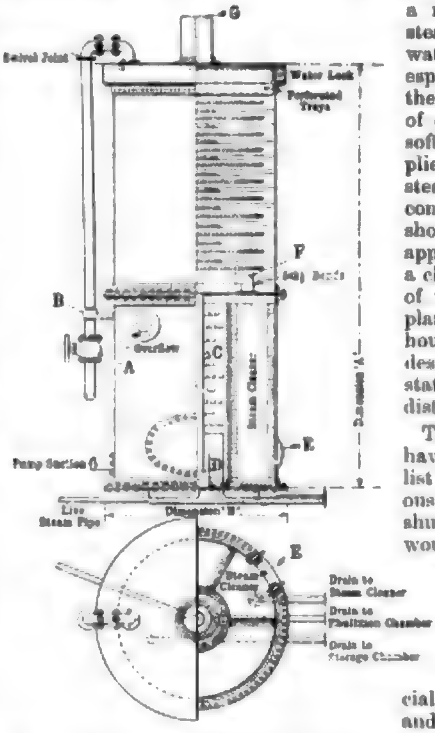
Catalogues, &c.—The Rhodes Electrical Mfg. Co., 70 and 71, Bishopsgate-street Within, London, E.C., are manufacturing a single-phase alternating-current motor of a new class. This motor, which is shown in the accompanying illustration, is a combination of a repulsion and induction motor, designed in such manner that the operation is, it is claimed, to all intents and purposes, as good as that of a direct-current series wound motor, having constant speed, however, when the induction side of the machine is cut in. This machine is being built in two types, the "R. X.," applicable to all kinds of power work, starting up with twice full-load running torque with starting current not exceeding double full-load value, and proportionately for a lesser starting torque down to full-load value, and capable of being brake-coupled to any class of apparatus which does not require instantaneous reversing. The "R. F." type of machine is specially applicable to lifts and travelling cranes, &c., where instantaneous reversing is necessary. This is effected by means of simply changing two connections worked by an ordinary chopper switch, the R. F. machine possessing a special winding for this purpose. The external carcase of these machines is made of cast iron, bored out to take the stator plates, which are built of laminated sheets of iron of high permeability, insulated by paper. The construction of the carcase permits of these plates being pressed into it under hydraulic pressure of more than 50 tons to the square inch, this system of manufacture ensuring the laminated sheets being perfectly coincidental with one another, and true in the stator casting. Ample cooling surface is allowed between the top part of the laminations and the frame through a space for air circulation right round the machine. The windings in the stator are hand wound, the copper wire being specially insulated and insulated bushes provided in the slots, which ensures high insulation resistance. The rotor is built up in a similar way to the stator, with the laminated sheets of iron insulated with paper assembled and keyed direct on to the shaft under hydraulic pressure of not less than 70 tons to the square inch, and clamped solidly between two cast-iron end plates which extend as flanges. The winding is effected in a similar manner to that of a direct-current armature. A high potential test of 2,000 volts alternating is taken between the windings and iron both on the stator and rotor. The slip rings are of gunmetal, insulated by a special insulation process and tested with about 4,000 volts to iron. All parts of the machine are interchangeable, and a large range of all windings and parts of every size frame are stocked for quick delivery. The machines are built throughout at the company's Bradford works, and the company claim to be the sole manufacturers in the United Kingdom of this type of machine.


RHODES SINGLE-PHASE ALTERNATING-CURRENT MOTOR.

In pamphlet No. 138, issued by the Electrical Co., 121-125, Charing Cross-road, London, W.C., a number of recent improvements in Nernst lamps are shown. A new multiple lamp illustrated is in the form of a combination of three large Nernst lamps in one fitting, the object being to provide in this way a competitor with arc lamps where a good volume of light is required. These lamps are made suitable for outdoor work by a special watertight cover, the light ranging between 60 c.p. and 820 c.p., according to circuit and according to whether the lamps are switched on separately or together. A new D type lamp is shown, similar in pattern to the company's B type, but somewhat larger, and of high illuminating power. This lamp for outdoor work is enclosed in a lantern. In the matter of Nernst lamp reflectors several improvements are listed, and both round and slanting types of these reflectors of new design for indoor use are listed. The new "Express" type of Nernst lamp was illustrated in our last issue, p. 770.

The Electrical Co. have also ready a number of pamphlets, &c., illustrating and describing respectively: No. 121, Electric power in weaving mills; 131, Automatic cut-off switches; 133, Weather-proof motor switchboards; 134, Motor switch and starting boxes; 135, Electric winding engines; 136, Electric capstans; 137, A 50-ton crane at Southampton Harbour. In No. 121 there are some excellent interior views of weaving mills, showing looms and other machinery equipped for electric driving.

A new catalogue is issued by the Lawrence Patent Water Softener & Steriliser Co., Norland Works, Uxbridge-road, London, W. This includes a description of a new type of exhaust steam softener and feed-water heater designed especially for use where there is a large quantity of exhaust steam. This softening plant is supplied with or without steam cleaner. The accompanying illustration shows a section of the apparatus, and conveys a clear view of the method of working. This is a plant of 3,500 gallons per hour capacity, specially designed for an electricity station in the London district.



The General Electric Co. have ready a new price list of "Witton" continuous-current motors, both shunt and compound-wound, and of the open-protected, semi-enclosed, enclosed-ventilated and totally-enclosed types. All the usual technical and commercial particulars are given, and the tabulated weights and dimensions are stated both in the English and metric systems. The motors range in size from ½ H.P. up to 100 H.P. Considerable space is devoted in the list to motors which are used intermittently. A useful appendix to the catalogue takes the form of an exhaustive table giving the approximate power required to drive various classes of machinery.

A gear shield for preventing wear on gears is described in particulars issued by Mr. F. J. Down, 6. 7 and 8, Crutched Friars, London, E.C. This is claimed to be a simple method for retarding wear on new gears and arresting excessive wear on worn gearing, making gears noiseless in working, and acting as a cushion on the wearing surfaces, preventing metallic contact between the teeth. For tramway and railway motor vehicle gearing, &c., it is said to effect considerable economy.

Telegraph and telephone cables of the dry core type, and the advantages claimed for the Dieselhorst and Martin variety of these cables, are treated in a set of sheets issued by Messrs. Siemens Brothers & Co.

Messrs. Davies, Kent & Stewart, 17, Berners-street, Oxford-street, London, W., have prepared a new catalogue of electrical accessories comprising a large range of manufactures. The list is fully illustrated.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from Feb. 22 to 28, with the ports of destination:—

Aden, £24. *Africa*—Alexandria, £76 (including £22 telegraph material); Cape Town, £1,968; Delagoa Bay, £112; Durban, £2,606 (including £1,949 telegraph material); East London, £580 (including £446 telegraph material); Port Elizabeth, £165. *Argentina*—Buenos Ayres, £941; Rosario, £30. *Australasia*—Adelaide, £486 (including £15 telegraph material); Fremantle, £510 and 74 cwt. (copper cable); Newcastle, £80; Perth, £498; Sydney, £642. *Brazil*—Rio Grande, £54. *Burma*—Rangoon, £10. *Canada*—Halifax, £765 (telegraph material). *Canary Islands*, £100. *Ceylon*—Colombo, £63 (telegraph material). *Chili*—Antofagasta, £177 (telegraph apparatus); Valparaiso, £46. *China*—Shanghai, £653 (including £153 telegraph material). *Germany*—Bremen, £75; Hamburg, £370 (telegraph material). *Gibraltar*, £609. *Holland*—Amsterdam, £45; Flushing, £74. *Hong Kong*, £108. *India*—Bombay, £246; Calcutta, £1,552. *Japan*—Kobe, £334; Nagasaki, £837; Yokohama, £905. *Malta*, £40. *Russia*—Libau, £50; Reval, £146. *Spain*—Vigo, £56 (including £47 telegraph material). *Straits Settlements*—Singapore, £468. *Sweden*—Gothenburg, £120. Total £16,621, against £20,363 in the corresponding week last year (Feb. 24 to March 1).

COMPANIES' MEETINGS AND REPORTS.

Telegraph Construction & Maintenance Co. (Ltd.)

The forty-first ordinary general meeting of this company was held on Tuesday, at the offices, 38, Old Broad street, London, E.C., Sir ROBERT G. W. HERBERT, G.C.B. (chairman of the board) presiding.

The SECRETARY (Mr. E. Dickens) read the notice convening the meeting, and the directors' report and the accounts were taken as read.

The CHAIRMAN then said: Gentlemen, we have a short tale to tell you, and not a very brilliant one, as to the outcome of the past 12 months' working. As you have seen from the report, it has been a very lean year with us, a year such as we have been unaccustomed to, but we have been able, I am glad to say, to scrape together for you, legitimately, a dividend of 15 per cent., which, I hope, will be acceptable to you under the temporary circumstances of depression with which we have had to deal. The figures in the accounts show a considerable difference as compared with those for the previous year. For instance, last year there was a net profit of £108,738 and this year it is only £48,800, after charging interest on the debentures. Then there was a disposable balance last year of £187,713 against only £146,899 this year. Therefore, after having given you a dividend of 5 per cent. in the earlier part of the year, we now propose to give you a dividend of £1. 4s. per share more, absorbing £44,820, which will make 15 per cent. for the year, free of income tax, and leave £102,079 to be carried forward, against £120,483 last year. As to the accounts, I think that I need not go through them in any great detail. A few variations have occurred in them. The pension fund of £67,085 no longer appears on the left-hand side of the balance-sheet, and on the other side of the balance-sheet there are considerable variations in the total figures. For instance, our property is now valued at £483,368, against £369,687. Among the items that cause this variation is the thorough rebuilding and renovating of some of our works, which has been an expensive process, and we have also had to build a new steamship, and that has been paid for. This has naturally added a good deal to the valuation of our stock-in-trade, materials, and property generally. The debts owing to the company are less than they were last year, partly on account of the pension fund, which has been taken away from the other side of the account, while sundry securities are somewhat less than last year. Our reserve securities are, as you know, invested in thoroughly sound and safe stocks. Then the balance carried down in the profit and loss account is £48,000, against £108,000 last year, and the net profits are £50,785, against £115,580. All this indicates to you very fairly that we have been doing a great deal of work, because there is a considerable amount of money earned, and that is work, probably, of maintaining and repairing cables for the great companies, and completing short and important lengths of cable. At the same time, it does not include any gigantic work like that we had in hand two or three years running. By carrying forward the substantial amount of over £100,000 to next year we shall make some preparation for the possibility, though I trust not the probability, of our not having important work to do. We shall certainly have a good deal of routine work, and this £100,000 odd is a good sum to start the year with. Our works are in good order. We have rebuilt part of the Greenwich factory and we have thoroughly put in order and have now in splendid condition the Wharf-road factory. Our new steamer, the "Cambria," is admired by all who have seen her. She is a handsome and workmanlike ship and will be a profitable one to work. She carries a large amount of tonnage of cables, and will be workable at a lower cost per ton than the previous vessels we have had—I think than any of them. We have parted with one vessel, the "Britannia," which was more expensive to work than the "Cambria" will be, and she will take her place economically and efficiently. I think that I have nothing more to say to you on the accounts. I hope we shall meet again under more gratifying circumstances before long. I will now propose:—

"That the report and accounts of the directors to Dec. 31, 1904, submitted to this meeting, be and the same are hereby received and adopted; and that a dividend of £1 4s. per share, in addition to the 12s. per share interest or interim dividend paid to June 30, 1904, be paid upon all the shares of the company for the year ending Dec. 31, 1904, and that such dividend be paid free of all income tax."

Sir JAMES PENDER, Bart.: I beg to second that.

Mr. H. S. S. CROFT: Mr. Chairman, we must all regret as shareholders that you are not able to present us with such a rosy account as you have been in the habit of doing, I am thankful to say, for many years. I have been a member of this company for a great many years—more years than I care to remember—and I have always recognised this fact, that the directors have to use their discretion as to what amount of information they can communicate to the shareholders, and I think that is a very good policy. They must, of course, use their judgment as to whether they think any particular piece of information should be communicated and published or not, in consequence of the great trade rivalry which exists in connection with all such companies as our own. I have, on many previous occasions, asked questions, and I am bound to say that I have generally received very satisfactory answers. Whether that was owing to the discretion of the directors or to the discretion of the person who asked the questions it is not for me to say. But, Sir, on this occasion I propose to ask two questions, and if you in your judgment think it is not desirable that they should receive any direct answer, I and the other shareholders must be content and bow to your ruling. I do not think, when I have put my questions, that you will see any objection to answering them. I was not present at the last half-yearly meeting in July, otherwise I should then have asked one of the questions which I am now about to ask. I think it was about that time that a notice appeared in the newspapers with regard to an intention on the part of the Danish Government to lay a cable to Iceland. As I was not present at the meeting, I wrote to the secretary of the company, and received an answer from him, and as you did not allude to the matter in your speech I should like to read that letter. The secretary wrote: "I have to acknowledge receipt of yours of the 12th inst. in which you state you have seen in the papers that the Danish Government has decided to lay a submarine cable to Iceland, and you wish to know if there is any prospect of this company obtaining the contract. In reply, I beg to say that the papers are very misleading, as the concession for laying the cable to Iceland is held by the Great Northern Telegraph Co., who have a period of two years in which to complete this cable, and during this period they will doubtless put the work out to tender." Now, that period of two years has not anything like elapsed, but I imagine that you and your brother directors have in some way ascertained what is likely to take place, and if you would not be betraying any trade secret, I should like you to say whether there is any likelihood of this company being able to participate in that intention. Then, Sir, the other question has reference to what appeared in the Press only a few days ago, and, of course, everyone here who takes an interest in this subject must have seen it. I refer to a report which appeared in the financial column of *The Times* on February 25th, in which it was said, "The Mackay Company have, in connection with the increase of the capital stock of the Commercial Cable Company, paid to the Commercial Cable Company the entire cost of a fifth submarine cable to Europe, the laying of which is rendered necessary by the growth of the Company's business and the rapid service demanded by the public. This fifth cable will be put in operation during the coming summer." There again, of course, I do not wish you to answer my question if you, in your judgment, think it undesirable to do so, but if you do not think there is any objection to answering it I think certainly, speaking for myself, I should like, and I daresay the other shareholders would also like, to know whether there is any possibility of our participating in the benefits which will undoubtedly arise to someone from the laying of this cable. You have rather hinted that the work to be done by this company during the current year may be of a routine character, and you have not foreshadowed anything in the shape of such a large increase of business as this paragraph would imply. I am quite content to abide by whatever answer you choose to give me, and if you think it would be in our interests that the question should not be answered I shall bow with great deference to your opinion.

The CHAIRMAN: Gentlemen, in reply to Mr. Croft's two questions, I may say, first, with reference to a possible cable between Denmark and Iceland, it will be, as he has correctly stated, put through by the Great Northern Company. We have heard no movement with regard to its construction so far. We have not been approached in any way, and we do not know whether they are going to carry out the work within the limited period mentioned. As regards the other matter, I did not mention the fact of this new Atlantic cable because the arrangements for it are not absolutely completed, but I have pleasure in informing you, and the other shareholders, that we have made arrangements for the construction of the cable. We shall be putting it in hand before long. The final documents are not completed, and so forth, and therefore, as our general practice is not to announce anything until it has crystallised, I did not speak of it in my opening speech, but as a question has been asked about it I may tell you we have that work to do and we shall hope to finish it before the end of the year.

Mr. J. GIBSON: Probably we are all agreed that the smaller dividend indicates, among other things, the very severe competition which there is in this business now. We cannot expect to have any monoply of the work. We must stand upon our merits, and I think it would be well for all of us to recognise and to make it known as far as possible that there is one record which is peculiar to the company, and that is a very long record of cables laid by us showing such a degree of stability as is not to be surpassed by any other concern. In that particular respect we have what I think we may call very properly a mental monopoly. I hope that people who want to have cables laid will not overlook this fact, and we must try to make it known as much as we can, so that any cable which requires to be laid may be placed in the hands of this company, which has scarcely ever had a misfortune in its work.

Mr. E. CHARRINGTON: You mentioned, Sir, that a new ship was bought last year, and that the reconstruction of our works had taken place. Will you tell us whether that was done out of revenue or out of capital? If it was done out of revenue it would make a lot of difference in considering the result of the year's operations. Everyone knows that last year was about as bad as it could possibly be for trading concerns generally. There is one cable company—I think I can mention this without disclosing any secret—had to pay for their raw material considerably over £100,000 more than in the previous year, and they got absolutely nothing for it. They are in the ring, I take it, like ourselves, and the ring has not put up their price. The company did not receive any profit on that extra expenditure. It may be of interest to some of the shareholders to know that this year already things are more prosperous, and I hope that business on the whole is going to look up. There is one item—sundry securities—in our balance-sheet I know nothing about. It stands at the large figure of nearly £946,000, and I should like to ask if that amount is invested in good marketable securities.

The CHAIRMAN: The expenditure on the ship and on the renovation of the factories comes, with regard to the ship more particularly, out of the reserve fund for the renewal of our fleet, but of both of these items some small proportion has come out of the company's current revenue. With regard to the sundry securities, I may tell you that these comprise a large portion of the reserves—the reserves for the renewal of the fleet and for the purchase of gutta, and so forth. The securities are all marketable securities of a high order. The money is not in the company's business in the ordinary manner, and it is only drawn upon when we have to come down upon it as a reserve.

The motion was then unanimously adopted.

The CHAIRMAN : There are two gentlemen who retire on this occasion from the board—Mr. Colin F. Campbell and Mr. Paget V. Luke—and they are both eligible and are candidates for re-election. I propose that those two gentlemen be re-elected directors of the company.

Sir JAMES PENDER, Bart : I shall be pleased to second that.

The resolution was carried unanimously.

Mr. GIBSON : I have pleasure in moving

"That Mr. John Gane and Mr. P. A. Glegg be and are hereby re-elected auditors of the Company for the year 1905 at the usual remuneration."

I believe we are all satisfied with our auditors, and it is not necessary for me to make any remarks in their favour.

Mr. ROBERTS : I have much pleasure in seconding the resolution.

The resolution was passed *nem con.*

The CHAIRMAN : Gentlemen, that concludes the business.

Mr. CROFT : I beg to propose a hearty vote of thanks to the board and the staff of the company. In a concern of this kind so much depends on the staff, and I think that they should be coupled in a motion of this kind with the directors, although the work that they undertake is of a different character.

Colonel GORHAM : I have great pleasure in seconding that, and to express my gratitude, and that of the shareholders as a body, for the excellent business which the board have done for us during a year of unexampled depression. We cannot expect to always get what we were getting a few years ago when there were so many new cables to be laid. Considering there has been no work of that sort going, I think it shows the stability of this company that we should be receiving 15 per cent. as the result of ordinary routine work. When there are any more big cables to be laid I think people will like to come to a company like ours which tenders at a moderate price and carries out the work satisfactorily.

The proposition having been agreed to unanimously,

The CHAIRMAN said : Gentlemen, we are much obliged for the kind vote of thanks which you have accorded to ourselves and to the staff. I should like particularly to associate with the latter our sea-going staff, who have managed our ships in a remarkably successful manner.

The proceedings then terminated.

National Telephone Co. (Ltd.)

The thirty-fifth ordinary general meeting was held on Tuesday, the Right Hon. Sir Henry Fowler, M.P., in the chair.

The SECRETARY (Mr. Albert Anns) having read the notice convening the meeting,

The CHAIRMAN alluded with satisfaction to the continued progress of the company, the yearly comparisons, he remarked, being the true test of their progress. The gross income for the past year was £2,018,979, an increase over 1903 of £183,136. The Post Office royalties for the year amounted to no less than £185,937, or £17,688 more. Working expenses were £1,154,696, an increase of £117,000. There were, however, special causes for this increase last year, and, of course, they could not expect to earn nearly £200,000 more revenue without a large addition to the working expenses. The net profits for the year—and this was the practical part of the statement—were £678,346, or £47,450 more than those of 1903. After paying debenture and other interest and dividends for the half-year at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred stock, and 5 per cent. per annum on the deferred stock, they would carry to reserve £115,000 for the half-year, or £215,000 for 1904, a considerable advance on the amount transferred to this fund in 1903. The number of their stations increased during 1904 to 315,829 (against 277,589), the number in the previous year, the increase being very fairly spread over London and the United Kingdom. There had been an increase in the London area of 8,336 and in the provinces of 29,404. Their capital expenditure had also been increased. The unexpired orders at the present time were 9,490 ; last year they were 9,443. They had, therefore, not been overtaken yet. The number of the staff at the end of December last was 13,844, having increased during the year by about 1,000. The most important paragraph in the report was the statement that the board, after protracted negotiations, had arrived at an agreement with the Postmaster-General for the sale to him on Dec. 31, 1911, of the company's undertaking. The negotiations had lasted very nearly 12 months, and had occupied the constant attention of the directors, who had been ably supported by the staff. He felt bound to mention in this connection the heads of their finance and engineering departments and the general manager, Mr. Anns, Mr. Gill and Mr. Gaine, from whom the board had received invaluable assistance. The shareholders were aware that the licence of the company would expire on Dec. 31, 1911. He had been repeatedly asked what they proposed to do when that date arrived, but they had not been in a position to say anything until 1904, as up to then the Government, under the Act of Parliament, had had the power to compulsorily take over the property, whether the company liked it or not. The Government had, however, frankly told them—and this had been endorsed by Parliament—that they did not intend to extend the licence beyond Dec. 31, 1911, and it was too late to argue whether or not this was a wise decision in the interests of the public. Parliament and the Government had determined that the telephone business of the country should on that date pass into the hands of the Postmaster-General, as the telegraph business passed under his control many years ago. In 1901, after protracted negotiations, the company and the Postmaster-General entered into an agreement with reference to the terms upon which the Postmaster-General should take over the London business of the company on Dec. 31, 1911. This agreement was the subject of a good deal of controversy, and a decision was arrived at by a very large majority in the House of Commons approving the transaction as wise in the interests both of the public and the company. The arrangement was approved by the shareholders. It had been in operation for three years, and as he had stated at their general meetings since, it had worked most satisfactorily for the public convenience and in the interests of the shareholders. He had always maintained that London was big enough for the operations both of the company and of the Post Office. Six months ago he said that if London was to be properly equipped and telephonic communication was to be fully developed, as recommended by Mr. Gaine on returning from his last visit to America, a very large amount of capital would require to be expended in the metropolis. The Post Office opened their exchange system in London at the end of February, 1903, and on Dec. 31 last they had 22,181 exchange stations. It might be thought that this competition had injured the company, but during the same period they themselves increased their exchange stations by 22,950 ; and the fact was that the competition was needed in order to meet the growing demand. At the end of last year the company's stations in London numbered 71,417. He mentioned these figures to show that there was a precedent for the agreement recently entered into, and that the arrangement, which was already in operation, had worked satisfactorily. In principle the agreement recently entered into was practically an extension to the whole country of the former arrangement with respect to the London business. The agreement recently made was subject to the approval of Parliament. The Government had determined, and he thought wisely, that they would refer it to a Select Committee of the House of Commons, and this Committee would have been moved for on the previous night if public business had permitted. Pending the consideration of the agreement by a committee and their report thereon, it would be most undesirable, in that room at all events, to discuss its detailed provisions. The directors were absolutely unanimous in their approval of the agreement and in recommending its adoption ; and with regard to the views of the shareholders, the board had received a larger number of proxies for that meeting than had ever been sent to them in the history of the company. Their authorised capital was at present £10,500,000, of which £9,189,593 had been issued. There were ordinary shares amounting to £500,000 not yet issued, and £810,407 of 4 per cent. debenture stock was also unissued. Their expenditure had been £10,840,780, or £1,767,120 in excess of the amount paid up. The reserve fund, which was invested in the business of the company, would amount that day, if the shareholders approved the directors' recommendation, to £1,618,000, which was nearly equal to the excess of the capital expenditure. He thought it possible that questions might be asked with regard to the respective rights of the various classes of stockholders, and what the board had decided on doing, if Parliament approved the agreement and the latter became operative, was to take the opinion as to those rights of the most eminent members of the English Bar. He would conclude his remarks by repeating what he said at their meeting last July : "I believe the Postmaster General will credit the board of directors with a desire to meet him in a fair spirit, and all I can now say is that I hope the negotiations will result in a satisfactory arrangement being arrived at, which will enable this great public service to be adequately and properly developed, and which will at the same time be equitable and fair to the shareholders." He then moved the adoption of the report and accounts and the payment of the dividends therein recommended

The VICE-PRESIDENT (Mr. George Franklin) seconded the motion.

A short discussion followed, in which Mr. J. Lea-Smith, Mr. Stevens, Col. Perry, Mr. Twining, Mr. Knoth, and Mr. Seward took part.

The PRESIDENT, in reply, said the directors intended to extend the business of the company as far as possible, but before dealing with the question of the amount of new capital to be raised or the conditions of its issue, they must wait and see whether the agreement which had recently been entered into with the Postmaster-General was to become operative. As to what the compensation to be received from the Government would cover, he would say that the board did their best for the shareholders in 1904, and 1911 must tell its own story.

The resolution was then adopted unanimously.

A very cordial vote of thanks to the chairman, directors and staff was passed, and the proceedings terminated.

Kensington and Knightsbridge Electric Lighting Co. (Ltd.)

The general meeting was held last week, Lieut.-Col. R. E. Crompton, C.B., in the chair.

The SECRETARY (Mr. R. S. Erskine) read the notice convening the meeting.

The CHAIRMAN then said : Gentlemen, this is our eighteenth meeting, and at no previous time has the state of our affairs been so satisfactory. In spite of our having given very considerable reductions to our consumers, reductions which have reduced the average price we receive per unit from last year's figure of 4·25d. to an average of 3·4d., we have been able to pay a distribution practically equal to that of last year. This satisfactory result has been obtained partly by increased economy of working and partly by the natural reduction in the distribution of the fixed expenses which follows on dividing them over an increased output. We are now taking two-thirds of our supply from the Wood-lane works, and are, therefore, greatly interested in their economical working. In order to facilitate this as much as possible, this Company has adopted a progressive policy by adding to the amount of accumulator plant we use, thus enabling us to work the plant at Wood-lane for longer hours, and we have been endeavouring, with some success, to persuade the company which works with us as our partners at Wood-lane, to follow our example by similarly increasing their accumulator plant. When this is done the Wood-lane works will receive full advantage from working the plant for long hours, so that I hope next year to show that the cost of the supply from Wood-lane has been still further reduced. The increase in the use of accumulators has been attended by no ill results in the way of increasing our maintenance charges. On the contrary, our accumulator plant has been thoroughly maintained and is in very perfect order. In spite of liberal expenditure on maintenance our accounts show that the works costs of producing our electricity is actually 5 per cent. lower than it was last year. We are, however, still groaning under the heavy load of municipal rates. The amount set aside on depreciation account this year is increased from £9,285 to £10,967. The renewal and depreciation funds now stand at the satisfactory figure of about £56,500. Turning to the proposed distribution of profits, I need not repeat the reasons I gave last year why we consider it advisable to continue paying a steady 10 per cent. dividend and take any extra distribution we can afford to make in the form of a bonus. The bonus this year is 2 per cent.—the same as last year. I think our policy of dividing up our profits in this way is a sound one. I now move that the report and accounts be adopted.

Mr. R. W. WALLACE, K.C., seconded the motion, which was carried.

Resolutions approving the dividends and bonus recommended by the directors, and re-electing the retiring director (Col. Crompton) and auditors were then approved.

A resolution that the remuneration of the directors be increased from £1,000 to £1,750 was then, after brief discussion, carried, the seconder (Mr. K. W. Hedges) making an interesting reference to the small beginnings of the old Kensington Court Co.

The proceedings then terminated.

BLACKPOOL & FLEETWOOD TRAMROAD CO.—At the meeting last week the chairman (Mr. G. Richardson) said the directors had been unsuccessful in their appeal to Quarter Sessions on the method of rating of the company's undertaking. The directors contended that they should be rated as all other railway companies at quarter rates, as provided by the Public Health Act, 1875. They had, however, appealed to the Queen's Bench Division, and, if necessary, would take the case to the House of Lords. To the three local authorities through whose districts their line passed they paid £1,044 in rates per annum, for which they got no more return than the trunk line railways. If successful, it would mean a saving of £800 a year to the company.

BRITISH ELECTRIC TRANSFORMER CO. (LTD.)—The accounts for 1904 show that, after paying all manufacturing costs and expenses of administration, there is a net profit of £12,030. 7s. 9d., which, with £1,572. 13s. 4d. from last year, makes £13,603. 1s. 1d. The directors recommend that £1,500 be allocated to depreciation, £2,000 to reserve, £1,500 off preliminary expenses, £1,150. 11s. 8d. in payment of preference dividend (£537. 12s. already paid) £4,957. 12s. in payment of dividend of 7½ per cent. on ordinary shares, leaving £2,494. 17s. 5d. to be carried forward. The extension of the works which has been carried out has been of great value and has enabled the company to deal with the increased volume of business. In spite of the general depression in trade, the works were fully occupied and running overtime during the whole year.

CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.)—At the meeting last week Mr. D. Munsey said the year had been full of work for the directors. At the end of 1903 they found their works were too small, and it was consequently decided to extend. That had been done. Business during the past year had been very satisfactory. In July they reduced the charge for energy from 7d. to 6d. per unit, and hoped by that to increase the demand. He thought the extensions they had made to their works and plant would suffice for 20 years. The report was adopted and a dividend of 7 per cent. for the year was declared.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The directors report for the year ended Dec. 31 shows that capital expenditure amounted to £55,827. 6s. 11d. The total revenue was £256,837. 14s. 5d. Expenses amounted to £114,245. 15s. 5d., leaving £142,591. 19s., besides £21,881. 14s. 5d. brought forward, or £164,473. 13s. 5d. Interest has absorbed £33,995. 17s. 7d., £45,500 has been transferred to reserves, leaving for division £84,977. 15s. 10d. The directors recommend payment of the balance dividends on the 6 per cent. preference shares, and of 6 per cent. on the ordinary shares, leaving to be carried forward £21,876. 17s. 6d. The number of customers being supplied at Dec. 31 was 11,558, compared with 11,197 in 1903, and the number (equivalent) of 8 c.p. lamps connected was 727,961 compared with 640,685. At Feb. 15, 1905, there were 754,754 8 c.p. lamps (equivalent) applied for, out of which 737,397 were connected, and the customers numbered 11,619. The units sold during 1904 (excluding public supply) were 16,320,288, compared with 13,596,075 in 1903, 12,988,615 in 1902, and 11,526,951 in 1901. The gross revenue was £256,838 an increase of £13,952 and the net revenue £155,399 against £150,349. The reserve funds now amount to £330,715. 15s.

CROSSLEY BROS. (LTD.)—At the meeting on Tuesday Mr. W. J. Crossley referred to the probability of doing a better trade in motor-car engines during the coming year. They could not complain of last year's trade, but there was promise of a great advance in the near future. Already they had orders for 50 of these engines. They were full of orders, particularly for large engines. Their invested reserve had appreciated some £2,000. The balance preference dividend and 12 per cent. on the ordinary shares (making 11 per cent. for the year) was declared.

HART ACCUMULATOR CO. (LTD.)—The chairman (Mr. G. W. Kidd) stated at the meeting on Wednesday that the company had had another very successful year's business. Competition had been as keen as ever, and the depression of trade throughout the country had been very bad. Yet they had been kept so busy that during the best part of the year they had had to keep night shifts going in order to carry out the work in hand. Their position was really a great deal better than it appeared in the balance-sheet, for, having had a very large turnover, and made a considerable profit, their manager had written down a great portion of the stock to scrap prices. During the year they had installed 16 central station batteries. There was hardly any class of work for which they did not supply batteries. As far as the motor business was concerned, they stood well in that direction too. Their staff was continually experimenting. In fact, they were spending a considerable amount of money out of revenue in trying to obtain the very best plate that could be got in the battery world. They had one motor-car which ran something like 5,000 miles before a penny had to be spent on its battery. If their battery worked like that they had nothing to fear. Their branches in Manchester and Birmingham were doing good business, and there was hardly a job going but they had something to do with it. Orders this year were quite up to last year's standard, while the sales in January and February showed an increase of 33 per cent. on those of the first two months of last year. Depreciation has been made on the whole of the plant and buildings to the fullest extent. They required more capital to go on with the buildings. They had spent nearly 50 per cent. more than the amount subscribed for the 6 per cent. preference shares. About 4,000 shares were taken up, but they required another £10,000 in order to finish the whole of the buildings. If the shareholders would take up those preference shares and get their friends to take them up they would help the company considerably. He would say no more except that the thanks of the shareholders were due to the staff, from Mr. Clark and Mr. Poulton downwards, for the way in which the business of the company has been carried out. The report was adopted.

IMPERIAL TRAMWAYS CO.—At the meeting, on Saturday, the chairman (Sir Geo. White), said the Middlesborough, Stockton and Thornaby Electric Tramways showed a net profit of £16,564, against £16,353, in addition to which they had added £1,4000 to the Middlesborough renewal fund. They had obtained powers to continue their existing system at Middlesborough, and to run through the populous manufacturing districts of North Ormesby, South Bank, Grangetown and Eston. Their net profit for the year was £41,655, and after paying the 6 per cent. preference dividend, it was proposed to pay a dividend at the rate of 10 per cent. on the ordinary stock, making 9 per cent. for the year.

LONDON UNITED TRAMWAYS (1901) (LTD.)—The chairman (Mr. C. T. Yerkes) at the meeting on Tuesday said it was satisfactory to be able to point to an increasing revenue for the past year, and at the same time a decrease in working expenses. The total receipts were £296,235. 11s. 2d., against £280,241. 16s. 1d., against working expenses £176,188. 5s. 10d., compared with £176,391. 12s. 7d. The percentage of working expenses was 59·47 per cent., against 62·94. The total number of passengers carried was 48,126,727, an increase of 2,833,254. The net profit was £120,047. 5s. 4d., and other items brought the available balance to £124,584. 8s. 5d. Payment of a final dividend on the ordinary shares at the rate of 6 per cent. per annum was recommended. £5,000 was placed to reserve, and £503. 11s. 3d. carried forward. The traffic receipts showed every sign of a steady increase. They had also let a contract for advertising on the cars, which would realise at least £5,000 per annum. Since the last meeting the line from Southall, via Hayes and Hillingdon, to Uxbridge, and also the connecting link from Hammersmith-broadway, via Askew-road, had been opened, and the result of the working of those lines since June last had fully realised anticipations. They had now 37 miles of electric tramways in operation against about 30 miles last year, and he called attention to the fact that there was no increase in expenses when the number of miles was increased. The directors were concluding contracts for the building and equipment of the authorised extension in Kingston, Surbiton, the Maldens and Wimbledon, and between Brentford and Hanwell. The work of construction would be proceeded with forthwith, and the lines, it was expected, would be completed and put into operation during the course of the year. Those lines would link up important centres of population, putting them in through communication with the rest of the company's system and with the London County Council's electric tramways system at Tooting. The electrification of the District Railway was rapidly approaching completion, and with the inauguration of the other tube railways controlled by their allies, the Underground Electric Railways Co. of London, and the introduction of through fares and facilities, their electric tramways would be a considerable factor in that most up-to-date and comprehensive scheme of City and suburban transit. It was with justifiable pride they could say that their system stood in the first rank of electrical undertakings, and their central power station had become one of the show installations of the United Kingdom.

NERNST ELECTRIC LIGHT (LTD.)—An adjourned general meeting shareholders was held on Thursday last to appoint a director and to elect auditors. Mr. A. M. Oppenheimer gave a lengthy explanation of his attitude and the history of his connection with the company, and justified the position he had taken up. The poll resulted in the re-election of Mr. R. J. Wallis-Jones, for whom 37,344 votes were cast, against 30,359 in favour of the amendment moved by Mr. Oppenheimer at the previous meeting, and reported in our issue of Jan. 27.

NEWCASTLE ELECTRIC SUPPLY CO. (LTD.)—A special report has been issued dealing with the purchase of the undertaking of the County of Durham Electrical Power Distribution Co., in which it is stated that the sum to be paid (subject to deductions upon final adjustment of liabilities and assets), is £256,000, payable as to £100,000 in cash (or at the option of Newcastle Co. in 5 per cent. preference shares in the Durham Co.) on or before July 1 next; £106,000 in four equal quarterly instalments in 1907, with no charge for interest for 1905, but with 4½ per cent. for 1906, and 5 per cent. for 1907, on amounts unpaid in each quarter; £50,000 in cash within next few months, as various contract works now in hand are completed to satisfaction of Newcastle Co.'s engineer. The last item, representing expenditure on various works now in progress, to be completed by June 30, 1905, will be refunded by Durham Company on completion. In order to develop the area over which the Durham Co. have powers, it is proposed that the Durham Co. shall at once make a public issue at par of the additional capital necessary to establish the business on proper lines.

NORTHALLERTON ELECTRIC LIGHT & POWER CO. (LTD.)—At the meeting last week Mr. John Hutton, M.P., said the company had made substantial progress during the past year, as they had increased their net profit by more than £100, and had sold 1,033 units.

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—The report for the past year states that more business to the extent of £7,300 was done than in 1903. Arrangements have been made with the Newcastle Electric Supply Co. to supply current in part of the company's area. The profits for 1904 amounted to £4,388, and £1,001 was brought forward. A dividend of 6 per cent. is proposed, £1,500 being added to reserve, £380 written off preliminary expenses and £257 carried forward.

NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)—The directors' report to Dec. 31 last states that capital expenditure stands at £224,267. 6s. 9d., including £7,932. 3s. 8d. for the past year. This has included £2,225. 12s. 6d. for new mains, and £3,973 for new battery of accumulators. The equivalent of 8 c.p. lamps has reached 132,132, compared with 116,360 in 1903, and the profit has reached £19,890. 9s. 5d., compared with £15,018. 4s. 7d. The number of consumers is now 2,267, nearly 98 per cent. of whom are supplied at 200 volts. The gross revenue was £34,563. 18s. 1d., an increase of £5,120. From the net profit of £19,890. 9s. 5d., depreciation, renewal and reserve fund take £2,750, and interest £2,450, £8,227. 5s. 8d. is allocated to interest and sinking fund of the joint Kensington and Notting Hill station, leaving £11,663. 3s. 9d. The directors now recommend the usual dividends of 6 per cent. on both preference and ordinary shares, and that the balance (£3,353. 3s. 9d.) be divided between the founders and the ordinary and preference shareholders. This will pay a further 1 per cent. to both ordinary and preference, with £3 per share on the founders' shares. The directors call attention to the increased amount levied for rates, £2,099. 8s. 6d. having been paid during the past year, in addition to £160, the company's proportion of rates at the joint Wood-lane station. These rates are equivalent to an income-tax of about 4s. in £ upon profits distributed to the shareholders, in addition to the usual income-tax. During the present session a considerable sum will have to be expended by the company upon law costs, as a large number of schemes have been brought forward for various projects in connection with the supply of electricity. In many of these bills clauses have been inserted authorising the undertakers to supply electricity in all parts of London. It is, the directors urge, a legitimate grievance that promoters should be able wantonly to submit the company to continuous and unnecessary expense of this nature.

OXFORD ELECTRIC CO. (LTD.)—The directors' report for 1904 states that the profit (including £890. 10s. 8d. from last year) was £11,803. 6s. 8d. After providing £2,050. 13s. 8d. for interest and writing off £698. 7s. 9d. on account of hire-purchase installations, the balance available is £9,144. 5s. 3d. A dividend at the rate of 7 per cent. per annum (tax free) is recommended (2½ per cent. was paid in September), £2,470. 14s. 8d. is added to reserve and renewal of plant account, and £898. 10s. 7d. is carried forward. At Dec. 31 there was the equivalent of over 65,000 8 c.p. lamps connected to the mains. The number of units sold during 1904 was 13 per cent. larger than in the previous year.

SOUTH LONDON ELECTRIC SUPPLY CORPORATION (LTD.)—The directors' report for 1904 states that, after making full allowance for depreciation and preliminary expenses, the net balance is £21,883. 19s. 7d., from which must be deducted interest (£2,437. 2s. 9d.), leaving £19,446. 16s. 10d. Out of this the board recommend payment of a dividend at rate of 4 per cent. on ordinary shares for year, carrying forward £6,446. 16s. 10d. The number of 8 c.p. lamps connected was 107,000, an increase during year of 15,098 lamps, while applications were in hand for a further 4,200 lamps. The total number of units sold in 1904 was 9,205,342, an increase for year of 1,390,861 units. The plant, machinery and mains have been maintained in a high state of efficiency out of revenue. The cost of production has again been still further reduced.

TRAMWAYS AND MOTOR BUSES.—At the meeting of the London General Omnibus Co. last week, the Lord Mayor of London, Ald. Pound (chairman of the company), said they had been watching during the past few years the various attempts of others to provide for the increasing traffic of London. Of underground electric railways they had seen many projected, some authorised, and a few constructed and opened for traffic. Now, those undertakings had certain disadvantages, but there could be no doubt that, suitably placed, tubes were a convenience to the public, and formed a swift means of communication from one district to another. They had seen the lavish and unprofitable expenditure of ratepayers' money on municipal electric tramways, with the result that traffic previously carried by the railways had been drawn back again to the roads, the streets congested, and the difficulties and expenses of the traders of their great city increased. They had seen the development of the motor omnibus. Companies formed to work motor omnibuses in London had failed, and they had studied the causes of their failure. They felt the time had now come when services of motor omnibuses could be successfully run by the London General Omnibus Co. and those associated with them. He was not one of those who imagined that motor omnibuses would bring more profit than they had made in the past; but he believed that they would form a solution of the problem of London traffic, and that, with their unique knowledge and experience of the conditions of that traffic, they were in the best position to make the new services a commercial success. They had on order for immediate delivery a number of motors of different makes for which they were building bodies in their coach factory, and hoped very shortly to replace their present omnibuses on certain routes with the new vehicles.

At the meeting of the Star Omnibus Co. the directors asked authority to issue debentures or debenture stock to provide capital to enable them to purchase a number of motor omnibuses. This meeting was, however, adjourned.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—The report of the directors for the year 1904 states that the net profit was £46,521. 4s. 8d. After payment of directors' and auditors' fees, interest and income tax, and making the usual allowance for depreciation of buildings, plant, machinery, &c., there remains £38,263. 11s. 4d., making, with £27,585. 7s. 5d. from last year, £65,848. 18s. 9d. £1,000 has been transferred to debenture redemption sinking fund, and a dividend on the ordinary shares at the rate of 15 per cent., less tax (including the interim of 5 per cent.), is recommended. Together with the preference dividend for the year, this will account for £39,337. 7s. 10d., leaving £26,511. 10s. 11d. to be carried forward.

YORKSHIRE ELECTRIC POWER CO.—At the meeting on Tuesday, Mr. A. G. Lupton said it had not been possible to have the full plant in working order by the end of the year. There had been small interruptions that had caused delay, and they had not yet got the turbines running. The station and the equipment were all complete, with this exception. In order to keep the company's contracts to supply current in December, the engineer ran temporary plant, and current was available on Dec. 31. The first permanent customer was connected on Jan. 21, and since then supply to him had gone on steadily. Meanwhile, the staff was being organised, and the concern put into thorough working order. They had settled agreements with customers for supplying current to the extent of 900 H.P., and were about to supply three local authorities—Pudsey, Liversedge and Mirfield. Other negotiations were in hand, and he had confidence that by the end of the year they would at least have doubled that supply of 900 H.P. The directors had under consideration a scheme for hiring out motors.

NEW COMPANIES, LIENS REGISTERED, &c.

NEW COMPANIES.

INTERNATIONAL DOWSING ELECTRIC HEATING AND APPLIANCES CO. (LTD.)—(83,693.) Reg. Feb 21, capital £20,000 in £1 shares, to adopt agreement with A. Romberg, liquidator of Compagnie Internationale de Chauffage par l'Electricité, to acquire any patents and inventions relating to heating and lighting by electricity, to carry on any scientific, therapeutic, medical or surgical institution, &c. First directors, W. Conelly, A. C. Newstead, H. J. Dowsing, D. Maclaurin and A. M. Romberg. Reg. office, 24, Budge-row, London, E.C.

LIGHT ELECTRIC MOTOR CO. (LTD.) (5,792).—Reg. in Edinburgh Feb. 21, capital £6,500 in £1 shares, to purchase business of manufacturers of electrical specialities, electric power and light contractors, &c., of Light Electric Motor Co., and to carry on same. First directors, J. Mackay, G. Rowland and D. Laurie. Reg. office, 164, Howard-street, Glasgow.

WEBSTER ELECTRICAL ENGINEERING CO. (LTD.)—(83,637). Reg. Feb. 23, capital £10,000 in £1 shares, (5,000 6 per cent. cumulative preference, 4,000 preferred ordinary and 1,000 deferred ordinary), to acquire business of electrical engineer carried on by C. W. Webster at Bradford. First directors, C. W. Webster (manager) and F. W. T. Newbould. Reg. office, Laycock's Mill, Thornton-road, Bradford.

ZEA ARC LAMP CO. (LTD.) (83,613.)—Reg. Feb. 17, capital £1,000 in £1 shares, to carry on the business of lamp manufacturers, suppliers of electric light, electricians, engineers, &c., and in particular to take over from E. G. Abrahams, the benefit of certain inventions relating to arc lamps. Reg. office, 2, Staple-inn, Holborn, London.

MORTGAGES AND CHARGES.

AUTO ELECTRIC RIFLE & TARGET CO. (LTD.)—Issue on Feb. 8 of a debenture for £50, part of series created Dec. 5, 1904, to secure £5,000, charged on company's undertaking and property, present and future. No trustees. No previous issue of same series.

BIRKDALE DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Particulars of a series of £3,000 debentures, created Feb. 14, charged on company's undertaking and property, present and future, including uncalled capital, have been filed pursuant to sec. 14 (4) of Companies Act, 1900. No trustees.

GLOUCESTERSHIRE ELECTRIC POWER SYND. (LTD.)—Issue on Feb 22 of £850 debentures, part of series created same date, to secure £1,500, charged on company's undertaking and property, present and future, including uncalled capital. Holders, H. C. Smith, N. P. W. Brady, D. MacKinnon, Sir James Mackay, Sir G. S. Mackenzie, S. Hall, Sir W. H. Marling, W. J. P. Marling, G. L. Addenbrooke, D. W. F. Winterbotham, P. Still and C. Bathurst, jun.

KENT ELECTRIC POWER SYND. (LTD.)—A mortgage or charge dated Feb. 14, 1905, to secure £4,275, has been registered. Property charged: debenture stock of Kent Electric Power Co., to nominal amount of £5,700, and instalments due in respect of sale thereof and company's undertaking and property, present and future, including uncalled capital. Holders, Hon. John B. Lubbock and G. C. Curtis.

MERTHYR ELECTRIC TRACTION & LIGHTING CO. (LTD.)—Acknowledgment of indebtedness, dated Feb. 16 (supplemental to a trust deed of Oct. 23, 1901), to secure £20,000 further debenture stock, making, with £30,000 previously acknowledged, a total of £50,000 debenture stock has been registered. The company has power under the deed to issue debenture stock up to half nominal share capital. Property charged: All company's assets, present and future. Trustees, Electric & General Investment Co.

ST. AUSTELL & DISTRICT ELECTRIC LIGHTING & POWER CO. (LTD.)—Issue on Feb. 15 of £500 debentures, part of series created June 1, 1904, to secure £2,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended		Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
			£	£		£	£
Aberdeen Corporation	Feb.	25	1,045	− 21	30	58,088	+ 5,761
Airdrie	„	17	194	− 6	7	1,368	− 10
Ayr Corporation	„	15	166	+ 9	41	12,249	+ 678
Barnsley	„	17	153	+ 7	7	1,008	+ 20
Barrow	„	17	188	+ 45	7	1,215	+ 62
Bath Electric Trams, Ltd.	„	22	531	+ 5	8	4,364	+ 465
Bexley District Council	...		...	...	...	...	...
Birkenhead	„	26	834	− 83	...	...	...
Birmingham Corporation	„	25	842	...	8	18,631	...
*Birmingham & Mid.	„	17	1,789	+ 251	7	11,268	+ 1,208
Blackburn Corporation	...		...	...	...	...	...
Blackpool Corporation	„	23	302	+ 26	47	45,912	+ 6,180
Blackpool and Fleetwood	„	25	178	+ 14	8	1,445	− 54
Blackp'l, St. Anne's & Lytham	„	23	169	− 3	17	2,160	...
Bolton Corporation	„	26	1,666	+ 19	48	66,827	+ 480
Bournemouth Corporation	„	22	849	− 14	‡47	50,122	+ 2,109
Bradford Corporation	„	25	3,564	+ 193	45	207,049	+ 29,739
Brighton Corporation	„	26	666	− 6	47	46,846	+ 3,616
Brisbane Tramways	Jan.	11	2,404	+ 105	1	2,406	+ 106
Bristol Trams & Carriage	„	24	4,263	− 94	8	18,214	+ 11
Buenos Ayres & Belgrano	„	22	2,926	− 44	15	41,884	− 481
	„	29	2,962	...			
Buenos Ayres Elec. Trams	...		...	...	...	...	...
Burnley Corporation	„	23	395	+ 23	21	8,198	+ 3,715
Burton Corporation	„	26	274	− 1	¶47	15,995	...
Calcutta Tramways Co.	„	25	a30,364	+ a3,186	8	a246,317	+ a33,292
Camborne-Redruth	„	27	94	+ 8	17	1,774	− 210
Cardiff Corporation	„	25	1,685	− 21	47	85,268	+ 1,924
Carlisle Tramways Co.	„	25	129	− 36	8	1,161	− 102
Central London Railway	„	25	7,169	+ 110	8	57,638	+ 1,118
Chatham & Dist. Lt. Rys.	„	23	564	+ 29	8	4,427	+ 410
*City of Birm'gh'm Tram Co.	„	17	5,392	+ 241	7	35,753	+ 776
City & South London Rly.	„	26	2,598	− 129	9	27,215	− 1,674
Colchester Corporation	„	18	149	...	4	618	...
Cork Electric Trams Co.	„	21	575	+ 8	8	3,147	+ 80
Darwen Corporation	...		...	...	...	...	...
Derby Corporation	...		...	...	...	...	...
Devonport & Dist. Trams	„	17	424	+ 5	7	2,961	− 93
Dover Corporation	„	15	157	+ 8	46	10,268	− 127
Dublin & Lucan Railway	„	24	91	+ 8	8	730	+ 10
Dublin Southern District	„	24	700	+ 45	8	84,429	+ 447
Dublin United	„	24	8,434	− 67			
Dudley—Stourbridge	„	17	767	+ 34	7	4,933	+ 78
Dundee Corporation	„	22	777	+ 17	¶16	33,610	+ 311
East Ham Council	„	25	626	+ 16	47	33,272	+ 1,814
Gateshead & Dist. Trams	„	17	662	− 18	7	5,260	− 101
Glasgow Corporation	„	25	18,526	+ 520	†30	553,537	+ 27,086
Glossop	...		...	...	...	...	...
Gravesend—Northfleet	„	17	186	− 12	7	1,249	− 133
Gt. Northern & City Rly.	„	25	1,630	+ 742	8	12,779	...
Greenock & Port Glasgow	„	17	550	+ 91	7	3,494	+ 367
**Halifax Corporation	„	12	2,418	+ 301	47	67,389	+ 5,001
Hartlepool Tramways	„	17	231	+ 9	7	1,616	− 28
Huddersfield	„	25	1,113	+ 81	47	63,445	+ 4,012
Hull Corporation	„	25	1,950	+ 15	47	102,657	+ 11,074
Ilford District Council	„	26	316	+ 9	§47	20,845	+ 1,050
Ilkeston Corporation	„	22	100	− 22	21	2,253	− 378
Ipswich Corporation	...		...	...	...	...	...
Isle of Thanet Co.	„	25	221	+ 4	21	5,730	+ 31
Keighley Corporation	...		...	...	...	...	...
Kidderminster & District	„	17	92	− 4	7	613	− 7
Kirkcaldy Corporation	„	22	188	− 59	...	...	...
Lanarkshire Trams Co.	„	23	596	+ 42	8	4,906	+ 864
Leeds Corporation	„	25	5,328	+ 475	49	275,480	+ 15,639
Leicester Corporation	...		...	...	...	...	...
Liverpool Corporation	„	18	9,772	+ 615	7	64,659	+ 2,156
Liverpool Overhead Rly.	„	25	1,402	− 65	9	18,184	− 512
*London County Council	„	18	14,878	+ 2,225	†16	886,367	+ 181,915
Lowestoft	„	25	120	− 8	8	940	...
Maidstone Corporation	„	23	91	...	82	4,215	...
Manchester Corporation	„	25	10,959	+ 324	47	570,886	+ 96,038
Mersey Railway	„	25	1,638	+ 143	8	12,667	+ 561
Merthyr	„	17	179	− 5	7	1,167	− 97
*Metropolitan Elec. Trams	„	17	1,974	+ 914	7	18,016	+ 5,792
Middleton	„	17	169	+ 44	7	1,755	+ 159
Nelson Corporation	„	25	93	+ 4	45	5,553	+ 1,368
Newcastle-on-Tyne Corp.	„	25	3,551	+ 296	8	28,271	+ 674
Newport (Mon.)	„	21	458	+ 86	21	10,558	+ 1,862
Oldham, Ashton & Hyde	„	17	493	+ 90	7	3,168	+ 27
Oldham Corporation	„	26	1,319	+ 245	47	60,326	+ 4,636
Perth (W. A.) Elec. Trams.	„	21	1,448	+ 128	8	11,782	+ 947
Peterborough	„	17	103	− 3	7	679	− 47
Poole and District	„	17	228	− 6	7	1,454	− 27
Portsmouth Corporation	„	25	1,261	− 39	§47	58,431	+ 6,429
Potteries	„	17	1,616	+ 57	7	10,099	+ 290
Reading Corporation	„	24	509	− 13	...	...	...
Rochdale Corporation	„	25	323	+ 177	46	17,606	+ 5,420
Rothesay	„	17	40	+ 3	7	800	+ 25
Salford Corporation	„	27	3,539	+ 85	46	191,628	+ 9,229
Sheerness	„	15	55	+ 9	7	547	+ 50
Sheffield Corporation	„	26	4,298	+ 206	§45	212,710	+ 6,003
Southampton Corporation	„	24	763	− 57	47	45,021	− 2,036
Southend Corporation	„	22	218	− 11	47	16,146	+ 1,576
Southport Tramways	„	17	239	+ 3	7	1,513	− 20
S. Staffordshire Trams.	„	17	673	− 8	7	4,391	− 815
Stockport Corporation	„	24	418	+ 45	47	25,481	+ 8,436
Sunderland Corporation	...		...	...	...	...	...
Swansea Trams	„	17	476	+ 46	7	3,059	− 25
*Taunton Trams	„	17	37	− 7	7	207	− 47
Tynemouth and District	„	17	163	− 24	7	1,165	− 217
Tyneside Trams Co.	„	24	357	+ 61	8	2,477	+ 317
Wallasey District Council	„	25	601	+ 52	§47	31,700	+ 2,394
Walsall	„	25	413	...	8	3,482	...
Warrington Corporation	„	24	291	+ 22	47	15,013	+ 573
West Ham Corporation	„	23	1,049	...	54	50,498	...
Weston-super-Mare	„	15	28	+ 6	7	176	+ 27
Wigan Corporation	...		...	...	...	...	...
Wolverhampton District	„	17	316	+ 13	7	2,223	+ 96
Worcester	„	17	254	− 11	7	1,658	+ 648
Wrexham	„	17	95	+ 1	7	6.0	− 27
Yorkshire Woollen District	„	17	568	+ 80	7	3,724	+ 423

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 5 days. ** Fortnight. * Partly electrical.

CITY NOTES.

MEMORANDA (March 2).—Bank rate 3 per cent. (since April 21, 1904) Price of silver 27 5/16d. per oz. Consols 91—91⅛ for money, 91⅛—91¼ for account; 2½ per cent. annuities 89⅞—90⅛. Consols Pay Day, April 5. Stocks and Shares Continuation Days, March 13 and 28; Ticket Days, March 14 and 29; Pay Days, March 15 and 30; Mining Share Carry-over Days, March 10 and 27.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—The directors recommend a dividend on the ordinary shares at the rate of 7 per cent. per annum for 1904. The transfer books and register of members will be closed from 10th to 23rd inst. inclusive.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—After placing £20,000 to reserve, the directors recommend a final dividend of 2½ per cent. (making 4½ per cent. for the year 1904), leaving about £5,000 to be carried forward. The transfer books and register of members will be closed from 3rd to 16th inst. inclusive, preparatory to payment of final dividends upon the ordinary and preference shares for the half-year ended Dec. 31.

FALKIRK ELECTRIC CONSTRUCTION SYNDICATE (LTD.)—The first (statutory) meeting was held at Edinburgh last week, when it was reported that 940 shares of £100 each (£94,000) had been allotted. 20 shares (£2,000) were allotted as fully paid in consideration of subscription of £50,000 of syndicate's capital.

GENERAL ELECTRIC CO. (LTD.)—The transfer books of the 4 per cent. debenture stock will closed from 18th to 31st inst. inclusive.

GREAT NORTHERN, PICCADILLY & BROMPTON RAILWAY CO.—There is being offered for sale £1,200,000 4 per cent. perpetual debenture stock of this company at 97 per cent.

KENT ELECTRIC POWER CO.—This company, which was incorporated in 1902, has completed the purchase of the undertaking of the Chatham, Rochester & District Electric Lighting Co. (Ltd.) as from Jan. 1 last.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The directors recommend a final dividend for 1904 of 11s. per share, making a total distribution for the year of 20s. per share, or 10 per cent., carrying forward about £9,000.

VICKERS, SONS & MAXIM (LTD.)—The directors recommend a final dividend of 1s. 6d. per share (tax free) on the ordinary shares, making 2s. 6d. per share (12½ per cent.) for the past year, carrying forward upwards of £190,000. A year ago the final distribution was 1s. 3d. per share, making 10 per cent. for the year, and the sum carried forward £86,699.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., Mar. 1.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Mar. 1. High est.	Business, Week to Mar. 1. Low est.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
[illegible]	3/0	Anglo-Argentine Ord. Shares	5⅝—5⅞	3 9 7	Ap, Oc	5¾	5 11/16
[illegible]	2/6	Do. 5% Cum. Pref.	5¼—5½	4 5 1	—	5⅜	5⅜
St.	6%	Do. Permanent 6% Deb. Stock	140 —145	4 3 11	—	141½	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 —105	4 15 8	—	..	..
10	6%	Barcelona Tramways Ord.	11½—12½	2 9 0	—	11⅞	12
10	5/0	Do. 5% Cum. Pref.	9½—10	5 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	96 —100	4 10 0	—	..	..
100	5%	Do. 5 per Cent. Debs.	99 —102	4 18 1	..	..	..
[illegible]	..	Brisbane Electric Trams. Invest. Ord.	1⅛—1⅜	..	..	—	..
5	2/6	Do. 6 per Cent. Cum. Pref.	4¼—4¾	5 17 3	—	4½	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	94 —96	4 11 10	..	95½	95
St.	6%	British Columbia Elec. Rlwy Def. Ord.	103 —106	5 14 4	—	104½	103½
St.	5%	Do. Pref. Ord. Stock	100 —103	4 17 2	—	102	102
10	5/0	Do. 5% Cum. Perp. Pref.	10 —10¼	4 10 11	—	10¼	..
[illegible]	4½%	Do. 4½ per Cent. 1st Mort. Dbs	103½—10 ½	4 5 9	—	..	..
100	4½%	Do. Vancouver Power Debs.	99 —102	4 8 3	..	..	..
[illegible]	1/6	Buenos Ayres and Belgrano Ord	3¾—4	5 12 6	—	4	3¾
[illegible]	2/0	Do. 6 per Cent. "A" Cm. Pref	6¼—6¾	5 2 2	—	..	..
[illegible]	3/0	Do. "B"	6½—6¾	5 9 1	—	..	..
St.	5%	Do. 5 per Cent. Debs.	107 —109	4 11 8	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov Certs.	103 —105	4 15 3	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	94 —97	5 3 1	..	..	..
[illegible]	3/0	Calcutta Tramways	5⅜—5⅝	5 13 8	—	5½	5⅜
100	4½%	Do. 4½% 1st Deb. Stock (red.).	106 —108	4 3 4	—	..	..
1	0/6	Cape Electric Tram Shares	1⅛—1⅜	5 0 0	—	1 3/16	1⅛
St.	5%	Colombo Trams & Ltg. 5% 1st Mt Deb. (red)	102 —104	4 15 1	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	101 —103	4 17 3	Ja, Jul	..	..
100	5%	†Montreal St. Ry. St'g 5% Mort Debs. (1908)	101 —104	4 16 3	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922).	103 —105	4 5 9	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	104 —107	4 13 5	..	[illegible]	..
		ELECTRICITY SUPPLY.					
[illegible]	3/0	Calcutta Electric Supply Ord.	9 —9½	3 10 3	—	9¼	9 1/16
[illegible]	..	Elec. Ltg. & Trac. Co. of Aust 6% Cum. Pref.	2 —2½	..	..	2	..
St.	5%	Do. 5% Debs.	86 —91	5 9 11	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	—	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	⅞—1⅛	..	—	..	..
1	..	Rand Electric	1 —1⅛	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	100 —102	4 8 9	Ap, Oc	..	...

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed. Mar. 1.	Rate per Cent. Yielded.	Dividend Due.	Business Week to Mar. 1.	
				£ s. d.		High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
1	..	Bath Elec. Trams Pref. Ord.	¾—1	..	..	[illegible]	[illegible]
1	1½d.	Do. 5% Cum. Pref.	1⅛—1⅜	4 14 1	..	1	..
St.	..	Do. 4½ 1st Mort. Deb. Stock (ex d.)	101—103	..	..	101½	101½
St.	4½%	B'ham & Midland Tram 4½ 1st Db. Stk.	97—99	..	..	..	..
10	8%	†Bristol Tramways and Carriage Ord.	13½—13¾	5 18 0	Feb, Aug	..	..
10	6%	Do. Cum. Pref. (fully paid)	10—10½	5 16 3	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106—108	3 14 0	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	9¾—9⅞	6 2 11	..	9⅞	9¾
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—11½	5 7 10	Feb, Aug	11⅛	11
St.	5/0	Do. 5 per Cent. Perpetual Debs	121—123	4 1 4	—	121½	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	97—99	4 10 11	..	98½	98¼
St.	4%	Central London Ordinary Stock	93—95	4 4 2	June, Dec	94½	93
St.	4%	Do. 4 per Cent. Pref. Stock	101—103	3 17 8	—	..	..
St.	4%	Do. Deferred Stock	83—86	4 13 1	—	83½	83
100	4%	Do. 4 per Cent. Debs.	110—113	3 11 5	—	111½	..
5	2/6	City of Birmingham Trams.5% Cm. Prf.	4½—4¾	4 17 6	—	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	101—104	3 17 8	..	..	..
St.	1½%	City and South London Rly. Con. Ord.	45—46	4 17 10	Feb, Aug	46	45½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120—123	4 1 4	Feb, Aug	..	..
St.	5%	Do. (1896)	118—121	4 2 8	..	..	..
St.	5%	Do. (1901)	116—119	4 4 0	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	107—109	3 13 5	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13—14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	10½—10¾	5 12 9	—	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	6—6½	5 13 0	—	6½	6¼
10	4/0	†Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9½—9¾	..	..	9½	..
10	10%	‡ Imperial Tramways Ord	19—20	5 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	15—15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	111½—112½	4 0 0	Jan, July	..	..
5	2/6	†Isle of Thanet Elec. Trams & Lt. 5% Pf.	3—3½	7 2 11	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89—92	4 7 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3¾—3⅞	3 18 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10—10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10—10½	4 15 3	..	10⅛	10
St.	4%	Do. 4% 1st Mort. Deb. Stock	102—104	3 16 11	—	104¼	103½
St.	..	Mersey Con. Ord. Stock	4—7	..	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10—13	..	—	..	..
1	..	Metropolitan Electric Trams Def	1⅛—1¼	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	1—1⅛	4 17 1	—	1	..
St.	4½%	Do. 4½% Deb. Stock	104—106	4 5 0	—	106	105½
5	..	New Gen. Tract. 5 per Cent.Cum. Pref.	¾—1¼	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	8¾—9	5 11 2	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9¼—9½	5 5 3	Feb, Aug	9⅜	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102—106	4 5 9	—	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London	98—99	5 2 0	..	99	98½
St.	3⅛%	†Waterloo and City Ord.	92—94	3 6 5	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99—102	4 0 0	Jan, July	..	..
10	..	Amazon Telegraph	1¼—1½	..	Jn, Dec ..	1⅜	1¼
100	..	Do. 5% Debs. (red.)	..	..	..	..	..
St.	17/6	Anglo-American	60—62	4 8 9	F.My.Ag.N	61½	60
St.	35/0	Do. Preferred	107—109	5 0 11	F.My.Ag.N	108½	108
St.	2/0	Do. Deferred	14½—14¾	..	F.My.Ag.N	14⅝	14½
100	8%	Commercial Cable Capital Stock	170—190	4 4 2	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	97—99	4 0 10	Jn Ap,Jy,O	98	97½
10	5/0	Cuba Submarine Ord.	8½—9½	5 8 0	Feb, Aug	9⅛	..
10	10/0	Do. Preference 10 per Cent.	17—18	5 11 1	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3½—3⅞	5 11 9	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8—8½	6 1 8	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	100%—102%	4 10 0	Jan, July	..	..
20	8/0	Direct United States Cable	11⅛—11⅜	4 12 2	Ja,Ap,Jy,O	11⅜	11¼
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	100—102	4 7 7	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	141—144	4 17 3	Ja,Ap,Jy,O	144	141½
St.	17/6	Do. 3½ per Cent. Pref. Stock	89—91	3 17 9	Ja Ap,Jy,O	90½	89
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107—109	3 13 6	May, Nov	108	107
10	2/6	Eastern Extension	14—14½	4 16 7	Ja,Ap,Jy,O	14½	14
St.	4%	Do. 4 per Cent. Deb. Stock	104—106	3 15 7	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb.1900	100—102	3 18 5	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%—103%	3 17 8	May, Nov	..	..
10	5/0	Great Northern (of Copenhagen)	31—32	4 13 9	Jan, July	31½	31
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100—102	4 8 3	June, Dec	..	..
25	12/6	Indo-European	46—48	5 4 2	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99—101	3 19 2	June, Dec	..	—
10	4/0	West African Telegraph Shares	8—8½	5 17 8	—	..	..
2½	..	West Coast of America	⅛—¼	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	99—101	3 19 2	Jan, July	..	..
10	..	West India and Panama	¾—1	..	May, Nov	..	1
10	7/6	Do. 6 1st Pref. ex 7 on act. of arrears	9—9½	6 6 4	May, Nov	9⅛	9
10	—	Do. 6 per Cent. 2nd Pref.	1½—1¾	..	May, Nov	1½	..
100	5%	* Do. 5 per Cent. Debs.	103—105	4 15 3	Jan, July	..	..
10	2/0	Western Telegraph	13½—14	6 0 0	Mr,Jn,O,D	13¾	13½
100	5%	* Do. 5% Debs. (2nd Series, 1900)	101—103	4 17 1	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	103—106	3 16 11	—	..	..
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	6¼—6½	5 8 8	August ..	6¼	6
1	0/7½	Monte Video Telephone Ord.	1⅛—1¼	2 11 9	..	..	..
St.	6%	National Co. Pref. Stock	112—113	5 6 2	—	113	111½
St.	5%	Do. Def. Stock	106—108	4 12 7	..	107	106
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13—14	4 5 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12—13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5¾	4 6 11	Feb, Aug	..	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98—100	3 11 6	June, Dec	100	99
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104—106	3 15 6	..	105	104
1	0/7½	Oriental	1⅛—1¼	5 7 8	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 11 5	..	..	..
St.	30/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101—104	..	..	..	..
5	5/0	United River Plate	7¼—7½	5 8 2	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4 17 9	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	116—118	4 12 6	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	1/6	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5¼	5 17 1	—	..	..
10	5/3	Globe Telegraph and Trust	10⅞—11⅛	5 2 4	Ja Ap Jy O	10⅞	10½
10	3/0	Do. 6 per Cent. Pref.	14—14½	4 3 11	Ja Ap,Jy,O	14½	14
100	6%	Submarine Cables Trust (Cert.)	125—128	4 15 5	April, Oct	..	..

Share.	Last Dividend.	Name.	Price Wed. Mar. 1.	Rate per Cent. Yielded.	Dividend Due.	Business Week to Mar. 1.	
				£ s. d.		High-est.	Low-est.
		ELECTRICITY SUPPLY.					
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12¾—13¼	6 5 6	..	12¾	12½
10	4/6	Do. 4½ per Cent. Cum. Pref	9¾—10	4 10 0	..	..	—
10	6/0	Do. 6% Cum. Second Pref.	11—12	5 0 0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104—106	4 4 10	—	..	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5¼—5½	3 9 7	..	..	..
St.	4½%	Do. Do. 1st Debs	101—104	4 7 0	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10¼—11	4 10 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10¼—10¾	3 5 1	Mar, Sept	10½	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105—108	3 14 1	—	..	..
5	4/0	†Charing Cross & Strand Electric Sup.	7¾—8¼	4 15 6	Feb, Aug	8¼	..
5	2/3	Do. 4½ per Cent. Pref.	5¾—6¼	3 17 0	Feb, Aug	5⅞	5¾
St.	4%	Do. 4% Deb. Stock (red.)	102—104	3 16 11	..	102⅝	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 4 9	—	..	..
5	2/3	Do. Do. (1898)	4¾—5	4 4 9	..	[illegible]	[illegible]
5	3/9	†Chelsea Electric Supply Ord.	7—7½	5 0 0	March ..	7¼	7⅛
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109—111	4 1 1	Jn, Dec ..	110½	110
10	5/0	City of London Electric Lighting Ord.	12¾—13	3 18 11	Feb, Aug	12⅞	12¾
10	6/0	Do. 6 per Cent. Cum. Pref.	13¾—14	4 5 9	Jan, July	13⅞	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	124—127	3 18 8	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	108—110	4 5 9	..	..	..
10	4/0	County of London Elec. Supply Ord.	8½—9	4 0 0	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12¾—13¼	4 14 ½	Mar, Sept	12⅞	12¾
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	109—112	4 0 4	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	102—104	4 6 7	—	103⅛	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5½—6	4 11 9	—	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101—104	4 6 7	—	..	—
5	3/6	Hove Electric Lighting Ord.	7½—8	5 6 3	..	—	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	100—102	4 8 9	..	..	..
5	7/0	Kensingtn. & Kngtsbdg. Ord. sc. & bonus	13¾—14	4 10 7	..	13⅞	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	—
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102—104	3 17 3	—	..	..
3	1/6	†London Electric Supply Ord.	2⅛—2¼	3 4 0	—	..	..
5	1/0	† Do. 6 per Cent. Pref.	6½—6¾	4 18 0	..	6⅛	6
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	99—101	3 19 3	Mr, Jn, S, D	100½	99½
10	9/0	Metropolitan Electric Sup. Ord.	18¾—19¼	4 16 1	April, Oct	19	18¾
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½—5¾	3 18 3	Jan. July	5¾	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110—115	3 18 3	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97—99	3 10 8	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	98—100	4 10 0	..	98½	98
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	12¾—13¼	5 7 2	Feb, Aug	..	..
5	8%	Newcastle Elec. Supply Ord.	8¼—8¾	4 18 2	Feb, Aug	8½	..
5	6%	Do. 6 per Cent. Non. Cum. Pref.	6¼—6½	3 17 10	Feb, Aug	6⅛	6
1	..	Northern Counties Elec. Sup. 17/- paid	16/3—18/9	3 0 0	Mar, Sep	..	..
10	6/0	Notting Hill Electric Ord.	14¾—15¼	4 0 0	March....	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	102—104	3 17 0	..	..	..
5	2/6	Oxford Electric Ord.	6½—6¾	5 0 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98—100	4 0 0	..	..	..
5	7/6	†St. James' & Pall Mall Elec. Ord.	13½—13¾	5 5 5	Feb, Aug	13⅝	13½
5	3/6	† Do. 7 per Cent. Pref.	8½—8¾	4 0 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	96—100	3 10 0	..	..	..
5	4/0	†Smithfield Markets Electric Sup. Ord.	2½—2¾	8 19 7	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	79—85	4 16 5	—	..	..
5	5/0	South London Electric Supply Ord.	4½—4¾	5 3 7	—	4⅝	4½
1	..	South Metrop'n Elec. Lt. & Power Ord.	¼—½	..	—	..	..
1	0/8½	Do. 7% Cum. Pref.	1¼—1⅜	4 15 4	—	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. Accm.)	107—110	4 2 3	—	108½	108
5	2/6	Urban Electric Supply Ord.	5⅛—5⅜	4 17 0	—	5	[illegible]
5	2/6	Do. 5% Cum. Pref.	5¼—5½	4 16 3	..	5½	..
St.	..	Do. 4½% 1st Mort. Deb.	106—108	—	..	106½	106
5	7/6	†Westminster Electric Supply Ord.	13—13½	5 3 8	Mar, Sept	13⅜	13
5	3/0	Do. 5 per Cent. Cum. Pref.	6½—6¾	3 15 6	—	6	[illegible]
		ELECTRIC MANUFACTURING, &c.					
1	6d.	†Alliance Elec. Co. 6% Cum. Pref.	⅜—⅝	6 6 6	..	..	..
1	6d.	Aron Elec. Meter 6% Cum. Pref.	⅞—1⅛	..	..	—	..
5	4/0	British Insulated & Helsby Cables Ord.	5¾—6¼	6 3 8	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¼—5¾	5 4 4	Jan, July	5½	—
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101—104	4 6 6	—	..	..
St.	4½%	†British Thoms'n-Houst'n 4½% 1st Mt. Db.	99—101	4 9 1	—	..	..
5	3/0	British Westinghouse 6% Pref.	5½—6	0 0 0	—	[illegible]	[illegible]
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	87—89	4 9 11	—	..	..
2	..	Brush Electrical Engineering	¾—1	..	March ..	..	..
3	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¾—1⅞	6 17 2	Mar, Sept	..	..
St.	4½%	† Do. 4½ per Cent. Perp. 1st Deb. Stock	92—96	4 14 9	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	79—82	5 9 9	Jan, July	..	..
5	6/0	Callender's Cable Con. Ord.	10¾—11¼	5 11 1	Jan, July	10⅞	10¾
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5½	4 7 0	Jan, July	5⅜	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	105—107	4 4 0	Nov, May	..	..
1	0/4½	Castner-Kellner Alkali Co. (fully paid)	¾—1	4 9 5	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	91—96	4 18 9	..	..	..
1	0/1½	Chadburn's (Ship) Telegraph Ord.	¾—1	8 17 8	..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	2¼—2½	3 3 4	Jan, July	2⅜	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	93—96	5 2 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	7¾—8¼	6 1 3	Sept	..	..
5	5/0	Do. 6% Cum. Pref.	6¼—6½	4 18 0	Sept	6⅜	6¼
St.	4½%	Do. 4½% Deb. Stock	105—107	4 4 0	..	..	..
5	—	Edison & Swan United ("A" Sh.) (£3 pd.)	¾—1	..	Feb, Aug	—	..
5	..	Do. (£5 paid)	1—1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77—82	4 17 8	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	79—84	6 0 6	..	83	81½
5	2/6	Edmundson's Elec. Corp. Ord.	6¼—6½	3 13 0	H'lf-yearly	[illegible]	[illegible]
5	3/0	Do. 6 per Cent. Cum. Pref.	6—6¼	4 16 0	—	[illegible]	[illegible]
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106—108	4 3 3	..	106	..
2	1/7½	Electric Construction Co.	1¼—1½	6 8 0	July	..	..
2	2/9	Do. 7 per Cent. Cum. Pref.	2¼—2½	6 12 2	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97—99	4 0 10	Jan, July	98	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90—95	5 5 3	—	..	—
10	5/0	General Electric (1900) 5% Cum. Pref.	9¾—10	5 0 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91—96	4 3 4	..	..	..
5	5/0	Henley's Telegraph Works Ord.	12¾—13	3 7 8	Feb, Aug	13	12¾
5	2/3	† Do. 4½ per Cent. Pref.	5½—5¾	4 3 11	Feb, Aug	..	..
St.	4½%	† Do. 4½ per Cent. Mort. Deb. Stock (rd.	109—111	4 1 1	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	16—17	2 18 10	Feb, Aug	16½	16¼
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	103—105	3 17 5	Mar, Sept	..	..
10	5/0	†Mather & Platt 5 per Cent. Cum. Pref.	11—11½	4 7 0	Mar, Sept	..	..
12	12/6	Telegraph Construction & Mainten'ce.	36—37	6 7 5	Mar, July	36⅜	36
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	102—104	3 16 11	Jan, July	..	..
5	—	Willans and Robinson Ord.	1½—1¾	..	Apr, Oct	..	..
5	—	Do. 6 per Cent. Cum. Pref.	3—4	—	Apr, Oct	3½	..
..	4%	Do. 4 per Cent. 1st Mort. Debs.	77—82	4 17 7	May Nov	—	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

As will be seen by our Parliamentary columns this week, the Bill by which it was proposed to construct a tube railway from Hammersmith to the City, and thence to Walthamstow and Palmer's Green, has been thrown out "on Standing Orders," and thus will not be allowed to proceed this session. It is regrettable that a scheme of this magnitude and utility should be prevented from being considered by Parliament on what is really a technical point, although it must be admitted that this is the fault only of the promoters themselves.

◆

FOR many years the desirability of a direct railway in a straight line from Hammersmith to the City has been apparent, but although several efforts have been made to provide such a means of communication, a variety of circumstances have tended to defeat the project. Provided that the Government permits the remaining tube railways Bills which have been deposited this session to proceed—and this is uncertain, to judge by a statement made on Wednesday by Mr. GERALD BALFOUR—there are still two other schemes which will connect the City with Hammersmith via Kensington and Knightsbridge, viz., a return loop of the Central London Railway, and the line proposed by the Great Northern, Piccadilly & Brompton Railway Company, which, however, only extends as far westwards as South Kensington. Both stop at the City, but the line to the north-eastern suburbs, which is also urgently needed, would be provided for by the passage of the North-East London Railway Bill, a deputation in favour of which was received by Mr. GERALD BALFOUR on Wednesday. Of the two lines under Piccadilly, the Strand and Fleet-street, the proposed loop of the Central London Railway would appear to be the more desirable on general grounds, as, up to its terminus in the City, it conforms precisely with the conditions laid down by the Joint Committee of 1902, whilst the Company has undoubtedly studied the comforts of the passengers on its existing line in a manner that should command the admiration of the public.

◆

MR. S. E. FEDDEN'S comparative tests on the Sheffield steam turbines, after erection and after five months' service, not only confirm once more that the Parsons turbine is a most efficient engine, but also bear out the contention, often advanced and often doubted, that the good qualities are lasting, and that the cutting action of the steam on the blades is practically of no importance. Five months, of course, is a short period upon which to base important conclusions, yet any deterioration or failure in one way or the other would surely have shown itself in this time. The mean output of a generator during the ten weeks' trial was slightly less than two-thirds its rated capacity, and although the steam consumed per kilowatt-hour averaged as low as 22·41lb., yet this figure is higher than might be expected from the guarantee figures, considering that the trials were undertaken at a time when the cooling water must have been at its best. This discrepancy between expectation and result may be explained by the fluctuations of load, and by the vacuum, which is not as high as might be looked for. Perhaps there was an insufficient quantity of cooling water available, for the temperature of river water should not be excessive from November to January. Mr. JOHN D. BAILIE, in a Paper read before the Leeds Local Section of the Institution of Electrical Engineers in January, mentioned a vacuum of 27·7in. at the Neepsend station, but Mr. FEDDEN'S average is considerably below this figure. This loss in vacuum means, roughly, an increase in steam consumption of ½lb. per kilowatt-hour.

A PAPER on "Earthing," which appears in abstract on another page of this issue, recalls the old controversy with regard to earthing the middle wire of a three-wire network. This controversy, which started in the days when the pressure on each side of the network was 100 to 110 volts, was settled definitely by the Board of Trade as soon as a number of undertakings had doubled their "declared" pressures, for on a 2 × 220-volt three-wire network the earthing of the middle wire is an essential to safety. Mr. LACKIE suggests an extension of this principle, apparently to meet some rather adverse conditions with regard to wiring which prevail at Glasgow—a city in which the maximum declared pressure of 250 volts has been adopted. His proposal that the iron barrel or lead sheathing which surrounds the wiring should be earthed through a resistance, possibly with an indicator in series with it, is similar to a suggestion put forward by Mr. F. C. RAPHAEL at the Institution of Electrical Engineers six or seven years ago (Institution *Journal*, Vol. XXVII., p. 511, and *The Electrician*, Vol. XLI., p. 78). Mr. RAPHAEL suggested earthing the iron barrel or sheathing of each consumer's premises through a fuse, which held up a connecting bar above two metal strips connected through a small resistance to each pole on the consumer's side of the main fuse. When a bad leak occurred, the fuse in the pipe circuit melted and released the short-circuiting bar, so that the main fuse also blew and the consumer was cut off. The patent for this device was abandoned after its provisional stage, as there seemed to be no demand for such a device at the time; but the idea may be worthy of Mr. LACKIE'S consideration for the Glasgow network, as the cost of the simple mechanism and the resistances, which are only in circuit momentarily, would be far less than that of the substantial resistances proposed by Mr. LACKIE. The point in Mr. LACKIE'S Paper, however, which deserves most attention outside Glasgow, is his reminder that in iron-barrel or lead-sheathed wiring the metal covering should preferably make no contact whatsoever with any other metal work in the building.

◆

THE science of Hertzian telegraphy has advanced with great strides during the last few years, but there are still a number of obscure points that have not been settled, and one of these points is dealt with in a report of Major S. O. SQUIER of which we give an abstract in another column. If, as the writer of the report contends, every living tree acts as an aerial, absorbing the Hertzian waves in its path, a forest would have great influence in impeding if not in staying altogether the transmission of signals over its surface, more especially in an untuned system; but, on the other hand, we believe that the majority of workers have found that the action of vegetation has been to improve the conditions. It is now universally allowed that Hertzian waves can be transmitted more easily over sea than land, and the explanation usually accepted is that sea is a better conductor than land; but we believe it is now also established that the waves travel round and over hills and not through them, so that the more conducting the surface of the hill the better it is for transmission. It is possible that the action of trees may be differential, partly acting as aerials and absorptive, and partly conductive and guiding, and we should expect that experiment will prove the latter action to be the most marked.

◆

FROM the experiments given, however, it does not seem quite conclusive that the results obtained were not due to electromagnetic waves through the ground. A simple test would have shown this. If at the completion of the experiment depicted in Fig. 1 (*c*) of the Paper, the tree had been cut down and an additional test had been made, signals would still have been received if the disturbance was through the earth, but they would have ceased in the case of true Hertzian waves save possibly under exceptional conditions. A point of interest in the experiments is that the true aerial was of high resistance—in some cases over 350 ohms per foot run—and the coherer could not be placed in the direct circuit, but was a shunt to the tree.

◆

THE section on "Electromotive Forces in Growing Trees" describes experiments of a preliminary character on a very difficult subject. It would certainly be of great scientific interest if it could be proved that the electromotive forces described are of a physiological character and not merely due to a difference of potential between the atmosphere at the top and bottom of the tree. It would have been instructive if the variation of potential grade, if any, in an inert aerial conductor could have been noted at the same time.

◆

WE have received a pamphlet concerning the wireless telegraph system of Prof. ALESSANDRO ARTOM, of Turin, which consists of a letter addressed by him to the Academy of Lincei, and states, boldly, the results of experiments carried out in Italian waters during 1903 and 1904. In this system Prof. ARTOM attempts to produce and utilise circularly or elliptically-polarised electromagnetic waves instead of the customary plane-polarised radiation. Very little definite information has been published of the actual disposition of the sending and receiving apparatus. So far as we can gather, there are at the sending end two spark-gaps arranged perpendicularly to one another, both put into operation by the same induction coil, but thrown out of phase by the inclusion in one spark-circuit of inductance or capacity. One of the balls is connected to an air-wire, which, it is presumed by the inventor, radiates elliptically-polarised waves. Now according to Prof. ARTOM, elliptically-polarised waves can be given a determinate direction more easily than plane-polarised waves. We do not know how the directing is accomplished; but the experiments in the pamphlet under notice appear to have proved that signals can be sent 300km. to the west without affecting a station—in tune, we have to suppose—only 100km. south of the sender. Notwithstanding all this, we find it difficult to see how, in the first place, elliptically-polarised waves are detached from a vertical air-wire or air-wires, and how, in the second place, the elliptic character is retained during propagation in spite of the inevitable and rapid dissipation of the horizontal component at the surface of the earth. We are forced, in fact, to the conclusion that only plane-polarised radiation of the ordinary type can reach the receiving station, and thus that the success of the recent experiments is due to the mode of directing rather than to the character imparted to the waves.

The James Forrest Lecture.—Col. R. E. B. Crompton, C.B., will deliver the 13th "James Forrest" lecture at the Institution of Civil Engineers on Monday, April 10th, at 8 p.m. The subject is "Unsolved Problems in Electrical Engineering."

Waterloo and City Railway.—In Mr. Herbert Jones' Paper on the Waterloo and City Railway, an error crept into the table printed on page 801, where the "units per passenger-mile (at switchboard)" should be 0·0858 "(at switchboard)" meaning units used for traction purposes. In our note on the same subject, on page 778, instead of 2¼ train-ton-miles, "1·47 train-ton-miles" should be read.

Personal.—Lord Kelvin will be the recipient of the first John Fritz gold medal awarded by the joint committee of the four national American engineering societies, under the deed of gift, to the man most representative of, and eminent in, scientific advance in the engineering field. This medal was founded three years ago on the occasion of the 80th birthday of John Fritz, the famous inventor and engineer in the iron and steel industry, who is still enjoying excellent health.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne—Pinheiros	Aug. 13, 1903	—
Belsai-Issa (Yemen)—Camaran	Oct. 22, 1902	—
Tarifa—Tangier	Jan. 18, 1904	—
Cayenne—Paramaribo	July 13, 1904	—
Jamaica—Colon	Jan. 10, 1905	—
Gibraltar—Tangier	Feb. 20, 1905	Mar. 7, 1905
Oran—Tangiers	Feb. 24, 1905	—
England—Channel Islands	Feb. 28, 1905	Mar. 7, 1905
Suakim—Jeddah	Mar. 3, 1905	—

Students' Section of the Institution of Electrical Engineers.—The first annual dinner of the Students' Section of the Institution of Electrical Engineers will be held on Thursday, March 16th, at the Holborn Restaurant, at 7 for 7:30 p.m. Mr. H. D. Symons, chairman of the Students' Section, will occupy the chair, and Mr. A. Siemens, president of the Institution, will be the guest of the evening. All students, who are able, are particularly requested to be present. Tickets can be obtained from the Students' hon. secretary.

Glasgow University Physical Society.—The annual business meeting of this society was held on March 1. The following are the office-bearers for 1905-6:—Hon. president, Lord Kelvin, G.C.V.O.; president, Prof. Andrew Gray, LL.D.; vice-president, James G. Gray, B.Sc.; secretary, John M'Whan; junior secretary, D. Meek; treasurer, George Green, M.A. Messrs. William Miller and John Miller read communications of research on "Magnetic Viscosity in Liquids," and "The Effect of Overstrain on Magnetisation."

Royal Society.—Among the Papers down for reading yesterday were the following:—"Ionic Sizes in Relation to the Conductivity of Electrolytes," by W. R. Bousfield, communicated by Prof. J. Larmor, F.R.S.; "Explosions of Mixtures of Coal-gas and Air in a Closed Vessel," by L. Bairstow and A. D. Alexander, communicated by Prof. J. Perry, F.R.S.; "On some Continuous Observations on the Rate of Dissipation of Electric Charges in the Open Air," by C. Coleridge Farr, communicated by Dr. C. Chree, F.R.S.

Glasgow University Engineering Society.—The annual visit of the Glasgow University Engineering Society is to Newcastle this year. The following works have consented to receive the members of the society: Messrs. Sir W. G. Armstrong, Whitworth & Co. (Ltd.), C. A. Parsons & Co., Swan Hunter & Wigham Richardson (Ltd.), the Wallsend Slipway & Engineering Co. (Ltd.), Stockton-on-Tees; the Cargo Fleet Iron Co. (Ltd.), and the Newcastle-upon-Tyne Electric Supply Co. (Ltd.). Other places of interest will be visited if time permits. Applications to take part in the visit received after March 15th will be disregarded, and members applying late will have to make their own travelling and hotel arrangements.

Strike on the New York Subway.—The whole of the employés of the New York subway, which was recently opened, went out on strike at the beginning of the week. The demands of the workmen are principally higher wages. Naturally great inconvenience has been caused, as practically the service on both the underground and the elevated railways has been suspended, only a very intermittent service being maintained. The question of arbitration has been suggested, but so far the companies take up the attitude that there is nothing upon which to arbitrate. So far as the subway is concerned, this is working under the superintendence of the New York Rapid Transit Commissioners, and the president of that body has hinted that if a full service is not resumed within a reasonable time the city authorities will take charge of the railway. Owing to the cars being worked by temporary and unskilled crews, a collision occurred in which several people were somewhat injured.

Royal Meteorological Society.—The Council of the Royal Meteorological Society have arranged to hold, by permission of the President and Council of the Institution of Civil Engineers, at 25, Great George-street, Westminster, an exhibition of meteorological instruments from Tuesday the 14th to Friday the 17th inst. The exhibition will be chiefly devoted to recording instruments, but will also include new meteorological apparatus invented or first constructed since the society's last exhibition, as well as photographs, drawings and other objects possessing meteorological interest. The exhibition will be open as follows:—Tuesday 14th 2 p.m. to 9:30 p.m.; Wednesday 15th, 10 a.m. to 9:30 p.m.; Thursday 16th, 10 a.m. to 5 p.m.; Friday 17th, 10 a.m. to 5 p.m. A brief address will be given each afternoon at 3:30 descriptive of the instruments included in the exhibition. The next meeting of the society will be held at 25, Great George-street on Tuesday, 15th inst., at 7:30 p.m., when a Paper "On the Growth of Instrumental Meteorology" will be read by R. Bentley, president.

University College (London) Engineering Society.—On Friday, February 17th, a general meeting of the society was held, at which Mr. W. Hunt read a Paper on "Arc Lamps and Methods of Arc Lighting adopted by the General Electric Co. of U.S.A." Mr. W. C. Clinton, B.Sc., occupied the chair. Mr. Hunt commenced his Paper by describing the variations of the carbon arc and the effect of the quality of the carbons on the light emitted. He next described the interchangeable parts of the multiple arc lamp and work of cleaning and repairing, and dealt with the various systems of working. The author concluded his Paper with a series of figures, contrasting the cost of working arc lamps with the cost of working incandescent gas lamps, afterwards exhibiting one of the latest types of arc lamps manufactured by the General Electric Co. of America. Mr. Clinton, in proposing a vote of thanks to Mr. Hunt for his Paper, stated that it was particularly interesting on account of the contrast drawn between the standard British and American practice. Messrs. G. B. Dyke, B.Sc., H. F. G. Woods and F. J. Kean took part in the discussion.

Bills in Parliament: Session 1905.—A report has been issued by the Board of Trade upon the Bills and Provisional Orders which will be dealt with in the coming Parliamentary session. Full particulars of all Bills, &c., of electrical interest have already appeared in our columns. Some figures, taken from the Board of Trade Report, however, as to the number of the various measures, &c., will be interesting. There are 28 tramway Bills, 15 Bills relating to the supply of electricity, and 11 Bills relating to electric railways. Under the tramway Bills 73 miles of tramways are proposed which will involve the raising of additional capital to the value of £1,971,457. The number of tramway Bills shows a decrease of 11 compared with last session. Under the Bills relating to the supply of electricity the proposed capital is £9,426,998. There have been 12 applications to the Board of Trade for Tramway Provisional Orders, the total length of the lines being 11 miles 27 chains double-track and 16 miles 52 chains single-track, while the estimated cost is £321,226. Electric lighting Provisional Orders to the number of 62 have been applied for, the total capital to be expended amounting to £783,037.

The Proposed North-East London Railway.—The President of the Board of Trade, Mr. Gerald Balfour, received on Wednesday a deputation from the local authorities whose districts will be traversed by the proposed electric railway from the City to Walthamstow and Cheshunt. Among those present were Mr. D. J. Morgan, M.P., Mr. Bousfield, K.C., M.P., and Sir M. Bhownaggree, M.P., the Mayor of Hackney, and others, the object of the deputation being to seek special facilities for the North-East London Railway Bill in Parliament. All the local authorities are in support and the need for the extra means of communication was strongly urged. In reply, Mr. Balfour said the present opinion of the Government and Public Departments was that no new large railway schemes affecting London should be allowed to be promoted until the Royal Commission on London Traffic had reported. Of course, the question was whether a special exception should be made in this case, and in favour of this, the promoters had the fact that such a special exception was made last year in respect of a similar bill, which was, however, thrown out in Committee on financial grounds. It was, however, a question not so much for the Board of Trade as for Parliament, and he would be very glad to lay before the authorities of both Houses the views of the deputation.

High-Voltage Continuous-Current Power Transmission.—According to the *Zeitschrift für Elektrotechnik*, the Compagnie de l'Industrie Electrique (Thury) in Geneva is carrying out a high-tension continuous-current power transmission between Moutiers and Lyon, 180km. (112 miles) distant. At the water-power station at Moutiers there are to be four generating sets, each consisting of a turbine driving two six-pole series dynamos at 300 revs. per min. Each dynamo is designed for 75 amperes and 7,200 volts, and the aggregate station capacity is, therefore, 4,320kw. Electric energy, at 57,600 volts, is to be transmitted, for the most part, by two copper wires of 9mm. (0·354in.) diameter, but within the boundaries of Lyons underground cables are to be used. It is anticipated that the absence of induction and resonance effects will permit the use of a cable normally designed for 50,000 volts alternating. Part of the electric energy is to be transformed in a sub-station in Lyons to continuous current at 600 volts for traction purposes, while the remainder is to be converted in a second sub station by motor-generators to three-phase current at 25,000 volts. Since the middle point both of the generating plant at Moutiers and of the motor plant at Lyon is earthed, the maximum electrostatic pressure between transmission line and earth is limited to 28,800 volts.

Post Office and the Telephone System.—The Postmaster-General on Monday received a deputation at the House of Commons of representatives of municipalities who have erected telephone systems. The deputation was headed by the Lord Provost of Glasgow, and the points put forward were summarised as follows :—It was stated that the partial purchase of the London system of the National Telephone Co. and the postponement of the purchase of the provincial systems was to be deprecated, as this was an incentive to the company to devote greater energy and capital towards crushing the provincial municipal telephone systems. It was not essential for the telephone service to be conducted as a national monopoly in as much as nearly 98 per cent. of the total calls were local calls ; and it was quite feasible for the Post Office to administer the acquired system of the National Telephone Co. in friendly competition with municipalities who had telephone licences, and to give greater encouragement to other local authorities to apply for licences. In the event of the postponement of the purchase of the National Company's undertaking, the Post Office ought to enter into vigorous competition with the company throughout the United Kingdom in co-operation with the municipalities in order to avoid the danger of inflated price being forced upon the Government. The possibility of an extension of the company's licence would meet with most strenuous opposition from the municipalities, it would prolong the existing unsatisfactory condition of telephone affairs in this country and enable the telephone monopoly to reach such gigantic proportions as ultimately to render a reasonable settlement impossible and to create a menace to the commercial interests of the Kingdom. The Postmaster-General (Lord Stanley), in a brief reply, pointed out that he was strongly of opinion that the telephone system of the country should be nationalised, and he would be pleased to have another interview with the deputation in order that this aspect of the question might be further developed.

Personal.—Mr. W. A. Chamen, the chief electrical engineer to the Glasgow Corporation, has just resigned his position in order to take up a post of responsibility with Messrs. Bramwell & Harris. Mr. Chamen's decision to leave Glasgow was made known at a meeting of the Glasgow Corporation on Thursday last week in a letter in which he expressed sincere thanks for the kindness and courtesy which have always been extended to him by the Lord Provost, magistrates, committees, &c., at Glasgow. The resignation was accepted, it being agreed to release Mr. Chamen at as early a date as possible instead of stipulating for the legal three months' notice. Mr. Chamen, who was born in 1863, commenced his electrical training at Messrs. Crompton's Chelmsford works in 1881 as an "improver." He remained with this firm until 1898, when he was appointed chief engineer to the Glasgow Corporation, the post which he is now relinquishing. Throughout has association with Messrs. Crompton & Co., Mr. Chamen was largely engaged on "outside" work. For a number of years he was chief outdoor engineer and he has superintended the erection of a large number of installations. Mr. Chamen has served on the Council of the Institution of Electrical Engineers, and was one of the sub-committee which prepared the Institution's Standard Rules, and was Chairman of the Glasgow Local Section of the Institution of Electrical Engineers in 1903. Mr. W. W. Lackie, the present chief assistant, is to be appointed Mr. Chamen's successor, at a salary of £800 rising to £1,000 per annum. Mr. Lackie's recent Paper on "Earthing" appears in another part of this issue. Mr. Archibald Page superintendent of the Glasgow Corporation lighting department generating station and sub-stations, succeeds Mr. Lackie as chief assistant. His commencing salary will be £500 per annum.

The Glasgow Corporation is losing another official in the person of Mr. C. A. King, who has resigned in order to accept a position with the Metropolitan District Railway Co. It will be remembered that Mr. John Young, the present general manager of this company, was at one time general manager of the Glasgow Corporation tramways.

Application of Electricity to Mines.—The following is an abstract of the discussion on Mr. A. C. Anderson's Paper on the above subject, read before the Birmingham Local Section of the Institution of Electrical Engineers on February 15th and reported in our issue of Feb 17, p. 695.

Prof. REDMAYNE favoured electricity as a motive power in mines for most purposes, but thought compressed air would continue to be a formidable competitor as long as there was any liability to sparking troubles with electric systems. Very old compressed-air plants might show an efficiency of 30 per cent., as quoted by the author, but modern systems, employing isothermal compression combined with re-heating, had frequently an overall efficiency of 70 per cent. With respect to drilling, however, he was of opinion that electricity had failed to compete with compressed air as a motive power. There were several electric drills, more especially of the rotary type, that would do good work, but they were not suitable for mines. They were much more complicated than pneumatic drills, and more costly in upkeep.

Mr. REAVELL (Ipswich), advocated air compressors in conjunction with electric generators at the pit head, and electric distribution to different parts of the mine. This system would reduce first cost and result in a greater economy of working than any other. Pneumatic machinery was most suitable for coal cutting, drilling, &c., and the compressed air for these could be supplied by an electrically-driven air compressor through short lengths of pipe. Coal cutters frequently jambed. With a pneumatic tool it was a simple matter to cut off the air supply, withdraw cutter, and make a fresh start. But in the case of an electrically-driven machine, it meant the replacing of a fuse, and a consequent delay. He then showed a lantern slide illustrating a portable electrically-driven air compressor suitable for the work he had indicated. Another advantage resulting from the use of compressed air was its storage capacity. With a system entirely depending upon electricity, the generating plant had to have a capacity capable of dealing with the whole of the equipment. He condemned compression at the pit head, as it frequently resulted in the loss of 50 per cent. of the power generated.

Mr. GOTT said that many engineers considered the loss of pressure of compressed air due to friction in the shaft pipes to be compensated by the head. One of the troubles of electric distribution was the fact that in the shaft cables the core was liable to slip down the insulation This necessitated a special form of suspension. A point the author had omitted was the necessity of lightning arresters, where overhead wires were used for lighting and power transmission at the pit head. He instanced a case in which the omission of this precaution had necessitated the replacing of the shaft cables.

Mr. M. B. WILD was in favour of continuous-current motors for many reasons, amongst which he mentioned over-load capacity and speed variation. For pumping and very large haulage, such as endless rope, main and tail with long runs, alternating-current, however, would be the better system. A standard speed for single or double drum gears was 5 miles per hour, but they worked without any trouble at speeds varying from 2 to 8 miles per hour.

Mr. H. M HOBART, in a written communication, expressed his opinion that both continuous and polyphase systems would find wide fields of usefulness in mining work. In those cases where the use of polyphase currents was most suitable, it was of paramount importance to employ a low frequency, for the power applications were of primary importance in mining, and any questions relating to the quality of the lighting were of secondary importance. Moreover, it was a fallacy to regard the question of lighting at low frequencies as offering grave difficulties. The lower the frequency the lower should be the voltage chosen for the incandescent lighting circuits, and the higher should be the candle-power per lamp; for by these means the carbon filament would be of sufficiently large section to store the heat and obviate material reduction of temperature between the peaks of current of successive cycles. The performance of the motors was enormously bettered by the use of low frequencies. This would lead to higher power-factors, lower magnetising current even with larger air-gap, greater overload capacity and also cheaper motors, since for a given output the diameters would be smaller and the lengths greater. Capacity effects in the cables would also be decreased. The squirrel-cage type should be freely used, even in motors of large capacity.

Mr. Anderson, in his reply, said that the replacement of fuses in coal cutters driven by polyphase motors was of rare occurence. Liquid rheostats were very good as starters; for variable speed work the ordinary type of regulator should be used. The advocacy of a low frequency was very interesting, but the low voltage necessary for successful lighting would hardly conduce to the best economy. The system of starting motors by running up with the generator added considerably to the capital outlay, as separate circuits were necessary.

Wireless Telegraph Notes.—On Friday evening last Mr. Marconi delivered a lecture on "Wireless Telegraphy" at the Royal Institution. After giving a résumé of the science from its beginning, he said that the "interference" objection advanced against wireless telegraphy was equally applicable to line work where several stations were on the same line. Considerable improvements were being made in methods of tuning, but he was unable to disclose any of them owing to pending applications for patents. As far as he knew, it had not been found possible to actuate satisfactorily a recording instrument or relay by means of a self-restoring coherer or anti-coherer. It had also been his experience that these non-tapped coherers were far too deficient in reliability for regular commercial work, especially if placed in the hands of inexpert operators. Referring to the magnetic detector, Mr. Marconi said:

> The adoption of this magnetic receiver was the means of bringing about a great improvement in the practical working conditions of wireless telegraphy, by making it possible to do away with the troublesome adjustments necessary when using coherers, and also by considerably increasing the speed at which it is possible to receive, the speed depending solely on the ability of the individual operators. Thus a speed of over 30 words per minute has easily been attained.

Evidently therefore, Mr. Marconi does not recognise Dr. De Forest's work, or he has not heard of it. In De Forest's Holyhead-Howth experiments a self-restoring coherer, or anti-coherer, was used with perfect success, and if this was not a sufficiently good commercial test then one has only to refer to the De Forest work carried out by Capt. Lionel James for *The Times* newspaper in the Far East. In this case messages of 2,000 words in length were sent from a ship at sea and received by a self-restoring coherer, or anti-coherer, without a single error. Moreover, in both instances the speed was well above 30 words per minute. These tests were duly referred to in *The Electrician*, of which Mr. Marconi is evidently a diligent reader. Mr. Marconi was glad to be able to announce that he had recently constructed a magnetic receiver that would work a relay and recorder. This had been effected by modifying the circuits, especially by increasing their length, and by using a particular quality of iron, so as to obtain a slowed-down impulse capable of working a recording instrument. It was possible by means of this device to use an automatic transmitter and attain a speed of working as high as 100 words per minute. For tuning purposes this form of receiver was much better than the ordinary coherer, for the reason that it possessed a low and uniform resistance. In conjunction with Prof. Fleming he had recently made some further improvements, but he was not at liberty to disclose them. A breakdown in the insulation of the apparatus at Cape Breton made it necessary to suspend *The Times* service of 1903, and the transmission of public messages will not be attempted until a reliable and continuous service can be maintained and guaranteed under all ordinary conditions. Mr. Marconi had not the slightest doubt but that in a very short time the practicability and reliability of trans-Atlantic wireless telegraphy would be fully demonstrated. There was considerable difference in transmission by day and by night, and the long-distance stations averaged by day two-fifths of the distance covered by night. This was partly due to obstruction caused by electrons thrown off from the sun. The "daylight effect" did not increase gradually as daylight increased, but the change took place in about two minutes. He concluded by expressing the opinion that the transmission of messages to the Antipodes would open up possibilities of carrying out tests of very great scientific interest, since the waves would travel round all parts of the globe and concentrate at a point. Thus it might be possible for messages to be sent to distant lands by means of a very small amount of electrical energy.

It was stated in *The Electrician* of February 24th that wireless telegraphy was to be established in the Suez Canal. The Egypt correspondent of the *African World* now announces that the Government has not seen its way to sanction the installation, and the Lloyd's men who would have worked the station are on their way back to England.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) **FRIDAY, March 10th.**

Rugby Engineering Society.

8 p.m. Meeting in the Benn Buildings, High street, Rugby, when Mr. J. T. Milton will deliver the second of his course of lectures on "The Minute Structure of Metals."

Physical Society.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "On the Stresses in the Earth's Crust before and after the sinking of a Bore-hole," by Dr. C. Chree, F.R.S. (2) "On the Lateral Vibration of Bars of Uniform and Varying Sectional Area," by J. Morrow. (3) "On Direct-reading Resistance Thermometers, with an Appendix on Composite Thermocouples," by A. Campbell.

Royal Institution.

9 p.m. Evening Discourse:—"The Structure of the Atom," by Prof. J. J. Thomson, F.R.S.

SATURDAY, March 11th.

Institution of Electrical Engineers: Students' Section.

2:15 p.m. Visit to Messrs. D. Napier & Sons' works, Acton Vale, W. Meet at the works.

Royal Institution.

3:00 p.m. Afternoon Lecture I:—"Electrical Properties of Radioactive Substances," by Prof. J. J. Thomson, F.R.S.

Birmingham and District Electric Club.

7:30 p.m. Meeting at the Colonnade Hotel, New-street, Birmingham. Paper to be read: "Electric Lifting Machinery," by E. C. R. Marks.

MONDAY, March 13th.

Society of Arts.

8 p.m. Cantor Lecture I.: "Telephony," by H. Laws Webb.

TUESDAY, March 14th.

Institution of Electrical Engineers: Manchester Local Section.

7:30 p.m. Meeting in the University (Physical Laboratory). Paper to be read: "Low-tension Thermal Cut-outs," by Prof. Schwartz and W. H. N. James.

Institution of Electrical Engineers: Glasgow Local Section.

8 p.m. Meeting at 207, Bath-street, when the discussion on Mr. W. W. Lackie's Paper on "Earthing" will be taken.

WEDNESDAY, March 15th.

Institution of Electrical Engineers: Students' Section.

7:30 p.m. Meeting at 92, Victoria-street, Westminster, S.W. Paper to be read: "Electrical Pyrometry," by P. L. Weir.

Royal Meteorological Society.

7:30 p.m. Meeting at the Institution of Electrical Engineers, 25, Great George-street, Westminster, S.W. Paper to be read: "On the Growth of Instrumental Meteorology," by R. Bentley.

Institution of Electrical Engineers: Birmingham Local Section.

7:45 p.m. Meeting at the University. Paper to be read: "Commutations in a Four-pole Machine," by J. K. Catterson-Smith. Time permitting, the following will also be read: "Notes on Heating and Sparking Limits in Variable Speed Motors," by A. H. Bate.

Royal Microscopical Society.

8 p.m. Meeting at 20, Hanover-square, W., when a lecture on "A Review of Work done by Metallographers" will be delivered by J. E. Stead, F.R.S.

THURSDAY, March 16th.

Institution of Electrical Engineers: Leeds Local Section.

7:15 p.m. Meeting at the University. Paper to be read: "Power Gas," by Dr. F. H. Bowman.

FRIDAY, March 17th.

National Physical Laboratory.

3.30 p.m. Meeting of the General Board at Bushy House.

Institution of Electrical Engineers: Manchester Students' Section.

7:30 p.m. Meeting in the Municipal School of Technology. Paper to be read: "High-Tension Switch Gear," by C. R. St. John

THE NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO.'S ACCOUNTS.

The total units sold by this company during the year ended December 31, 1904, amounted to 17,132,153, which, compared with the previous year's figure of 9,033,625 units, shows the remarkable increase of 8,098,528—nearly 100 per cent. Of these 17 million units, 2½ million were sold to consumers for lighting, 6 million for power and 8½ million for traction and "in bulk." No less than 7,446,397 units were used in the works or "unaccounted for." In 1903, over 7 million units were sold to consumers for lighting and traction, and nearly 2 million for traction and "in bulk."

The business done in 1904 resulted in a gross profit of £61,440. 7s. 11d., most of which has been distributed to the shareholders, but £6,000 has been set aside for depreciation and £872 is being carried forward. In addition to this £6,000, the depreciation fund has also been increased to the extent of another £25,000, drawn from the reserve fund, to which, however, no contributions have been made out of revenue, the basis of the fund being premiums received in issuing new capital. The gross profit on the previous year's working amounted to £42,567. 4s. 2d., none of which was carried to the depreciation fund.

During 1904 the maximum load was 11,200kw., as against 6,405kw. in 1903. The number of consumers at the end of 1904 was 3,316, whereas it was only 2,468 at the end of 1903, and the connections to mains equivalent to 8 c.p. lamps reached the figures of 850,000 and 347,248 on Dec. 31 of each year respectively. The capacity of the works was increased from 7,425 to 16,250kw. during 1904.

Excluding "management charges" the cost of generating and distributing 17 million units was £28,423. 11s. 6d., while for the 9 millions in the previous year it was £22,888. 8s. 4d.

The following Table shows the various costs per unit sold:

Generating and distributing costs.	Year ended Dec. 31, '03.	Year ended Dec. 31, '04.
Coal	0·229d.	0·162d.
Oil, waste, water and stores	0·042d.	0·022d.
Proportion of salaries of engineers and officers	0·083d.	0·051d.
Wages, maintenance and repairs	0·254d.	0·163d.
	0·608d.	0·398d.
General costs.		
Rents, rates and taxes	0·060d.	0·074d.
Management, insurance and law expenses	0·172d.	0·191d.
Depreciation of sundry stocks and office furniture	0·053d.	0·003d.
Total costs	0·902d.	0·666d.

The sum of £31,000 carried to depreciation account in 1904 represents 0·435d. per unit sold in that year, and if added to the total costs would bring the total to 1·101d. per unit, but of course this sum may be divided over a number of years in estimating the real cost of production.

In 1903 the load-factor was 16·1 per cent., and 17·46 per cent. in 1904.

The following is an analysis of the capital expenditure:

	Total expenditure to Dec. 31, '03	£ per kw.	% of total.	Total expenditure to Dec. 31, '04	£ per kw.	% of total.
	£			£		
Lands, incl. law charges incidental to acquisition	53,799	7·3	5·3	51,092	3·1	4·5
Buildings	98,264	13·2	9·6	123,238	7·6	10·7
Machinery	353,298	47·6	34·5	410,998	25·3	35·9
Accumulators at generating and distributing stations	16,659	2·2	1·6	18,683	1·2	1·6
Mains, including laying	319,438	43·0	31·3	338,928	20·8	29·6
Transformers, motors & installations on consumers' premises, &c.	108,658	14·6	10·6	116,304	7·1	10·1
Meters	16,020	2·2	1·6	19,769	1·2	1·7
Electrical instruments	30,059	4·1	2·9	40,286	2·5	3·5
Cost of licence, provisional orders, acts, &c.	26,967	3·6	2·6	28,107	1·7	2·4
	1,023,162	137·8	100·0	1,147,405	70·5	100·0

An interesting statement in the directors' report is the announcement of an agreement, confirmed by the shareholders last Thursday, for the transfer of the County of Durham Electric Power Supply Co.'s undertaking to the Newcastle-upon-Tyne Electric Supply Co. We gave particulars of this agreement in our last issue, and publish a report of the company's meeting this week.

STEAM TURBINE AND BOILER TESTS AT THE NEEPSEND ELECTRIC STATION.

Mr. S. E. Fedden, general manager and engineer of the Sheffield Corporation electric supply department, sends us the following interesting and instructive figures relating to the turbine plant and boiler equipment at the new Neepsend generating station of the Sheffield Corporation. A full description of this station was published in *The Electrician*, Vol. LIII., p. 465.

The boilers and turbo-generators have now been in regular service for about 5 months, and the comparisons of the results obtained under actual working conditions with the trial tests taken in the makers' works and on site will be of considerable value.

The two-phase turbo-generators—two in number—are of the revolving armature type and were specified to give an output of 1,500kw. at 2,000 to 2,200 volts and 50 ~ per second on an inductive load having a power factor of 0·85, and an overload capacity of 10 per cent. for one hour, with a steam pressure of 190lb. at the stop valve, a superheat of 100deg.F. at the stop valve, a temperature of circulating water of 60 to 80deg.F. and at a speed of 1,500 revs. per min. The steam consumption in lbs. per kilowatt-hour was to conform to the following figures:—

With circulating water at 60°F. .. 18·4 at full-load, 21·2 at half-load.
" " 70°F. .. 19·5 " 22·5 "
" " 80°F. .. 20·2 " 23·4 "

The above figures were not to include the power required for the air and circulating pumps, as these are motor driven from the station 'bus bars. The exciters are direct coupled to the turbine shaft.

Test of 1,500kw. Turbo-Alternators for Sheffield Corporation at Makers' Works, without Vacuum Augmentor.—November, 1903.

At stop valve.					Steam used per hr.	
Press. above atmosphere. Lbs. p. sq. in.	Superheat. Deg. F.	Vacuum in inches.	Speed, r.p.m.	Load in kw.	Lbs.	Lbs. per. kw.
115·6	148·0	25·18	1,500	1,029·30	21,264·0	20·70
137·0	119·0	25·97	1,500	534·25	12,820·0	24·02
150·3	72·4	26·62	1,500	0·00	2,957·4	—
128·5	125·3	26·76	1,500	1,584·65	27,855·0	17·61*
131·0	128·6	27·52	1,500	1,070·90	19,591·5	18·34
145·0	110·0	28·14	1,500	529·90	11,453·0	21·58†
148·7	38·4	28·57	1,500	0·00	2,878·0	—
Test of Same Machines after Erection at Neepsend Power Station.—July, 1904.						
179·8	92·7	27·08	1,500	1,596·9	30·200	18·9‡
193·7	100·8	27·40	1,500	1,611·4	29·590	18·3§

* Average full load excitation, 0·5 per cent.
† Average pressure drop, from no load to full load, 3·15 per cent.
‡ Air and circulating pump motors used 2·14 per cent. of output.
§ Exciter output, 0·52 per cent. of total output.

After running for five months at 16 hours per day and six days a week, during which time the normal load has been about 1,000kw. during daytime and 1,400kw. to 1,600kw. during the dark hours before 11 p.m., an average was taken of 10 weeks—November 20th to January 22nd—with the results shown in the following table:—

At stop valve.					St'm used per hr.	
Press. above atmos. Lbs. per sq. in.	Superheat. Degs. F.	Vacuum in inches.	Speed, r.p.m.	Load in kw.	Lbs.	Lbs. per kw.
190	100	27	1,500	979	21,850	22·41

The boilers are of the Stirling five-drum water-tube type, two in number, and connected each to its own turbine, with provision for connecting to a common steam main if required.

The fuel, a low-grade slack, is fed by gravity through measuring chambers into the hoppers of Bennis sprinkler stokers, the grates being fitted with the standard hollow bar and superheated steam jets by the same makers. Each boiler has four furnaces, the air supply being induced and heated by the flue gases on the Ellis & Eaves system, with some modifications introduced by Mr. Fedden, which provide for a supply of heated air to the fire-bar inlets as well as to the front of the furnace and bridge.

The specification for this steam-raising plant provided—

That each boiler should be able to evaporate 30,000lb. of water per hour (from and at 212°F.), assuming the calorific value of the fuel to be not less than 13,000 B.Th.U.

That the full-load efficiency (30,000lb.) taken over a period of eight hours should not fall below 75 per cent.

That the most economical load efficiency (25,000lb.) should similarly be not less than 80 per cent.

That the heating surface should be 6,210 sq. ft., and the grate surface 72 sq. ft.

Ratio of grate and heating surface 1 to 86·2.

Test of Water-tube Boiler at Neepsend Works.—July, 1904.

Duration of Test, 8 hours.

Fuel. Shireoaks engine slack.

Calorific value, including 5·2 per cent. moisture	B.Th.U.	11,886·7
Total coal in 8 hours	lb.	41,440
Average coal per hour	lb.	5,180
Average weight of coal per hour per sq. ft. of grate	lb.	71·9
Total ash in eight hours	lb.	3,195
Total ash per hour	lb.	399·3
Total ash and clinker per cent.		7·72
Total water evaporated	lb.	354,850
Water evaporated per hour	lb.	44,356
Water evaporated per hour per sq. ft. of heating surface	lb.	7·14
Total water evaporated from and at 212°F.	lb.	432,775
Water evaporated from and at 212°F. per hour	lb.	54,096
Boiler pressure, average	lb.	196·8
Temperature of steam at above pressure		386·4°F.
Temperature of superheated steam average		475·4°F.
Average superheat		89°F.
Water per pound of coal, actual	lb.	8·563
Water per pound of coal from and at 212°F.	lb.	10·443
Factor of equivalent evaporation from and at 212°F., including superheat		1·2196
Average temperature of feed-water		96·2°F.
Average temperature of flue gases at fan		480°F.
Average temperature of heated air entering fires		315 F.
Average CO_2 in flue gases	per cent.	15·2
Average draught at fan suction		2in.
Efficiency, including superheat	per cent.	84·9

Costs at Neepsend Station averaged over 10 weeks.

Units generated	940,620
Working hours	960
Coal.—Consumed tons	1,328
Ditto, cost per unit	0·096d.
Water.—Consumed pounds (191,000lb. is make-up water, costing £4. 15s. 6d.)	21,079,000
Ditto, cost per unit	0·0012d.
Oil, waste, stores per unit	0·002d.
Salaries and wages per unit	0·072d.
Maintenance, light, power for auxiliaries, &c. (charged at 0·5d. per unit)	0·038d.
Total	0·209d.

The plant is still in the makers' hands, but Mr. Fedden concludes by saying that experience with similar machines in the Sheaf street station does not lead him to fear any notable increase in the upkeep charges after the period of maintenance has expired.

THE MURRAY TYPE-PRINTING TELEGRAPH.

The following is an abstract of the discussion which took place on Thursday, March 2nd, in connection with Mr. Donald Murray's Paper describing his type-printing telegraph read before the Institution of Electrical Engineers on Thursday, February 23rd. An abstract of the Paper was given in our last issue on page 782.

Mr. **JOHN GAVEY** said that one of the principal reasons why the old-fashioned Morse system of telegraphy had not yet been ousted by type-printing systems was the fact that the telegraphic public had been educated to expect a high rate of speed, whether the messages were to be transmitted over two or three miles or over several hundred miles. The result was that there had been a tendency to discourage any operations that intervened between the receipt of the message at the counter and its passage over the wires, and again at the far end between its reception and its being handed over to the messenger. Of course it had always been recognised that, although this was an excellent system for the rapid transmission of messages, the large number of lines required rendered this system rather costly. That difficulty had been got over in a measure by duplexing or quadruplexing and other methods. He need hardly remind the audience that the B or increment side of a quadruplex system was the weak portion of it, and that when trouble occurred—bad insulation and other faults with which the telegraph man had to contend—the B side was the side that always failed. The British Post Office authorities, however, had had a very marked measure of success in the use of quadruplex working on the underground lines which were now being laid and which were rapidly approaching completion between London and Glasgow. These wires had been laid in the majority of cases in loops, because they knew that there would be a large amount of mutual induction—static and magnetic—between neighbouring wires if they were worked as single wires, earthed. They had adopted the following method of working so as to get an equally effective service out of metallic loops as was obtained by single wires. They joined up a high-speed Wheatstone or quadruplex on to a loop and superimposed a duplex circuit, so that they were enabled in this manner to get six channels out of two wires. When they considered, however, the transmission of Press matter, it was here that machine telegraphy had not only been generally used, but he had no hesitation in saying that the work of the country could not have been carried out without it. Now the Wheatstone system which has been commonly used in this connection was an admirable system so far as transmission was concerned, but the reception had always, to his mind, been the weak portion of it. They could transmit messages at the rate of 300 or 400 words per minute, but at the receiving end they had to employ scores of men to write them out laboriously, and when he first heard of Mr. Murray's beautiful system it struck him that therein lay the solution of economic distribution of news matter, as well as perhaps of improving the method of delivering public messages. Within the last 18 months the British Post Office authorities had carried out experiments on the Rowland telegraph, which was exhibited in Paris and briefly described by him in a Paper read before the Institution shortly after the Paris exhibition,* on the Buckingham system, the Mercardier system, in which they had promised 24 messages simultaneously, the Cried system and finally Mr. Murray's beautiful system. The last, he hoped, would be as successful as it promised to be. Perhaps the most novel feature, and certainly the one he had appreciated most in the apparatus, was the extremely ingenious method of getting synchronism between the transmitting and receiving apparatus, and the method of placing buffers at the extremities of the vibrating reed by clipping the signals was a beautifully designed thing, and in itself one of the prettiest features of the whole thing.

Mr. **H. LAWS WEBB** said that Mr. Murray had described how the perforating operator could correct errors he knew of, but in his experience of ordinary type-writing operators a good many errors occurred which the operator was unconscious of, and he had no doubt that similar errors occurred in sending these telegraphic messages, which got through to the other end of the line, and were received at the receiving instrument and were actually printed before they were caught. It would be interesting to know how such received errors were taken care of. Then again there were errors which must occur in any telegraphic system, caused by kicks and current impulses getting shortened or lengthened, which must, of course, transmit themselves on to the receiving instrument. He hardly thought Mr. Murray had done justice to the actual performance of key-board perforators for telegraph work. The Buckingham key-board perforator, which was an electrical perforator producing letters of unequal length, had absolutely displaced in the New York offices of the Western Union Telegraph Co. all the metal punches formerly used for Wheatstone working, because the capacity of the operator was increased so very much and was much more regular. It had not been found very hard for an expert operator to perforate messages at the rate of about 80 words per minute on the Buckingham key-board, and a certain male operator in New York had punched 47,708 messages in 152 days. This was one man's work on a keyboard perforator for Wheatstone working, and it gave an average of just under 314 messages a day, and on some days the work done had reached 600 messages or even 700 messages a day. The average American message was a good deal longer than the average English message, for the reason that the custom still held in America to allow the signature and address to go free of charge. The Buckingham system, it was stated in the Paper, had been tried and rejected by the British Post Office during the winter of 1903. It certainly was rejected, but opinions differed as to how far it was tried. Mr. Murray had stated that his system was experimented with by the Post Office for 18 months and possibly he would not have been far wrong if he had doubled that period. On the other hand, the Buckingham system was actually tried by the Post Office for something like eight weeks, and the trial was stopped before the operating staff had had a fair chance to get hold of the new system. He could appreciate the theory that Mr. Gavey had explained which rules the Post Office system—namely, that what the public wanted was very rapid transmission, and that they took no account of distance in demanding a minimum amount of delay, but he had not the slightest doubt that with proper organisation in the handling, commercial messages could be transmitted just as quickly by an automatic machine system as by hand.

Mr. **W. JUDD** said that one of the things which interested telegraph people—and cable people also—was the question of alphabets. It was almost impossible in a large system of telegraphy to tamper with the alphabet. As an example of this, he mentioned that in one of the Australian colonies, not so many years ago, where the original Morse alphabet was used, it was determined to introduce the international code. Whether they succeeded or not he did not know, but a very chaotic period intervened, and he thought that before altering the alphabet on any large system they would have to consider the matter for a very long time.

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* *The Electrician*, Vol. XLVI., p. 166.

Mr. Murray had come to him with an idea that by means of Mr. S. G. Brown's relay perforator and Mr. Murray's apparatus it would be possible to punch out the slip of his alphabet at the other end of a long cable, pass it through a transmitter and so repeat the succession until the other side of the world was reached. This would be a comparatively simple matter if there were separate cables for each country—viz., if there were straight-through lines everywhere. But on all the main lines there was traffic coming on and going off at all times, and they would be confronted with the difficulty of the running number of each circuit. Starting with London, the number would have to be carried right through, but it would be impossible to do this owing to the circumstance mentioned above, for the number would have to be transferred from one circuit to another with all sorts of intermediate numbers coming on. Under such conditions it would be impossible to keep any control over the traffic. He was very interested in the question of keyboard perforator speeds. His company had a model of their own which was coming along very soon, and the speed attainable on it was a matter of some interest. When the last speaker mentioned that operators were doing 70 words per minute he felt very relieved, and hoped we should be able to do the same here. As to synchronism, his company had always more or less shied at synchronism. They might start from a civilised place where it was appreciated, but the cable might end in a jungle, and the people there would not probably like it, although they had to accept it in the end.

Mr. F. HIGGINS (Exchange Telegraph Co.) said that, although the Murray system would be of very great use over long lines, it would be of no service whatever in the business with which he was connected. For instance, between Ludgate Circus and Temple Bar they delivered messages to the newspaper offices on six or seven lines at the rate of 5,000 words per minute. The initial delay in preparing the message by the Murray system and the translation at the end would involve delay and make the service a slow one as compared with the present. They now had a wire for each separate service, and an operator sent the messages out direct without any previous preparation, and they were received in the newspaper offices in Roman characters. They were handed direct to the compositors, and in some instances the messages were delivered to the public within a few seconds of their having been delivered from the tapes.

Mr. H. M. SAYERS said he did not think the discussion ought to close without a few words as to the admirable way in which Mr. Murray's Paper had been written. It seemed to him to be a model Paper both as regards mechanical logic—if he might invent a phrase—and historical logic. He was interested in what Mr. Murray had said about speed of punching, because once upon a time he was a Wheatstone puncher himself. In those days the Wheatstone was the fastest instrument in use in this country. It had not attained the record figures which had been reached of late years because iron wires were still in universal use, and they thought they had done well with a fine day and dry weather all along the line if they worked to Glasgow at 100 words a minute without a relay. A Wheatstone perforator was capable of 25 to 30 words per minute when a good operator had a continuous flow of work, and from 40 to 45 words a minute were easily punched in spurts, especially in newspaper work. With the Wheatstone perforator—as everyone knew, of course—there were only three keys, and there was no need to look at them. An expert operator could punch at full speed in the dark, if the message were dictated to him. In the ordinary course, however, an expert operator kept one eye on his slip and one eye on his copy, and as he could read each of them a little faster than he could punch, the process of looking out for errors did not interfere in any way with the rapidity of punching. If with a Wheatstone puncher in which the operator had to make up his letters according to the Morse alphabet a speed of 30 to 40 words per minute was a commercial speed, it seemed to him that with a keyboard instrument, as described in the Paper, an operator with sufficient experience ought easily to reach a speed of 80 to 100 words per minute. Whether it would be possible to keep an eye on the slip and the copy and punch at that speed was another question. An ordinary Wheatstone operator took six months to reach 40 words per minute, and it might take years to reach this speed on a keyboard instrument in which there were more keys. One point of historical interest was in connection with a reference to space signals in the Paper. He wondered if Mr. Murray remembered that the old Cooke and Wheatstone five needle instrument had a space signal alphabet. One, two or three of the needles were worked together simultaneously, so that it was an alphabet formed by space signals and not time signals.

Mr. F. J. MUDFORD said that he worked on the practical side in connection with a telegraphic type-setting machine some 12 or 14 years ago, and would like to make one or two suggestions with regard to the Murray instrument. With regard to the noise that the instrument made, he thought this would be considerably diminished by hanging the vibrating reed on rubber cords. Again, he thought there would be a great gain by having two series of two magnets opposite each other near the revolving wheel, so that the pole came exactly opposite the spindle. With only one magnet, as in the Murray apparatus at present, the drag on one side was very strong and set up a very considerable vibration, and also interfered with the ease with which the wheel revolved. In the instrument which he had worked a considerable saving was experienced by having a magnet on each side, and, of course, in this case, there would have to be two magnets on either side. In his own instrument he had done away with the second revolving wheel, and it had actually been worked between King's Cross and Holloway. The wheels ran at 250 revs. per min., and this introduced the difficulty that too small a space of time was left for the contact. This was got over by having two contacts instead of one for each signal, and having a system of inter-sections somewhat similar to what Mr. Murray had done in his printing machine. By this means, with 30 contacts, he could get four times 24 signals, so that there was a very much longer time for the electrical operation of the relays. Another difficulty was the effect of the operator keeping the key down too long. In that case a repeat signal was obtained with the rate at which his machine was worked. This led to the design of a little apparatus which should release the thing after the signal had passed. Briefly, they had first of all to put the connection on the battery to the key through an electromagnet, which depolarised the permanent magnets releasing that contact, when the current passed to line. But the current was not able to pass to line until the operator had released the key and enabled a little lever at the bottom to be in a position to rise directly the current passed.

Mr. A. J. S. ADAMS mentioned that if a Morse slip was handed to an operator to transcribe and the operator happened not to be well there might be some delay in the transcription, but by using the Murray apparatus the telegram was torn off immediately it was done and there was no delay.

Mr DONALD MURRAY, in reply to the discussion, said that the chief point seemed to be with regard to the speed of keyboards. This was the very essence of printing telegraphy. If it was not superior to the Morse key or any other method, then all printing telegraphs were doomed. As a matter of fact it was superior, but when an operator had to sign and time numerous short messages, say, of 20 words, and to take them off and to lay them aside and the other little operations like that, it was time lost, and had to be taken account of. Mr. Webb had mentioned the Buckingham system. He had some records of this system, which was wonderfully good. One man, he was told, in New York had punched 717 messages in seven hours, but we must not take the maximum speed of the maximum operator. We must be guided by the average speed of the average operator. Mr. Webb had mentioned the case of a man who for 152 days had done no less than 314 messages a day. This was very good, and better than he would have expected, but taking 8½ hours a day, which was the usual time that an American operator worked, and deducting half an hour of that for lost time, which left eight hours a day, this gave 40 messages an hour. This was not much better than a good Morse operator did in America. Multiply that by 30 words, which was the average American message, and divide it by 60, and we got 20 per minute. That was the average work of a good operator and would not be exceeded. This was for continuous work, but sometimes an operator would not be sending messages for a considerable period during the day and this had to be accounted for when estimating the number of words per minute. There was, however, a good margin between the results obtained by the Morse and the keyboard systems. A contest was held in America some time ago between five male and five female operators who had maintained 41 words per minute and 39 words per minute respectively. Mr Gavey had mentioned quadruplex telegraphy, but a printing telegraph could be worked duplex or quadruplex provided they had a sufficiently good quadruplex. It could certainly be used on the first side of the quadruplex. An unconscious error made by the operator could not, of course, be corrected. Mr. Judd mentioned some points about cable work. This would be very important for the future, but it would be some time before printing telegraphs were applied to submarine cables. With a complicated world telegraph system like that of the Eastern Telegraph Co., it was impossible to change over from the Morse alphabet, but it was possible to modify his machine in several ways so as to enable it to use the Morse alphabet, and this would be the starting point in the application of this printing system in combination with the Brown relay in its application to cable work. On the Atlantic cable there was no such objection as Mr. Judd pointed out, for there was direct communication between the two sides, and it was quite possible that in the near future something might be done in the direction of working over these cables with the Brown cable relay and the perforator. With regard to Mr. Higgins' remarks as to the local distribution of news, the instrument at present in use had been developed to great perfection and there was no suggestion of competition. They had a field to themselves which was unique, and their high speed was not comparable with the keyboards because the character of the messages was so distinctly different.

The PRESIDENT (Mr. Alexander Siemens) said that Mr. Judd had stated that it would be impossible to alter the alphabet. Of course, for the ordinary instruments that was quite true. There was the difficulty at present that in the United States a different alphabet was used from what was used in this country, and that would, and did, cause a lot of trouble. But he was afraid he had not understood the apparatus, because looking at it as an outsider, the sending clerk had to punch his message on the keyboard on which the letters were marked and the receiving clerk received the message ready printed in Roman characters. Where did the alphabet come in?

Mr. JUDD said that supposing the printer broke down it would be necessary to read the tape and see what was on it. Surely it would not do to have the message in an unknown language on the tape. The alphabet on the tape was a different alphabet to that which was used now.

Mr SIEMENS said he understood Mr. Judd's explanation. Other speakers, he said, had explained that any system of printing telegraphy was only practicable where long messages had to go over long distances, such as Press messages. For long distances then, printing instruments were all right, and judging from the time he took to learn the Morse alphabet when he was young he did not think it would take him very long to learn the other if he had to. These instruments would always be of a special character, and special clerks would have to be employed to work them. He was perfectly certain that the system of having all the signals of exactly the same length made the simplicity of the apparatus possible. In this connection he thought the Murray apparatus had quite a unique feature which he had never before seen in that room—namely, that the demonstrator was able to take the instrument absolutely to pieces before his audience and put it together again and then make it work. This, he thought, was the correct principle for designs of printing telegraphs. Generally these instruments were the most fearful complications and this was against them, and the simpler they could be got the better for them.

ELECTRICAL EQUIPMENT OF MESSRS. HARLAND & WOLFF'S SHIPBUILDING WORKS.

What is one of the largest examples of electric driving in the United Kingdom is now being completed at Messrs. Harland & Wolff's shipbuilding works in Belfast. By the courtesy of this firm we were able to inspect their works last week, and were greatly pleased with the entire arrangement which is being adopted there. Evidently great thought and considerable engineering skill have been expended in carrying out the "electrification," and we are pleased to be able to give our readers a detailed description of what has been done. In the preparation of this we have been greatly assisted by Mr. J. W. Kempster, who is in charge of Messrs. Harland & Wolff's electrical department, and has designed and carried out the whole of the conversion to electric driving, including the erection of the power house. With the consent of the management he has placed much data of a most interesting nature at our disposal, and has gone into the arrangements with us very fully.

The two most interesting features about the equipment of the works are the employment of both continuous and three-phase current for driving, and the adoption, in almost every shop, of individual drive for the machines, so that an enormous amount of belting and counter-shafting has been displaced. The chief object that has been had in view throughout the design of the electrical equipment is to obtain the maximum output from every machine in every shop. Although efficiency in power consumption is of considerable importance, owing to the large amount of energy used in the works, it must not be forgotten that the cost of this energy in any case bears but a small proportion to the cost of wages on a works of this character, so that an increase of output by 10 or 20 per cent. implies an enormously greater gain than an improvement of the same percentage in the power consumption. It is largely on this account that both the three-phase and continuous-current systems have been employed, so that a supply from either system is available in almost every shop, and each machine may be run in the manner best suited to it. No less than 1,200 B.H.P. is supplied by three-phase current, 800 H.P. in the form of continuous current for power purposes, and 1,000 H.P. for lighting. When the electrical equipment of the entire works is completed at least another 1,000 H.P. will be added.

From Fig. 1, which is a diagram plan of the whole works, the supply available at each of the different shops will be at once visible. The three-phase current is supplied at 450 volts, and preference is given to this system wherever the conditions permit. It has been estimated that the repair bill of the three-phase motors is some 25 to 30 per cent. less than that for continuous-current motors, and, when it is remembered that while a motor is being repaired the machine is standing idle, the importance of this figure will appeal to every works manager. Continuous current at 450 volts has been employed for cranes, winches, &c., and for cases in which reversible or variable speed motors have been called for. The arc lamps are also placed eight in series across the 450-volt continuous-current mains. All the shops are lighted by means of arc lamps, there being 618 arcs in all, mostly of the 20-ampere open type, made either in the electrical department of Messrs. Harland & Wolff's works or by Messrs. Crompton & Co. There are about 100 10-ampere arcs and about 100 7½-ampere Jandus arcs. The total current taken for arc lighting is about 1,350 amperes at 450 volts. Arc lighting is used, also, to a large extent outside the works and in the open yards and on the nine launching slips. The majority of the 450-volt power and lighting feeders are three-wire with balanced neutral, so that 225 volts is also available at a large number of the feeding points for special purposes, such as for motors with large speed range, and in the case of shop lighting when it is desired to run four 20-ampere open arcs or two 7½-ampere Jandus arcs in series for overtime or during the night shift, to save current. In cases where temporary wiring is required or wandering cables to portable tools are employed, as in the building slips, on the ships themselves and the fitting-out jetties or docks, the 110-volts continuous-current is available, this being supplied at a number of points, as indicated by the letter D on the diagram Fig. 1.

The position and shape of the power station buildings are seen in Fig. 1, the long and narrow shape having been necessary owing to exigencies of space. The entire block, however, is not used for the power house proper, as it includes the electrical stores, testing room, and a large fitting and repair shop for the electrical department, in which the motors and gears are fitted for the various tools. The firm had no hesitation in building its own power station instead of taking its power from the existing electricity works of the Belfast Corporation. The power required is so large that in any case special plant was necessary, and as the works are over 2 miles away from the Corporation electricity station their position will enable the generating costs to be considerably less than the cost of generation and distribution from the latter. The station occupies a piece of newly-made ground, 469ft. long by 68ft. wide. The ground consisted chiefly of saw mill refuse and soft mud, extending, in some parts, to a depth of 20ft. to 25ft. Piling was therefore necessary for the foundations, and the main and division walls are carried on about 1,000 larch piles 35ft. to 40ft. long, with 10in. by 9in. timber rafts secured to the top of the piles, and the concrete footings are laid on and embedded around these rafts. The piles for the engine and chimney foundations are 500 in number, and are 12in. square pitch pine 40ft. long. Under the engine pits the piling was surmounted by 11in. × 3in. channel iron, interlaced so as to throw an equal portion of the weight on each pile.

The engine room, shown in Fig. 2, is 171ft. 6in. long by 64ft. wide, the height from engine room floor to wall plate being 36ft. 6in. Below this floor there is a basement having a height of 10ft. 2in., where all the steam exhaust and circulating water arrangements are accommodated, together with motor-driven centrifugal pumps, condensers, air pumps, feed pumps, &c., the passages giving easy access to any parts desired, with entrances to each generator pit. The walls and generator pits are entirely lined with white glazed tiles, the floor being of concrete with a top surface of granolithic cement. The engine-room floor is constructed of 9in. by 7in. rolled steel joists and concrete, the whole of unoccupied spaces being finished with white octagonal encaustic tiles with green dots; the openings in floor necessary for the convenience of attending to valves, &c., are fitted with chequer plating of special pattern. The whole of the walls from floor to wall plate are decorated with an artistic design carried out in Messrs. Doulton's faience ware, special features being embodied in the treatment of the piers supporting the arches on each side, the arches themselves, and the method adopted of screening from view the girders, carrying the travelling crane rails. The main entrance consists of a pair of highly ornate wrought iron doors with fixed screen above, the whole measuring 22ft. by 10ft. wide, the framework formed into moulded panels filled in with magnificent scroll, relieved with foliated leaf work, the whole backed with plate glass in hinged frames to allow for cleaning. The approach to this entrance is by a double flight of steps with wrought-iron balustrade.

The switchboard gallery running along one side of the engine room is, in common with the rest of building, of fireproof construction, being supported by seven rectangular moulded and panelled columns, opening at bottom into the basement and at top into a space formed between the floor of gallery and the steel plate ceiling beneath, these columns forming convenient ducts for the mains from the generators to their respective panels. Access to this gallery is by two ornamental iron winding staircases, one at each end.

The roof of engine room is supported by seven principals, built of angles and tees, and carrying eight H-iron purlins, the two at top supporting a lantern; a special feature of these principals is the curved knee introduced, causing the tie beam to assume an arched shape. The remaining principals, eleven in number, have similar scantling, but without the curved knee.

The engine room is spanned by a 15-ton overhead three-motor electric traveller, the span between rail centres being 62ft. 2in., a great improvement being the substitution of gratings for the usual solid-boarded gangways on each side of crane; a large amount of light is thus gained.

Owing to the limits of space already referred to, the boiler house is in rather a disadvantageous position with regard to the

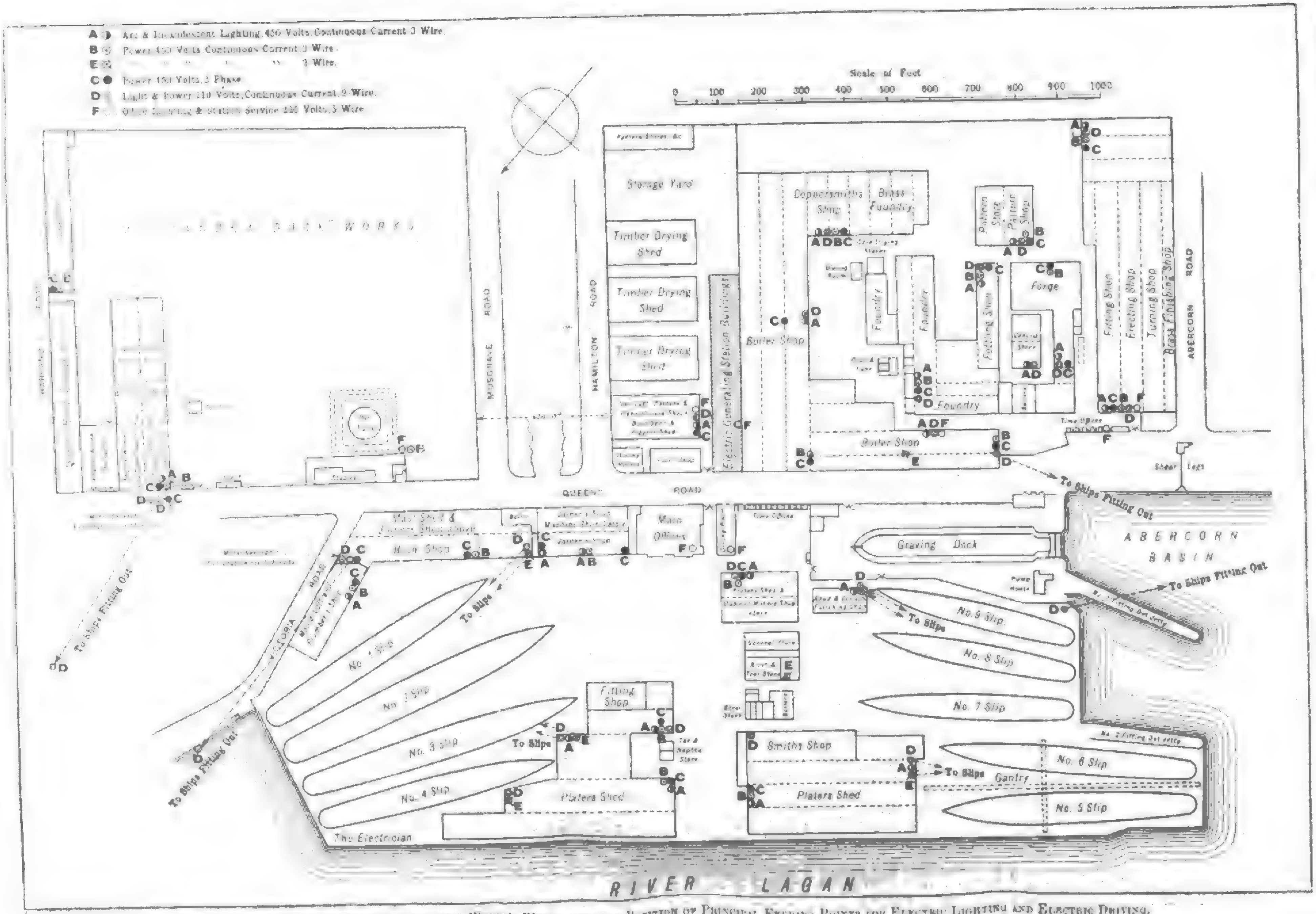
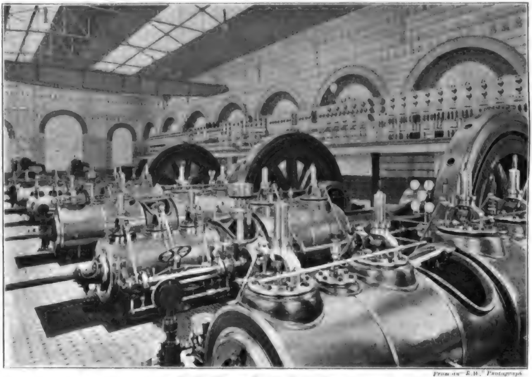

A Arc & Incandescent Lighting 450 Volts Continuous Current 3 Wire.
B Power 450 Volts, Continuous Current 3 Wire.
E " " " " " 2 Wire.
C Power 450 Volts, 3 Phase
D Light & Power 110 Volts, Continuous Current, 2 Wire.
F Other Lighting & Station Service 220 Volts, 3 Wire
Scale of Feet
0
100
200
300
400
500
600
700
800
900
1000
Storage Yard
Timber Drying Shed
Timber Drying Shed
Timber Drying Shed
Electric Generating Station Buildings
Coppersmiths Shop
Brass Foundry
Boiler Shop
Foundry
Foundry
Pattern Store
Pattern Shop
Forge
Fitting Shop
Erecting Shop
Turning Shop
Brass Finishing Shop
Boiler Shop
ABERCORN ROAD
HAMILTON ROAD
MUSGRAVE ROAD
QUEEN'S ROAD
VICTORIA ROAD
To Ships Fitting Out
ABERCORN BASIN
Shear Legs
Graving Dock
Pump House
Main Offices
Mast Shop & Joiners Shop
Main Shop
No. 9 Slip
No. 8 Slip
No. 7 Slip
No. 6 Slip
No. 5 Slip
No. 4 Slip
No. 3 Slip
No. 2 Slip
No. 1 Slip
To Ships
Gantry
Smiths Shop
Platers Shed
Platers Shed
Fitting Shop
RIVER LAGAN
The Electrician

FIG. 1.—DIAGRAM PLAN OF MESSRS. HARLAND & WOLFF'S WORKS SHOWING POSITION OF PRINCIPAL FEEDING POINTS FOR ELECTRIC LIGHTING AND ELECTRIC DRIVING.

engine room, being placed at one end of it, so that it is necessary for the steam main to be taken the whole length of the engine room beneath the floor. By means of careful lagging and systematic drainage, however, the disadvantages of this are reduced to a minimum. The boiler house is 115ft. long by 68ft. wide, the height from ground level to eaves gutter being 43ft. Near the centre of the boiler house the chimney rises to 180ft. 6in., the first 65ft. being octagonal and the remainder circular. The firebrick lining extends 100ft. from the bottom of the flue. The chimney was erected by the Custodis Chimney & Construction Co. on their usual principle.

There are five boilers of the single-ended marine type constructed at Messrs. Harland & Wolff's own works, each having a heating surface of 2,225 sq. ft. and a grate area of 56¾ft. Their diameter is 14ft. 8in. and their length 10ft. 6in. Space is provided for five more boilers of similar size. The hot gases are carried round and under the boilers on their way from the smoke boxes to the flues. Steam is generated at a pressure of 200lb. per square inch, and is carried to the engine room by a 10in. welded iron ring main with wrought steel-pressed flanges. Normally, only one side of the ring is employed. In order to take up the expansion in the long lengths of pipe, balanced expansion pieces are used. The engines exhaust into surface condensers, and town water is employed for the make-up feed. Two Weir pumps, 6½in. and 5½in. diameter by 15in. stroke, each capable of pumping 45,000lb. of water per hour, deliver the water either to the head tank of a Paterson purifier, or to storage tanks placed above the battery house, which adjoins the boiler house. These pumps have also a suction from the town mains to enable the storage tanks to be filled should the town pressure be insufficient. A description of the Paterson purifier appeared in *The Electrician* for February 24th, p. 747, and we may mention that the general view given there was the actual purifier in use at this station. The storage tanks measure 22ft. by 10ft. by 7ft., and contain 24 hours' supply in case of a failure of the town supply. After passing through the purifier the water finds its way by gravity to a smaller tank, 13ft. by 7ft. 6in. by 4ft., and any make-up feed required is introduced here by means of a ball-float valve in connection with the storage tanks. Two Weir live-steam feed heaters are placed on the discharge side of the feed pumps, and there is also an exhaust-steam feed heater, through which the suction from the float tank passes, this heating the water about 60 F. The mean temperature of the feed water as supplied to the boilers is 212°F. No economisers are employed.



From an "E.R." Photograph

FIG. 2.—GENERAL VIEW OF ENGINE ROOM.

For the main generating plant, horizontal Sulzer engines and Lahmeyer dynamos have been selected. One of the three 1,000 H.P. engines drives a three-phase generator and both continuous and three-phase machines are connected to each of the other two. These two machines have a capacity of 650kw. so that the engine can drive one of its two generators at full load and the other partially loaded, or both at about three-quarters full load. One reason for this arrangement is that at night time, or whenever less than 1,000 H.P. is required, one main engine is sufficient to supply for all purposes. The engines are triple condensing, and the usual arrangements have been adopted with the high-pressure and low-pressure cylinders in tandem on one side and the medium pressure and a second low-pressure cylinder in tandem on the other side. The diameters of the cylinders are:—H.P. 17·323in., M.P. 27·55in. and the two L.P. cylinders 31·49in., the stroke being 47·245in. As the valves are of the Sulzer drop-valve type the engines are very efficient at three-quarters load, and they are designed to take an overload up to 1,240 H.P. Each engine exhausts into a surface condenser of 870 sq. ft. cooling surface, with the usual by-pass into the atmosphere. The circulating water system presented rather a difficult problem as the position of the station was not very favourable for the erection of cooling towers. It was decided, therefore, to make use of the water from the Musgrave Channel, a branch of Belfast Harbour. Two 20in. diameter inlets, provided with double strainer boxes, lead from the Channel to a 36in. low-level inlet pipe, and this terminates in an enormous cast-iron tidal culvert 116ft. by 10ft. by 6ft., built below the water level alongside the station. This is below low-water level, and enables each of the circulating pumps to draw its water independently, as if direct from the Channel. Allen variable speed electrically-driven centrifugal circulating pumps, with 7in. suction and discharges, supply the condensers which discharge through a common high-level discharge pipe 24in. in diameter into the River Lagan. The total distance from the inlet to the outlet is nearly $\frac{1}{3}$ mile.

Each of the three three-phase generators are of the Lahmeyer flywheel type. The revolving magnet wheels weigh about 30 tons and have 64 poles, and the speed being 107 the frequency is 57 periods per second. The main dimensions of the three-phase machines are as follows:—Outside diameter of stator, 24ft.; outside diameter of stator core, 18ft. 2$\frac{1}{8}$in.; width of ditto, 7$\frac{7}{8}$in.; diameter of stator bore, 17ft. $\frac{3}{4}$in.; diameter of magnet flywheel outside poles, 16ft. 11$\frac{13}{16}$in.; flywheel effect, 185,000kgm^2. They are star-wound and generate current at 440 to 460 volts, and their capacity, as already stated, is 650kw. with an overload capacity of 750kw. The main dimensions of the continuous-current machines are as follows:—Outside diameter of magnets, 13ft. 1$\frac{1}{8}$in.; Inside diameter across polar face, 8ft. 7in.; diameter of armature, 8ft. 6$\frac{3}{8}$in.; width of ditto, 1ft. $\frac{3}{16}$in.; outside diameter of commutator, 7ft. 5in.; armature resistance about 0·006 ohms; flywheel effect 25,000kgm^2. Their fields are separately excited at 220 to 230 volts, current being taken from 'bus bars independent of the main 'bus bars and fed by two high-speed 60kw. Allen sets, in parallel with a battery of 112 Chloride cells whose capacity is 1,530 ampere hours at a nine-hours rate. The motors for all the electrical auxiliaries, including the engine-house crane, and the barring motors for the main engines, as well as the lighting of the generating station, are supplied from these same 'bus bars. But whilst the excitation is permanently connected to the 'bus bars without fuses, all the other circuits can also be run off the main generators on the three-wire system. Change over switches are provided for this, and, except at starting and stopping and during the dinner-hour, &c., the main 'bus bars feed all the electrical auxiliaries. A Lahmeyer 120kw. synchronous motor-generator, with two continuous-current machines, one on either side of the alternator, has been provided for converting continuous into three-phase current or vice versa. This set usually runs as a balancer on the continuous-current three-wire system, the three-phase motor not being excited. At periods of light load it permits of only one of the two small high-speed generating sets being run according to the nature of the demand: of these one is 350kw. three-phase and the other 250kw. continuous-current.

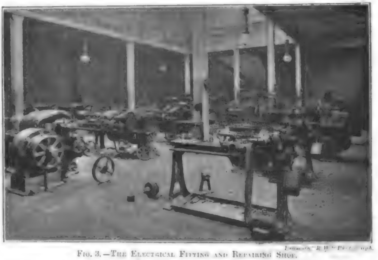


FIG. 3.—THE ELECTRICAL FITTING AND REPAIRING SHOP.

A continuous-current 450:110-volt motor-generator of 120kw. is installed for the low voltage system and for charging the cells. There is also a Highfield automatic reversible booster for charging the cells.

The switchboard is of the British Thomson-Houston Co.'s manufacture, and consists of 64 white marble panels each 2ft. wide by 7ft. 6in. high by 2in. thick, and comprise the following sections:—

I. (*a*) Three phase generators; (*b*) 20 three-phase feeders. II. (*a*) Continuous-current generators; (*b*) continuous-current feeders, two and three-wire, of which 12 are for lighting and 25 for power. III. Continuous-current balancers. IV. Accumulator and booster panels. V. Sub-station panels.

These latter comprise six 110-volt feeders, which ramify throughout the works, chiefly for the shipbuilding slips or fitting-out jetties, and are fed either from the station or at two points by motor generators outside the station. In addition, circuits for lighting the three office buildings have been provided, whilst the electrical department itself has four circuits for lighting and power. There are also instrument panels for the paralleling voltmeters, Lincoln synchroniser and integrating wattmeters, on the basis of whose readings the units delivered are charged to the various departments. All the ammeters and voltmeters are of Messrs. Elliott Bros. moving coil type, the voltmeters having illuminated dials.

The workshop (Fig. 3) already alluded to has a floor area of 6,300 sq. ft., the ground floor being occupied by electrically-driven machine tools of various descriptions, including lathes, winding lathe, milling machine, drills, armature stands, &c., each machine being provided with a "tidy." There are also five fitters' benches, with patent vices, &c., and foreman's office. A gallery runs around three sides of shop 18ft. 6in. above floor level, 16ft. wide at sides and 23ft. at end; this gallery is constructed to carry machine tools if necessary, the seven stanchions supporting main girders being compounded of two 10in. by 6in. with $\frac{1}{2}$in. cover plates; the main longitudinal girders supporting the floor joists are composed of two 12in. by 5in. R.S.T. with two $\frac{1}{2}$in. plates top and bottom. These girders also carry the rails for a 5-ton travelling crane, the motor for hoisting and lowering being controlled from the ground floor. The floor of gallery is of 6in. by 3in. deal decking. The ground floors of stores, test house and workshop are paved with wood block paving laid on a concrete bed and jointed with mastic cement.

(*To be continued.*)

ELECTRICITY METERS.*

BY C. H. W. GERHARDI.

(*Continued from page 796.*)

The Eclipse Type C.R. Meter.—This ampere-hour meter is made in sizes up to 10 amperes. It is a motor meter having an armature which rotates in a magnetic field due to two permanent magnets. The armature coils are quite flat, being supported on a partially cut away aluminium disc which forms the brake. The current to be metered is passed through a platinoid shunt having a drop of about 1 volt at full load. A small fraction of the main current passes, by means of very light brushes and a very small commutator, through the armature which is connected across the shunt, and therefore has a very small voltage applied to the brushes. A light spindle, having its base polished to a hemisphere, rests on a jewel and supports the disc on which the armature coils are laid. Its revolutions are transmitted by a worm on its upper end to a wheel train of the cyclometer pattern.

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* From a forthcoming book to be published by "The Electrician" Printing and Publishing Co. All rights are reserved.

In Fig. 41, which is a view of the "C.R." meter, the right-hand magnet has been removed to give a better view of the armature, brush brackets and low resistance which carries the main current. The magnets, jewel screw and brush brackets are all supported by a plate standing out from the back. The low-resistance shunt consists of two spirals, seen in the back, one end of each being connected to each main terminal, whilst the other ends are supported by an insulating clamp fixed underneath the magnet-supporting plate near the front. Contact between the two spirals is made through an adjustable clamp; by altering the position of this up and down the straight portions of the resistance (just underneath the supporting plate), a certain amount of alteration the speed of the meter can be made The magnets are also adjustable.

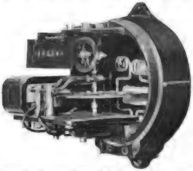

Fig. 41.—View of Eclipse Type C.R. Meter, Right-hand Magnet Removed.

A better view of the armature is seen in Fig. 42, which shows how the three flat, fine wire coils are laid on the partially cut-away aluminium disc and held in position by threads at intervals. The three-part commutator to which the ends of the coils are attached is just above the disc. The diameter of the disc is $3\frac{3}{4}$in. and the thickness of the disc and coils 50 mils. The diameter of the commutator is 0·11in., and the weight of the whole moving system 24 grammes. From tests made, the mean torque at full load appears to be about 4·8 gramme cm. In common with other ampere-hour meters having shunted armatures the speed is high, being 9,000 revs. per Board of Trade unit, or 300 revs. per min. at full load. Each brush consists of two extremely thin strips of silver, clamped at one end to the stout brass supporting rod (Fig. 41), the other ends of the strips being held by a fine steel wire which is clamped to the same rod by the second clamp. By this means the strips are caused to bear on a small arc of the commutator. Good contact is obtained in this manner, but at the expense of slightly increased friction. The meter is a very small one, the diameter of the back casting being only $4\frac{3}{4}$in., which would be advantageous in cramped situations.

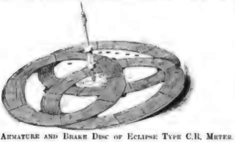

Fig. 42.—Armature and Brake Disc of Eclipse Type C.R. Meter.

The Electrical Company's Continuous-current Meters.—The type R.A. meter is an ampere-hour meter, and consists of a motor the field of which is supplied by a large permanent magnet. A three-coil armature is connected by its commutator and very light brushes to the terminals of a strip or wire, and thus a small fraction of the main current passes through the armature, the greater part going through the strip, the ends of which are connected to the main terminals. The armature coils are former wound, and are laid on the outside of an aluminium cylinder. The cylinder, passing as it does through the field of the magnet, acts as a Foucault brake. The drop in the main strip or wire is directly proportional to the current passing, and thus the P.D. at the armature terminals is proportional to the main current.

Fig. 43 illustrates this meter with its cover removed. The magnet, as will be seen, is of the horse-shoe pattern, having large pole-pieces bored out to take the armature. In order to make the air-gap as small as possible, an iron core is fixed in the gap so that the latter is reduced considerably, and only a small clearance is left between the core and the pole-pieces to allow the cylinder to rotate freely. A hole in the centre of this core allows the spindle to pass down to the footstep.

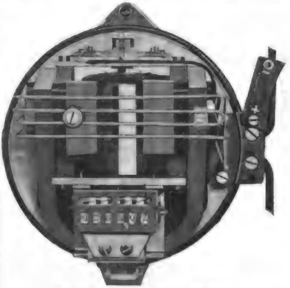

Fig. 43.—The Electrical Co.'s R.A. Meter.

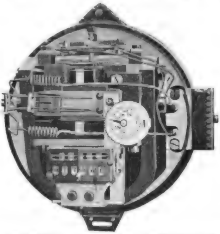

Fig. 44.—The Electrical Company's R.A. Meter with Adjustment for varying Voltages.

The pole-pieces form a support for the brush bracket and top bearing, and a worm near the lower end of the spindle works the counting train, which is of the cyclometer pattern, as on all the meters of this make.

The speed is adjusted by altering the resistance of the wire forming the main circuit by shifting the position of the clamp, consequently altering the pressure across the armature. There is no compensation for mechanical friction, which is kept as low as possible. The speed is high (200 revs. per min. at full load), and the full-load torque is also large (16 gramme-cm.); thus mechanical friction does not affect the curve except at extremely low loads. The starting current is therefore very small, and the meters will start on $\frac{1}{100}$th of full load. The full-load drop is high; the makers give it as 1 volt for all sizes. It depends on the adjustment to a certain extent, however, and has been found to be as much as 1·4 volt on a 5-ampere meter.

The bottom bearing is a jewel, the spindle resting on a ball as has been described in connection with the alternating-current meter of the same make. A clamping gear is provided to prevent damage during transport, and is worked with a screwdriver through a hole in the case.

The meters are made up to a capacity of 50 amperes. The watt loss at full load on a 50-ampere meter is 50 watts, a very high figure, it being 1 per cent. of the transmitted power on a 100-volt supply. This meter is also made as shown in Fig. 44 with an adjustment enabling it to read Board of Trade units at varying voltages. Two ranges are provided—viz., 100 to 125 volts and 200 to 250 volts. The adjustment is easily made by inserting a screwdriver through a hole in the cover just in front of the slot on the pinion (see Fig. 44). This pinion is turned until the pointer on the circular dial points to the desired voltage. The hole in the case is then closed by means of a small brass cap, which can be sealed.

(To be continued.)

TRAMWAYS PERMANENT-WAY CONSTRUCTION AND MAINTENANCE.*

BY JAMES LORD.

During the time I was working as assistant under other engineers, four in number, each had a particular fancy for the lines being laid by one of the following methods, viz.:—(1) That the concrete be laid first, the metals afterwards, and packed up. (2) That the concrete be laid first, the metals to be put on whilst the same was wet. (This I consider a dirty and very unsatisfactory way.) (3) That the rails be packed up on blocks, crowed, and the concrete be put in afterwards.

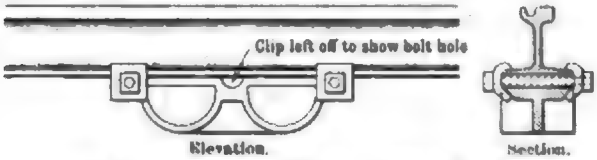

Fig. 1.—Bull-Dog Sole Plate. Scale 2" = 1 foot.

In Halifax, tramways were first laid in the year 1897 for the purpose of running electric cars, and up to the commencement of the year 1900 (the time I was appointed engineer), there had been some 12 miles laid. On these the concrete was laid first, then the metals afterwards, packed up with chippings and cement. The rails were of the girder pattern and weighed about 95lb. per running yard with fish plates 24in. long weighing 46lb. per pair, and sole-plates 24in. by 8in. by $\frac{3}{4}$in., weighing 41lb., bolted to the bottom flange of the rail without being anchored down.

Since the year 1900 I have used girder rails weighing 96lb. per yard, with fish-plates 25in. long weighing 70lb. per pair, and anchored down at the joints with Howard Cooper's patent joint, 24in long, with six rivets into the bottom flange of each rail. This joint block is simply a piece of rail turned the opposite way and the two flanges riveted together. I have also used an intermediate anchor (either one similar to those at the joints, or what is known as the Ames Crosta Bull Dog anchor block, Fig. 1). As to price of these anchors, there is very little difference. I am strongly of opinion that it is better to lay the metals first and the concrete afterwards and this practice I always carry out. I place the metals on wooden blocks packed up with wedges to the exact level, at intervals of about 9ft. apart, then the line is crowed, afterwards the concrete is packed under the metals and the remainder of the track to the level of the bottom flange of the rail; after this has stood for two days the wooden blocks are taken out and the holes filled in with concrete and the following day the whole of the crevices under the metals are run in with a mixture of sand and cement (1 to 1). I have had several of the lines tested, but never found one rail in the least hollow. My objection to packing is that men do not pack equally, and this leaves the rail slack in places, which, with the vibration of the cars, causes the setts to lift, and, further, when the concrete is laid first it does not give such an even surface for the paving unless it is skimmed over afterwards, which adds to the expense and, in my opinion, is not so satisfactory a job.

Since the year 1900 I have laid about 36 miles of track, and have used rails 60ft., 45ft., and a few 35ft. long, but much prefer the 45ft. lengths, for the following reasons—viz., they are much more readily handled, especially in narrow and steep roads, such as exist in Halifax; secondly, there is not the same danger that occurs with the longer rail, the latter very often acquiring a permanent set or hogback by sagging with its own weight, therefore the 45ft. rail is better to pave to and it is much easier to curve. It is true that in the 60ft. rails we have less joints to contend with, which also means less electrical resistance, but to counteract the cost of the joints the 45ft. rail only requires one intermediate anchor, whereas the 60ft. rail ought to have two to each rail, or we find the rail will not sit perfectly solid. The rail used in Halifax is 7in. deep, with a bottom flange 7in. wide and with a tread 2in. wide, groove $1\frac{1}{4}$in wide and 1in. deep, manufactured to the following specification:—

Weight.—No extra weight over 1 per cent. per lineal yard above the specified weight will be paid for, or no rail weighing more than 1 per cent. per lineal yard less will be accepted. 85 per cent. at least of the rails shall be 45ft. long, the remaining 15 per cent. may be cut from longer lengths with defective ends, to lengths as follows: 5 per cent. 40ft., 5 per cent. 35ft., and 5 per cent. 30ft. No variation exceeding $\frac{1}{4}$in. will be allowed in the respective lengths of the rail. The ends of each rail to be perfectly square, smooth, free from all burrs and other defects, each rail to be coated with boiled oil whilst hot.

Analysis.—The chemical proportions in the bloom shall conform to the following: The quantity of carbon shall be from 0·32 to 0·45 per cent.; silicon not to be more than 0·06 per cent.; phosphorus not to be more than 0·09 per cent.; sulphur not to be more than 0·065 per cent. The blooms are to be free from defects of any kind and regular in quantity. The only metals of which they shall consist shall be iron and manganese, with a bare trace of copper. The engineer shall have power to have samples of the steel from time to time analysed by a chemist, and should these analyses not prove satisfactory, the expense must be borne by the contractor.

Quantity and Test.—The rails shall be perfectly straight, free from cracks, burrs, blisters and other flaws, and of uniform section throughout. They shall show, when broken, a clear, close, and homogeneous fracture. Their ends shall be sawn off perfectly square and machined. The ingots shall be cast of such a size as to leave, when rolled into the finished rail or rails, a crop of at least 1ft. 6in. in length at each end, which shall be afterwards cut off. A piece of rail 5ft. long will be taken from each blowing and placed on solid bearings, 3ft. 6in. apart, and the solid bearings shall be fixed on a solid cast-iron block weighing not less than 5 tons and be well bedded thereon. In order that the rails of that blowing may pass, the test piece shall stand the following test:—

1st. By a weight of 1,120lb. falling in proper guides upon the centre of each sample from a height of 10ft.

when at the	1st blow	the set shall not exceed	$\frac{3}{4}$in.	Sample not to be cracked or broken.
do.	2nd	do.	$1\frac{1}{2}$in.	
do.	3rd	do. rail reversed.		

2nd. By a weight of 1,120lb. falling in proper guides upon the centre of each sample four times from a height of 20ft., without sample breaking. Every rail shall be stamped with a mark which shall distinguish the blowing of which it formed part. All holes shall be drilled according to drawing, and shall be true and square through the rail.

Fish-plates.—The fish-plates shall be rolled from the same quality of steel in all respects as that specified for the rails. They shall be capable of being bent, when cold, round a bar 4in. in diameter without fracture.

It will be noted in the above specification that the percentage of carbon is somewhat lower than in many engineers' specifications, the reason being that having so many rails to bend on account of the number of curves, we have less breakages than we should have with a higher carbon.

The writer has used rails 105lb. to the yard on sharp curves with $1\frac{1}{4}$in. groove. The engineer must be very careful in the gauging of the rails, or it is a great strain on the wheels of the cars. The gauge on curves should be slightly less, varied according to the sharpness of the curve. I have used both manganese and crucible cast-steel points and crossings, and think the former has a longer life. I have not had any experience in manganese steel-hardened renewable centre pieces, but I do not see any great advantage in them. I use 8ft. 6in. points with 5ft. tongues and 4ft. crossings, except on very sharp curves, then it is necessary to use shorter ones, but the writer would advise that the length of each tongue should be 6in. longer than the wheel base of the car so that the trailing wheels would be on the tongue before the leaders leave, and then the strain is not so severe. I believe in a fair number of tie rods, especially if wood pavement is to be used, or the expansion of the blocks is liable to put the track out of gauge.

Concrete.—The mixture I use is five parts of broken gritstone, one of clean sharp sand and one of best Portland cement, turned over twice dry, then turned twice after water has been added.

Formerly the whole of the tracks in Halifax were paved with local stone setts 6in. deep, but now I use nothing but granite or wood, except on the very steep gradients (those steeper than 1 in 10), and even then I use granite for the 18in. margins. The whole of the pavement is run in or grouted with pitch on the level roads to the top of the setts, but in gradients the top ½in. is grouted in cement. If this is not done the pitch runs in hot weather and is liable to run down the tread of the rail, which is dangerous for traffic. I laid in 1900 about half a mile of track on longitudinal sleepers 10in. by 4in. creosoted red wood; it is less rigid, and, therefore, better for the rolling stock. These sleepers were embedded in concrete, and the metals screwed down with coach screws at intervals of 4ft. 6in., but my difficulty has been to keep the setts level with the rails, owing to the slight vibration that takes place. If it were not necessary to keep the surface of the road in good condition for vehicular traffic, the writer would much prefer the lines to be laid on timber.

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* Abstract of a Paper, read before the Leeds Local Section of the Institution of Electrical Engineers on February 16th.

The whole of our lines which were laid and were packed up from the concrete have gone badly at the joints and the setts are continually lifting and dropping, owing to the bumping of the cars on the joints and these lines have constantly to be repacked and repaved. In fact one line about one mile in length which was filled in with tar macadam, I had taken up last year and found some of the joints down quite 1½in. In relaying this track I welded the whole of the joints on the Thermit process (cutting off the bad ends of the rails and putting in short pieces) and anchored the rails at the joints and centres and paved the surface with granite. The apparatus used for the Thermit welding is shown in Fig. 2. This work has proved very satisfactory up to the present. Of course I may say it is not so perfect as would have been the case had new rails been used, owing, as above stated, to the joints being done and the rails hog backed, but the road is not a very busy one and will last for years to come.

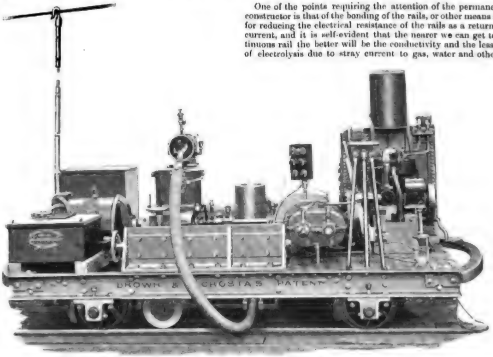

FIG. 3.—EMERY RAIL GRINDER AND DRILLING APPARATUS, BY MESSRS. AMES CROSTA & CO.

The life of local setts on busy thoroughfares was certainly not more than three or four years, those next to the rail wearing down quite 3in. in that time. I have had little or no repairs as yet on tracks that have been anchored down. It is advisable to use anchors oftener on curves than on the straight as the rail does not sit so well. The wear-and-tear on the metals in Halifax is very great owing to the steep gradients which necessitate the constant use of the slipper brake.

I think it is essential that every engineer having under his control the construction and maintenance of permanent way should have possession of an emery rail grinder. The one in use at Halifax (Fig. 3) is, I think, up to the present, unique, it being the only one of its kind so complete. It was built by Messrs. Ames Crosta & Co., sanitary engineers, Nottingham, specially for Halifax, and is fitted up with an electric motor so that it can travel and work from the overhead wire. It is also fitted with a 12 H.P. petrol motor, and can travel and grind from this if the overhead equipment is cut off, or in case of construction where the same has not been completed. The machine is fitted up with a complete set of drilling apparatus for drilling longitudinally and vertically, or, if required, at any angle, which is very useful and can be run from either motor.*

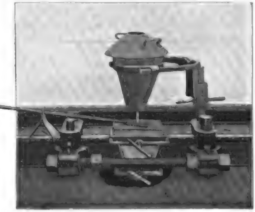

FIG. 2. —THERMIT WELDING.

One of the points requiring the attention of the permanent way constructor is that of the bonding of the rails, or other means adopted for reducing the electrical resistance of the rails as a return for the current, and it is self-evident that the nearer we can get to a continuous rail the better will be the conductivity and the less danger of electrolysis due to stray current to gas, water and other metal pipes. I have had some tests made of the electrical resistance of Thermit welding and otherwise, with the following results:—

1.	Taking a solid rail 8ft. long as a standard resistance..	0·000067	ohms.
2.	With Thermit welded joint, without bonds, same length	0·000072	,,
3.	Ditto ditto with one ditto	0·000067	,,
4.	Fishplates, sole-plate and two bonds, newly constructed	0·000078	,,
5.	Ditto ditto after two years..	0·000095	,,

The welded joint has a considerable value mechanically by giving increased strength to the track. In proof of this I may mention that I have made a number of tests, and in all instances the rail has broken and not the joint. The lay out of the curves is an important item in the maintenance account, as will be gathered from the following instance:—I had a curve with a radius of 30ft., the wheel base of the car was 5ft. 6in.; this curve never lasted a longer period than six months, but some 2½ years ago this was altered to a 45ft. radius, and it is little worse to-day. On many of the curves which are 35ft. radius I have to put in a new check rail at intervals of about nine months.

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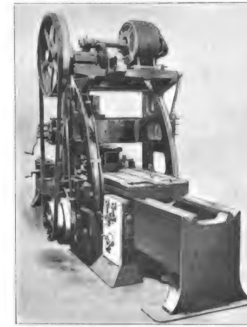
* The makers inform us that the machine is fitted with carborundum grinding wheels carried by compound slides constructed so that the grinder may be moved logitudinally, transversely and vertically to the rails to be ground. Both rails can be ground at one setting. The grinding wheels, which are clearly shown in Fig. 3, are driven from the motor by a flexible steel shaft, and the drills are actuated through the flexible shaft shown in the centre and front of the illustration.—ED. *E.*

MOTOR-STARTING PANELS EQUIPPED WITH CIRCUIT-BREAKERS.

The general practice of using a separate switch panel for each individual unit in a motor-driven workshop or factory has much to commend it. Before the introduction of this system, and in those installations where it is not yet used, main and starting switches, circuit-breakers, fuses, &c., have been mounted in the most convenient places available, which are often neither safe nor possessed of good insulating properties. The use of a proper panel for one thing ensures the correct mounting of the apparatus, and, if it is so arranged as to be easily attached to the frame of the machine operated by its motor, it provides a method of control that is unequalled for convenience. The accompanying illustration shows a Westinghouse starting panel employed in this fashion. It is for direct current, and is fitted with a two-pole, type D, circuit-breaker instead of the customary switch and fuses. The circuit-breaker is especially adapted for this use, as one pole is connected in each side of the circuit, the poles closing independently but tripping simultaneously. In closing the circuit, if there is a short-circuit or overload on the motor, the pole first closed opens immediately upon the closing of the second, thus instantly interrupting the circuit and preventing damage.



Motor Starting Panel Fixed to Planing Machine.

The circuit-breaker is strongly built, with few parts, none of which are small, and is provided with hinged movable contacts of the brush type, with carbon tips, to which the current is shunted when the circuit is broken, thus preventing sparking at the main contacts. The circuit is fully broken at these contacts before there is any movement of the carbon tips. There are no springs except the strong strip of spring steel which carries the carbons, the blow of the armature tending to open the switch and not simply to release the moving parts. We are informed that the device is reliable in its action and may be adjusted for various loads. These panels with circuit-breakers are furnished in two styles—those with field rheostats for motors requiring shunt field regulation for varying speed, and those without field rheostats for constant-speed motors.

With Westinghouse motors, a starting rheostat with minimum voltage release is generally employed, and as soon as the supply current is interrupted, the rheostat automatically opens the circuit, making it impossible to damage the motor by restoring full line pressure when it is standing. The field resistance ordinarily provided with Westinghouse motors is mechanically strong, and will stand continuously the field current of the machine with which it is used in any position of the handle. In addition, no combustible material is used in its construction. The slab of the apparatus illustrated is of slate, with a dull black marine finish harmonising with the black oxide finish of the switches. When ordered, brackets are supplied for wall mounting, or gas pipe frames of rigid construction (such as are used with the Westinghouse Type 7 B panels) are provided for mounting upon the floor. In capacity these panels range from ⅛ H.P. to 50 H.P. at 110 volts, and from ¼ H.P. to 100 H.P. at 220 volts. The sizes vary from 11in. by 23in. by 1in. to 20in. by 48in. by 1¼in., according to the space required for the apparatus. In capacities up to 10 H.P., 110 volts and 13½ H.P., 220 volts, panels without field rheostats are made with front connections if desired.

VEGETABLE ANTENNÆ FOR WIRELESS TELEGRAPHY.*

The experiments described below were conducted principally at Fort Mason, San Francisco, California, where the United States Signal Corps has a wireless telegraph station, and between this point and Alcatraz Island, San Francisco Bay, another wireless station of the Signal Corps, at a distance of about 1½ miles. Later, the Naval Wireless Station at Yerba Buena Island, at a distance of 3¼ miles, was also used as a transmitting station, through the courtesy of Admiral Whiting, United States Navy. A grove of eucalyptus trees on the lawn in front of Major-General Arthur MacArthur's quarters at Fort Mason, was utilised as a receiving station.

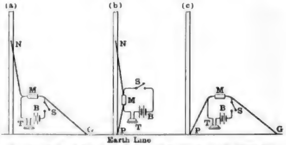


Fig. 1.—B, Local Battery; G, Ground Connection; M, Microphone: N, Tree Connection (upper); P, Tree Connection (lower); S, 2-ft. Switch; T, Telephone Receiver.

In testing the effects of different arrangements of receiving circuit, and of capacities and inductances in its branches, it was more convenient to use the station at Fort Mason for transmitting, which is about 320yds. distant from the trees utilised as receiving antennæ. The transmitting apparatus at Fort Mason consists of a small Apps induction coil of about 4in. spark, and a vertical antenna wire suspended from a 75ft. pole situated on a bluff about 80ft. above sea level. This was one of the first wireless stations installed in the United States. The detector used consists of a simple microphone made by partially filling a small ebonite tube with the regular-sized spherical carbon granules used in telephone transmitters, and by imbedding therein two steel needles as electrodes so that they nearly touch each other at the central part of the tube. This apparatus, which serves to give roughly quantitative results, decoheres itself readily, an occasional slight tapping with the hand being all that is required to keep it sensitive. A head telephone was used to interpret the signals.

No attempt has been made thus far to determine to what ultimate distances this method may be employed for wireless signalling, since this is dependent upon many things, notably high power in the sending apparatus, and extreme sensitiveness in the receiver. The experiments described have reference to the general features of the phenomena observed. The wave length employed in most of the tests was about 300ft., corresponding to a frequency in free space of $3{\cdot}27 \times 10^6$ per second.

In Fig. 1 are shown three typical arrangements of receiving circuits, which have been found efficient in practice. In this figure a growing tree is represented by the double line. In Fig. 1 (*a*) N represents a point of electrical contact with the tree, made in any convenient manner, such as by driving an ordinary iron nail or pin into the tree, preferably through the outer, living part thereof. The point G represents a conducting contact with the earth, made by driving a metallic pin therein. M is a microphone, T a telephone, and B a source of E.M.F. In Fig. 1 (*b*) and (*c*) the corresponding letters represent similar apparatus. The first experiments tried were with an arrangement of circuits indicated in Fig. 1 (*b*).

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* Abstract of a Report by Major George O. Squier, of the U.S.A. Signa Corps.

The electrical contact with the tree at the point P, was made by driving a nail into the tree itself an inch or two above the earth line, so that the contact would be distinctly with the tree, and not with the earth. The whole apparatus used for these preliminary experiments was extremely simple, consisting of a few feet of flexible lamp cord, a microphone, with three small dry cells, and a head telephone receiver, suitably mounted on a small board about 10in. by 12in. With the electrical contact at the point P remaining stationary, the upper point N was shifted up and down the tree, the effects being noted. In this experiment, the transmitting station remained unaltered as far as possible, sending a simple signal, such as the letter S. It was found that as soon as the distance PN became more than 3ft. or 4ft., faint signals were heard, which in general increased in loudness with the distance between P and N, along the trunk or stem of the tree, up to the general region where the first branches began to diverge, beyond which a further increase could not be certainly noted.

In order to ensure that the effects observed were actually due to electromagnetic waves from the tree itself, and not to the short antenna wire represented by MN, in (*a*) and (*b*) Fig. 1, a careful exploration of the tree was made, using lead-covered insulated wire for the connections PM and MN, the lead covering of this short antenna being carefully grounded, so that the actual wire used was encased throughout in an earth-connected metallic conductor, which would effectually screen the electromagnetic waves from affecting the wire inside. With such a wire, with the point P remaining stationary, experiments were made, showing that as soon as the distance PN became more than about 3ft. for the particular distance and apparatus used, faint signals began to be heard. Upon removing the terminal an inch or two away from the tree, still keeping it at the same height above the earth, the signals disappeared entirely, returning again when electrical contact was restored. These effects increased in general as the distance PN became greater.

Metallic net screens of fine mesh were also used to protect the whole receiving apparatus, and were placed close to the tree on the side toward the receiving station, and above the height of the point N for a considerable distance. A tree selected behind a masonry embankment 8ft. high, and growing close up against the wall and on the side directly opposite the sending station, was also used for receiving purposes, so that the whole receiving apparatus, including the upper contact, was considerably below the surface of the ground sustained by the retaining wall. These conditions did not perceptibly interfere in receiving signals through the tree. The method employed in these experiments has the disadvantage of requiring the results to be interpreted by relative intensities of sound to the human ear, which method is well known to be unreliable in general, as compared with any method involving an instrument, for instance, where deflections may be read by the eye, yet the effects were so pronounced and unmistakable that they were readily confirmed by repeated tests. It was found that the upper contact point N could be made either to a metallic nail or pin, driven into the tree trunk, its smaller branches, or by pressing the wire against its leaves, buds or flowers.

Since a vertical wire, earthed at its lower extremity, possesses a potential node, and a current anti-node for electromagnetic waves at approximately the point where the wire intersects the earth line, it was thought that a growing tree, which can be regarded as a vertical conducting cylinder, earthed at its lower end through its root system, would possess a more or less well-defined potential node region at or near the intersection of the earth line with the trunk or stem of the tree. Experiment confirmed this, and the point P at the base of the tree was therefore used, in general, as one of the advantageous points of connection throughout the experiments, and comparisons usually made from this point to others, both up and down the tree itself on the one hand, and in exploring the ground surrounding and adjacent to the tree on the other.

In Fig. 1 (*c*) is shown an arrangement for receiving electromagnetic effects from the surface of the ground itself immediately surrounding the growing tree. Here, as in (*b*), the point P was a metallic nail in the tree at its base, whereas the point G was at various radial horizontal distances up to and somewhat beyond $\lambda/_4$. With this arrangement it was then an object, using P as one terminal, to explore horizontally along the surface of the ground with the other terminal. It was found that a marked difference in effects could be obtained by changing the point G, relative to the base of the tree, at times even as little as a foot or two, provided, however, it was in a zone beyond 6ft. or 8ft. distance from P. This minimum distance, however, is a matter of the sensitiveness of the instruments, as well as of the power used at the transmitting station. No law has been observed, thus far, relative to the position of the point G from P, since the local effects produced are quite likely due to the unsymmetrical distribution of the root system immediately beneath the surface, which root system readily conducts electromagnetic waves, and may therefore be considered as an extension of the antenna into the earth.

When the wire at P was entirely removed from the nail at the base of the tree, and inserted in the ground itself immediately adjacent thereto, but not actually touching the tree at all, the signals were heard. Here, then, we are receiving electromagnetic effects without any actual contact with any form of antenna, but directly from the earth itself immediately surrounding the foot of the antenna, and under its electrical influence. In Fig. 1 (*a*), which is a combination of (*b*) and (*c*), is represented a third type of receiving circuit which gave slightly stronger results than either (*b*) or (*c*) independently.

With the three typical circuits diagrammatically indicated in Fig. 1, a number of experiments were tried, with the following results:—Inserting impedance in MN, Fig. 1 (*a*) and (*b*), invariably cut down the intensity of the signals, whereas, impedance inserted in MP (*b*) and (*c*) had little or no effect. A large choke coil with an iron core, inserted at the lower contact P of the circuits, made practically no difference, whereas the reducing influence of 100 ohms in the branch MN, (*a*) and (*b*), was decidedly noticeable. A small air core coil, made by winding a few turns of small wire, and inserted in this branch of the circuit, cut down the effects perceptibly, while 7,000 or 8,000 ohms would cut off all signals. With the arrangement Fig. 1 (*a*), short-circuiting from a point at the base of the tree to either side of the microphone, alternately, made no appreciable change in intensity of signals. The detector in use being a microphone, operated by P.D., and not by energy or current, attempts to increase the effect in the microphone by a number of parallel branches MN, made to several separate metallic pins in the tree around its circumference at the height N, and joining each to the same terminal of the microphone, produced no perceptible increase in intensity, as was expected. The same may be said, of course, with respect to substituting for the single metallic electrode P at the base of the tree several such points connected in parallel to the microphone.

Several trees of a large grove were connected in parallel by joining the upper terminals thereof to one terminal of the microphone, the other terminal of the microphone being to earth. Here, again, slight increases were shown upon cutting in different trees in succession, singly and in combination. The slight differences noticed were probably due to differences in size and character of the trees, the resultant effect upon the microphone being merely that of the most efficient tree of the number being used at any one time. In an effort to determine means for increasing and concentrating a greater proportion of the electromagnetic waves absorbed by the whole tree system, and for localising the effect at the proper point in the receiving circuit, the following significant experiment was made.

With the arrangement, Fig. 1 (*b*), several other contacts were prepared around the circumference of the tree at N, and also at P, and these short-circuited by wires direct, affording metallic paths for the waves to reach the earth other than the one actually containing the microphone. Not the slightest diminution of the signals could be noticed upon connecting such short-circuit wires, either singly or in combination, provided only, of course, the short-circuit was not between the actual nails used in the receiving circuit, but was confined to other terminals in the tree, even when very close thereto.

This experiment shows that the electromagnetic effects utilised in the single circuit, shown in Fig. 1 (*b*), are but a very small proportion of the total effect absorbed by the whole tree system. This indicates that if we use a wave detector which operates by electrical energy instead of P.D., we can easily magnify the effects. Manifestly, this can be done by surrounding the tree at the selected upper point by a conducting ring or collar containing many metallic contacts with the tree itself, thereby multiplying and concentrating at the detector, almost at will, the proportion of the energy of the electromagnetic waves absorbed by the tree system as a whole. In similar manner, the point P, at the base of the tree, may become a conducting ring or collar, with many actual contacts with the tree itself.

If a wire is attached to the same upper tree contact which is being used for receiving, and its other terminal touched in succession to other contacts along the tree nearer and nearer to the lower contact point P of the microphone, then a perceptible decrease in intensity of the signals is noticed as the lower contact P is approached; this operation causes the signals to almost entirely disappear when this wire is touched to the tree within a few inches of the point P. In the latter case, a lower impedance path to earth than that through the microphone is offered the electromagnetic waves.

The point G in Fig. 1 (*a*) and (*c*), can be made by metallic strips or nets laid upon the ground, or by driving metallic nails or pins into the projecting root system, at sufficient distances from the base of the tree. The position in azimuth of the contact point N relative to the distant sending station had no effect upon the received signals, the intensity being the same, even with the points P, N in an element of the cylinder of the trunk of the tree on the side directly opposite the sending station. In Fig. 2 (*a*) is shown an arrangement of transmitting antenna which, however, has been used only over very short distances up to the present time, as the experiments thus far have been principally confined to receiving. In the Figure, the earth or ground is made through the root system of the growing tree, and the aerial is merely suspended, using the tree itself as a supporting mast. Since the capacity of a vertical wire is increased by the presence near it of a conductor parallel thereto, the efficiency of the arrangement can be changed by varying the distance of the vertical wire from the trunk of the tree.

Attempts were made to note if there is any screening effect from neighbouring trees in line with the receiving station; in other words, if electromagnetic shadows are cast. With the wave lengths used, and the distances involved, the results seemed equally good from even smaller trees immediately behind a bank of larger ones in line with the transmitting station. Short-circuiting the trunks of trees by direct wires from contacts at a point where the main branches diverge to a terminal at the base of each had no appreciable influence upon the signals being received from neighbouring trees. A direct current sent through the tree by 100 volts of battery when thrown on, off and reversed showed no perceptible effects upon the signals being received through the microphone. No difference in receiving was noticed, resulting from the different wave lengths used in transmitting, whether from the Fort Mason station, Alcatraz Island station, or the Naval station at Yerba Buena Island. No effects were observed with a telephone in series with a source of E.M.F., and connected directly to two small needle electrodes inserted in the smooth living surface of the inner bark of the tree. This result was expected, but the experiment should be more hopeful if the waves were made to traverse a portion of a minute living hair root, as we would then be dealing with an electrolytic detector built up of vegetable cells. As indicating the order of magnitude of the ohmic resistance invollved in these experiments, it may be stated that in a eucalyptus tree about 15in. in diam. the resistance between two nails 15ft. apart was about 5,500 ohms.

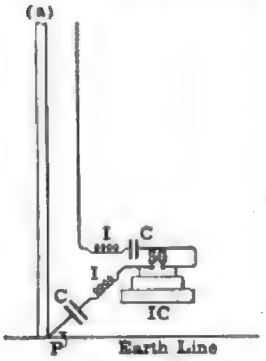

FIG. 2.

In the cases measured the resistance circumferentially was greater than that measured over the same distance vertically, or with the grain of the wood. In trees possessing a well-defined heartwood the effect of girdling is pronounced, since in such a tree the only living portion is a comparatively thin outer layer, the central portion of heartwood being practically dead and free from sap. In cases of rapid growth, especially in this climate, the whole tree is practically alive, and the effect of girdling, even to a considerable depth, has comparatively little influence on the measured ohmic resistance.

As an example: In a young eucalyptus tree at the Presidio, San Francisco, 18in. in diameter and about 50ft. high, the resistance was measured between two points on the tree trunk 15ft. apart, and was found to be 5,450 ohms. After completely girdling the tree to a depth of 1½in. for a distance of about 2ft. between the electrodes, another measurement was taken over the same distance, and the resistance was found to be but 6,150 ohms.

The efficiency of an elevated capacity area attached to an antenna is not wholly dependent upon the extent of such area, but also upon its general configuration, or, in other words, upon its capacity. In like manner, the efficiency of an artificial earth for grounding an antenna does not wholly depend upon the area of the plate buried in the earth, but also upon the shape and disposition of such surface, it having been observed that a given area of earth plate is more efficient in the form of strips, radiating out from a common point, at the foot of the antenna, than in the form of a single circular plate. It appears possible, therefore, that the manifold and varied forms and shapes given by nature to the leaf surfaces of vegetation, adapt them for absorbing electromagnetic radiation; while the general configuration of the root systems of trees, consisting of large radial root trunks, proceeding out from a common stem and supplemented by innumerable branches and microscopic hair roots and rootlets filled with conducting fluids, is not ill-suited for the conduction of electromagnetic waves into the earth. Again, the strength required in towers and masts for supporting antennæ wires is provided in the antennæ here suggested, since a great tree with its natural buttresses and its root system often extending deep into the earth is well designed to resist the elements.

WIRELESS TELEGRAPHY FOR MILITARY FIELD OPERATIONS.

In order to test other kinds of trees than those available at Fort Mason, California, a telegraph auto-car recently purchased for the Signal Corps of the Army, was temporarily fitted with the necessary transmitting apparatus, and a tour made through Santa Clara and Alameda counties, California, installing and operating field sending and receiving stations at various points along the route.

The electric power required was in the form of two small portable storage batteries of 10 volts each, which were used to excite a large Apps coil. When a tree was used to support the sending aerial, the "earthing" was accomplished through the root system of the tree itself by attaching a wire to one or more iron nails driven into its base. The tree stem was utilised to support the aerial, the only electrical connection therewith being at its base. Several kinds of trees of various sizes were used for receiving, such as willow, pine, spruce, oak, &c., and a marked difference in efficiency observed. A tree with little leaf surface, and generally dry and unhealthy, is difficult to use at all, even for very short distances, while a tree perfectly dead behaves as an insulator.

After a little practice, two men, a sergeant and corporal of the Signal Corps, one a good lineman and the other the chauffeur of the machine, who also acted as telegraph operator, could instal a sending station in 10 to 15 minutes. A receiving station is even less trouble to instal, since there is nothing to transport except what can be carried in the hands.

E.M.F.s IN GROWING TREES.

In the course of these experiments it was desired to measure with a Wheatstone bridge the electrical resistance of living vegetable cells, such as between metallic electrodes, inserted in the trunk of a tree. In attempting such measurements it became evident that there are E.M.F.s. present in growing vegetation, which are exhibited in this case by the great difficulty experienced in making any accurate measurements of resistance at all, due to the continued unbalancing of the bridge by these E.M.F.s. The phenomenon is complicated, and considerable experimental care and many observations upon different kinds of trees in various locations and in different kinds of weather would be needed to clear up the matter satisfactorily. For instance, unless platinum or other non-oxidisable electrodes are employed, there would be voltaic effects caused by the vegetable acids of the sap of the tree in contact with the metallic electrodes imbedded therein, and also, unless modified by the tree itself, we would expect a difference of potential between an electrode at the base of a tree and one higher up the tree, since the upper atmosphere is positive with respect to the earth. Again, it has been shown that a living tree serves as an earthed conductor, and is sensitive to electrical disturbances outside of itself. The resistance measured evidently depends also upon the size and shape of the electrodes used, &c.

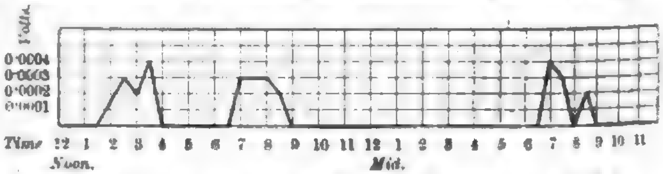

FIG. 3.—Volt-Time Curve showing Diurnal Variations of E.M.F. in a Eucalyptus Tree (Fort Mason, Cal., Oct. 11, 1904). Distance between Voltmeter Terminals, 25ft.; Resistance, 6,150 ohms; Diameter of Tree, 2½f.

A suitable electrometer was not at hand, so that in order to determine roughly the general character of these phenomena some observations were taken with a Weston Laboratory Standard milli-voltmeter with a diagonal scale capable of indicating E.M.F.s as small as 0·00002 of a volt. Several curves were taken, but sufficient regularity was not observed to enable any adequate theory to be advanced at present. An electrostatic instrument, whose readings are independent of the ohmic resistance between the electrodes, should be used for such experiments.

The curve, Fig. 3, exhibits the volt-time variations observed between two points in the trunk of a eucalyptus tree, one at the base of the tree, and the other at 25ft. elevation. The electrical contacts were made by inserting metallic pins in the tree itself, no earth connections being used. The resistance of the tree between the electrodes was about 6,150 ohms, which was large in comparison with that of the voltmeter, and the readings, therefore, do not represent actual values of the voltages, but serve merely to note general diurnal variations in a particular case.

From this curve it is observed that the upper contact is positive with respect to the one at the base of the tree, although slight reversals of very small value and comparatively sudden changes, evidently due to causes outside the tree itself, were noticed several times. These, however, were too small and too sudden to be read on this scale. The observations for this curve were obtained by half-hour readings over a period of 24 hours, during a great portion of which a severe rainstorm was raging. The day in general was extremely cloudy, with little sun. It appears from the curve, that from 9 p.m. until 6:30 a.m. the E.M.F. was too small to be recorded by the instrument, and that the principal changes occurred between 6:30 p.m. and 9 p.m. and between 6:30 a.m. and 9 a.m., with another rise between 1:30 p.m. and 4 p.m. Variations of the E.M.F.

between the lower tree terminal and the earth itself are comparatively large and indefinite in manner, as has been observed frequently before, due to earth currents proper. In examining the curve in Fig. 2, it is interesting to note that two of the maximum changes occurred, one in the early evening and another in the early morning, about 12 hours apart, or at about the periods when the general influence of the sun during the day is withdrawn for the night, and again when it reappears in the morning after a long period of darkness. In other cases, the readings between electrodes a short distance apart indicated as much as 8 millivolts, and at times the terminal at the base was positive instead of negative.

Resistances were more easily measured at night than in the daytime, as the balancing of the bridge was then more readily obtained. According to present theory, during the daylight the air is filled with electrons, carrying positive and negative charges of electricity which are more or less recombined during the night. In this connection, it is interesting to note that it is stated by Sir Oliver Lodge, in a footnote to his Royal Society lecture of 1894, that he found that leaves of geraniums discharge positive electrification five times as quickly as negative under the action of an arc light. Evidently, these phenomena require careful investigation.

EARTHING.*

BY W. W. LACKIE.

The Glasgow Corporation has for the past six years consistently refused to connect installations in which a metal sheathing was used as a protection to the wiring and as a means of carrying or supporting the conductors unless it was earthed at one point at least and electrically connected throughout its entire length.

Gas pipes should not be used as earth connections, as frequently the current which flows to earth when a conductor gets in contact with an earth is sufficient to melt a soft metal pipe; and, further, the method of jointing a gas branch pipe of iron to a main gas pipe often does not make a good electrical contact between the branch and main, the branch pipe being in some cases insulated by brown paper and white lead. A water pipe is almost universally used for an earth connection.

The rule referring to earthing and bonding, in the general rules recommended for wiring for the supply of electrical energy, issued by this Institution, is as follows:—

Rule 12.—Conductors conveying current at pressures exceeding 250 volts must be completely enclosed in metallic sheathing or tubing efficiently connected to earth, and such sheathing or tubing must be electrically continuous throughout its length.

This rule is badly worded, inasmuch as any one might at once assume from it that conductors conveying currents at pressures of 250 volts and under need not have the tubing efficiently connected to earth. The rules referring to earthing in the General Rules for the Prevention of Fire, and the other rules to be observed in the wiring for the supply of electrical energy, issued by the Glasgow Corporation, are as follows:—

Clause 35.—All metal-sheathed cables and metal tubes or conduits must be perfectly bonded at all joints and effectively connected together and to earth by means of an insulated stranded copper conductor equal in area to the conductor within the sheathing, tube or conduit, but not less than the equivalent of 3/22 S.W.G. This earth conductor, however, need not be larger than 7/16 S.W.G. The earth connection must not be to a soil pipe, rhone or gas pipe, but to a water-supply pipe. This is a most important rule, particularly in buildings where there is a gas supply in compo piping.

Clause 39.—All electric conductors must be kept away from gas pipes and most carefully insulated from them by a spacing not less than 1in. in thickness, of wood, if in dry places, and of tile or other waterproof non-conducting material in damp places. This precaution must be taken, no matter what system of wiring be adopted. Special attention must be paid to clause 35.

One other part of a rule which bears on this subject is—

Clause 43.—All fittings must be substantially insulated from any adjacent metal pipes, joists, columns, &c., so as to avoid contact with them, which might break down the insulation of the lampholders. Fittings exposed to the weather or fixed in damp places must have the lampholders sufficiently insulated from them.

During the years 1902, 1903, and 1904 35 fires were reported to the electricity department of the Glasgow Corporation by the fire department, as having been due to defective electric light installations. Two of these were, in the opinion of the electricity department, not due to electricity at all. Of the remaining 33, 15 were due to the melting of gas pipes by a current of electricity, the installation in each case having been carried out with metal-sheathed cables; eight of the fires occurred on installations where the metal piping or metallic sheathing of the cables were not properly earthed; seven were on installations where the iron piping or metal sheathing was earthed. The causes of the remainder have probably no bearing on the subject of earthing, but may be of sufficient interest to be stated here—

Five were caused by the cables having been chafed and the insulation consequently damaged by contact with the sharp edges of iron pipe ends.

One was due to a piece of hot carbon falling from an arc lamp upon some muslin goods in a shop window.

Five were due to defective twin flexible conductors

Three were due to deterioration and defects in switches.

Three were due to wooden casing having been saturated with water.

And one was caused on a wood casing installation where the conductors were not protected, but were lying against a soft gas pipe, and the insulation of the conductor failed.

Perhaps it might be well to point out in passing that the effect of these fires was much more serious in the 15 cases where soft gas pipes were melted, and the author begs to express the hope that electrical engineers will do all they can to stop the use of this class of pipe, and, if possible, see that it is removed from any building into which electric lighting or power is being installed.

It is impossible to test an installation after it is completed, with a view to ascertaining whether the metal sheathing is in itself properly electrically continuous throughout its entire length, and whether the continuity of earthing throughout is not due to the sheathing being earthed at one point by the earth wire run for that purpose, and at another point by means of a gas pipe or other pipe. It may be that for part of the course a gas or water pipe is the bonding or cross-connecting link between two lengths of sheathing (Fig. 1).

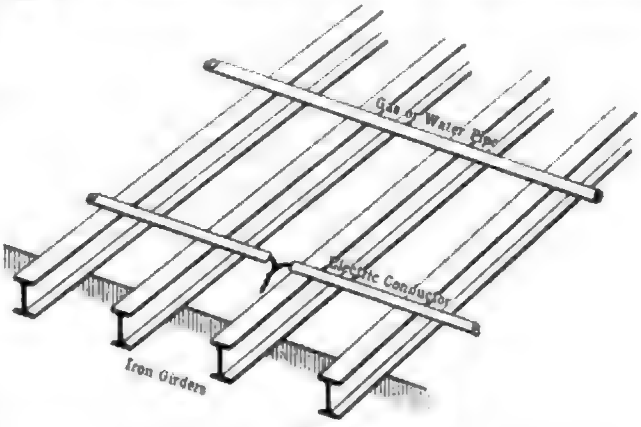

FIG. 1.

With the present system of earthing, if one conductor, even in a small branch circuit, comes in contact with the sheathing, the current that flows momentarily, but long enough to blow both branch and main fuses, is frequently 250 to 800 amperes, and is sufficient not only to cut off the whole supply from the installation on which the fault has occurred, but to interfere with the supply to other consumers by causing an unpleasant blink in the light. A momentary short-circuit has been reported on several occasions to the mains section of the electricity department of this city by the generating section of the same department, as having taken place in such and such a district, and it has afterwards been found that these short-circuits were due to an earth on a three-ampere branch circuit in a consumer's premises. Bearing these facts in mind, the author has come to the conclusion that the present method of earthing at any point and direct is wrong, and it is his opinion—

(1) That the metal sheathing on installations for connection to public supply mains should be kept clear of all other metal work throughout the entire run of the conductors;

(2) That the connection to earth should be through a resistance of such an amount as would allow not more than, say, two or three times the normal current of the installation flowing to earth in the event of one of the conductors coming in contact with the sheathing; and

(3) That the metal sheathing on installations for connection to public supply mains should be joined to earth at one point only.

Taking these three points seriatim, a few words on each of them may not be without interest.

1. *Metal Sheathing kept clear of all other Metal Work.*—If it is necessary and proper to keep pipes containing electric conductors clear of all other pipe work underground it is obviously just as necessary, if not more so, to keep clear of all pipes and other metal work inside buildings. It will readily be seen that if the sheathing used for carrying electric lighting and power conductors was insulated throughout its entire length, even it were only by ½in. of wood, cheap rubber or fibre, it would be possible to test, after any installation was completed, and to see that the cable sheathing was clear of all other metal work in the building, and also that it was in itself electrically continuous. These considerations are most important.

2. *A Resistance in the Earth Circuit.*—If a resistance was in the earth circuit the rush of current would be reduced enormously and

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* Paper read before the Glasgow Local Section of the Institution of Electrical Engineers, February 14th.

would probably result in only a small branch fuse melting, the main fuse remaining intact—*i.e.*, where the fault or earth occurred in a branch circuit. It would be even a better arrangement if each set of branch pipes had a proportionate resistance inserted to a separate slightly insulated earth wire and the sheathing of the mains had also a resistance as shown in Figs. 2 and 3.

When metallic sheathed conductors were first started in earnest it was common practice to have the branch fuses on the distribution-board system of wiring, and the main fuses enclosed in cast-iron boxes, these cast-iron boxes being connected to the metallic sheathing, and consequently earthed. It was then frequently found that when a fuse blew, an arc was formed between a conductor and the case, owing to the distance between the 'bus bar and the side of the case being less than the break of the fuse and short enough to keep up an arc. Sometimes this arc has melted a hole in the iron box and has also frequently caused the blowing of the main fuse. The remedy adopted by several contractors and consulting engineers was to insulate these cast-iron boxes by mounting them on wooden bases, and to connect the pipes across the gap by means of a bonding wire, or to have the fuses enclosed in a wooden case. Many makers of cast-iron switches have also been troubled with an arc forming between one of the terminals or blades and the side of the switch-box where the switch-case was of a normal size, and the same course was adopted—viz., to insulate the cast-iron case of the switch on a wooden base and join the sheathing round by means of a bonding wire. The author is of opinion that if a resistance were inserted in the earth circuit this arcing to earth would be reduced. One good reason for earthing the metallic sheathing covering electric conductors is, of course, the prevention of possible dangerous shock to the public, and the insertion of a resistance of the size suggested would not militate against this in any way.

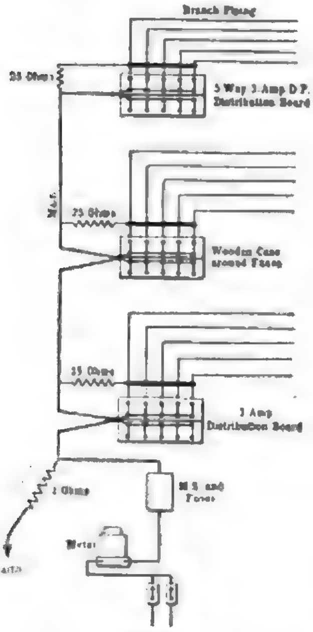

FIG. 2.

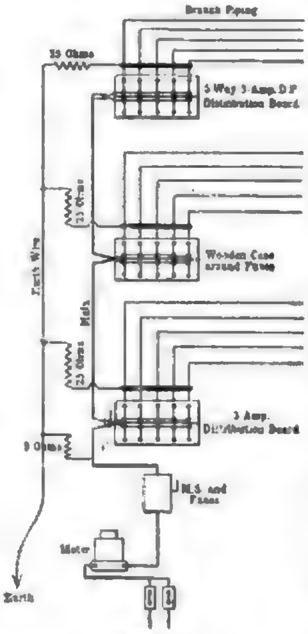

FIG. 3.

Several stations have adopted this course to protect their works from a complete shut-down. To ensure continuity of supply the middle wire of the three-wire system is earthed through a resistance of $\frac{1}{10}$th ohm or in some cases 1 ohm. It will therefore be seen that in the event of the positive or negative main going to earth, the maximum current will not exceed 2,500 or 250 amperes, which is less than the available supply.

The method of earthing the middle wire in the Port Dundas Electricity Works in this city is as follows:—In circuit with the usual recording ammeter there are 10 200 c.p. 250-volt lamps connected in parallel, which are, however, short-circuited by a fuse. Should an earth connection come on the positive or negative conductor, so that more than 50 or 60 amperes is made to flow back to or out from the generating station, the fuse short-circuiting these lamps goes and the lamps light up. When this state of affairs takes place (let it be said it is not a normal state) the difference of potential between earth and the positive and negative poles is far from being 250 volts. If an earth of very low resistance comes on the negative, the positive will be 500 volts and the middle conductor 250 volts above earth, and if the fault be on the positive side the negative will be 500 volts below earth and the middle 250 volts below earth.

Mr. Raphael, in his book on "Faults in Electric Mains," describes a mechanical model constructed by Mr. A. P. Trotter, electrical adviser to the Board of Trade, to show the difference of pressure between each of the three conductors on a three-wire system and earth with varying leakages or earths.

The idea of introducing a resistance, to the extent suggested, on the earth circuit, is probably novel so far as wiring is concerned, but to introduce a resistance of some kind is not new in underground mains work, as the Howard Conduit Co., Trafford Park, Manchester, in a descriptive pamphlet of their asphalt conduits for underground mains, advocate this.*

If in circuit with, or if the earthing resistance on a consumer's premises took the form of an electromagnet, which would close a secondary circuit so as to ring a bell, sound an alarm of some kind, or light a tell-tale lamp, each installation would become self-testing. The winding of the resistance in the form of an electromagnet would also, in cases of dead earths, act momentarily as a choking coil. It has frequently happened that for some reason or other the fuse on the branch main connected to the neutral wire on a two-wire installation (*i.e.*, on an installation connected to one side of a three-wire system) has gone, and the installation has had an earth connection on the same conductor (*i.e.*, the neutral) inside the premises beyond the fuse. The installation still continues to have a satisfactory supply through this earth connection and the earth connection at the generating station. Such a state of affairs goes on until a time when the positive or negative conductor goes to earth somewhere else, when either the lamps dim down very much or brighten up and probably burst. If a resistance of the amount suggested was inserted in the earth connection, the chances are that the consumer would very soon see that something was amiss, due to the bad pressure brought about by the supply having to come or go by the earth resistance; and, moreover, if a bell or other device was connected, as indicated, with the resistance, it would immediatey show that current was passing by the earth circuit.

8. *Earth at One Point Only.*—The reason for earthing at one point is obvious if a resistance is to be inserted in the earth connection. The resistance of the earth part of the circuit may be exceptionally low in Glasgow. If in other cities or towns, or in places where isolated plants are laid down, the resistance of the earth part of the circuits is high, or where earth plates are used, and not the water or other service pipes, the earth circuit may form the resistance now advocated. In Glasgow the earth resistance has been taken between several places. Between the generating station at Port Dundas and Waterloo-street, a distance direct of 1,000yds., the earth resistance is approximately 0·05 of an ohm. The circuit from the generating station to a consumer's premises on the three-wire continuous-current system at Glasgow has an average resistance of 0·046 of an ohm, and, taking an average circuit in a consumer's premises at 0·4 of an ohm, it means that when an earth current of 50 amperes flows the full pressure on the feeder, distributor, and wiring up to the fault, and from the earth connection to the generating station is 25 volts; with 300 amperes, 150 volts; so that the fault, sheathing and earth circuit on the consumer's premises must have a fall of anything between 200 and 100 volts. The resistance of 50yds. of $\frac{5}{8}$in. tubing with joints has been found to be 0·4 of an ohm and the resistance of 50yds. of 3-20 twin lead-covered wire 0·8 of an ohm. It looks from this, therefore, as if the current to earth would equal a considerable pressure divided by the resistance to earth of each circuit, and this may explain the melting of the gas pipes and consequent fires in the seven cases of fire referred to in another part of this Paper.

In installations carried out with lead-covered conductors, the core being stranded, many faults have occurred due to a strand breaking and making contact with the lead. The contact made has been so good and the current so great for the instant that the lead has been burned clean off from the point of the broken strand, and the fuse protecting the circuit has in some places gone and in other cases stood. When it has gone the lead has been melted clear of the strand; testing shows nothing; and the fuse can be replaced. The fuse is inserted and the installation may seem all right again, but sooner or later trouble will be experienced with a conductor in this state. What has just been said might be used as an argument in favour of solid wires up to No. 14 in place of small wires stranded for lead-covered cables, seeing that the lead covering makes the cable rigid irrespective of what the copper core is. With a resistance in circuit with the lead sheathing to earth, the author feels that the current should not be so great as to melt away the lead at the point of contact with a broken strand of a small cable. May the same reasoning not be used in advocating the introduction of a resistance on the earthing wire from a motor or dynamo? The comparatively enormous damage generally done to a small motor when one of the conductors in it goes to earth, in the opinion of the author, justifies putting in a resistance to limit the current. At one time the author thought of suggesting that in circuit with the earth wire resistance a solenoid might be connected so as to act on the main switch, and switch off the whole supply, but he did not think this

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[*] A description of the method employed by the Howard Co.—illustrated by a diagram of the arrangement referred to—appeared in *The Electrician*, Vol. XLVIII., p. 214.

would add to the efficiency of the supply. On a motor circuit, however, such an arrangement could with advantage be added to the over-load release. A similar arrangement might also with advantage be put in circuit with the earth wire from dynamos and motor-generator sets (when not connected to steam plant), which would indicate, if it did not switch out of circuit, the dynamo or motor. Reverse current cut-outs are now almost universally used on generators, and the writer thinks that in the majority of cases the breakdowns are due to one of the conductors going to earth via the earth connection. If, therefore, the non-return cut-out had an extra coil added in the earth circuit it would be an extra safeguard. An electromagnet in the earth circuit to close a bell circuit would certainly be an improvement. There are already many metallic sheathed installations in Glasgow connected to the Corporation electricity mains which only require the resistance in the earth wire to put them in line with what is advocated in this Paper. The sheathing has been kept clear of all other metal work in the buildings in which they are contained, by means of a strip of wood run throughout the installation for the purpose of cleating the pipes or cables to, and earthed at one point in the basement. It will be remembered that a Paper on underground mains was read in 1902 to this Section, and in the discussion that followed it was made pretty clear that the faults on lead-covered cables were not due to electrolysis, but due to fusion—*i.e.*, melting by excessive currents and arcing. Pieces of lead covering of underground mains have frequently been shown to the author with holes burned in them, and it has been reasoned that electrolysis must have been going on at these points. The author submits that the fragments of a blown fuse might as well have been produced in proof of such a contention, and surely no one will say that electrolysis goes on over a fuse. The author believes that the hole in the lead of the piece of cable then produced was due to fusion. If proper sized resistances could be inserted in the earth connections on metal-sheathed underground mains, fusion could and would be removed.

The author has been emboldened to put these proposals before this Section by the fact that what he suggests is not an expensive fancy, and will hardly appreciably increase the cost of an installation. A resistance for a 25-ampere installation—viz., a resistance of about 8 ohms to carry about 70 to 90 amperes—will not cost more than 30s., and for a 100-ampere installation £2. The resistance need only be one to carry the maximum current for, say, half a minute.

The reason for insisting that fittings and lampholders, or lampholders alone, should be insulated is given in Rule 48 of the Corporation Rules in the words, "which might break down the insulation of the lampholder." Another and even more important reason is that if the lampholders were not insulated they would most assuredly break down the insulation of the lamp caps in use. All lamp caps on 250-volt lamps will stand 250 volts between the two terminals, but few will stand 250 volts between one of the contacts and the metal collar on metal-collared lamps, or the lampholder on porcelain or vitrite-capped lamps. Besides, it will have been noticed that in the abnormal state of division of pressure between the positive, neutral, and negative conductors and earth—*i.e.*, when the positive or negative main is to earth—it is quite possible that between one lamp contact and earth, if the holders are earthed, there will be at times a difference of pressure of 500 volts. The lamps in general use to-day are not meant for this, and consequently the simplest and the cheapest way is to insulate the lampholders and remove these two dangers.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Action of Radium Emanation on Poisons.—C. Phisalix has found that the poison of the viper, after an exposure of 50 to 60 hours to radium rays, completely loses its poisonous character. A similar action takes place on the poison of the cobra, although it is well known that this poison resists the action of heat much longer than that of the viper. In the expectation that radium emanation would have a much more pronounced effect than radium rays, the author filled a glass tube to two-thirds of its length with a 0·1 per cent. solution of viper poison, exhausted the tube, and filled it up with air containing radium emanation. After leaving it in contact for 24 hours, the liquid had acquired an opalescent lustre and a peculiar odour. It had no effect when injected into a guinea-pig, except that the animal lost weight and took some time to recover its normal weight. When the poison is diluted with distilled water and exposed as before, it loses its toxicity in six hours, but it takes much longer when the liquid contains some glycerine. The opalescence is due to suspended particles. It is a curious circumstance that radium emanation has no effect on the poison of the lizard or the common toad. Indeed it only appears to decompose albuminoid poisons. This fact indicates a new means of investigating the constitution of poisons.

[C. PHISALIX, *Comptes Rendus*, February 27, 1905.]

The Arc in a Magnetic Field.—C. D. Child has made an attempt to unravel the complicated phenomena exhibited by the arc when placed in a magnetic field. He finds that if two carbon pencils are placed on the opposite sides of an arc, the P.D. between them is changed when the arc is deflected towards one of them by means of a magnetic field. This change may be as high as 4 volts. The effect cannot be produced by blowing the arc to one side, nor by moving the carbon pencils to one side of the arc. Rapidly reversing the field and with each reversal reversing the connection to the voltmeter does not diminish the effect. The only consistent explanation seems to be that the positive ions of the arc move more rapidly than the negative ions. The effect decreases as the strength of the field is diminished. Changes in the current through the arc do not appreciably influence it. It is, however, increased by lengthening the arc. The effect is smaller with cored than with solid carbons. It decreases and in some cases entirely disappears when salts are placed in the arc, and it cannot be detected in an arc between metals. The effect decreases as the pressure of the surrounding gas is diminished, and with a pressure of approximately 1cm. of mercury it disappears. The common equation for the Hall effect gives a change of potential in the opposite direction to the change actually observed. But it does not apply in any case, since there is here a motion of the ions in a direction transverse to the direction of the impressed E.M.F. Taking this motion into account, the author shows that almost all the phenomena can be explained on the supposition that the positive ions move more rapidly than the negative ones. That this should be so in a place as hot as the electric arc is not what one would have expected. But when the anode is very hot we may expect ebullition of the anode with subsequent condensation on the negative ions, causing them to move more slowly. This slow movement would react on the drop in potential at the anode, and make it greater.

[C. D. CHILD, *Physical Review*, February, 1905.]

Drift of Ions under Electromagnetic Waves.—G. W. Walker shows mathematically that when an electromagnetic impulse passes an ion, the velocity of the latter remains unchanged, but it is shifted forward in the direction of propagation of the wave. The continuance of the waves thus involves the result that the ion must continue to change its position in space. It thus appears to move in a definite manner, which can be determined in terms of the initial circumstances of the ion and the constants of the train of waves. The result is very remarkable, and is not confined to an infinite train of harmonic waves. Similar results follow in the case of any form of electromagnetic disturbance propagated in a straight line. If the ion is originally moving with a velocity a little less than the velocity of the wave, it may, so to speak, be picked up by the wave and carried forward with the velocity of the latter. The velocity is an even function of the charge, so that ions of both signs will be affected equally, and even a neutral molecule made up of positive and negative ions will be made to drift in the direction in which the waves are travelling. If energy is absorbed from the passing wave, the ion will acquire a velocity which persists after the wave has passed over it. These results have an important bearing upon the theory of radio-activity. Radio-active substances may be regarded as sources of electromagnetic waves, and the projection of material particles may be due, partly at least, to the drift of ions produced in the gas by the waves passing through it. If that is the case, it is not necessary to suppose that the radio-active substance is ever used up. Another interesting point brought out by these results concerns aberration. In free space the propagation of waves in a straight line is quite independent of any static electric or magnetic field. But if the waves are propagated through a part of space containing matter, the streaming of the ions produced by the waves seems to lead to the conclusion that the propagation of the waves is no longer independent of the statical electric and magnetic field, and aberration must result.

[G. W. WALKER, *Proceedings* Roy. Soc., February 21, 1905.]

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THE ADMINISTRATIVE COUNTY OF LONDON AND DISTRICT ELECTRIC POWER CO.

The London daily newspapers have been furnished with numerous paragraphs, articles and "interviews" during the past fortnight, promising a revolution in the charges for electricity supply in London. On this occasion, the welcome result is not to be brought about by a new primary battery defying all the laws of electro-chemistry, nor by a perpetual-motion engine, or a dynamo with a few hundred per cent. efficiency; the process is summed up in the word "Concentration." All the existing sources of electricity supply are apparently to be "concentrated," and enormous economies are to result. Moreover, the method by means of which this concentration is to be effected is not a combination of all the existing electricity supply companies in London—in fact, such a combination is excluded by the terms of their Provisional Orders—but by the formation of a new company which is seeking extraordinary powers for electricity supply over the whole of London and surrounding districts. And this new company is not welcomed by the present holders of Provisional Orders as a desirable means of effecting economies in electricity supply; they are far-sighted enough to see that what is being offered them is not Concentration but Competition of the bitterest and keenest nature—Competition in the most profitable outlets of the business—viz., power supply, street lighting and electric traction. The scheme that is being "boomed" by the Press notices to which we have alluded, is that which is outlined in the Bill introduced in Parliament this session by the Administrative County of London and District Electric Power Co. There is no need to refer to "rumours" and to accept without qualification *ex parte* statements made with reference to the scheme, as our daily contemporaries have done; the Bill has already been read a second time in the House of Lords, and we are able to write with a copy of it before us. The gist of the Bill has already been published in our columns, but it will bear repetition and more detailed investigation at the present juncture, in view of the fierce opposition which it is sure to encounter in Committee stage in the House of Lords, and subsequently in the Commons in the event of the Bill passing the Upper House.

The area in which the new company proposes to extend its operations includes the whole City and County of London, and the surrounding districts on the west, east and south,—as far as Brentford and Southall to the west, Gravesend to the east, and Croydon to the south. This area is at present supplied by 22 electricity supply companies and 32 local authorities, who have between them some 70 generating stations, and far from desiring "concentration," one and all have lodged petitions against the Bill. The area is divided into two portions, the non-industrial and the industrial. The latter includes the Metropolitan Boroughs north, south and east of the City, and the portions of Essex and Kent scheduled in the Bill with the exception of Bromley, Beckenham and Penge, which are non-industrial. In the non-industrial area, the company seeks power to supply "in bulk," and also for street lighting, traction and large consumers, such as Government Departments, railway companies, and so on. In the industrial area, electrical energy is to be supplied for power purposes (and for lighting to power consumers), but in the case of consumers requiring less than 500 H.P. a formality is first to be observed. The consent of the "authorised distributor" is first to be asked, and, on this being withheld, application may be made to the Board of Trade for this consent to be dispensed with if the new company can supply on better terms than the "authorised distributor" itself. It must be pointed out, however, that the powers sought by the new company involve relief from the most important restrictions of the Electric Lighting Acts. The purchase clause in the Act of 1888, under which all the London companies are liable to be bought up by the Local Authorities in 1931, is not to apply to the new company, and a fairly free hand is given to the new company to refuse consumers if it considers that their custom would not be remunerative. The idea of the promoters is therefore evidently to undersell the existing undertakers in the case of all the more profitable power and large long-hour lighting consumers. An obligation to supply all and every consumer who desired to be furnished with electrical energy would at once destroy the scheme of the company's operations, for a maximum price of 1½d. per Board of Trade unit is laid down in the Bill.

For this ambitious scheme a large capital would of course have to be provided. The amount given in the Bill is £5,000,000, with borrowing powers up to £1,666,666. Interest of 3 per cent. may be paid out of capital during the first four years. Compulsory powers are asked for to acquire land for three generating stations in West Ham, Greenwich and Fulham.

Some of the inspired articles that have been published in favour of this scheme point out that the sphere of the company's operations will be mainly to supply the existing undertakers "in bulk," so that an additional capital expenditure by them will be unnecessary. The existing undertakers would thus continue to make their business profitable without further capital commitments, and all would work in perfect harmony. The reasoning is plausible, but it is only necessary to examine the capital expenditures of the 54 undertakers alluded to in order to see that it is fallacious. At the end of 1902 they had expended about 14⅓ millions; at the end of 1903 17½ millions. If the present rate of increase were not exceeded, there would thus be an additional capital expenditure of 12 millions (or nearly double the proposed capital and borrowing powers of the new company) by the time its four-years' construction period had expired. But we repeat, whatever may be the statements made by promoters to interviewers, it is evident from the Bill itself that its object is to establish competition with existing undertakers and not to assist them. The promoters are men of capital, and some of them are noted men of finance, but we doubt whether they would be prepared to control "concentrated" undertakings representing 17½ millions sterling and growing at the rate of three millions a year. Their engineer, Mr. C. H. MERZ, is an able electrical engineer of the younger school and has done exceedingly good work in connection with the Newcastle-upon-Tyne Electric Supply Co., whose low works costs for the last two years are analysed on another page. But he also is too ambitious if he seeks either to control or to fight effectively 54 electric supply undertakers, well established in their respective areas, owning works with an aggregate capacity of nearly 200,000kw., with almost unlimited capital at their back and already supplying about 150 millions of Board of Trade units annually.

THE SELECTION OF ELECTRIC CABLES.*

BY L. B. ATKINSON AND C. J. BEAVER.

(Concluded from page 786.)

APPENDIX I.

GLOVER'S TEST FOR TINNED HIGH CONDUCTIVITY COPPER WIRE.

Samples.—From the batch of wire to be tested true average samples are taken, the number of samples being proportioned to the total weight of the batch and to the gauge of the wire, for works purposes. Two classes of samples are taken :—

(*a*) Samples from interior parts of coils or bundles, the results obtained from which may be taken to indicate the actual efficiency of the tinning.

(*b*) Samples from exterior parts of coils or bundles, to show to what general extent the efficiency of the tinning has been impaired by mechanical abrasion in transit or handling.

For consulting engineers' or inspectors' purposes samples are taken from the strand before the cable is vulcanised.

Reagents.—Hydrochloric acid of S.G. 1·088 (=44 per cent. of acid of 1·2 S.G.)

Sodium sulphide solution of S.G. 1·142 (=about 25 grammes per 100 cubic cm. water).

Testing Process.—The samples are cleaned with alcohol or ether, and immersed for one minute in the hydrochloric acid. They are then rinsed in clean water, and immersed in the sodium sulphide solution for 30 seconds, again washed, and examined under a hand lens.

This cycle of operations is repeated until blackening of the wire becomes clearly visible. The number of such cycles required to produce this blackening effect is noted, and taken to represent the measure of efficiency of the tinning.

The tests are performed in duplicate.

The wires are bent into loops before immersion, to avoid testing ends. The loops should not be bent to a smaller radius than 12 to 15 times the diameter of the wire.

As a mechanical test for adhesion of the tinning to the wire, samples may be bent round a rod having a diameter equal to four times the diameter of the wire. Any cracking or parting of the coating will be plainly shown by one immersion, according to the test described above.

No wire should show blackening after the mechanical test on immersion for one minute in the sodium sulphide solution only.

The *average* values obtained from samples taken from any batch of wire should be as shown below :—

Diameters of wires.	Number of immersions at 60°F.	
	Single-tinned wire.	Double-tinned wire.
From 0·0076" to 0·048" inclusive	6	8
Above 0·048" to 0·080" ,,	5	7
,, 0·080" all sizes	4	5½

NOTE.—In practice a variation of one immersion from the average values tabulated above may be allowed if the batch of wire under test gives fairly uniform results. If a wide variation between individual tests is observed, further samples may be taken, as it would obviously be unfair to allow an isolated defective sample to bring down the average value obtained on the samples. A little experience enables the operator to readily distinguish between defects due to imperfections in the tinning process and those due to subsequent mechanical damage.

APPENDIX II.

GENERAL SPECIFICATION FOR LIGHTING AND POWER CABLES FOR LOW-TENSION PRESSURES UP TO 500 VOLTS.

Lead-covered Paper Insulated Cables.—Conductors of plain copper, as per paragraph 1, insulated with Diatrine paper, as per paragraph 3, lead-covered, as per paragraph 5.

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* "Some Points on the Selection of Electric Cables," read before the Manchester Local Section of the Institution of Electrical Engineers on Jan. 31. Slightly abridged.

Vulcanised Rubber Insulated Cables.—Conductors as per paragraph 2, pure and vulcanised insulation, as per paragraph 4, taped and braided, as per paragraphs 7 and 8.

Leadless Paper Cables.—Conductors as per paragraph 1, insulated with paper, as per paragraph 3, and sheathed with bitumen compound, as per paragraph 6, taped and braided or lapped, as per paragraphs 7 and 8.

Bitumen Cables.—Conductors as per paragraphs 1 and 2, the outer layer of the strand being composed of tinned copper wires, insulated with bitumen compound, as per paragraph 6, finished with tapes and braids or lappings, as in the case of the leadless paper cables, as per paragraphs 7 and 8.

Fire-resisting Cables.—Conductors as per paragraph 2, pure and vulcanised rubber, as per paragraph 4, taped and braided as per paragraphs 7 and 9.

Materials.

1. *Conductors.*—Conductors of all wires and cables are to be of solid, well-annealed high-conductivity copper, English drawn, the strands of cable to be of suitable lay, so as to produce a compact conductor. The conductivity of the copper to be not less than 100 per cent. of pure copper, Matthiessen's standard. The resistances and weights of the various sizes to be as specified in the Cable Makers' Association Circular, dated December 31, 1902.

2. Where cables are insulated with materials which will react with, or be acted upon by the copper, the wires are to be uniformly and efficiently tinned. The tinning is to be free from lead or other impurities, and must conform to Glover's standard test for tinned high conductivity copper wires. No joints in single wires are to be within 12in. of one another.

3. *Dielectric Paper.*—The paper to be composed of pure Manilla fibre. It is to be free from all metallic particles, carbon spots or foreign matter, and to show no trace of chlorine or other residual chemicals on analysis. It must be free from the slightest admixture of straw, wood or other ligneous fibres. The paper after drying to be impregnated with a high-class insulating compound at a temperature not exceeding 250°F., and to be laid spirally upon the conductor in strips to required thickness in such a manner that the joints are efficiently staggered. The paper strip to be of uniform thickness throughout, not exceeding 0·006in. before impregnation. The tensile strength of a standard strip 15mm. wide, cut longitudinally from the paper before impregnation must not be less than 10kg., but it should be so highly impregnated that its strength is increased by 15 per cent. after impregnation. The insulating compound should be of such a character that it is solid at the ordinary working temperature, and should have no tendency to drain away from the cable. It should also be capable of allowing the cable to be sharply bent without any sign of cracking in the paper dielectric. The compound must have no deleterious effect on the copper, paper or lead.

4. *Rubber*—The conductors are to be covered, first, with a layer of pure unvulcanised fine Para rubber, containing not more than 2·25 per cent. of rubber resin, and then with two layers of vulcanising rubber compound to an approved thickness. The vulcanising rubber compounds to consist of the finest hard Para rubber mixed with sulphur and mineral matter only. No rubber substitute or organic matter other than rubber is to be used. The proportion of hard fine Para rubber in the vulcanising compound rubber, in the case of the 500-volt cables, is to be not less than 40 per cent. by weight. In the case of wire, or cables having a sectional area of less than 0·06 sq. in., the rubber compound is to be applied longitudinally. Larger cables are to be spirally lapped to an approved thickness. The pure and compound rubbers to be vulcanised into a homogeneous mass after taping.

5. *Lead Sheathing.*—The cable to be sheathed by a solid tube of the best pure English lead which shall not contain more than 0·5 per cent. total impurities on analysis, and shall be free from pinholes, lead oxide and other manufacturing defects, and shall be made direct on the insulated core under strong hydraulic pressure, the lead being allowed to set before pressure is applied. The insulated core to be passed through a bath of compound immediately prior to its entering the lead press. The lead sheathing shall be of uniform thickness, and shall not show any signs of cracking after having been subjected to the bending tests hereafter specified.

6. *Compound.*—To be of the vulcanised bitumen class of compound, containing not more than 20 per cent. of mineral matter, to be of such consistency that it will not become decentralised at such temperatures as ordinarily obtained in practice. It must not become brittle at the freezing point of water. It must be so made that it is not really oxidizable, and that it will resist the action of weak acids and alkali. It is to be applied to the cable in the form of a solid tube free from pinholes and similar defects, so that the insulation resistance shall show no deterioration after the insulated cable is submitted to hydraulic pressure of 100lb. per square inch for at least five minutes.

7. *Tapes.*—Tapes for vulcanised rubber cables should be of fine cotton cloth, counting not less than 70 by 70 per square inch, thoroughly waterproofed on one side with rubber compound, containing not less than 35 per cent. of pure rubber. Tapes for leadless and bitumen type of cables to be of stout cotton cloth thoroughly impregnated with bituminous compound. For outer coverings Hessian tapes treated in a similar way before application to the cable may be used when required.

8. *Braidings and Lappings.*—For rubber cables the braiding may be of jute or cotton, tanned or gray, as required; to be braided on the cable at a suitable lay, and with a sufficient number of ends to efficiently cover the cable. The braidings for main cables, whether rubber, leadless paper, or bitumen cables, should be of tanned jute. In all cases braids are to be efficiently impregnated with preservative compound. In the case of main cables, jute lappings may be used instead, or in conjunction with, braidings, as above described; such lappings should be of tarred jute, containing not less than 45 per cent. of the best Stockholm tar. After application to the cable these lappings should be thoroughly impregnated with preservative compound.

9. *Fire Resisting Coverings.*—The fire resisting coverings may consist of cotton tapes, jute, or cotton lappings, or braidings. The radial thickness of such coverings to be proportionate to the diameter of the cable and the radial thickness of the insulation. The tapes, braids, or lappings to be chemically treated prior to their application to the cable, with suitable fire resisting compound, which shall have no deleterious effect on the fibrous material or the insulation of the cable, and shall be of a permanent character. During the taping, lapping, or braiding process the fire resisting coverings to be further served with suitable fire-resisting compound, and finally served over all with special compound of a similar nature, to insure a firm but flexible finish.

In special cases leadless or bitumen cables may be finished with fire-resisting coverings, as above described.

10. *Armour.*—Where cables are to be laid direct in the ground or in situations where they may be exposed to mechanical injury, they should be armoured with steel tapes of suitable widths and of thicknesses as specified in the C.M.A. Circular dated December 31, 1902, and applied to the cable, so that the spaces between the convolutions of the first layer of steel tape are covered by the second tape. Joints in steel tapes are to be either brazed or welded, no other method being allowable. They are to be laid on a bed of tarred jute, served as described above, and covered with a double layer of jute in a similar manner. Where galvanised iron or steel wires are used as armour, the wires must closely sheath the cable and be applied over a bed of tarred jute lapped on in the opposite direction to the lay of the wires. The wire should be of suitable gauge, and composed of a good quality of steel, which should have a breaking strain of not less than 25 tons per square inch, and should be capable of being bent round its own diameter in reverse directions without fracture. The galvanising must adhere firmly to the surface of the wire, and must not crack or scale off when the wire is bent round a cylinder 12 times its own diameter. The efficiency of the galvanising must be such that no sign of a deposit of copper should be visible after three one-minute immersions in a saturated solution of copper sulphate at 60°F.

11. *Insulation Tests.*—All cables, as specified above, should be tested after 24 hours immersion in water in the case of vulcanised rubber cables, and after five minutes hydraulic test in a closed tank at 100lb. per square inch in the case of the other types with a battery giving an E.M.F. of not less than 500 volts. The insulation resistance must be taken after one minute's electrification, and such electrification must proceed steadily and uniformly. After the application of 2,500 volts for half-an-hour there should be no appreciable difference in the insulation resistance of the cables.

12. *Mechanical Tests.*—A 10ft. length may be taken from any of the cables and bent three times in reverse directions round a drum having a diameter of not more than 12 times the diameter of the cable. The length when subsequently immersed in water, and tested with a gradually increasing voltage, should not break down under a pressure of 5,000 volts.

The following is an abstract of the discussion that took place in connection with the Paper on January 31st:—

Mr. MILLER pointed out the necessity for some recognised certificate, given by an independent authority, to protect purchasers of cable. In his experience decentralisation of vulcanised bitumen cable had only taken place when laid in the vicinity of urinals. He had experience of 150 yards of lead-covered cables, with paper insulation, laid in 18in. troughs with 1in. to ¾in. compound around, and 12in. covers, failing, and had never been able to explain it satisfactorily.

Mr. WATSON mentioned that of the total capital expenditure for electricity works, one-third or a-half represented the cost of mains. He also pointed out that in Table I (*The Electrician*, Feb. 24, p. 745) sample B showed 34·7 per cent. and C 18·27 per cent. of minerals; but yet, according to Table II., there was less decentralisation in the case of C. Was this correct? He considered vulcanised bitumen cables best on account of tramway and lighting earth currents. This class of cable had been in successful use for 10 to 12 years in large towns. The solid system was a great protection. Drawn-in systems were also successful when the material was of excellent quality. Rubber had ceased to be used in towns for mains on account of the troublesome nature of even the best makes. Rubber cable failed most unaccountably.

Mr. J. CONNOLLY referred to the necessity of employing a "separator" between the pure rubber and the vulcanising rubber in indiarubber cables to prevent decentralisation and to keep the sulphur from the wire. The subject of cables was too vast for the ordinary buyer, but he should notice that the twining was bright, the rubber tough and elastic, the thickness of insulation uniform and sufficient, and also that raising the temperature of the cable from 40°F. to 200°F. had no appreciable effect on it appearance. Then he need not doubt that the article was a good one.

Mr. COOPER (Colne) had had no trouble with lead-covered cables through electrolysis. He believed in thorough metallic connection throughout, wiped glands at the joint boxes, and an efficient earth at the station. A bad earth would lead to bad results. He gave an instance of failure in a paper-insulated lead-covered cable. It was in use down a mine shaft, and the pressure of the oil with which the paper insulation was impregnated burst the lead sheathing at the bottom. He thought very well of vulcanised bitumen cables, which were all right unless subjected to a high temperature. He had heard of them being laid near a baker's oven, and failure resulting.

Mr. AITCHESON had had eight or ten years' experience of lead-covered cables drawn in cast-iron pipes, and they gave no trouble for alternating-current supply. Rubber cable had given much trouble under similar conditions. He had had failure in one high-tension lead-covered paper cable laid in cement-jointed ducts, and put it down to the cement.

Mr. BERRY stated cement had no effect on the lead covering of cables. The National Telephone Co. had laid cable of that class in concrete blocks for eight years, and no trouble had resulted. He called attention to the remarks regarding unexplained failures in cables. He thought that if they would just think of the enormous strains put on a cable with the draw-in system—say, a 3in. cable drawn into a 3½in. pipe in 70yd., 80yd. or even 100yd. lengths—they would find reason enough for faults. He had invented a lubricated duct to overcome this difficulty.

Mr. TAYLOR said that great care should be taken properly to impregnate the paper insulation of cables with oil. He had tried experiments with old specimens and badly-made specimens, finding after bending them round a 4ft. drum that the paper split across because the oil gave no sliding action.

Mr. PIPER had found that cables should be properly dried out before applying a disruptive test.

Mr. BEAVER having replied briefly,

Mr. PEARCE proposed a vote of thanks to the authors. In the course of his remarks, he stated that it might be interesting to know that he had written to 30 or 40 engineers in different places for their opinions and practice regarding earthing and bonding lead-covered cables, and there was no uniformity whatever; they all seemed to have ways of their own.

CORRESPONDENCE.

THE TROTT-HAMILTON CABLE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the report of the meeting of the Anglo-American Telegraph Co., published in your issue of February 10th, and to the Chairman's remarks concerning the Trott-Hamilton cable, I would ask permission to call attention to some important facts in connection with the particular type of cable mentioned.

In 1888 a length of 48 nauts of this cable was inserted in the 1869 Brest–St. Pierre cable between longitude 26° 24′ and 27° 44′ W., in a depth of from 1,800 to 1,900 fathoms; and another piece of this type was put in farther west in the same cable during that year.

In 1891 the 1873 cable was repaired off Ireland, the western splice being 217 nauts from Valentia, and a length of 38 nauts of the Trott-Hamilton cable inserted. The condition of the original cable, laid in 1873, was such, over the greater portion of the ground worked on, that it was absolutely impossible to raise it in other than short lengths, and, but for the automatic electric grapnel (Kingsford's) used on that occasion, no knowledge of the presence of the cable on the grapnel would have been possible.

The cable was so rotten—that is to say, the "closed" portion thereof—that nothing of any strength remained but the core and core serving. This was on the Irish Bank and in depths up to 400 fathoms. But the cable was found to be perfectly sound in 680 fathoms.

Now, this cable, although rotten, in respect to its strength-giving material, would probably have remained intact, as far as the core was concerned, for many years, as the deterioration was general over a long length, and there was, consequently, no concentrated energy at one spot to twist the core asunder. Unfortunately, the cable had to be cut into to remove a fault of several years' standing.

The hempen cable inserted during this repair was shipped on November 11, 1889, and was repeatedly buoyed, end up, and numerous splices were made in it as the ship fleeted outwards on the line, so that it is evident that it had suffered no serious deterioration during the 19 months it was on board the ship.

The chairman at the Anglo meeting in question stated:

> The particular cable was one patented by Capt. Trott and Mr. Hamilton, and was laid many years ago, as it was considered to be worth trying, the principal point about it being that there were no iron wires and it was supposed at the time that it would be more easily handled being so much lighter. But in course of time the directors found that the cable could not be lifted at all. The moment they began to deal with it it went pieces, so they came to the conclusion that it would be better to cut out the Trott-Hamilton cable and put in a good cable.

Both types of cable here spoken of, being laid on what may truly be described as rotten ground, deteriorated. Neither type was quite suitable for that particular locality, so that it is hardly just to condemn one and not the other. There are patches of ground on which no type of cable will endure for any considerable length of time. This hempen cable was never advocated by the inventors for general use in depths under 400 fathoms, although it had lived for over six years in 11 fathoms. Still, after the experience with it in deep water the directors were justified in trying it in shallower depths.

If an earnest desire is felt to ascertain the true merits or demerits of this hempen cable, let it be raised on the 48-knot length in mid-Atlantic.

Such an operation, however, would have to be carried out under proper conditions. No rough and ready method of trusting to a dynamometer would do in this case, for dragging a cable out of line until a strain is shown on the dynamometer is a fertile source of delay and failure in cable-repairing operations.—Yours, &c.,

F. A. HAMILTON.

Halifax, N.S., Feb. 23.

MANCHESTER TRAMWAYS—POWER SUPPLY*.

BY H. C. GUNTON AND S. L. PEARCE.

SECTION I.

The area served by the Manchester Tramways is approximately 41 sq. miles, and at the present time there are 144 miles of single-track equipped, and about 400 cars in use, divided as follows: 125 double-deck, double-truck; 255 double-deck, single-truck; 20 single-deck, double-truck.

The power supplied is furnished as follows:—

1. *City area.*—The city area, which may be taken approximately as that portion of the city within a ¾-mile radius of the Town Hall, is supplied from the Bloom-street station, and also to a small extent from the Dickinson-street station.

2. *Outside district and suburban areas.*—These areas are supplied from the Stuart-street station through the various sub-stations. The city area is separated from the outlying districts, and each sub-station area is isolated, the section insulators being placed at the junctions of the overhead networks. The city area is further divided into four sections, and in addition switches are placed on the poles at some 25 places on the principal routes to facilitate the splitting up or cutting out of any faulty sections. Potential and telephone wires are laid along all routes.

In an appendix attached to this Paper will be found a brief summary of the plant at each station.† Particulars are also given of the extensions at Stuart-street, although, with the exception of the switchboard, this plant is only now being brought into use.

Bloom-street.—From the switchboard at the Bloom-street station 12 low-pressure feeders run to the various pillars situated in the city area, each feeder consisting of two ½ sq. in. vulcanised bitumen cables laid on the solid system. Insulated returns are used throughout. A diagram of the feeder and section pillar connections is shown in Fig. 1, and a drop of potential record taken between Market-street and Middleton-road, Cheetham Hill. It will be noticed that in the event of any positive feeder breaking down, the negative feeder can be used to take its place for the time being, the current then returning partly by the rail. The overhead equipment was dealt with in a Paper read before this Institution at their last session by Mr. McElroy.‡

Dickinson-street.—Any power supplied from Dickinson-street for traction purposes is transmitted through the Bloom-street switchboard.

Stuart-street.—From the Stuart-street station 82 high-pressure feeders are brought out by means of a subway approximately ⅝ mile long, thence diverging to 19 sub-stations.

In nearly every case the high-tension feeders are in duplicate. Fig. 2 shows diagrammatically the general arrangement of the system of feeders. At the present time the lighting and traction main switchboards at the generating station are coupled together, and it is found convenient to do so, the varying traction loads not having any appreciable effect on the speed of the main engines, and hence on the lighting pressure, owing to the large number of cars supplied. Should it, however, be desirable at any time in the future to supply the traction and lighting feeders from separate mains, arrangements for doing this are provided. Duplicate 'bus bars are provided, which can be coupled together as required, and selector switches enable the feeders to be connected to either set of 'bus bars; each feeder is connected through high-tension fuses or oil circuit breakers of the overload type. Feeder-charging gear is provided, two types being employed—(*a*) a synchronous motor-generator with step-up transformer; (*b*) a water resistance. All the sub-stations are equipped with synchronous motor generators operated at 50 cycles, and in certain of these the same sets are available for lighting as well as for traction purposes. The Polygon* is one of the 10 included in the first installation designed by Dr. Kennedy, the general design in each case being the same, although the size and arrangements are modified to suit local conditions. Each traction set consists of a synchronous motor operated direct at 6,500 volts and coupled to a 220kw. continuous-currrent compound-wound generator, the exciting current for the motor field being obtained from an exciter mounted on an extension of the shaft, or, as an alternative, from the lighting 'bus bars. Means are provided for interconnecting the duplicate 'bus bars of the lighting and traction high-tension boards, so that traction sets may be run from lighting feeders, or vice versa if required, or both lighting and traction sets can be run from one feeder.

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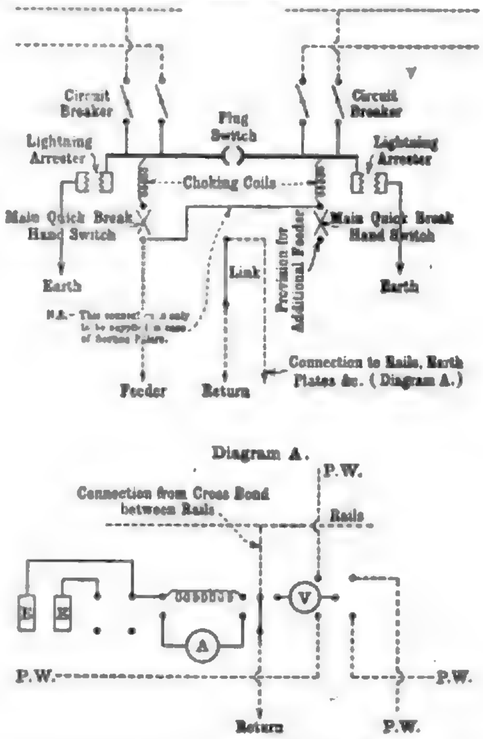
* Abstract of a Paper read before the Manchester Local Section of the Institution of Electrical Engineers on February 21st.

† [See also *The Electrician*, Vol. XXXI., p. 613, Vol. XL., p. 194, XLVI., p. 926, and Vol. L., pp. 672, 715.—ED. *E.*]

‡ [*The Electrician*, Vol. LIII., pp. 68 and 69.—ED. *E.*]

The second type of sub-station is represented by "Oldham-road," which is typical of the second 10 sub-stations included in the extensions carried out by Mr. Metzger, each motor generator set being available for either lighting or traction purposes as required. The equipment is generally similar to the previous type of sub-station, the low-tension outputs of the various machines varying from 250kw. to 150kw. The excitation for the high-tension motors in this type of station is taken direct from the terminals of the low-tension generators for the larger sets. The high-tension board controls the incoming and outgoing feeders and synchronous motors, and is provided with two sets of 'bus bars, to which the lighting and traction feeders are respectively connected.

Normally, at all sub stations, the high-tension feeders, supplying the traction and lighting boards, although connected to the same


Circuit Breaker
Circuit Breaker
Plug Switch
Lightning Arrester
Lightning Arrester
Choking Coils
Main Quick Break Hand Switch
Main Quick Break Hand Switch
Provision for Additional Feeder
Link
Earth
Earth
N.B.—This connection is only to be supplied in case of Section Pillars.
Connection to Rails, Earth Plates &c. (Diagram A.)
Feeder
Return
Diagram A.
P.W.
Connection from Cross Bond between Rails
Rails
E
E
V
A
P.W.
P.W.
Return
P.W.

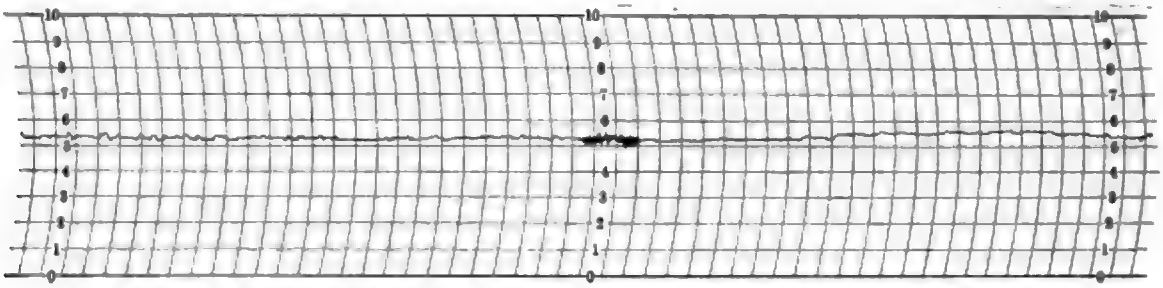


FIG. 1.—DROP OF POTENTIAL RECORD, AND DIAGRAM OF CONNECTIONS, &c., FOR FEEDER AND SECTION PILLARS.

Table I.

Load in amps.	Volts.	Kw. generated.	Steam pres. at engine.	Pressure in receiver.	Vacuum in inches.	Mean av. pressure in H.P. cylr.	I.H.P. of H.P. engine.	Mean av. pres. in L.P. cylr.	I.H.P. of L.P. engine.	Canal temp. deg. F.	Disch'ge temp. deg. F.
..	..	..	154·0	26·0	28·0	54·2	1,247·78	15·2	1,385·96	80	88
3,950	426	1,682·7	155·0	25·0	28·0	53·6	1,233·92	15·5	1,413·32	..	..
4,200	427	1,793·4	158·0	27·5	28·0	54·6	1,256·94	16·33	1,489·0	..	..
4,200	429	1,801·8	159·0	29·0	28·0	54·6	1,256·94	16·65	1,518·18	77	..
4,200	428	1,797·6	158·0	28·5	28·0	55·6	1,279·96	16·65	1,518·18	..	92
4,200	427	1,793·4	160·0	26·5	28·0	56·0	1,289·17	15·7	1,431·55	..	..
4,200	428	1,797·6	160·0	27·0	28·0	58·2	1,339·82	16·0	1,458·12	79	..
4,250	428	1,819·0	156·0	27·0	28·0	56·6	1,302·98	16·85	1,536·41	..	..
4,300	429	1,844·7	157·0	28·0	27·8	57·2	1,316·80	16·88	1,539·15	..	..
4,250	428	1,819·0	160·0	26·5	27·9	57·6	1,326·0	16·4	1,499·03	82	92
4,300	428	1,840·4	155·0	27·5	27·8	57·4	1,321·40	16·6	1,518·62	..	..
4,250	428	1,819·0	152·0	28·5	27·75	55·4	1,275·86	16·9	1,540·97	..	..
4,250	430	1,827·5	156·0	27·5	27·75	56·6	1,302·98	17·0	1,550·09	82	..
4,300	431	1,853·3	155·0	29·0	27·75	56·4	1,298·38	17·1	1,539·21	..	..
4,300	436	1,874·8	160·0	27·5	27·75	58·7	1,351·33	16·9	1,540·97	..	..
4,200	438	1,839·6	160·0	29·0	29·75	58·1	1,337·52	16·9	1,540·97	80	90
4,250	440	1,870·0	167·0	29·0	27·75	58·0	1,335·21	16·7	1,522·73	..	..
4,150	443	1,838·4	160·0	28·5	27·75	58·8	1,353·63	17·0	1,550·09	..	..
4,000	447	1,788·0	155·0	28·5	27·6	57·4	1,321·40	17·0	1,550·09	83	92
4,000	450	1,800·0	159·0	27·5	27·3	57·0	1,312·19	16·3	1,489·0	..	..
4,000	452	1,808·0	150·0	28·5	27·3	55·1	1,268·45	16·7	1,522·73	..	..
4,000	452	1,808·0	157·0	29·0	27·5	58·0	1,335·21	17·2	1,568·32	86	94
4,150	450	1,867·5	158·0	29·0	27·1	57·6	1,326·0	16·9	1,540·97	..	..
4,050	452	1,830·6	154·0	30·0	27·1	56·6	1,302·98	17·6	1,604·80	..	104
4,150	449	1,863·3	160·0	31·0	26·9	58·4	1,344·42	17·7	1,613·92	96	..
4,100	446	1,836·6	154·0	31·0	26·9	57·3	1,319·10	17·5	1,595·68	..	104
4,200	441	1,864·8	160·0	32·5	26·7	57·9	1,332·91	18·0	1,641·27	..	108
4,150	439	1,821·8	156·0	31·0	26·7	57·0	1,312·19	17·3	1,577·4	100	110
4,250	438	1,861·5	159·0	30·0	26·6	56·4	1,298·38	17·2	1,568·33	..	..
4,100	438	1,795·8	152·0	30·0	26·7	56·6	1,302·98	17·0	1,550·94	..	110
4,150	437	1,813·5	160·0	28·0	26·7	58·2	1,339·82	16·5	1,504·50	101	..
4,150	437	1,813·5	157·0	28·5	26·8	55·9	1,286·87	16·6	1,513·62	..	..
4,150	437	1,813·5	154·5	30·0	27·0	57·3	1,319·10	17·1	1,559·21	..	106
4,250	434	1,844·5	162·0	28·5	27·0	58·5	1,346·72	16·5	1,504·50	97	..
4,050	437	1,769·8	160·0	27·0	27·0	57·0	1,312·19	15·2	1,385·96	..	..
4,200	436	1,831·2	152·0	29·0	27·0	56·4	1,298·38	16·6	1,513·62	..	108
4,100	436	1,787·6	150·0	28·5	27·0	55·2	1,270·75	16·5	1,504·50	99	..
Engine friction						2·75	63·3	1·35	123·09	..	..

ALL CALCULATIONS ARE BASED ON THE WATTMETER READINGS.

Total units generated, 11,130 in 6 hours (wattmeter), 1,855kw. per hour.
Units absorbed in pumps, 120 in 6 hrs., 20kw. per hr. (two pumps).
Net units, 11,010 in 6 hours.
Tot. water, 218,420, 36403·3lb. per hour.
Average I.H.P., 2,832·2.
Mean pres. at stop-valve, 156·7lb.
Mean vacuum, 27·42in.
Av. units generated (from switchboard instruments, 65,531·7/36, 1,820·32kw. per hour.
All tapped and drain water reckoned in with air-pump discharge.

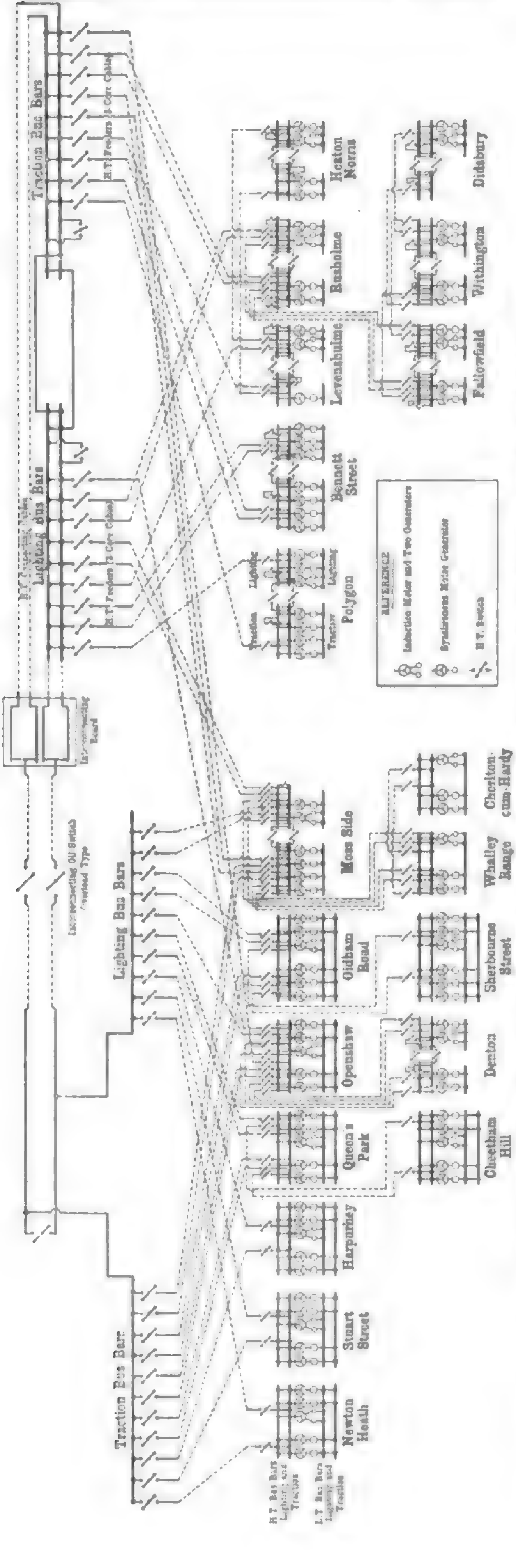
BOILERS.

Boilers under test, Nos. 5, 6, 7 & 8.
Firegrate area in square feet, 228 (four boilers)
Consumption of coal in pounds per 6 hours, 28,512 gross total.
Ditto per hour, 4,752.
Ditto per square foot of grate area, 16·5 per hour.
Evaporation of water per pound of coal, 9·3 from and at 212 F. with 90°F. superheat.
Ditto per pound of dry coal, 8·06 from and at 194°F.
Average temperature of feed-water at boilers, 194°F.
Ditto at pumps, 96°F.

ACCEPTED AVERAGE RESULTS.

Combined efficiency with pumps, 86·5%, without pumps, 87·49%.
Water per I.H.P. per hour, with pumps, 12·64lb.
Water per kw.-hour, with pumps, 19·88lb., without pumps, 19·65lb.

[* See also *The Electrician*, Vol. LIII., p. 552.—ED. *E.*]



Traction Bus Bars
H.T. Feeders 3 Core Cables
Lighting Bus Bars
Heaton Norris
Didsbury
Rusholme
Withington
Levenshulme
Fallowfield
Bennett Street
Polygon
Traction
Lighting
REFERENCE
Induction Motor and Two Generators
Synchronous Motor Generator
H.T. Switch
Interconnecting Board
Interconnecting Oil Switch Overload Type
Moss Side
Chorlton-cum-Hardy
Whalley Range
Oldham Road
Sherbourne Street
Openshaw
Denton
Queen's Park
Cheetham Hill
Harpurhey
Stuart Street
Newton Heath
H.T. Bus Bars Lighting and Traction
L.T. Bus Bars Lighting and Traction

FIG. 2.—GENERAL DIAGRAM OF H.T. CONNECTIONS OF MANCHESTER THREE-PHASE SYSTEM, STUART ST. GENERATING STATION AND SUB-STATIONS.

'bus bars at Stuart-street, as mentioned above, are kept separate at the sub-station end. By this arrangement the induction motors which drive the small lighting generators are not affected by the fluctuations in pressure due to the variations in the traction load supplied from the same sub-station, but are only affected by the variations in speed and pressure of the main generators at Stuart-street. The synchronous traction sets at all the sub-stations are all started up on the low-tension side, either from the traction or lighting 'bus bars. In the event of a low-tension supply not being available from the mains, each station is provided with an induction motor lighting set, which can be started from the alternating-current side, and will furnish a low tension supply on to the lighting 'bus bars, from which the traction sets can be started up in the usual manner. From the sub-station low-tension traction boards, low-pressure feeders, lead-covered and paper-insulated, are laid to the various feeding points in the area supplied by the different sub-stations.

In the case of the area supplied by the city stations, the current is metered at the main switchboard, and in the case of the outlying areas at each low-tension sub-station switchboard. The total consumption for the year ending March, 1904, was 17,125,857 units.

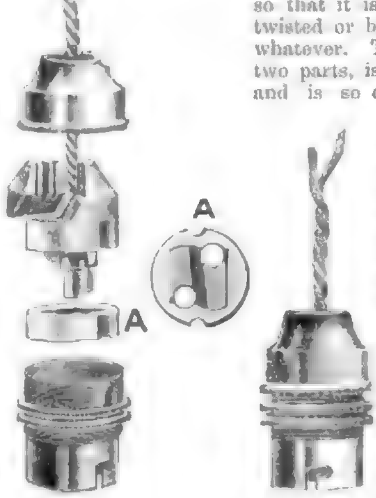
In Table I. are given the results of a six hours' test carried out on one of the 1,800kw. Musgrave-Westinghouse continuous-current sets on October 21, 1902, at the Bloom-street station. The plant was run on a steady lighting load at approximately the full-load output. Saturated steam from four boilers was used, and the water measured at the air-pump discharge. Readings were taken every 10 minutes, and the average speed was 74·1 revs. per min. The station temperature rose from 79°F. at the beginning of the test to 80°F. at the end, the field-magnet temperature from 79°F. to 103°F., the armature temperature from 79°F. to 102°F., and that of the commutator from 79°F. to 104°F. A further test was carried out on October 22, 1902, at full load with superheated steam, and using two boilers only. The following were the chief figures obtained:—

Type of engine..................	Cross-compound vertical. Cylinders 38½in. and 76in.
Revolutions	75 per min.
Duration of test	2:30 p.m.—5:30 p.m.
Steam pressure	155lb.
Vacuum..........................	27·5in.
Superheat.......................	90 F. at boiler.
Weight of air-pump discharge	77,420lb.
Units generated	4,500.
Steam per kilowatt-hour	17·2lb.
Do. allowing for circulating pump .	17·43lb.

(*To be continued.*)

A NEW LAMPHOLDER.

We have received from Messrs. Baxendale & Co., Miller-street Works, Manchester, a specimen of their new patent "Thikflex" cord-grip lampholder. As may be seen from the illustration, the case is in two parts only, which screw together and interlock the cord-grip, china interior and terminals with each other, so that it is impossible for them to be twisted or become detached in any way whatever. The interior, which is also in two parts, is of the best English china, and is so constructed that when put together the terminals, which are not permanently fixed to the china, are held quite firmly in position, and are entirely insulated from one another and from the case, no metal being exposed beyond the plungers themselves. When the holder is wired and made up, the cord-grip cannot possibly be twisted, and retains such a firm hold on the flexible that all strain is taken off the connections, as may be seen by inserting the flexible without connecting the terminals at all. We have examined this lampholder carefully, and have come to the conclusion that it should fulfil all claims put forward by the makers, and its selection may be especially recommended for situations in which rough usage, and other severe conditions, have to be encountered.



ROTATING FIELD-MAGNETS FOR TURBO-GENERATORS.

Considerable difficulty has been encountered in the construction of dynamos for direct connection to steam turbines on account of the centrifugal forces due to the high speed, and of the excessive noise due to air resistance when attempt is made to ventilate the more usual construction. The object of the design shown in the illustration (Fig. 1), as patented in the United States on January 11, by B. A. Behrend and W. D. Pomery, is to secure a compact and rigid well-balanced construction with all parts well protected and firmly held in place and to obtain good ventilation of all heated parts.

The core, which is of the slotted type, is built up of laminæ grouped in sections spaced from each other by separators. The illustration represents a revolving field magnet, the windings being connected in series, so as to produce, when excitedby direct current, a north pole and a south pole diametrically opposite each other, giving a bipolar field. The windings are retained in the slots by wedges of phosphor bronze, and the external surfaces are finished so as to give a perfectly smooth exterior. The end connections of the windings are covered by cylindrical pieces of nickel steel having great mechanical strength. These cores serve not only to protect the coils, but also to withstand the great centrifugal force exerted upon them. The coils are separated from each other by spaces for ventilation, and the cylindrical covers are provided with openings for the same purpose, the openings coinciding with the spaces between the coils, and additional openings which are provided in the retaining end plates.

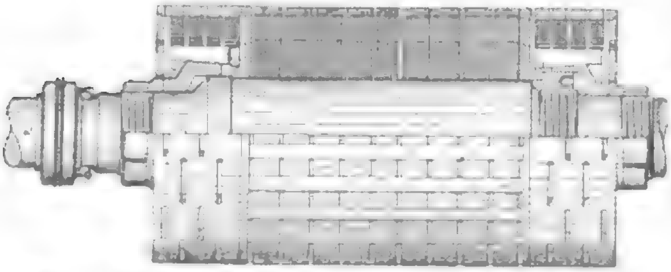


Fig. 1.—B. A. Behrend and W. D. Pomery's Design of Rotating Field Magnet.

At the interior surface of the end connections are located wedge pieces, four of which comprise an expansible ring, one of which rings is used at each end of the rotor. Within the wedge pieces is placed a clamping ring, which, when forced into position, causes the wedge pieces which seat against the end plates to press outwardly against the end connections and securely hold them in a fixed position. In the operation of the rotor there is a free circulation of air through the openings in the end covers and between the projections of the wedge pieces and out through the spaces between the coils and through the openings in the cylindrical covers. Ventilation is further secured by air passing into and out of the spaces between the sections of laminæ.

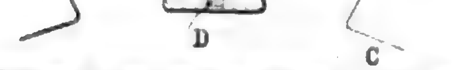


Fig 2.—Details of Rotating Field Magnet by the Allgemeine Elektricitats-Gesellschaft.

Another design of rotating field magnet—i.e., that of the Allgemeine Elektricitats-Gesellschaft in Berlin, was recently described by Herr J. Seidener in the course of a lecture before the Electrotechnischen Verein in Vienna. In order to minimise the objectionable hum of field magnets rotating at high speeds, the field magnet in uestion is in form of a perfect cylinder as indicated by Fig. 2. haft and spider are in one piece of cast steel, and the spider is proided with a number of dove-tailed slots spaced equidistantly around the periphery. The field coils are wound with copper strip, the coils being subsequently tested with alternating current at a voltage 30 times that of the continuous current which is afterwards to be used for excitation (usually 110 or 220 volts). After the coils have been put in place, the piece B is let down and secured in the dove-tailed slots of the spider. In order that this may be done piece B is divided into two halves, which are—after being fixed in their proper position—held apart by wedge D, this wedge D in its turn being secured by another wedge E. The wedges are made of bronze. The slip rings are mounted directly on the shaft, but, of course, insulated therefrom. Each slip ring is composed of two parts. Artificial cooling is procured by two fans, mounted on either side of the rotating magnet. They produce a powerful air blast which is directed from both sides into the gap between rotating magnet and stator from which it escapes through openings in the stator. It is stated that the power consumed by these fans is below ½ per cent. of the turbo-generator capacity.

Of considerable interest is the way in which the rotating part is tested as to perfect balance. For this test the field magnet is supported by two special bearings which rest on a number of balls so as to be mechanically as free as possible. The test piece is then rotated by a light and pliable belt, the electric motor which drives this belt being vertically above the cylindrical part tested. If there is perfect balance, the bearings will remain stationary, but if the rotating part is out of balance in any way, then the test piece and with it one or both of the bearings will shift. If the rotating field magnet is so well balanced that the bearings indicate no movement when the the test piece rotates at from one-third to one-half its normal speed, no trouble will be experienced, it is said, with the rotating part in actual service.

PARLIAMENTARY INTELLIGENCE.

LIGHT RAILWAYS BILL, 1905.

In the House of Commons on Thursday last week, Mr. GERALD BALFOUR, President of the Board of Trade, introduced a short bill to amend the Light Railways Act, 1896. It is as follows:—

1. The powers of the Light Railway Commissioners under the Light Railways Act, 1896 (in this act referred to as the principal act), shall continue until Parliament otherwise determine.

2. (1) If any order under the principal act is not confirmed by the Board of Trade on the ground that the proposals of the promoters ought to [illegible] submitted to Parliament in pursuance of sub-sec. 3 of sec. 9 of the principal act, the Board may, if they think fit, submit the proposals to Parliament by bringing in a bill for the confirmation of the order.

(2) If, while a bill confirming any such order is pending in either House of Parliament, a petition is presented against the order, the bill, so far as it relates to the order, may be referred to a Select Committee, or, if the two Houses of Parliament think fit to so order, to a Joint Committee of both Houses, and the petitioner shall be allowed to appear and oppose as in the case of private bills.

(3) On bringing in a bill under this section for the confirmation of an order, the Board of Trade shall make a special report to Parliament with respect to the order.

3. This act may be cited as the Light Railways Act, 1905, and shall [illegible] read as one with the principal act, and the principal act and the Light Railway Commissioners (Salaries) Act, 1901, and this act may be cited together as the Light Railways Acts, 1896 to 1905.

A bill in precisely similar terms has already been presented to the House of Commons on two previous occasions—viz., 1903 and 1904, but was abandoned in both years. Should it become law, the effect is to prevent delay, for under the present conditions, if a light railway order [illegible] rejected by the Board of Trade on the ground that the promoters ought to have proceeded by means of a private bill a lapse of at least a year must necessarily take place The power of the Board of Trade to place the matter before Parliament at once will be appreciated by promoters.

HAMMERSMITH, CITY AND NORTH-EAST LONDON RAILWAY.

The Standing Orders Committee of the House of Commons considered the report of the examiners that this bill had not complied with standing orders on Tuesday. The points raised before the examiners with regard to this were reported in our issues for Feb. 3 and 10. The promoters asked that standing orders in the particular cases should be dispensed with, but the Committee decided against this. Consequently the bill will have to be dropped for this session. The proposal of the bill was to construct a deep level tube railway from Hammersmith, via Knightsbridge and Kensington to the Strand, Fleet-street and City, whence branches were to go to Walthamstow and Waltham Abbey on the east, and northernwards to Tottenham and Palmer's Green. The capital to be authorised was £7,200,000 share capital, with £2,400,000 borrowing powers. The length of route was 19 miles 60 chains. The promoters were Arnold Hills, David Urquhart, and James Worsfield.

ACCIDENTS (MINES AND FACTORIES) BILL.

A bill has been presented in the House of Commons to amend the law relating to returns and notification of accidents in mines, collieries, factories and workshops. The bill carries out, as far as regards mines and factories, the recommendations contained in the report of the Departmental Committee appointed in 1901 to inquire into notification of industrial accidents. The main object of the measure is to prescribe that all accidents which result in the death, or disablement for more than 14 days, of any persons employed in or about the mine, shall be notified as provided for in Sec. 33 of the Coal Mines Regulation Act of 1877 and Sec. 1 of the Metalliferous Mines Regulation Act of 1875. Among the accidents to be reported are shocks by electricity, the notices being sent in writing to the inspector of the district on the form prescribed by the Secretary of State A similar provision is included in the bill as applicable to factories and workshops.

ACCIDENTS ON ELECTRIC RAILWAYS.

In the House of Commons on Tuesday, in answer to Mr. Herbert Samuel,

Mr. GERALD BALFOUR said that on the Lancashire & Yorkshire and North-Eastern Railways nine fatal and 22 non-fatal accidents had occurred through contact with the third rail. No accidents from contact with the third rail had been reported to the Board of Trade on any of the other lines which had recently been equipped for the use of electrical power in place of steam, and no such fatal accident had, it was believed, occurred on any of the tube railways. No separate record of such accidents upon tube railways had been kept, but the number, if any, was very small. The matter was one that received unremitting consideration from the inspecting officers of the department in the execution of their duties.

THE ELECTRIFICATION OF STEAM RAILWAYS.

Mr. WEIR has notified his intention of asking the President of the Board of Trade whether, having regard to the fact that the North-Eastern Railway Co. have "electrified" a portion of their system without obtaining specific statutory powers, he proposes to notify other railway companies in the United Kingdom of the irregularity of such a course. Mr. Weir also asks how many miles of the North-Eastern Co.'s system have been electrified, at what date the system came into force, the number of accidents resulting therefrom, the number of persons who have lost their lives through contact with the third-rail, and whether the Board of Trade inspectors are now quite satisfied that the rails are sufficiently protected.

THE TELEPHONE AGREEMENT.

In the House of Commons on Monday,

Mr. COHEN (for Sir Joseph Dimsdale) asked the Postmaster-General whether any estimate had yet been arrived at of the sum of money that would be payable to the National Telephone Co. for the purchase by the Postmaster-General of their undertaking in 1911 under the agreement of Feb. 2, 1905, and if so, what was the amount of the estimate; and whether he would alter the notice of motion standing in his name with regard to the reference of that agreement to a Select Committee, so as to give local authorities and others interested the right to be heard by counsel or otherwise before the Select Committee.

Lord STANLEY, in a printed reply, said that the price to be paid to the National Telephone Co. for plant in 1911 must depend on many things, including the maintenance of the plant in the meantime and the expansion of the system. It was impossible, therefore, to estimate at the present time the amount to be paid to the company. The Committee would have power to send for persons, papers and records, and could take any evidence they might consider requisite. He did not think any further directions necessary.

TRUNK TELEPHONE FEES IN GREAT BRITAIN.

In the House of Commons on March 1,

Mr. SLOAN asked the Postmaster-General if he would consider the advisability of reducing the present charge over the trunk telephone lines through the United Kingdom, so that the commercial community of Great Britain might in this respect have similar advantages to those received by Continental nations.

Lord STANLEY, in a printed reply, said that the average payment for a conversation over the telephone trunk system of the United Kingdom was less than 6d., and having regard to the cost of the trunk lines and to the difficult conditions to which the construction of those lines were subject in this country, he was not prepared to recommend any reduction in the present scale of charges. New trunk lines were filled with traffic almost as soon as they were opened, and it was difficult to keep pace with the demand for increased facilities even at the present rates. The charges in other European countries were subject to conditions which did not obtain here. For instance, in most countries, in order to obtain prompt communication, the public had to pay three times the ordinary rate; and in one important country, at least, the capital for construction was provided without interest by local authorities or by commercial bodies, and not by the administration which conducted the service. He might, perhaps, mention that in the United States the charges for the same distances were much higher than in this country.

TRUNK TELEPHONE SERVICE IN IRELAND.

In the House of Commons on March 1,

Mr. O'DOHERTY asked the Postmaster-General if he would state the cause of the delay in the extension of the trunk telephone system from Belfast to Londonderry; had any progress as yet been made with the extension, and if so when might the citizens of Londonderry expect to be placed in communication with the trunk system throughout the Kingdom.

Lord STANLEY, in a printed reply, said that a considerable amount of work was involved in the extension of the telephone trunk system to Londonderry, but substantial progress had been made, and he hoped to have the work completed about the end of April. He was informed by the National Telephone Company that they had recently concluded an agreement with the Corporation of Londonderry which would enable the company to convert their exchange system in Londonderry into a double-wire system suitable for use with the trunk lines, and that the company hoped to complete the work of reconstruction in about three months.

SECOND CLASS ENGINEERS IN THE POST OFFICE.

In the House of Commons on March 1,

Mr. SCHWANN asked the Postmaster-General whether he was aware that certain officers of the engineering department sat for an examination and passed for the positions of second-class engineers in April, 1904; whether these officers had received promotion, seeing that other persons examined on Nov. 8, for the same positions had received appointments; whether he was aware that the men examined in April, 1904, had been in the department for many years and had rendered good service to the department, whilst the men promoted as a result of the November examination were juniors who had had to be taught their duties since their entry into the engineering department; and, if so, would he redress any well-founded grievance which he might find to exist.

Lord STANLEY, in a printed reply, said that the officers to whom the honourable member referred underwent a departmental examination to test their eligibility for promotion within the service. This examination, unlike the examination of the Civil Service Commission, was conducted without reference to the number of vacancies in existence. After the officers had passed, they were promoted from time to time as suitable vacancies occurred. The persons who were described by the honourable member as "juniors" were outside the service, and passed a competitive examination before the Civil Service Commissioners for specific vacancies which had been reserved for open competition. He was not aware of any grievance created by those circumstances. Any of the officers in question who were duly qualified would be promoted as vacancies among the appointments reserved for persons in the service became available.

THE SALARIES OF TELEGRAPHISTS.

In the House of Commons on Tuesday,

Lord STANLEY, in reply to Mr. McNEILL, said he had no intention of raising the maximum pay of the general body of telegraphists beyond the present – namely, £160 per year. He hoped, however, to make some improvement in the pay of the cable-room staff of the central telegraph office, which formed a separate establishment.

TELEGRAPHIC COMMUNICATION WITH SHETLAND.

In the House of Commons on Feb. 28,

Mr. CATHCART WASON asked the Postmaster-General if he was aware that telegraphic communication with Shetland has been interrupted for three weeks, and that prompt action to repair the cable was not taken.

Lord STANLEY replied that there had been no avoidable delay in restoring communication, as the telegraph ship "Monarch," which left the Thames to do the work on Feb. 18, had met with very severe weather. He had endeavoured to minimise the inconvenience by providing a special boat service for telegraphs.

WIRELESS TELEGRAPHY IN THE NAVY.

In the House of Commons on Monday, in presenting the Navy Estimates,

Mr. PRETYMAN, referring to the distribution of the Fleet, said that this depended almost entirely upon its mobility. By increasing the mobility, the number of less-up-to-date ships in all parts of the world and also the smaller and more distant bases had been reduced. One of the factors of the greatest importance in this connection was the use of wireless telegraphy.

The second reading of the bill which has been introduced by the Government to create a Ministry of Commerce has been deferred until Tuesday, March 14.

The following petitions against the Shropshire and Worcestershire Electric Power Bill have been withdrawn :—Tamworth Gas, Light & Coke Co. and Lichfield Gas Co.

The promoters of the Thames and Medway Canal Bill have intimated their intention of not proceeding with this measure.

The Oldham and Saddleworth Tramways Bill will now proceed as an unopposed measure, all the opponents having been settled with.

In the House of Lords on Thursday last week, March 2, the Tyneside Tramroads & Tramways bill and the Central Electric Supply bill were read a second time. On Friday, March 3, the following bills were read a second time: Southend & Colchester Light Railways, County of London Electric Supply, Mexborough & Swinton Tramways, and Oldham & Saddleworth District Tramways.

In the House of Commons on Friday last week, March 3, the Ulster & Connaught Light Railways bill was read a second time. On Tuesday, March 7, the following were read a second time: Heckmondwike Improvement, Baker Street & Waterloo Railway, Charing Cross, Euston & Hampstead Railway, Edgware & Hampstead Railway, Great Northern, Piccadilly & Brompton Railway (No. 1).

The Rathmines and Rathgar Urban District Council bill, which will shortly come on for second reading in the House of Commons, originally contained a proposal to enable the local authority to undertake the electric wiring of consumers' houses. Considerable opposition was made to this by the Electrical Contractors' Association, and a motion for the rejection of the bill on second reading was to have been made. We now learn, however, that the electrical contractors have agreed a case with the promoters by which the wiring of consumers' premises and the supply of fittings to them will be carried out by the Council, but through a contractor.

LEGAL INTELLIGENCE.

Jandus Arc Lamp Co. (Ltd.) v. Arc Lamps (Ltd.)

This case again came before the Court of Appeal (Lord Justices Vaughan Williams and Stirling) on Wednesday on appeal of defendants from an order of Mr. Justice Kekewich.

Mr. BOUSFIELD, K.C., for defendants, said the matter was of considerable importance to his clients, as the injunction which Mr. Justice Kekewich granted last week (assuming that that court did not take the same view of the case as Mr. Justice Kekewich), if not stayed pending the appeal, would do the defendants irreparable injury, for which there would be no remedy. The defendants had been manufacturing arc lamps for some years past without let or hindrance. Mr. Justice Kekewich had found that defendants had infringed plaintiffs' patent, and he granted an injunction. His Lordship admitted it was a difficult case, and it was not easy to see what the Court of Appeal would do when it got there, but he (counsel) submitted that under the circumstances the right course was to stay the injunction until the appeal was heard.

Mr. MOULTON, K.C., for the respondents, said the patent had only two more years to run, and it would be the greatest possible hardship and would greatly prejudice them and be unfair to their licencees if the defendants were allowed to go on infringing.

Lord Justice VAUGHAN WILLIAMS said they must take it that the plaintiffs were not in a position to controvert the statement that the injunction would do the defendants serious and irreparable damage if they won. He had no doubt that prima facie they ought to see, if they could, that things were left in statu quo. But Mr. Moulton had not condescended to say what hardship would be done to plaintiffs. It would seem to be met by sufficient security for royalties.

Mr. MOULTON said people would not take licences and would commence to infringe, and plaintiffs would not be able to bring another action before the patent was out. They were prepared to give defendants a licence.

Lord Justice VAUGHAN WILLIAMS: Are you content that they should take a licence without prejudice to their appeal?

Mr. MOULTON: No; that would be "Heads I win, tails you lose."

After further conversation, however, Mr. Moulton consented to this course, the defendants paying the same royalties as other licencees.

Mr. BOUSFIELD: You mean pay into Court?

Mr. MOULTON: No; pay to us.

Lord Justice VAUGHAN WILLIAMS: You must return it if you are beaten.

Mr. MOULTON submitted that it was unfair that the man who refused to take a licence should be put in a better position than the licencees.

Ultimately, however, it was agreed that the defendants should take a licence, paying the same royalties as the other licencees, the plaintiffs giving an undertaking to return any moneys in the event of the appeal being successful, costs of the application to be costs in the appeal.

Brunner, Mond & Co. v. Cobbold.

At Liverpool Assizes on Friday, before Mr. Justice Walton, plaintiffs sought to recover from defendant £291. 13s. 4d. for goods sold and delivered, and alternatively upon a guarantee.

In February, 1904, plaintiffs declined to supply goods to the Rylands Glass & Engineering Co. (Ltd.) until they received a guarantee from defendant, who was receiver for the debenture holders. Goods were then ordered over the signature of defendant, and the question was whether he or the company was liable for payment on account of goods supplied. The defence set up the Statute of Frauds and contended that the documents did not impose any guarantee upon defendant personally.

His LORDSHIP, setting aside the question of the direct liability of the Rylands Company, held that the defence failed, and gave judgment for plaintiffs, with costs.

Beale v. W. Griffiths & Co.

In the High Court, before Mr. Justice Lawrance and a special jury last week, plaintiff sought to recover damages for personal injuries sustained through alleged negligence of defendants. On Nov. 20, 1903, plaintiff said he was driving a pony and barrow along the Borough-road, London, S.E., when one of the wheels skidded along a raised tram rail, which had been temporarily placed in the road by defendants. The barrow was upset and plaintiff thrown out and injured.

The defence was that the temporary tram lines had been laid down on the most approved method, and that a similar method had been adopted elsewhere.

The jury found that the accident was caused from negligence in constructing and maintaining the temporary rail, and awarded the plaintiff £860 damages. Judgment accordingly.

Electric Tramways Construction & Maintenance Co. (Ltd.)

A petition for the compulsory winding-up of this company was dismissed on Tuesday by Mr. Justice Buckley, the company having gone into voluntary liquidation.

African Transcontinental Telegraph.—The terminus of the African Transcontinental telegraph is still at Ujiji (German East Africa), on the eastern shore of Lake Tanganyika, pending a discussion of the possibility of employing a system of wireless telegraphy for some of the more difficult stretches of country to the north of Ujiji on the proposed route of the line.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Bermondsey (London) Council invite applications for the position of electrical engineer at a salary of £425, rising by annual increments of £25 to £525 per annum, without pension. The duties will include the management and running of the electricity and dust destructor works. Applications to the town clerk (Mr. Fredk. Ryall), Town Hall, Bermondsey, S.E., by noon 22nd inst. See also an advertisement.

A junior assistant for physics is required at Merchant Venturers' Technical College, Bristol. Salary £130 to £160. Particulars obtainable from registrar until March 28. See advertisement.

Southampton Corporation require a general manager for the electric tramway undertaking. Salary £500, rising by annual increments of £25 to £600. Applications by 15th inst.

London County Council require two divisional inspectors (at £600 per annum, rising by annual increments of £25 to £800), one possessing special qualifications in mathematics and science and the second in technology, including electrical and mechanical engineering; also an inspector in wood and metal work at £400, rising to £500. Applications by 10 a.m. April 1.

A lecturer in civil and mechanical engineering is required at the University of Leeds. Salary £300 per annum. Applications by March 25.

Middlesbrough Education committee require a teacher of engineering in the high school. Salary £200.

Wakefield Corporation require a first assistant electrical engineer. Applications by 14th inst.

Mr. John Miller, B.E., has been appointed assistant in the mathematical department of the City and Guilds Central Technical College, Exhibition-road, London, S.W.

Mr. P. E. Rycroft, works manager at Islington (London) electricity works, has been promoted to the position of chief assistant engineer (vacated by Mr. C. H. Yeaman on his appointment to Hanley) at £300 per annum. Mr. T. Margery, senior mains engineer, becomes superintendent of mains work on probation for six months at £180 per annum.

Mr. H. Neale, superintendent of telephones, Hyderabad, Deccan, having retired, Mr. Fred. Gordon has been appointed officer-in-charge of the Telephone Department of H.H. the Nizam's Government.

Mr. J. H. Dobson has been appointed professor of electrotechnics at the Transvaal Technical Institute, Johannesburg. Mr. Dobson, who was formerly an apprentice at the Crewe Railway works, won a scholarship at Crewe Mechanics' Institute, proceeded to University College, Liverpool, was afterwards appointed head of the engineering department at the Gamble Institute, St. Helens, and last year went to South Africa with Prof. Hele-Shaw.

Mr. H. G. Stanley, of the Armstrong College, Newcastle-on-Tyne, has been appointed professor of metallurgy at the technical institute, Johannesburg.

Anglo-Chinese Telegraph Convention.—It is announced that the director of the traffic branch of the Indian Government Telegraphs (Mr. T. D. Berrington) has left for Shanghai to assist in negotiations for the renewal of the Anglo-Chinese Telegraph Convention of 1894, the Chinese Government having notified a desire for the modification of certain clauses. The line in Yunnan beyond the Bhamo border is reported to be in a deplorable state of disrepair.

Assessment of Electric Light Works.—Although the premises were still in the hands of contractors and would not be in working condition for some time, the new generating station of the Yorkshire Electric Power Co. at Thornhill, near Dewsbury, was assessed at the rateable value of £1,200. The company (we are informed) sought advice of the Machinery Users' Association, with the result that a reduction was secured to £10, until such time as the station should be profitably working.

Belfast.—The workmen engaged by the contractors (J. G. White & Co.) in the reconstruction of the permanent way of the tramways have been out on strike for some days, and all efforts at conciliation have hitherto failed.

Yesterday a deputation from the labourers on strike waited upon the Lord Mayor, who informed them that the minimum rate of 18s. 6d. per week could not be increased, but each man would be put on a full six-day week instead of three-day as at present. The men subsequently held a meeting and decided to remain out.

Bermondsey (London).—The Council on Tuesday decided to adjourn consideration of a recommendation by the Electric and Lighting committee to authorise certain mains extensions at an estimated cost of £6,159. 3s. 6d., and the putting in of interconnecting switch fuses at an estimated cost of £804. The resignation of the borough electrical engineer (Mr. W. H. Vincent) was the determining factor in deciding to postpone. With reference to complaints as to the electric lighting installation at Tanner-street Workhouse, which was carried out under the supervision of the Council, Mr. Vincent reported that steam from coppers condensed on the walls and got into the casing, causing the insulation of the wires to become defective. The defects were not due to the manner in which the work had been carried out. The equivalent of 35,144 8 c.p. lamps is on order for private lighting or, with public lighting, a total of 38,130.

Brest-Dakar Submarine Telegraph Cable.—Capt. C. F. Cromie, H. B. M. Consul at Dakar, under date Feb. 17, states that the Brest-Dakar cable has been landed at Yof Bay, but as it has been found necessary to erect a new land line from that point to Dakar, two months must elapse before the cable can start working.

Brighton.—A stormy meeting of the Council took place last week upon a recommendation of the Works committee to pay £17,500 to Messrs. Macartney, McElroy & Co. in settlement of their claims in the matter of their recent litigation with the Corporation. Ultimately, however, the report was adopted, and it was decided to apply for sanction to a loan of £12,188. 17s. 7d. for 30 years. At the same meeting it was announced that the General Purposes committee had accepted the resignation of the borough surveyor (Mr. F. J. C. May) as from Sept. 29 next, and that he had been granted leave of absence as from 25th inst. The committee found that no responsibility rested with any subordinate member of the department "for certain errors which had come to light in the course of the action of Macartney v. the Corporation."

Burton-on-Trent.—The Council have adopted the report of the electrical engineer (Mr. P. J. Pringle) on the extension of the tramway generating plant to deal with the additional service of cars which the Burton and Ashby light railway calls for, and tenders are being invited for a 100kw. continuous-current dynamo, with switchboard and connections for same.

Cape Town.—A bill is to be introduced into the Cape Parliament authorising Port Elizabeth Town Council to construct works for electricity supply for all purposes.

Cheshunt.—The Board of Trade threaten to revoke the Cheshunt Electric Lighting Order, 1901, as the Council have done nothing beyond entering into an agreement with a company (which is alleged to be ultra vires) for a transfer of the order. The Board will be asked to grant an extension of time.

Chili.—The "Financial News" states that a company has been formed in Chili for carrying out electric light and power installations in the provincial towns of the Republic.

Church Lighting.—St. Thomas' Church, Newport, Isle of Wight, has been wired and fitted up for electric light to the specification and under the supervision of Mr. B. H. Jenkinson.

City of London.—The Streets committee have reported on the proposal of the Charing Cross Electricity Supply Co. to change the pressure from 100 to 200 volts in the western area of the City, where 100 volts supply is now being given.

The committee recommend that the company make the necessary alterations to consumers' lamps, &c., at their own expense, and be required to allow a deduction of 10 per cent. in the price of electric energy to consumers whose supply is changed.

The recommendation has been approved by the Common Council.

Colchester.—Recently the Council applied for sanction to a loan of £16,500 for electric lighting extensions. Authority has now been received for borrowing £12,920, repayable within 24 years.

Customs Decisions.—New Zealand Customs Commissioners' Orders recently published fix the import rates of duty in that colony on electric gas lighters and slot rails for tramways cable at 20 per cent. ad val.

The Canadian Department of Customs have decided that the following articles are subject to the special duty enforced by the "anti-dumping" clause of the Canadian tariff:—Air-brake equipments and air pumps, electric travelling and hand-power cranes, column and other heavy castings, insulated wires and cables, incandescent and arc lamp sockets and receptacles, cutouts, plugs, rosettes and wiring accessories, cross arms, switches, porcelain insulators and cleats, lightning arresters, electric meters, transformers, dynamos, generators, motors, switchboards, wire rods, steel rails and railway fish-plates, electric fuses for blasting, &c.

From July 1 next a number of changes will come into effect in the rate of duty charged upon electrical machinery, apparatus and accessories imported into Italy.

A number of alterations affecting the import duties on electrical goods imported into the Argentine Republic are published. The following articles are affected: Wires and cables, measuring instruments, lamp globes and bulbs, arc lamp carbons, electric motors for fans (complete or in parts), glass lamp shades and iron insulating tubes.

Depreciation of Naval Stores.—In the report of the Comptroller and Auditor-General of the Navy upon the stores account for 1903-4 reference is made to an item for depreciation in electric cable amounting to £1,720 included in "Deterioration while on store charge," and £1,921 for depreciation of the same article included in "Adjustment of value on re-survey." £1,074 further has been written off as depreciation of electric cable returned to Portsmouth in February, 1904, but has not been included in the above statement.

In the papers relating to the matter it is stated that the greater part of the cable had never been used, as the cable had been received and paid for after due examination and test by Admiralty officers, and it was not practicable to make any claim on the contractors, several of whom had, however, been struck off the list for that description of cable in consequence of the rapid deterioration of the cable supplied by them. The faults were not, however, wholly due to the contractors, but to the fact that a mining cable had not yet been introduced into the service which would successfully withstand storage in a hot climate, and that experiments were still being carried out to discover the most suitable type.

Darlington.—Halfpenny fares on the tramways have involved an approximate loss of £4. 9s. 10d. per week.

The electrical engineer (Mr. J. R. P. Lunn) has reported that to meet the increasing demand for current there will have to be extensions of the works at an estimated cost of between £2,000 to £3,000.

Dewsbury.—A loan of £10,000 for additional plant and mains extensions has been applied for.

Electric Driving in Cotton Mills.—The Acme Spinning Co., which has been formed to erect and carry on a new spinning mill at Pendlebury, Manchester, has decided to adopt electric driving. It is claimed that this will be the first spinning mill in England to be entirely lighted and driven by electricity. The mill will have 84,000 spindles. The supply of electricity will be obtained from the Lancashire Electric Power Co.

Electricity in Building Operations.—At the "Courier" buildings now in course of erection at Dundee there is an electrically-operated derrick, which was erected on the advice of Mr. H. Richardson, city electrical engineer. The derrick, which was supplied by George Anderson & Co., Carnoustie, has a jib 60ft. in length and stands on a gantry 75ft. high. A 15 H.P. motor supplies power, and the average cost works out at five lifts for 1d., the current consumed being $\frac{1}{16}$th of a unit per lift. This is claimed to be more economical than direct steam driving.

Exeter.—Recently a special committee was appointed by the City Council to investigate the charges made as to the professional competency of the city electrical engineer (Mr. H. D. Munro), and as to the management of the electricity department.

At a meeting of the Council on Wednesday the committee reported that they were not yet prepared to report fully upon the general reference, but having regard to the special reference as to the general competency of the chief officer, they presented an interim report. After careful inquiry they were fully satisfied with the competency of Mr. Munro as an electrical engineer, and were of opinion that the electrical engineer should have charge of all the works in connection with the electric lighting undertaking, including mains, and of the electrical equipment in connection with the tramways.

Having regard to the extent of the works and the growth of the undertaking, the committee consider that this is sufficient to fully occupy the electrical engineer's time, and that some other arrangement should be made, by a readjustment of the present staff, with regard to the supervision and control of what may be called the mercantile side of the undertaking, by an officer who should be in direct communication with the committee. They recommended that the matter be again referred to them, in order that they may report upon the general question of the management of the undertaking.

Exhibitions.—Mr. C. Cordingley's (10th) Motor Car Exhibition will be open at the Agricultural Hall, London, from March 18 to 25 inclusive.

An electrical exhibition organised by the Urban Electric Supply Co. is being held at Carn Brea (Cornwall) this week. There is a good display of electric lamps, fittings, cooking and heating appliances, Röntgen ray apparatus, &c. The proceeds will aid the funds of the West Cornwall Miners' Hospital at Redruth.

Farnworth.—The Council have adopted a free-wiring scheme, and have sanctioned the sale of electric lamps at the works.

Faversham.—The Council are recommended to put down additional generating plant at an estimated cost of £4,800. The consulting engineers (Messrs. Talbot & Stevens) will attend the next meeting to explain the extension proposals.

Finchley.—The Council are applying for sanction to a further loan of £23,500 for electricity extensions.

Glasgow.—New wiring rules have been issued by the Corporation Electricity department, and will come into force on May 1.

Hammersmith (London).—The Council decided on Wednesday, on the recommendation of the borough electrical engineer (Mr. G. G. Bell), to substitute enclosed arc lamps for the existing lamps in certain thoroughfares.

Mr. Bell has submitted a plan showing the proposed arrangement of flues, economisers and uptakes for the new boiler house. The scheme provides for a separate steel uptake for each boiler rising just up to the roof of the new house. To prevent nuisance from dust each uptake to be fitted with a special form of dust catcher and supplementary air heater in the base after the gases pass through the economiser. A stand-by fan and engine is to be provided, one at each end of the cold air supply pipe.

The estimated cost of this work is £1,000. The work, in accordance with Mr. Bell's plan, is to be proceeded with.

41,190 units of current were supplied to Olympia during the recent motor exhibition.

Hackney (London).—On the recommendation of the consulting engineer (Mr. R. Hammond) the Electric Lighting committee propose to sink an artesian well, at a cost (including electrically-driven pumps and an overhead storage tank) of £2,000. The quantity of water used by the works in 1904 was 3,300,000 gallons, and Mr. Hammond estimates the annual saving at £1. 10s., with an additional saving of £25 for every further million gallons of water used.

Hull.—The estimates of the Finance committee adopted by the Council last week provide for a contribution of £9,500 out of tramway profits to relief of rates. The estimated gross income of the tramway department is £112,488.

Huntingdon.—Mr. F. J. Warden-Stevens has been requested to report upon and advise regarding an electricity supply scheme.

Ilford.—The Council have decided to pay £2,500 (equivalent to a 2d. rate) to the general district fund out of the profit of £4,500 earned by the tramways last year.

Islington.—The Council last week decided to suspend payment of the increased wages recently granted by the Lighting committee to employés at the electric lighting station until such increases had been reported upon by the Parliamentary and General Purposes committee.

Kilmarnock.—The tramway route from King-street to Riccarton is to be doubled at an estimated cost of £2,300. The Tramways committee have been authorised to purchase three additional cars.

Leeds.—A revised scale of fares and stages will be introduced on the local tramway service on April 1. At present the penny stages vary from 1½ to a little over 2 miles, but it is proposed to have a uniform length of 2 miles. Experimental ½d. fares will be introduced on two sections, a distance of ¾ mile.

The Corporation are about to erect a tramway depot on land recently purchased at Stanningley-road, near Bramley Town End, and on a portion of the same site an electric lighting sub-station, to which current will be supplied from the Crown Point tramway power station, and from whence consumers in outlying districts of West Leeds will be supplied.

Light Railways.—An inquiry will be held on 17th inst. into the application for power to construct a light railway between Maidstone and Headcorn.

"Owing to onerous conditions insisted upon by the local authorities," the Mansfield & District Light Railways Co. have withdrawn their application for an order for extensions.

London County Council.—At Tuesday's meeting

Mr. ALLEN BAKER, replying to questions, said the figures he quoted a fortnight ago as to the cost per car-mile for electric tramways (5½d. to 6½d.) were quoted from an article in *The Electrician*. Since then the chief officer had got out a return for 43 electrical companies and the average cost worked out at 6¾d. per car-mile. As to the Council's tramways, the estimate was 8d., but he was glad to say that, notwithstanding the fact that last year they had set aside £22,120 to write off the temporary generating station, as against the £9,000 they had intended to write off, the actual cost worked out at 7·94d. per car-mile. If they excluded the sum set aside for the temporary generating station the cost worked out at less than 7½d. The chief officer estimated that when the generating station was completed they would save at least 1d. per mile.

Maidstone.—An inquiry has been held into the application of the Council to borrow £6,000 for electric lighting extensions. The town clerk (Mr. S. Lance Monckton) supported the application, and the electrical engineer (Mr. E. E. Hoadley) supplied technical details and presented figures as to the present position of the electricity undertaking.

Manchester.—The Board of Trade have adopted the recommendations of their inspector (Col. von Donop) as to the distances between tramcars when running, and also as to the restriction which shall be placed on the use of certain tramway lines.

Cars in the central parts of the city can approach each other very closely, but in the outer districts a distance of 25yds. is to be maintained.

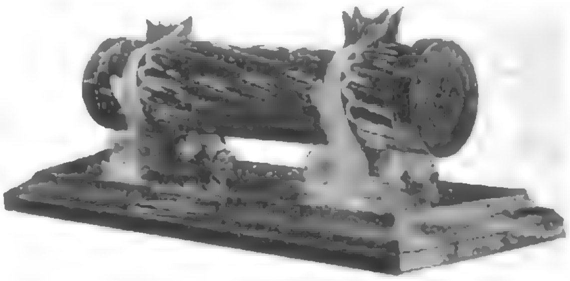
Metropolitan Asylums Board.—The Board are applying for permission to invite tenders from nine selected firms for proposed electric lighting installation, telephones and fire-alarms at the Southern Hospital, approximately estimated to cost £9,000, including £3,000 for underground mains.

Metropolitan District Railway Co. and its Employes.—Friction has arisen between this company and its employés in regard to the proposed changes in their conditions of service when the line is worked electrically.

The directors of the company met yesterday to consider certain representations made on behalf of the men. The contemplated alterations include extensions of the hours of labour and reductions in wages. They have been considered by the men, who have made counter proposals. These counter proposals commence with the proposition that "owing to the great responsibility involved in the general working of the motors, two men should be employed in the motor compartment." As to wages, that motormen shall be paid 8d. per hour for the first year, and 1d. additional per hour for the second and third years, for leading motormen 10½d. per hour. Conductors and motormen's assistants to receive 5½d. an hour for the first year and an additional ½d. each of the two years following. Gatemen to have 4½d. per hour for the first year and 5d. at the end of the first 12 months' service. Nine hours to constitute a day's work, eight hours to be reckoned a day when working overtime, each day to stand by itself, payment of time and a half for Sunday duty and such duty to stand alone, and a guarantee of six days' pay. All trainmen to be allowed annual holidays as at present. Long-service pension or grant on retirement, and a staff train morning and night between Bromley at the one extremity and Hammersmith at the other are also asked for.

Natal Imports.—For the 12 months ended Dec. 31 last the imports into Natal of electrical fittings were valued at £34,000, compared with £60,000 for the previous year. Railway and tramway material stands for £55,000, compared with £57,000 in 1903.

Presentation to Mr. W. S. Andrews.—To celebrate the long association of Mr. W. S. Andrews with the Indo-European Telegraph Co., and as an expression of their regard for Mr. Andrews as a colleague, the Board of Directors of that company recently presented him with a casket and an illuminated address, on the occasion of his severing his connection with the company. An illustration of the casket is shown below. Mr. Andrews' association with the Indo-European Telegraph Co. extends over a period of 34 years. He was managing director of the company from 1884 to 1900, and from that time up to December, 1904, retained a seat on the board. Mr. Andrews' connection with telegraphy has been by no means restricted to the Indo-European Co. From the early 50's he has been in telegraph work, first as acting engineer to the Submarine Telegraph Co. and in cable laying in Danish waters, then as secretary to the British & Irish Magnetic Telegraph Co. In 1860 he joined the United Kingdom Telegraph Co. as manager and secretary, and afterwards became its electrician and engineer. In the negotiations which culminated in the 1870 transfer, Mr. Andrews played a prominent part. He then became associated with the Indo-European Co. as manager and secretary, and in 1884 was appointed managing director. In 1877 he became a director of the Western & Brazilian Telegraph Co., and in 1888 was chairman of the company. On the amalgamation of the Western & Brazilian with the Brazilian Submarine Co., Mr. Andrews became chairman of the combined undertaking (the Western Telegraph Co.), which position he resigned in 1902. He is still a director of the Western Company and is on the board of the London Platino-Brazilian Co. and of the West India & Panama Telegraph Co., which latter company he joined in 1874 and became its chairman in 1897. On the formation of the Amazon Telegraph Co. in 1895 Mr. Andrews was elected chairman.



DESIGN OF CASKET PRESENTED TO MR. W. S. ANDREWS.

Presentation.—On resigning the position of managing engineer to the County of Northampton Electric Power & Traction Co., for a similar position with the Sheerness & District Electric Traction Co., Mr. H. J. Nisbett has been presented with an illuminated address, &c.

Sheffield.—The City Council have decided to apply for Parliamentary powers to run motor vehicles to act as feeders to their tramway system for the carriage of parcels, &c.

A committee was appointed on Wednesday to consider the means of giving a cheaper supply of electric current, to report on the advisability of closing one or more of the existing generating stations, as to the utilisation of surplus heat from the destructors for the production of current, and to report upon the question of electric supply generally.

Southport.—The Electricity committee recommend that arc lamps be let on hire for outside lighting at £1 per annum, and that such lamps be repaired and maintained at £1 each per annum, carbons to be paid for at 4s. 6d per dozen pairs, energy consumed by such lighting not to be deemed to affect the present maximum demand.

Sunderland.—The Council have reduced the price of electrical energy for tramways from 1⅜d. to 1⅛d. per unit, for lighting on the flat rate from 5d. with discount to 4½d. with the same discount, and on the maximum demand system from 5d. and 2½d. to 4½d. and 2½d. An alternative price is offered to small hour motor users of 2½d. per unit for the first hour's use per day in the summer months and the first two hours per day in the winter months, and 1½d. for all units after.

Torquay.—A poll of ratepayers on the proposal to establish new electricity works has resulted in a large majority against.

West Ham.—The Council have adopted a recommendation of the Electric Lighting and Tramways committee to increase the salary of the tramways manager (Mr. H. E. Blain) by £50, with further increases of £50 in August and February.

Wigan.—The Council have appointed the borough electrical engineer (Mr. J. Slevin) as chief engineer not only of Wigan station but also of the station at Pemberton.

Yarmouth.—On Tuesday a cable was laid under the River Yare for the supply of current to Gorleston. The cable has been supplied and laid by Callender's Co. A trench 7ft. in depth was dug by a dredger for the cable.

York.—The Electricity committee recommend that 20 arc lamps in two of the leading thoroughfares be replaced by 28 enclosed arc lamps.

Dinners.—The annual dinner of the *Leeds Local Section* of the Institution of Electrical Engineers took place on Friday last, when About 80 gentlemen were present. The chair was occupied by Mr. W. Emmott, who was supported by the Lord Mayor of Leeds, Mr. A Siemens, Ald. F. Matheson (chairman of Leeds electric lighting committee), Mr. J. McLaren, Mr. G. R. Goldsack president of Leeds Association of Engineers), Mr. E. Brown (Newcastle), Mr. C. D. Taite (Salford), Mr. G. C. Lloyd (secretary of the Institution), and Mr. G. R. Blackburn (Bradford, local hon. secretary).

In giving the toast of "The Institution of Electrical Engineers" the Lord Mayor expressed a hope that Leeds, which stood now third in the list of branches of the parent society, would soon take the second place it used to occupy.

The third annual dinner of the *Eastern Telegraph School's Athletic Club* was held on Thursday last week at the Holborn Restaurant, London, under the presidency of Mr. T. A. Bullock, divisional superintendent. The guests included Mr. A. R. Hardie, Mr. W. Hibberdine, Mr. E. Steer Hodson, Mr. J. T. Crowe, Mr. A. Penney, Mr. J. L. Verne and Mr. F. G. Burrell.

The CHAIRMAN referred to the early days of the club, which was started in a small way and had encountered many difficulties, but had been carefully nurtured by Mr. Burrell and had succeeded in demonstrating its usefulness. The board of directors of the Eastern Companies had, at the instance of the managing director (Sir John Denison-Pender) generously provided the club with fine accommodation at Cricklewood. He had the satisfaction of acknowledging the receipt of telegrams from many of the old schoolboys at London and Lisbon wishing prosperity to the club.

Responding to the toast of his health, Mr. BURRELL, president of the club, attributed its success to the energetic committee over which he presided.

In reply to the toast of "The Guests," proposed by the hon. sec. (Mr. R. Noble), Mr. A. R. HARDIE expressed the pleasure which everyone felt at the good influence the club was exercising on the probationers and upon the service generally, and said the Eastern & Associated Companies were well advised in providing facilities for athletics, which formed an important element in the health and well-being of the men abroad.

Mr. J. T. CROWE proposed "The Chairman," to which Mr. Bullock responded in his own inimitable manner.

The vocal and instrumental programme given during the evening was provided by the members of the club and their friends.

Fulham (London) electricity department held their second annual dinner on the 3rd inst. The chief engineer (Mr. A. J. Fuller) took the chair, and about 70 members of the staff were present. An enjoyable evening resulted, the musical programme being provided by the Council's employés.

Mr. Fuller proposed "The Electricity Undertaking," and said he was able to record a steady increase in output and revenue and a steady decrease in cost of production, and these satisfactory features had enabled the Council to sanction a reduction in the charge for lighting current to 3½d. per unit with a small discount. He thanked his staff and all in any way connected with the department for the loyal support given and interest shown in the enterprise. It was due to the fact that all were pulling together to make the undertaking even more successful that such a state of affairs could be recorded. The toast was responded to by Mr. R. M. Prescott (town clerk) and Mr. Councillor A. J. Warner (chairman of Establishment committee).

The annual dinner of the staff and employés of the *Croydon Corporation electricity works* took place on the 24th ult. The borough electrical engineer (Mr. A. C. Cramb) presided, and presented prizes for the best batting and bowling averages made by the members of the cricket team of the department. Mr. C. W. Salt, who is leaving Croydon for Bradford, was presented with a travelling bag.

The first annual staff dinner of the Anchor Cable Co., Leigh, Lancs., was held on the evening of Feb. 27, Mr. R. H. Harvey, manager, in the chair.

Marriage.—On 1st inst., at St. John's Church, Stanmore, Mr. Frederick A. Cortez Leigh (of Messrs. Lacey, Sillar & Leigh) was married to Dorothy, only daughter of the late Sidney Humbert, of Watford.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1905 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date (to Feb. 22), and the Directorial Division of the new volume has been corrected up to February 11th, 1905. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. The number of large sheet Tables, &c., has been increased, and the 1905 Edition of this indispensable work is offered as the most complete book of the kind ever published.

Among the chief features of the Handbook Division are Notes of the Year on Electric Traction and Electric Power, Turbine Notes, Electric Lamp Notes, Wireless Telegraph Notes (very full), Parliamentary Summary, Legal Decisions, and a complete set of all the chief documents used by Government Departments affecting the Electrical Industry (including the new "Special Mining Rules," issued Feb. 22).

TENDERS INVITED.

Derby Tramways committee require tenders for the supply and delivery of materials and construction of works in connection with the permanent way and electrical equipment of a portion of their authorised electric tramways, and the supply and delivery of cars. Plans, &c., for permanent-way construction from the borough surveyor and engineer (Mr. John Ward) and for the cars from the borough electrical engineer, (Mr. T. P. Wilmshurst). Tenders to the town clerk (Mr. G. Trevelyan Lee), 15, Tennant-street, Derby, by 9 a.m., March 21. Further particulars are given in an advertisement.

Norwich Corporation invite tenders for rubber-covered wires and accessories, underground cables and incandescent lamps. Specification, &c., from the city electrical engineer (Mr. F. M. Long). Tenders (addressed Chairman of Electricity Committee, Electricity Works, Duke-street, Norwich) by 10 a.m., March 20. See also an advertisement.

Great Yarmouth Corporation invite tenders for delivery of surface condenser, with steam-driven air and circulation pumps. Specifications, &c., from the consulting engineers (Messrs. Preece & Cardew), 8, Queen Anne's-gate, Westminster, S.W. Tenders to be delivered at the Town Hall by noon, March 29. See also advertisement.

Salford Electricity committee invite tenders for supply of rubber-insulated fire-resisting cables. Specifications, &c., from the borough electrical engineer (Mr. C. D. Taite). Tenders to the town clerk (Mr. L. C. Evans), Town Hall, Salford, by 18th inst. See also advertisement.

Hornsey Town Council invite tenders for the supply of cables, junction boxes, fuse boxes and meters. Forms of tender, &c., from the borough electrical engineer (Mr. Norman Staniland), Electricity Works, Tottenham-lane, London, N. Tenders to the town clerk (Mr. F. D. Askey), Municipal Offices, 99, Southwood-lane, Highgate, N., by 27th inst. See also an advertisement.

Marylebone (London) Borough Council invite tenders for the carrying out of certain installation work and alterations to existing consumers' installations in the Marylebone district. Specification, &c., from the electricity offices, 11, Manchester-street, London, W. (after 14th inst.). Tenders to the town clerk, Mr. James Wilson, Town Hall, Marylebone-lane, London, W., before 4 p.m., March 21. See also advertisement.

The directors of the *Great Western Railway Co.* invite tenders for supply, delivery and erection of plant at their electricity generating station at Park Royal and proposed sub-stations and distribution centres, including high tension three-phase direct-current switchboards and battery boosters at Park Royal; three-phase static transformers and high and low-tension switchboards at various sub-stations and lighting distribution centres; and high and low-tension, three-phase direct-current switchboards at Royal Oak, Shepherd's Bush and Old Oak in sub-stations ([*a*] three-phase switchboards, [*b*] direct-current switchboards, and [*c*] six motor-driven boosters in connection with storage batteries at Royal Oak and Shepherd's Bush sub-stations). Tenders to the secretary, Paddington Station, London, W., by March 13.

Gloucester Electricity Supply Committee invite tenders for supply and erection of plant at the electricity works, including [illegible] Lancashire boilers and accessories, one 600kw. generating set and accessories, electrically-driven surface condensing plant to deal with 80,000 pounds of steam per hour, steam, exhaust, feed, drain, condensing water and sundry pipes, valves, &c., and an electrically-driven boiler feed pump. Tenders to the town clerk by 1 p.m. March 16.

Edinburgh Corporation invite tenders for supply of stores for their electricity department for one year from May 15, including arc lamp carbons, cast-iron pavement and road boxes, electricity meters, house service fuse boxes, earthenware troughing, bitumen and arc lamp globes. Tenders to town clerk (Mr. Thomas Hunter, W.S.) by March 13.

Shoreditch (London) Borough Council invite tenders for stores for one year from April 1 next, including electric cables and sundries, gas pipe and fittings, engineers' stores, glass, &c., for street lanterns, smiths' and plumbers' work, timber, &c. Tenders to town clerk (Dr. H. Mansfield Robinson), before 3 p.m. March 14.

Plymouth Corporation invite tenders for supply of stores for the 12 months ending March 31, 1906, including electricity meters, transformers and cables (paper insulated). Tenders to borough electrical engineer (Mr. E. G. Okell), by March 18.

Plymouth Corporation also require tenders by 18th inst. for 12 months' supply of lubricating oils, engine-waste, &c., to their electricity department.

Hoylake and West Kirby District Council invite tenders for supply and erection of one 250kw. steam alternator, with piping and accessories. Tenders to chairman of Electric Supply committee before 10 a.m. March 21.

Torquay Electric Lighting committee invite tenders for 1,200 to 1,500 tons of smokeless coal. Tenders to town clerk (Mr. Frederick S. Hex) by noon March 20.

Peterborough Corporation require tenders by 23rd inst. for electric lighting set, Lancashire boilers, superheaters, engines, pumps, feed-water softener, &c.

Keighley Electricity committee require tenders by 10 a.m. 27th inst. for 300kw. direct-current dynamo, high speed engine and Lancashire boiler.

Birmingham Public Works committee invite tenders (by March 20) for special tramway castings and works in manganese steel, with fishplates, anchor pieces and connecting rails.

Glasgow Corporation require tenders by 10 a.m. 23rd inst., for three 1½-ton lorry-chassis suitable for tower waggons for tramway overhead work.

Glasgow Tramways department also invite tenders by 10 a.m. April 5, for stores for one year from June 1.

Bray District Council require tenders by 10:30 a.m. 20th inst. for 12 months' supplies for the electricity works.

Stockport Gas and Electricity committee invite tenders for coal, oil, &c.

Rotherham Corporation invite tenders by 18th inst. for motor-balancer and tramway watering car and track sweeper.

Bolton Corporation invite tenders by March 30 for cooling tower and condensing apparatus.

Gravesend Council invite tenders for stores by March 14 for the electricity department.

Swindon Corporation invite tenders by March 21 for stores for the electricity and tramways department.

Burton-on-Trent Corporation invite tenders by March 14 for a 100kw. D.C. tramway generator.

Leeds Tramways committee require tenders by 15th inst. for supply of stores, &c., for 12 months.

Aston Manor Corporation require tenders by noon 24th inst. for reconstruction of existing tramways and construction of other works.

Johannesburg Council invite tenders for the supply of 30 direct-current arc lamps and 30 lanterns. Tenders to the consulting engineers, Messrs. Mordey & Dawbarn, 82, Victoria-street, Westminster, S.W., by noon March 13.

The *Belgian* State Railway authorities (La Bourse, Brussels) are inviting tenders until 22nd inst. for plant for the electric lighting of the south station at Antwerp.

TENDERS RECEIVED AND ACCEPTED.

Hammersmith (London) Council accepted on Wednesday the following tenders for annual supplies :—

British Thomson-Houston Co., meters (5, 10, 15, 20, 25, 40, 50, 75, 80, 100, 120, 200 and 500 amperes); W. H. Willcox & Co., oils, £95. 16s. 8d.; G. Angus & Co., packing and jointing materials, £131. 5s.; G. MacMillan, rubber goods, £37. 8s.; Jas. Gibb & Co., tools, £99. 19s. 4d., and metals, £174. 1s.; Pimblett & Co., gauge glasses, £10. 0s. 9d., and oilman's goods, £334. 6s. 8d., Mosers (Ltd.), screws, £10. 10s. 7d.; General Electric Co., electrical accessories, £27. 4s. 8d., insulating materials, £74. 13s. 10d., and incandescent lamps, £197. 2s. 8d.; E. Allen & Co., files, £59. 16s. 8d.; Johnson & Phillips, insulated wires, £343. 15s. 5d.; C. R. Heap, carbon brushes, 4s. 8d. per set; Leeds Fireclay Co., firebricks, clay, lime, &c., £146. 8s. 9d.; City Glass Co., arc lamp globes and lamp shades, £48. 16s.; F. Bird & Co., brooms and brushes, £50. 11s.; W. Cory & Sons, Nixon's navigation coal, 11s. 6d., 14s. 5d. and 17s. 5d. per ton; J. Waddell & Sons and Messrs. E. A. Cleeves & Co., anthracite coal, 13s. per ton.

Burslem Corporation have accepted the tenders of Grant & Son for the erection of electricity works and refuse destructor buildings at £3,745 and destructor chimney at £850, and that of Crompton & Co. for switchboard at £598 and for arc lamps at £443.

Chelsea Electricity Supply Co. have accepted the tender of J. Greenwood (Ltd.) for the erection of a new generating station at Manor-street, Chelsea, at £11,865.

Sutton (Surrey) Council have accepted the tender of Kavanagh & Co. for construction of a cooling pond at the electricity works at £328. 13s. 3d.

The City & South London Railway Co. have let a contract to Walter Scott & Middleton for the construction of the extension of their line from the Angel, Islington, to Euston, about 1¼ miles.

The tender of the General Electric Co. has been accepted by the King's Lynn Corporation for a steam dynamo (Belliss engine) with condenser and piping.

Brighton Corporation last week accepted the tender of Siemens Bros. & Co. for the supply and laying of low-tension cables at £2,350.

The tender of J. Richards has been accepted for wiring Leek town hall at £87.

Newton Abbott Guardians have accepted the tender of E. & E. Taylor for an electric lift at £181.

Spennymoor Council have accepted the tender of J. Morgan for an electric bell installation at the hospital at £13. 17s. 6d.

Colchester Town Council have accepted the tender of Davey, Paxman & Co. for an economic boiler at £305 and for pipework at £155.

Salford Town Council have placed an order with S. Dennison & Sons for a 3-ton suspended weighing machine at £19. 10s.

Dover Council have accepted the tender of Dick, Kerr & Co. for four tramcars at £375 each.

British Thomson-Houston Co. have received an order from Stockport Council for supply of tramcars.

Hampstead (London) Council have accepted the tender of J. Gibb & Co. for tools and electrical engineers' stores.

BUSINESS NOTICES.

The Phœnix Dynamo Mfg. Co. have opened a London office at 17, Victoria-street, S.W.

The Electrical Engineer Institute of Correspondence Instruction has been removed to 13, Southampton-street, Holborn, London, W.C.

Geo. Hubert Woods and Randal Beresford Slacke (trading as G. H. Woods, Slacke & Co.), electrical engineers, Blackburn, have dissolved partnership. Debts by Mr. Woods.

BANKRUPTCIES, LIQUIDATIONS, &c.

The public examination took place on Friday of Harold Edward Parris, formerly trading at 184, Upper Thames-street, London, E.C., under the style of the St. George's Electrical Mfg. Co.

Debtor stated he began business as an electrical supply factor in 1900, and took premises in Upper Thames-street in 1903. He attributed his failure to want of capital and to bad trade. Examination closed. Liabilities £215. 2s. 9d., net assets 38s.

A meeting will be held on April 13 at 78, Coleman-street, London, E.C., to receive an account of the winding up of the River Plate Electric Light & Traction Co. (Ltd.).

The Fireproof Electric Switchboard Co. (Ltd.) is to be wound up voluntarily, Mr. Thos. Lomas, 83, Egerton-street, New Brighton, Cheshire, is liquidator.

Military Stores for Sale.—Messrs. Horne & Co., 8, Delahay-street, Westminster, S.W., will sell by public auction at the Royal Arsenal, Woolwich, on 23rd inst., at 11 a.m., by order of the Secretary of State for War, a quantity of obsolete stores, including electric cables, telephones, telegraph instruments, lamps, drawing instruments, a quantity of metals, 20 lathes, &c. On view at the Arsenal on Monday, Tuesday and Wednesday previous to and on morning of sale. Catalogues at the War Office, Pall Mall, S.W., at the Ordnance Office, Tower, E. C., and at the Royal Arsenal, Woolwich. See advertisement for further particulars.

Electrical Apparatus for Sale.—Tenders are invited for the whole of the manufacturing apparatus and stock-in-trade contained on premises situate at Moresk Mills, Truro. Tenders will be received up to March 20 by the liquidator of Headley Limited (Mr. Wm. Rowe), Strand, Falmouth. See also an advertisement.

Plant, &c., for Sale.—A 80 H.P. Babcock-Wilcox boiler is advertised for sale in another column. Applications to Messrs. Tebbitt's, Latona-road, Old Kent-road, London, S.E.

Aldershot Urban District Council have for sale 24 Watson penny prepayment meters for 200-volt circuit. Further particulars from the chief electrical engineer (Mr. F. Garside), electricity works, Grosvenor-road, Aldershot. See also advertisement.

Messrs. White Bros. & Co., High-street, Stratford, have for sale an electric lighting generating set. See an advertisement.

Premises for Sale, &c.—A ground floor, area 2,700 super. ft., equipped with electric power, and suitable for general engineering, is to let. Applications to Messrs. Marshall & Co., Campbell Works, Stoke Newington, London, N. See advertisement.

Some premises at Latona road, Old Kent-road, London, S.E., are to be sold or let. See advertisement.

A corner warehouse near London Bridge station (total area 21,000ft.), with two cranes, lift, electric light, &c., is to be let or sold; also a freehold new factory on the canal, Old Kent-road. Apply to Trustee, 2, Crediton-road, West Hampstead, N.W. See advertisement.

John W. Collis & Co., 148-4, Holborn Bars, E.C., have for sale or to be let on lease some conveniently situated factory premises at Belvedere, Kent. See advertisement.

The Journal.—Part 107 of "The Journal of the Institution of Electrical Engineers" is now ready, price 5s. Particulars of contents are given in an advertisement.

Steam Engine Economy.—Messrs. Willans & Robinson, Victoria Works, Rugby, have prepared an interesting pamphlet entitled "The Economy of the Willans Engine." The textual matter includes particulars of steam trials at the electricity works of Poplar (London) Borough Council and at the electricity works of Blackburn Corporation. The economy of the Willans engine in mill working is shown in a description of a trial at a cotton mill near Manchester and also as illustrating the cost of electric generation at a paper mill at Linwood, near Paisley. That the economy claimed by Messrs. Willans & Robinson for the Willans engine is maintained under working conditions is demonstrated in a separate chapter. Some introductory remarks accompany a number of excellent illustrations, and the results of the various trials are tabulated. Noteworthy amongst these tests is the one carried out at Blackburn Corporation works, under the supervision of Mr. A. S. Giles. The generating set tested was one of three sets, and consisted of a Willans single-acting engine of "3-V" size, directly coupled to a 750kw. Dick-Kerr dynamo. With a boiler pressure of 180lb., 112°F. superheat, a vacuum of 22in. only, and at an output of 775·2kw. the steam consumption per kilowatt-hour touched the remarkably low figure of 18·34lb.

Electric Advertising Devices.—The Electrical Co., 121-125, Charing Cross-road, London, W.C., have recently placed upon the market a "Twinkling Socket" device for advertising sign purposes which obviates the necessity for special installations and so reduces the first cost to a minimum. Advertising by means of electric signs has greatly developed of late years, and there are indications that the demand for apparatus and accessories connected with this development are on the increase. Everything, therefore, which tends to reduce the initial capital outlay will be welcomed by contractors. The twinkling socket can be fixed into an ordinary lampholder for use with incandescents of 10 c.p. or 16 c.p. on 110 or 220-volt circuits. When current is switched on each lamp is cut in and out quickly and continuously at regular intervals of time, so that if a complete sign is fitted with a number of these special sockets an effective result is secured, as each lamp is cut in and out independently of every other lamp, and produces a twinkling or flickering effect.

"**Partnership Assurance.**"—This is the subject of a pamphlet issued by Messrs. C. & E. Layton, giving an analysis of the advantages of partnership assurance, with tabulated illustrations of simple and complicated instances. The author is Mr. T. P. Wansbrough. (Price 1s. 6d.) The death of any member of a firm is apt in many cases to cause serious monetary inconvenience, and sometimes even financial disaster, and the object of this pamphlet is to present a solution of such difficulties. Taking various examples of partnership arrangements, Mr. Wansbrough shows how the partner or his estate would be affected on the death of any member of the firm, and pointing to the course it is advisable to adops in order to protect his capital with due regard to the partnership arrangement. The book should serve a very useful purpose.

"**Mitchell's Press Directory.**"—For 60 years, with unerring regularity, this admirable Press directory has been published, and for the greater portion of this period the introductory address has come from the pen of Mr. Walter Wellsman, who has been associated with the directory from its first issue. "Mitchell's Press Directory" is a more comprehensive book than most of its kind, and, besides being an encyclopædia on the subject of the Press of the universe, is famous for its excellent series of special articles on journalistic topics. The 60th annual issue is in no way behind its predecessors in this respect, for Sir Alfred Harmsworth discourses on "The Daily Newspaper of To-day," Dr. H. Fraser has an instructive article on "The Legal Year in its Relation to the Press," "The Judgment of the Press" is dealt with by Sir Edward Russell, "The Empire and the Tariff Movement" comes under treatment by Mr. E. E. Williams, and the Hon. W. P. Reeves, Agent-General for New Zealand, has a critical review on "The Australian Labour Party and the Empire." The above is but a short leet of the many subjects which come under review in the 1905 Mitchell, and all who may be interested in, or who desire a more intimate knowledge of, the world's Press can be recommended to consult this work.

Catalogues.—The International Steam Pump Co., of New York, have prepared a history of pumping operations upon the Comstock Lode during the past quarter of a century, the object of these particulars being to acquaint mining engineers with the work of the company in the unwatering of mines. The notes are by Mr. C. G. P. de Laval.

Messrs. J. H. Holmes & Co. have prepared a list of ship and yacht lighting installations which they have carried out.

A catalogue of Hellesen cells is to hand from Fuller, Macleod & Co., Norfolk House, Laurence Pountney-hill, London, E.C., who are sole British agents for Hellesens Enke & V. Ludvigsen, the makers of these cells, of Copenhagen. The catalogue contains particulars of a practical cell tester, claimed to be a time and labour saving device, and specially designed for use by telephone engineers. The catalogue is interesting beyond the ordinary in that the particulars given concerning the cell are very complete.

A new catalogue of electrical supplies is to hand from the Western Electric Co. of America. In this catalogue a large variety of apparatus, accessories and material is listed, specially designed for use in railway work.

The "Excello" intense-flame arc lamp is the subject of a circular list now being issued by the Union Electric Co., 151, Queen Victoria-street, London, E.C. A number of these lamps have been installed in prominent positions in the City of London, and they are specially recommended for street lighting and the illumination of large areas.

Imports.—The following are official values of imports of electrical machinery, material and apparatus into this country during February:—Electrical machinery, £31,396 (a decrease of £17,571 compared with February, 1904); telegraph cables and apparatus, £11,235 (increase £8,850); other electrical goods, £80,097 (increase £15,341). The total values of imports of the three classes for the two months ended Feb. 28 last were, respectively, £78,321 (increase £17,580), £17,148 (increase £10,414) and £156,493 (increase £17,063).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from March 1 to 7, with the ports of destination:—

Africa—Alexandria, £252; Cape Town, £248 (including £9 telegraph material); Durban, £929 (including £33 telegraph material); East London, £406 (including £381 telegraph material); Port Elizabeth, £486; Sekondi, £1,522; Sierra Leone, £44 (telegraph material). *Argentina*—Buenos Ayres, £967 (including £90 telegraph wire). *Australasia*—Adelaide, £10; Lyttleton, £200; Melbourne, £207, and 71 cwt. telegraph wire; Perth, £153 (including £15 telegraph material); Sydney, £169; Wellington, £157. *Belgium*—Ostend, £10. *Brazil*—Bahia, £150. *Canada*—Toronto, £38. *Ceylon*—Colombo, £215. *China*—Shanghai, £459. *Dutch Guiana*—Surinam, £58. *France*—Paris, £400. *Germany*—Hamburg, £64. *Gibraltar*, £5. *Holland*—Amsterdam, £81; Rotterdam, £22. *Hong Kong*, £220. *India*—Bombay, £3,703; Calcutta, £1,589; Madras, £48. *Japan*—Kobe, £120; Nagasaki, £1,850; Yokohama, £489. *Portugal*—Lisbon, £19. *Russia*—Reval, £2,009. *Siam*—Bangkok, £157. *Spain*—Grenada, £10. *Straits Settlements*—Penang, £520 (including £67 telegraph apparatus and instruments); Singapore, £415 (including £176 telegraph material). *U.S.A.*—New Plymouth, £450. *West Indies*—St. Thomas, £15,735 (telegraph cable). Total £34,586, against £11,674 in the corresponding week last year (March 2 to 8).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"The Insulation of Electric Machines." By H. W. Turner & H. M. Hobart. (London: Whittaker & Co.) 10s. 6d.

"Fortschritte der Electrotechnik." Edited by Dr. Karl Strecker. No. 2. 1904. (Berlin: Julius Springer.) 7m.

"Leçons sur l'Electricité." By E. Gerard. Vol. II. 7th edition. (Paris: Gauthier Villars.) 12fr.

"Proceedings of the Royal Society." Vol. LXXIV. No. 504. February, 1905. (London: Harrison & Sons.) 2s.

"Building a Lathe." By A. W. Burford. (London: Dawbarn and Ward.) 6d.

"Proceedings of the American Institute of Electrical Engineers." February, 1905. (New York: The Institute.) 50c.

"Practical Methods of Electro-Chemistry." By M. F. Perkin. (London: Longmans, Green & Co.) 6s.

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

December 30, 1904.

28,968 Maschinenfabrik Oerlikon. Series commutator motors for single-phase alternating current. (Date applied for, Feb. 29, 1904, date of application in Switzerland.)*
29,001 J. Van Aerschot. Electric railway conduit systems.*
29,004 C. Mackintosh. Electric railways and tramways.
29,014 R. Lonoden. Switches.
29,015 Siemens Brothers & Co. and P. G. Ledger. Automatic control of overloads in electric circuits.
29,054 C. Schwabe. Liverpool. Incandescent lighting devices.*
29,057 M. Meirowsky. Liverpool. Insulation.
29,058 L. Renault. Terminals. (Date applied for, May, 1904, date of application in France.)*
29,059 L. Renault. Electric ignition plugs for internal combustion engines. (Date applied for, May 2, 1904, date of application in France.)*
29,063 E. Giraud. Insulators of overhead conductors. (Date applied for, April 14, 1904, date of application in France.)*
29,064 E. Giraud. Safety devices for overhead conductors. (Date applied for, April 14, 1904, date of application in France.)*
29,065 H. W. Butler. Dry batteries.
29,074 J. A. Rey. Metal reflectors for electric lanterns.
29,079 G. G. M. Hardingham. (V. Arcioni, Italy.) Electric current measuring and recording apparatus.
29,092 P. Marical. Electrically-propelled automobiles.
29,107 R. H. Davis and A. Graham. Telephones for diving, &c.
29,118 E. H. Fairbanks. Insulator supports.*
29,125, 29,126 and 29,127 L. K. Joh. Automatic electric advertising devices.
29,129 W. Blackmore. Electromagnetic separators.
29,138 C. A. Day (Empire State Dry Battery Co., U.S.). Dry batteries.
29,142 and 29,143 J. S. Stone. Space telegraphy. (Date applied for, Feb. 23, 1904, date of application in U.S.)*
29,144 and 29,145 J. S. Stone. Space telegraphy. (Date applied for, April 11, 1904, date of application in U.S.)*
29,146 J. S. Stone. Support for use in space telegraphy. (Date applied for, May 3, 1904, date of application in U.S.)*

December 31, 1904.

29,187 H. Guillon. Electric igniters for explosion motors. (Date applied for, Jan. 2, 1904, date of application in France.)*
29,233 Albion Motor Car Co. and T. B. Murray. Glasgow. Low-tension electric ignition devices for internal-combustion motors.*
29,259 E. P. Melancthon Eldridge. Charging plug and leads for charging accumulators from the lampholder on any direct-current circuit.
29,281 J. Gunning. Opening and closing circuits at pre-determined times.
29,307 A. Frey. Switches for incandescent lamps.*
29,308 G. F. Anderson. Detection and recording of electrical impulses or oscillations and apparatus therefor.
29,310 A. Loehl. Electrical dumb-bells and similar appliances for physical exercises.*
29,337 G. E. Gaiffe. Protection of electrical apparatus on circuits traversed by currents of high frequency.
29,343, 29,345 and 29,345 H. L. Down and D. H. Wiseman. Electrical gas-igniting and extinguishing apparatus.
29,347 G. Stern. Transformers.*
29,353 L. J. Hunt and Sandycroft Foundry Co. Liverpool. Rotary converters.
29,354 G. Grabosch. Liverpool. Transmitting electric signals or impulses.
29,363 H. H. Lake. (V. Arcioni, Italy.) Electric measuring instruments.*
29,368 H. W. Sullivan. Induction coils.
29,369 H. W. Sullivan. Relays and recorders.
29,377 M. B. Field and Ferranti (Ltd.). Fuses for electrical circuits.
29,384 E. B. L. Morris. Alarms, particularly burglar alarms.
29,386 F. Gutzmann. Electrical generators having double T-shaped armatures.*
29,397 and 29,401. H. H. Lake (W. L. Bradshaw, A. Keough, M. Keough and J. Keough, U.S.). Pendent electric fixtures.*
29,408 L. Renault. Current distributors for electric ignition devices of internal combustion engines. (Date applied for, Sept. 23, 1904, date of application in France.)*
29,417 D. Cook. Electro-magnetic machinery.
29,422 A. T. Dawson and G. T. Buckham. Electrical apparatus for transmitting and receiving signals.
29,428 P. Ribbe. Automatic photographing telegraphs.*
29,429 P. Ribbe. Synchronising systems.*
29,435 and 29,436 Siemens Brothers & Co. Alternating current collector motors. (Siemens Schuckert Werke, Germany.)
29,437 J. A. Torrens. Electric ignition for internal combustion engines.
29,438 J. H. Gray. Electrical measuring instruments.
29,463 O. Konitzer. Arc lamps.
29,487 G. F. Anderson. Space telegraphy and apparatus therefor.
29,504 N. A. Smith. Galvanic elements.
29,516 H. G. Turnell. Automatic circuit breaker or cut-out for overhead tramway systems.
29,529 F. Vollmer. Telephone systems.
29,531 F. S. Holmes. Electrical signalling apparatus. (Date applied for, March 25, 1904, date of application in U.S.)*
29,532 F. S. Holmes. Electrical signalling apparatus. (Date applied for, March, 1904, date of application in U.S.)*
29,538 J. E. Bemiller and E. C. Weisensale. Electric circuit closer for fire alarms. (Date applied for, May 7, 1904, date of application in U.S.)*
29,607 Bruce Peebles & Co. and A. C. Peebles. Liverpool. Liquid resistances.
29,613 G. Hookham. Electrolytic meters.
29,627 C. Shore and C. Heap. Manchester. Electrical fire alarm.
29,645 W. G. Inglefield. Manchester. Telephone and like plug cords.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each

1904.

1,860 Boardman. Conductors of electric railways or tramways.
2,285 Green. Apparatus for polarisation of Hertzian waves. (Date applied for, Jan. 29, 1903.)
2,288 Wilson and Marshall. Electric signalling apparatus.
2,450 B.T.-H. Co. (G.E. Co., U.S.). Controlling switches and cut outs.
4,874 Kilbourne and Flower. Trolley poles.
6,362 Veulle. Contact breakers for internal combustion motors.
5,582 Wilson. Electrostatic wattmeters or watt-hour meters.
5,731 Howorth. (A.G. "Magneta" Electrische Uhren ohne Batterie und ohne Contacte.) Electrical regulating devices for clocks.
6,792 Leitner. Preliminary treatment for accumulator plates.
6,857 Dick. Electrical switching apparatus.
6,878 Eckstein and Coates. Electrical ignition apparatus.
7,061 Leeds Cooper Works and Jobling. Electro-depositing apparatus.
7,317 Simms. Magneto-electric machines.
8,139 Barlow. Bayonet joint for electric lamps.
9,964 Centner. Electrical percussive drill.
12,206 Rees. Sparking mechanism for internal combustion engines.
13,463 Werner. An electric block signal system.
15,526 Drexler. Electro-pneumatic actions for keyboards.
19,525 Baumann. Electro-motors. (Date applied for, Sept. 12, 1903.)
22,404 Kirwan & Quaney. Preventing broken trolley wires from falling.
25,948 Soc. Electro-Métallurgique Francaise. Manufacture of steel. (Date applied for, July 8, 1904.)
26,262 Scholl. Magnetic separating apparatus.
26,285 Abel. (Siemens & Halske A.G.) Rotary-field electricity meters.
27,000 Lindquist. Switches and electromagnets therefor.
27,076 Abel. (Siemens & Halske A.G.) Electrical signalling apparatus.
27,114 Virgin. Operating gear for moving rail and conductor points.
27,862 Gardiner. Accumulators.
27,865 Blackmore. Reducing aluminium and other metals.

COMPANIES' MEETINGS AND REPORTS.

City of London Electric Lighting Co. (Ltd.)

The fifteenth ordinary general meeting was held on Wednesday under the presidency of Mr. J. B. Braithwaite, jun. (Mr. George Herring, chairman of the company, being abroad).

The MANAGER and SECRETARY (Mr. J. Cecil Bull) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: You will see that our chairman's forecast last year that an additional dividend would be possible this year has been borne out by the result, and that is mainly owing to the exertions of our engineering staff and the success they have attained in further reducing the cost of generation of the electricity we sell. I think it an extremely satisfactory thing that we are able year after year to provide for the additional plant and the increase of our mains out of net revenue. I am in hopes that we shall be able to continue that policy, unless we have to incur any great capital expenditure in connection with any of the new powers that we are seeking to obtain. We have spent on plant £19,831, on mains £26,720, on transformers and buildings about £3,600, and at Southwark, on mains, &c., £4,171, making a total for the year of £56,203. With regard to reserve, we are continuing the policy of placing considerable sums to that account. We are placing this year £45,500 to leasehold redemption account, or about £5,500 more than we are distributing to the ordinary shareholders, so that we are not starving the property in order to pay higher dividends. The total revenue for the year is £221,671 from sale of current, against £211,186 last year. The revenue under contracts remains nearly the same—£13,449 against £13,277. Meter rentals have gone up owing to the increase in the number of customers, and other items have increased, the total result being that the revenue is £255,087, against £242,101. Sales of current have reached 17,621,110 units, against 14,806,469 in 1903. The total cost of generating these additional units was inside £1,000, or only 0·076 of a penny per unit. A considerable portion of the extra demand was for motive power, which gives us a better load-factor than for lighting. With regard to the increase in our lamps and connections, we have made a very satisfactory increase both in number of customers and in number of lamps connected. The former have increased by 361 and the latter by the equivalent of 87,000 8 c.p. lamps. Last year we increased to the extent of 66,000 8 c.p. lamps, so that we have not only maintained the increase, but have improved upon it. The net result is that we have earned the extra 1 per cent. dividend on the ordinary stock without diminishing our contribution to reserve or depreciation, and without reducing the balance carried forward. As I have said, this reflects great credit on the engineering staff for the manner in which they have been able to further reduce the costs of generation. This is the more satisfactory in view of the fact that the price we get for our current continues to fall. We have received only 3½d. on the average in the past year, a reduction of nearly ½d. per unit, I think, as compared with 1903.

I do not think there is any other point with regard to the report to which I need call attention especially. But there is one matter which has occupied a good deal of attention in the newspapers. I mean the great £5,000,000 power scheme, as it has been called. We are taking all necessary steps to oppose this scheme, and without leading you to be unduly sanguine, I think we have some reason to hope our efforts will be successful. This new company comes along, and does not propose to take the responsibility of supplying lighting, but only to supply power in bulk to other authorised users. They also ask to be exempt from the purchase clause, and generally for easier conditions than those our company is working under. And all the hope held out in return for these concessions is that they will be able to supply current cheaper. My belief is that that is a fallacious hope. I cannot see that such a company can buy coal cheaper than we can, or put in more efficient engines or machinery than we have put down at our works. We have, moreover, this great advantage, we are comparatively close to our customers, whereas they propose to go a considerable distance out of London, and they will necessarily have to bear a considerable loss in the transmission of the electricity from the generating station to the place where it is to be used. Then as to large units of plant, it is true that a station generating 15,000 H.P. or 20,000 H.P. can produce electricity cheaper than one doing 3,000 H.P. or 4,000 H.P., but there is a point when any increase in size ceases to produce any corresponding economy in the price of the current generated. In my opinion the figures which are being put forward will lead to great disappointment if the company ever get the powers they are asking for. I now move the adoption of the report and accounts.

Mr. F. W. REYNOLDS seconded the motion, which was carried unanimously.

Resolutions approving the dividends set out in the report, re-electing Mr. George Herring as a director and re-appointing the retiring auditors were then passed, and a hearty vote of thanks to the chairman, the directors and the whole staff of the company terminated the proceedings.

Notting Hill Electric Lighting Co. (Ltd.)

The eighteenth ordinary general meeting was held on Tuesday, under the presidency of Sir William Crookes, F.R.S.

The SECRETARY (Mr. R. G. Rawkins, F.C.I.S.) having read the notice calling the meeting and the report and certificate of the auditors,

The CHAIRMAN said: Gentlemen, this is the seventeenth time on which I have had the pleasure of presiding at your general meetings, and of presenting our report and the accounts. On this occasion the pleasure is greater inasmuch as the past year has been a record one in the advance the Company has made since its incorporation, and the present position is eminently reassuring and satisfactory. With regard to our capital expenditure during the past year, we have had to spend nearly £8,000, the largest item being £3,973 for a new battery of accumulators. The next largest item is for new mains, a little over £2,000 having been spent for this purpose. The £663 spent on new buildings was principally to house the new battery of accumulators, and the £505 for new machinery mainly represents the cost of a booster required to deal with the current stored by the accumulators. New meters have cost us £540, and this item of expenditure must keep pace with the increase in the number of our customers. The total capital expended now amounts to £224,267 6s. 9d. The credit side of this account shows that we have received during the year the sum of £9,000 from the issue of debentures, making the total capital received £208,000. The balance of £16,267. 6s. 9d., which we have expended in addition to this, has been provided by employing the reserve funds in the Company's business. The result of our year's working is eminently satisfactory, the increase in revenue and net profit being in advance of any previous record of the Company. Revenue has increased, the net profit has increased, the amount placed to reserve has been more than doubled, while perhaps the most satisfactory increase from the shareholders' point of view is the increase in the dividend. On the other hand, there has been no corresponding increase in the expenses as economies have been effected all round. This is clearly indicated by the fact that, although the net profit has increased by £4,872, or 32 per cent., the expenses have increased by only £293, or 2 per cent., and this increase is wholly accounted for by the larger amount paid in rates. This item is assuming very large bulk, but I fear under the present law we can look for no amelioration. In regard to our purchases of electricity from the Wood-lane works, here also economies have been effected, and last year we purchased 1,900,000 units against 1,550,000 the year before, at a considerable saving, and we hope still further to reduce the cost of production. The net revenue account shows that the total profit for the year was £19,890. 9s. 5d. From this we must deduct the amount credited to the depreciation fund, debenture interest, and also the interest and sinking fund on the Kensington and Notting Hill joint debenture stock, leaving a balance to be divided of £11,663. 3s. 9d., being more than £3,000 above the balance available for division in any previous year. Depreciation, renewal and reserve fund account now stands at £20,500, and nothing has been charged against this fund during the past year. On the other hand, it has been credited with the sum of £2,750 out of last year's profits, as against £1,250 on the previous occasion. At the end of last year we had connected to the mains 2,267 customers with the equivalent of 132,132 lamps of 8 c.p., comparing with 2,052 and 116,360 in 1903. At our meeting last year I ventured to predict an increase in the revenue of about £4,000, and that practically the whole of this would be additional profit. This figure, however, has been exceeded, principally owing to the heavy fogs during the latter part of December, the actual increase being £5,120 in revenue and £4,872 in net profit. You will be glad to hear that the rate of progress is being maintained this year. When I addressed you last year there was only a very small advance to report over the previous 12 months, owing to the reduction in price charged to consumers. This had a material effect on the business during that year, and stopped our rate of increase in profit for the time being, but I think we were justified in the reduction as we now are reaping the benefit of the increased business obtained by so doing, and it has enabled us to keep on good terms with our customers. I must not conclude without mentioning that our thanks are due to the staff for the manner in which they have carried out their duties throughout the year, and for thus enabling us to present you with so satisfactory a report. I now move the adoption of the report and accounts, and the payment of the dividends and bonus therein recommended.

Mr. MARTIN, M.P., seconded the motion, which was carried unanimously.

The retiring directors (Mr. A. E. Franklin, J.P., and Mr. J. T. Jervis) were re-elected, as were the shareholders' auditors, and a very cordial vote of thanks to the chairman, directors and staff terminated the proceedings.

W. T. Henley's Telegraph Works Co. (Ltd.)

The twenty-sixth ordinary general meeting was held on Monday, under the presidency of Mr. Sydney Gedge.

The SECRETARY (Mr. A. E. Salmon) read the notice calling the meeting, and the auditors' report having been read,

The CHAIRMAN said: Gentlemen, there are various subjects of congratulation in the report of our last year's work. You will remember that last year, after paying 20 per cent. for the previous three years, we reduced the dividend to 15 per cent., and it was then right and necessary for me to go fully then into the matter, and with the addition of the assistance given to me by Mr. Sutton, the Managing Director, in seconding the report, to show you why it was that our dividend had been reduced, and to state our views as to the prospects of the Company. We are again asking you to sanction the declaration of a dividend of 15 per cent., and, having regard to the general commercial, and especially the general industrial, depression which has not entirely passed away, and to the fact that the capital upon which dividend has to be paid, both preference shares and ordinary shares, has been considerably increased, I think you will have no reason for complaint that the dividend is again only 15 per cent. Our hope is that we shall at least be able to keep up that dividend, but as I find that when I ventured into prophecy last year I was not altogether successful, I will abstain from doing so this year. The points on which I was not successful in prophesying last year were that the keen competition and depression of trade would not continue. I cannot say that the depression has passed away, nor that the keen competition has not continued. Nevertheless, we hold our own, partly by the aid of our new works and partly by continuing that which has been our rule from the commencement of our existence – namely, of giving as good work as we possibly can give. Another prophecy I made last year was in expressing the hope that our new works at Greenwich would be completed and ready to earn money for us by the present time. I regret, however, to say that various circumstances have delayed their completion, and I fear that another six months will elapse before they will be able to earn any money for you, although, when once they are started, we hope to do very good business with them. In speaking of the dividend recommended of 15 per cent. as the same, you will remember that it is not only paid upon a larger capital, but that a portion of that capital – and a considerable portion of it – will not be earning anything for us until, say, next autumn; and, therefore, we are paying a dividend on capital which up to the present is not earning dividend. All that makes the 15 per cent. the more creditable and the more enjoyable. I now move the adoption of the report and accounts. You will see that our share capital has increased from £350,000 to £400,000, the reserve has increased from £100,000 to £120,000, and that £5,000 has been put to machinery and plant renewals account, which is, in fact, ear-marking a portion of the reserve account for a particular purpose. Our assets have increased with our capital. We have £50,000 more capital on which to pay a dividend, and we received £25,000 for the premium upon that capital, making £75,000 additional money. Our assets, however, have increased by the amount of £79,720, so that the additional money is well represented by the assets. I should like to add that in 1903 it took £34,250 to pay the dividend of 15 per cent, but this year, by reason of the greater part of the capital having been paid up, it has taken £39,000, and next year it will take £40,000. It is not only, therefore, the fact that we pay the same dividend, but it has cost this year £4,750 more to do it, all of which has been fairly earned.

The MANAGING DIRECTOR (M. George Sutton), in seconding the proposal for the adoption of the report, said: The year which has passed has been one of general industrial depression, and I may say that the cable trade particularly has felt the depression. We have had a capacity of production in this trade far in excess of the demand, and that, of course, means a great struggle to get business for the various cable-making companies and a corresponding reduction in profits. There have, however, been indications during the first two months of this year that the trade of the country, as far as the electrical industry is concerned, is reviving. We are now getting more inquiries and more orders, and I think we have reasonable ground for hope that the current year may be a better year for trade than the past year was. The competition which we have had in the past year of course brought a great deal of anxiety to the managers of the business. It is not simply the low prices that we have received, but the high prices that we have paid for raw materials. One may usually assume that when you get low prices for your manufactured articles you are going to buy your raw materials cheaper, but with regard to some of the staples this Company deals with we have had to pay prices which are higher than any recorded in the past. We have, therefore, been hit on both sides—by lower profits and higher costs. I may say that that state of things has caused a great deal of anxiety to the managers, and it has entailed very hard work on all concerned in the conduct of your business; and I take this opportunity of publicly thanking the staff of this Company for the endeavours they have made to second the efforts of the managers throughout an anxious year—a year which, although full of anxieties, I consider has been a very successful one, and one upon which I can congratulate the shareholders. I do not know that I should be going too far in saying that, although it is not the year of the largest dividend and not the year of the largest profits, it has been the most successful year's trading the Company has ever had, taking all the circumstances into consideration. There is one point, gentlemen, to which I should like to refer—to which I must refer: it is due to myself as your Managing Director that I should refer to it. I like you to know what my views are on the conduct of the business, so far as it is necessary to give them to you, and as I hope to have some large voice in the business for a good many years, I think I ought to refer to this point. It is that I am not in entire accord with the majority of the Directors with respect to the dividend recommended for your acceptance. I am aware that I am, perhaps, taking an unpopular side in this, for shareholders like large dividends. Looking at the future and at the engagements the Company is entering upon with respect to the new works, the expenditure of capital, &c., I thought that a smaller dividend—say 12½ per cent.—would have been a welcome dividend to the shareholders. I just mention this so that you may know my opinion on the point. I would not ask this meeting not to adopt the recommendation of the Board with respect to the dividend. It has been earned, we have the money, and it can be paid. As bearing on the subject of this dividend, I should like to say a word with respect to my view of the reserve. The reserve that we have is invested, as you are aware, in the business of the Company. That means that for every £1,000 you put to the reserve account we require £1,000 less borrowed or share capital. I am one of those who think that while the Company can pay reasonable dividends, the cost of the extension of its operations should, as far as possible, be paid for out of revenue. I now have the pleasure of seconding the adoption of the report.

Mr. WONTNER enquired the method on which the stocks on hand were valued.

The MANAGING DIRECTOR, in reply, stated that the raw material and the partly-manufactured material were all valued by the works manager in conjunction with his foremen and principal clerks, and the manufactured material was valued in London. He was personally responsible for the prices of all manufactured articles, but there were others who were responsible under him. He supposed that there was not a stock book in the kingdom that was not more carefully kept and checked than were the stock books of their Company.

The motion was then carried unanimously, as were resolutions approving the dividend, the re-election of Mr. Gedge as a Director, the re-appointment of the auditors, and a cordial vote of thanks to the Managing Director, the Secretary, and the staff in London, the provinces and abroad for their valuable services. A hearty vote of thanks to the Chairman terminated the proceedings.

British Electric Transformer Co. (Ltd.)

The second ordinary general meeting was held on Monday at Salisbury House, London-wall, London, E.C., Mr. E. PHILLIPS presiding.

The SECRETARY (Mr. J. C. Wrist) read the notice convening the meeting.

The CHAIRMAN, in moving the adoption of the report, congratulated the shareholders on the satisfactory position disclosed by the accounts, and observed that there were not many engineering companies able to present so favourable a balance-sheet at the end of two such bad years as those which had been experienced since the inauguration of the Company. The prospects were very satisfactory, as the orders received since Jan. 1 were far in excess of those received in the corresponding period of the year under review. Dealing with the accounts, he said that the temporary loan from the Company's bankers had been paid since Dec. 31. The item of fees and expenditure in respect of additional patents, £1,373, was explained by the fact that Mr. A. F. Berry, who had a very large interest in the Company, had presented them with certain patents which had already proved of value. In return the directors reimbursed Mr. Berry his out-of-pocket expenses in connection with the matter. Their testing shop was thoroughly equipped, so that orders received could be passed through efficiently and quickly. The Company would be quite independent of outside sources when the arrangements made by the directors for the supply of power were completed. The debts due to the Company were a large amount—£25,159, but of this sum £14,326 had been received since Jan. 1, and as the customers were principally corporations and companies, working under special Acts of Parliament, the board had no anxiety about the balance. The profit and loss account showed that the general charges were heavier than those of last year. The net profit, £12,030, added to £1,572 brought forward, gave a total available balance of £13,603. The directors had put £1,500 to depreciation reserve, more as a matter of precaution than of necessity, because the buildings, &c., were kept in a state of thorough repair out of revenue and the machinery was of a nature not likely to depreciate to any great extent. The reserve fund (which added to last year amounted to £4,000) would be available for equalisation of dividend or any other purposes, but he hoped that the Company would be able to add to the amount year by year. The profit divisible would allow of a larger dividend than 7½ per cent., but the directors thought the shareholders would agree that it was more prudent to carry forward a substantial balance than to divide up to the hilt. The works had been fully occupied during the whole year and overtime was still necessary. The Company had recently obtained a large order for transformers from Johannesburg municipality, and had also executed orders for South Africa, South America, Australia and China. Competition was still very keen, but the Company had been able to hold their own against all competitors. During 1904 the value of the output of the works was 50 per cent. in excess of that of 1903. The profit of £12,030 earned during 1904 was very nearly 20 per cent. greater than that earned during 1903. The orders consisted now more than formerly of transformers for power purposes, and as this necessitated larger transformers, heavier machinery and appliances had been installed, and the works adapted to the altered conditions of the work required of them. At the conclusion of his remarks the Chairman complained of the practice of certain outside people who flooded the shareholders with circulars offering shares of the Company at prices at which they would not deliver them. He had known many cases within the last few months where endeavours have been made to purchase shares so offered, but when it was found that a buyer existed no shares were forthcoming.

Mr. A. F. BERRY seconded the motion.

The CHAIRMAN, replying to questions, stated that there had not been a single difference of opinion on any important question during the year. A notice was about to be sent out that if the calls unpaid were not met within a certain time, in accordance with the articles, 10 per cent. would be charged. Negotiations were still going on with regard to the French company. The Company had no monetary interest in that concern, but within the next month or two he hoped they would make satisfactory arrangements for giving the French Company a licence to work the patents.

The resolution was carried unanimously.

The CHAIRMAN then moved the approval of a dividend for the year 1904 of 6 per cent. on the cumulative preference shares (already paid), payment of a dividend of 7½ per cent. on the ordinary shares and the allocation of the balance of profit as recommended by the directors.

Mr. A. M. BILLINGTON seconded the motion, which was adopted.

Mr. A. F. BERRY was re-elected a director, and the auditors were reappointed.

BRITISH ENGINE, BOILER & ELECTRICAL INSURANCE CO.—At the meeting on Friday Mr. M. Longridge congratulated the shareholders upon the continued progress of the company. Among the best fire insurance offices the ratio of losses to premium income was about 60 per cent., and the ratio of office expenses, including salaries, about 30 to 35 per cent., whereas in their case these figures were approximately reversed, the larger percentage being spent mainly upon inspection for the prevention of damage, and the smaller percentage for payment of claims, including the numerous mishaps to steam and gas engines, and the still more numerous breakdowns of electrical machines. The amount paid for damage to boilers in 1904 was nearly three times as great as in the preceding year, but this was not due to explosions or to inefficient inspections, but was due to a dry season causing trouble with the water supply. There had been no explosion of any boiler insured by the company during the year. It was a matter for personal gratification to him to know that the system of periodical inspection of boilers, first organised 50 years ago by his father, had done so much both to prevent explosions and to bring about improvements in details of construction and in conditions of working. The same system had in these later days been applied both to steam, gas and oil engines, and to electrical plant, and while it was impossible with such much more complex structures to reduce the number of mishaps to the same extent as with boilers, it was satisfactory to observe the educative effect upon owners and attendants of the regular visits of the company's inspectors. After carrying £6,000 to reserve and writing £500 off furniture and instruments account the directors recommend a bonus of 1s. per share in addition to the usual dividend of 3s. per share, leaving £3,127. 6s. 2d. to be carried forward.

CITY OF CARLISLE ELECTRIC TRAMWAYS CO. (LTD.)—At the recent meeting Mr T. D. Lingard said the high price paid to Carlisle Corporation for electric energy militated against the success of the company, and the experiment to continue running a 10 minutes' service in winter instead of a quarter-hour service also mulcted them in an expenditure of over £600 to make £200 in extra fares. Try as they would, the Corporation would not reduce the cost per unit, which was much in excess of what other tramway companies paid elsewhere. It was the desire of the company to accommodate the citizens, but it was absolutely impossible to continue the 10 minutes' service while the Corporation were so exacting in their prices.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The report for 1904 states that capital expended during the year amounted to £83,503. 16s. 2d., bringing the total expenditure on the London district to £1,393,592. 16s. 1d. Balance from last account was £5,255. 7s., and after deducting all expenses the balance from revenue account is £85,279. 3s. 2d., making together £90,534. 10s. 2d. Interest absorbs £32,297. 6s. 2d., interim preference dividend £8,568. 15s., interim ordinary dividend £7,616. 13s. 4d., and £19,150 is carried to reserves. This leaves for further distribution £22,901. 15s. 8d., and the directors recommend payment of the balance preference dividend and a further dividend on the ordinary shares to Dec. 31 at the rate of 5 per cent. per annum (making 4½ per cent. for the year), less tax. This will absorb £18,050, leaving £4,851. 15s. 8d. to be carried forward. Application has been made for a provisional order for Croydon Rural District, which adjoins the company's southern areas. The company is promoting a bill in Parliament for powers to interconnect its London stations, to obtain compulsory powers for acquiring lands, and to supply energy in bulk to authorised undertakers.

The profits derived from the company's London stations for 1904 amounted to £92,730. 19s. 6d., against £73,423. 11s. 6d. in 1903, an increase of 26·29 per cent. The percentage of working expenses to revenue from sale of current fell from 50·6 to 45·3 per cent. Applications for connection to the company's mains up to Dec. 31 were equivalent to 647,711 8 c.p. lamps, an increase of 118,855 lamps, against an increase of 112,564 lamps for 1903. Included in these figures are 865 users of motors aggregating 7,811 H.P., an increase of 1,974 H.P. for 1904. The total units sold were 7,181,309, against 5,754,633 for 1903.

HOVE ELECTRIC LIGHTING CO. (LTD.)—The report for 1904 states that the net profits have increased from £11,215 in 1903 to £11,807. There are 1,236 houses connected, representing an equivalent of 82,968 8 c.p. lamps, against 1,148 houses and 77,366 lamps in 1903. 820,781 units were sold, against 779,985. After placing £3,000 to reserve, a dividend at the rate of 10 per cent. per annum for half-year is declared (making 8½ per cent. for the year).

LANCASHIRE ELECTRIC POWER CO.—At the meeting last week Mr. F. E. Gripper said the company was now about commencing operations. The generating station at Radcliffe was practically completed. The company had started laying mains, and by the time supply could be given from the station one section will be ready for use. The company had entered into agreements with the Councils of Swinton and Pendlebury and Westhoughton for a supply of energy, but the company would, at the request of the Councils, also act as their distributing agents. Negotiations were proceeding with several other Councils.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The directors' report for 1904 states that in consequence of the sale of the Marylebone portion of the undertaking and the acquisition by the London County Council of the Sardinia-street station, the capital expenditure, which at the end of 1903 amounted to £2,090,763. 8s., has been reduced by £759,152. 6s. 11d. expended to that date in Marylebone and on buildings and plant at Sardinia-street. The expenditure during the year on the remainder of the undertaking was £207,971. 0s. 10d., and the capital expenditure now stands at £1,539,582. 1s. 11d. The gross revenue amounted to £306,540. 15s. 3d., compared with £281,422. 5s. 8d. in 1903. Cost of generation in 1904 was £66,140. 14s. 1d., a decrease of £12,451. 16s. 7d. over 1903. The £1,212,000 awarded to the company for the sale of the Marylebone portion of the undertaking (less £10,000 paid into Court pending settlement of certain questions of title raised by Borough Council) was received on July 5. After crediting capital account with the portion of that sum representing expenditure in Marylebone, and providing for certain arbitration and other expenses, there remained in hand, subject to final adjustment, £862,551. 0s. 11d., of which £600,000 was paid to the holders of ordinary shares. The balance (£62,551. 0s. 11d.) has been placed to credit of depreciation and reserve fund. An agreement was entered into with Marylebone Borough Council on July 5 for supply by the company, as agents for the Council, of all electricity required in Marylebone until the Council are ready to give supply from their own generating works now in course of erection.

£183,150 awarded to the company in connection with the compulsory acquisition by the County Council of the Sardinia-street Works was received on Aug. 8, when the new freehold site near Kingsway was conveyed to the company. After crediting capital account with the original cost of buildings and plant acquired by the Council, and certain arbitration and other expenses, and setting aside £9,850 to meet cost of transferring the feeder connections from the old station to a new sub-station at Fisher-street, there remained, subject also to final adjustment, £17,356. 18s. 8d., which has been placed to credit of depreciation and reserve.

The directors are of opinion that it would be advantageous to sub-divide the existing £10 ordinary shares into £5 shares, and resolutions authorising this, and to double the number of votes attaching to preference shares, will be brought forward at the approaching meeting. The balance at credit of revenue, before providing for depreciation, is £176,837. 5s. 6d. The directors have set aside £20,000 as an addition to depreciation and reserve, which now amounts to £216,355. 5s. 5d., carrying to credit of net revenue £156,837. 5s. 6d. This, with balance from last account and other receipts, makes £170,982. 7s. 11d. Deducting interest, preference dividend and other charges (including interest paid to Borough Council of St. Marylebone under agreement) there remains £108,157. 9s. 5d. An interim dividend of 9s. per share (at the rate of 9 per cent. per annum) on the ordinary shares has been paid on Aug. 9, and the directors now recommend that a further dividend of 11s. per share, making 20s. or 10 per cent. These together absorb £100,000 and leave £8,157. 9s. 5d. to be carried forward. The total number of 8 c.p. lamps connected at the end of 1904 was 912,000, an increase of 80,000 during the year. The present number connected is 930,000.

NEWCASTLE-UPON-TINE ELECTRIC SUPPLY CO. (LTD.)—At the meeting last week Dr. J. T. Merz said that last year the company had sold 17,000,000 units, compared with only 9,000,000 units the previous year, the greater part of the increase being for power. There was a reduction in working costs, but there was also a reduction in the price received from 1·65d. to 1·29d. per unit, due to the increase in the sale of current for power. The net profits were £61,440, compared with £42,567, while the total expenditure to date was £1,147,000. They had taken over the works of the Northern Counties Electricity Supply Co., which extended their district in Northumberland as far as Blyth. A final dividend of 5½ per cent. was declared on the ordinary stock (making 8 per cent. for year), and of 3½ per cent. on the special ordinary stock, making 6 per cent. for the year.

Dr. Merz then moved approval of the agreement to purchase the shares of the Durham Electrical Power Distribution Co., and said that at Parliamentary inquiries it had been laid down that a station with plant of 10,000 H.P. should be able to do a satisfactory business, but they had found that the scale should be a far larger one, and now had a site on the Tyne at which they would be able to produce ten times that amount at a lower rate than at present, because working costs would be considerably reduced, and to profitably use that increased production they had to increase their area of supply. So far the property of the Durham Company had only been developed in Gateshead, Jarrow, and Durham City. The capital of the Durham Company would be increased by the immediate issue of new capital to the extent of £350,000, that course being adopted instead of issuing further capital of their own, so as to avoid depreciating their own shares by burdening them with a large amount of capital likely to be unproductive for some time. The resolution was carried unanimously.

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—The working operations for 1904 embraced the areas of Blyth, Spennymoor, Alnwick, Hebburn, Thirsk, Whitley, Ashington, Hartlepool, Morpeth, Felling, Malton and Cambois (Bedlingtonshire), the five last-named places having come into operation during the year. The consumers connected at Dec. 31 were 3,866, against 2,482 in 1903; the equivalent in 8 c.p. lamps connected was 88,177, against 39,639. Units sold were 986,873, against 344,781. The gross receipts from current were £12,280. 12s. 2d., compared with £4,979. 2s. 1d. As we announced last week, the directors recommend a dividend of 8 per cent., £1,500 has been placed to reserve and £380 written off preliminary expenses, the balance forward being £256. 16s. 5d.

OXFORD ELECTRIC CO. (LTD.)—At the meeting last week Sir H. C. Mance said they were able to pay 7 per cent. dividend for the past year. They had added during 1904 the equivalent of 9,519 8 c.p. lamps, making the total over 65,000 lamps connected. The number of customers had increased by about 140. Electric lighting had been introduced into Corpus Christi College, while extensive additions had been made in Jesus College, Somerville College and the Taylorian Buildings, and at Oriel, Christchurch, Merton, Brasenose, Magdalen, New College and Exeter. Those additions in the colleges were very satisfactory. An important installation had been made at the post office, including motive power for operating elevators.

VICKERS, SONS & MAXIM (LTD.)—The report states that the results of the past year have enabled the directors to recommend the payment of an increased dividend on the ordinary shares. The amount standing to credit of reserve in the balance-sheet last year has been written off against goodwill and patents, and after deduction of a further £50,000 from profits of 1904, goodwill and patents stand as a separate item at £637,456. 17s. 11d., or under 8 per cent. of total assets. The £50,000 written off will cover the amount required to pay the first instalment of the £1,000,000 second mortgage 4½ per cent. debentures in October next for redemption, and it is proposed that in future years sums at least equal to those required for this service shall be written off goodwill and patents till it is extinguished. After making this provision the directors recommend an increase in the the amount carried forward to credit of profit and loss account to £191,074. 11s. 3d. This amount being in excess of the sum required to pay 5 per cent. dividend on the ordinary shares the directors state that an interim dividend of 1s. per share (5 per cent.) will be paid on the ordinary shares on Aug. 1 next. Prospects for 1905 are quite satisfactory. The net profits for 1904 were £686,895. 7s. 8d. which, with amount from previous year (£86,699. 3s. 7d.) made £773,594. 11s. 3d., which has been appropriated as above.

SCARBOROUGH ELECTRIC SUPPLY CO. (LTD.)—At the meeting on Monday Mr. J. E. Ellis, M.P., said that £16,368 had been expended on capital account during the year. 75 per cent. of that had been spent on plant for the Scarborough electric tramway system, electric power having been supplied by the company since June. After placing £1,500 to depreciation the net divisible balance was £5,648, a dividend of 6 per cent. was declared. A reduced scale of charges would come into force in January.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO. (LTD.)—Mr. H. St. John Winkworth at the meeting last week said the company continued to make satisfactory progress, the number of lamp connections having increased by 47,851, of which 18,279 were added during the year, and 29,572 were taken over with the undertaking of the Crystal Palace District Co. in June. The number of consumers had increased to 2,555, and the net revenue from £11,041 to £16,574. Their undertaking now embraced an area of 15 sq. miles, with a present population of over 250,000. The work in connection with the change of system had made satisfactory progress. About one-fourth of the consumers had already been changed over, and were being supplied in the daytime from the generating station at Greenwich, and it was confidently expected that the whole of that area would be changed over during the present year. When that was completed the company would begin to reap the benefit of the more economical working of that portion of its undertaking. The purchase price for the sale of a small portion of the new area to Beckenham had not yet been adjusted. The price, however, was fixed by the provisional order at the capital expenditure plus 33 per cent. The company would shortly require to raise further capital for the completion of the purchase of the Crystal Palace Co. and to provide for the continual development of the business. The profit earned on the average capital expenditure, which was 3·58 per cent. in 1902, increased to 4·47 per cent. in 1903, and 5·57 per cent. in 1904. Mr. Henry W. Bowden, managing director of the company, said that the capital required to change the Crystal Palace system from direct to alternating current was £25,000. The first new 250kw. alternator was delivered in November, and was now running daily during the evening—third shift—supplying energy to that portion of the area changed over and to new customers. The second alternator would be delivered this week, and should be available by the end of the month. For convenience of working they had divided their district of supply into northern and southern areas. The improvement in the efficiency of distribution was being obtained by placing their transformers—which in the majority of cases were placed in tanks buried in the ground—where the demand was likely to be made, thus reducing capital outlay in cables and dispensing with all moving machinery at the sub-stations. They had recently entered into a power contract in their southern area, where the minimum consumption was to be 50,000 units per annum for five years. The cost per unit for their southern area was very high, but he had every hope of seeing this cost considerably reduced. In regard to the northern area, the coal cost was 0·61d. and the working costs 0·9d. per unit. There the demand for power was nearly 50 per cent. of the total units generated, and in order to further encourage that part of their business, they had amended their prices during the past year, and their load-factor had increased from 11 to over 15 per cent.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON.—At a special meeting of this company on Thursday last the chairman (Mr. C. T. Yerkes) said the company having sold £2,500,000 of debentures of the Baker-street and Waterloo Railway Co., the Great Northern, Piccadilly and Brompton Railway Co., and the Charing Cross, Euston and Hampstead Railway Co., the shareholders would not be asked to sanction the proposed increase of the borrowing powers of the Underground Company.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

CORDOBA CENTRAL BUENOS AYRES EXTENSION RAILWAY (LTD.) (83,643).—Reg. Feb. 21, capital £700,000 in £10 shares, to adopt an agreement with Cordoba Central Railway Co. (Ltd.), to acquire, construct, equip, maintain and work railways, tramways, telegraph and telephone lines and other means of communication in the Argentine Republic, to acquire concessions, privileges, running powers, rights and easements, to generate and supply electricity, &c.

ELECTRICAL & HARDWARE CO. (LTD.) (83,661).—Reg. Feb. 22, capital £1,000 in £1 shares, to manufacture and deal in electrical and other lamps, bulbs, bells, batteries, toys, novelties and accessories, hardware, ceramic ware, &c.

ELECTROMOBILE HIRING CO. (LTD.) (83,703.)—Reg. Feb. 25, capital £8,000 in £1 shares, to let out to hire, sell and deal in electric and other motor cars and carriages, and to carry on the business of automobile store and garage keepers, motor repairers and cleaners, suppliers of electricity and other motive power, &c., and to adopt two agreements with the Electromobile Co. (Ltd.). First directors, Lord Westbury and T. G. Chambers.

ENGINEERING CONTRACT CORPN. (LTD.)—Reg. March 1, capital £15,000 in £1 shares, to take over the business of engineers and contractors carried on by the Engineering Contract Corpn. (Ltd.) and its liquidator, Mr. G. F. Storey.

FERRANTI LIMITED.—Reg. Feb. 27, capital £130,000 in 60,000 preference, 60,000 ordinary and 10,000 deferred shares of £1 each, to take over all or part of the undertaking, assets and liabilities of Ferranti Limited, incorporated in 1901; to adopt an agreement between Ferranti Limited, of the first part, I. M. Henderson (the liquidator thereof), of the second part, and this company of the third part, to acquire any other electrical, mechanical or sanitary engineering business, and to carry on the business of contractors for the erection and maintenance of electricity stations, constructors of railways, tramways, motor cars or waterways and appliances appertaining thereto, telephone, telegraph and electrical apparatus manufacturers, suppliers of electric power, electric generators, lamps, engines and motors, manufacturers of and dealers in glass, indiarubber, vulcanite, iron, copper and metal electric conductors or non-conductors, wire drawers, insulators and coverers, electrical, mechanical and general engineers, &c. The signatories are:—A. W. Tait, (C.A.), E. D. K. Busby, G. Taylor, A. J. Sife, S. Pedder, S. W. Hennain and B. Heyburn. First directors, A. W. Tait, A. Whitaker, J. M. Henderson and S. Z. de Ferranti. The holders of the first mortgage debenture stock and the holder of the second mortgage debenture stock may jointly nominate two directors. Remuneration, £250 each per annum (chairman £100 extra). The directors' borrowing powers are limited to £150,000. Reg. office, Hollinwood, near Manchester.

HOLMAN JAMES & CO. (LTD.) (83,694).—Reg. Feb. 17, capital £300 in £1 shares, to acquire from W. H. James British patents for an improved electric fuse box, single and double pole, together with the right to contract for, sell and deal in the counties of Buckingham, Berks., Middlesex, Kent, Surrey and Oxford, electrical and other goods manufactured, sold or dealt in by Heatley (Ltd.), to carry on at Maidenhead or elsewhere the business of electrical engineers, contractors and fitters, &c., and to adopt agreements with W. H. James and Heatley (Ltd.). First directors, J. B. Ormond (chairman), F. J. Lakies, J. J. Finch, T. L. Lakies, F. N. Lakies and W. H. James. Reg. office, 103, Queen-street, Maidenhead.

HOUGHTON-LE-SPRING & DISTRICT ELECTRIC LIGHTING CO. (LTD.) (83,781).—Reg. March 3, capital £15,000 in £1 shares, to acquire from Sunderland District Electric Tramways (Ltd.) the electric lighting provisional order for the supply of energy in the districts of Houghton-le-Spring, Hetton-le-Hole and Easington (Durham), and to carry on the business of electricians, suppliers of electricity, mechanical engineers, &c. The subscribers are Sir Douglas Fox, H. R. Hope, C. A. Osborne, E. G. Nisbet, W. H. Priestley, F. W. Moore and J. H. Swainson. Reg. office, 13, St. Helen's-place, London, E.C.

LONDON & DISTRICT MOTOR 'BUS CO. (LTD.) (83,760.)—Reg. March 1, capital £405,000 in 400,000 ordinary shares of £1 each and 100,000 deferred shares of 1s. each, to carry on business as omnibus, motor car, van, and cab proprietors, carriers by electrical, oil or other power, or by animal traction, manufacturers of and dealers in motor omnibuses and vehicles of any description, electrical and general engineers, &c. Reg. office, Basildon House, Moorgate-street, London, E.C.

MANN, EGERTON & CO. (LTD.) (83,789).—Reg. March 3, capital £30,000 in £1 shares (15,000 cumulative preference), to acquire (1) business of electrical engineers and fitters carried on by G. N. C. Mann and F. A. Jackson as G. N. C. Mann & Co., and (2) the business of motor car engineers carried on by the said G. N. C. Mann and G. W. Egerton as Mann, Egerton & Co. First directors, G. N. C. Mann, F. A. Jackson and H. W. Egerton. Reg. office, Bank Plain, Norwich.

MANSFIELD & SONS (LTD.) (83,671).—Reg. Feb. 22, capital £20,000 in £1 shares, to carry on business of electrical, gas, sanitary, hydraulic, civil and mechanical engineers, dealers in apparatus used in connection with the generation, distribution, supply and employment of electricity, gas and water, &c. A. Mansfield is managing director for life.

PEEBLES STEAM CAR CO. (LTD.) (83,805).—Reg. March 4, with capital of £30,000 in £1 shares (15,000 preference), to adopt an agreement with Bruce Peebles & Co. (Ltd.) and the Electric Conversion Synd. (Ltd.) to acquire patents, inventions, processes or rights, and to carry on the business of manufacturers of steam, electric, petrol or other engines, railway carriages and waggons, cars, locomotives, rolling stock, &c., engineers, ironmasters, founders, &c. No initial public issue. Bruce Peebles & Co. (Ltd.), the Electric Conversion Synd. (Ltd.) and H. G. V. Adler have the right to nominate three directors. Reg. office, 25, Victoria-street, Westminster.

PRESTEA RAILWAYS (LTD.) (83,672).—Reg. Feb. 22, capital £50,000 in £1 shares, to acquire light railway or tramway now in course of construction between Fura and Broomassie, Gold Coast Colony, to enter into an agreement with companies engaged in construction, to obtain an ordinance of the Legislative Council of the colony for working ther ailway and to carry on the business of railway and tramway proprietors, suppliers of electric power, electrical and general engineers, &c. First directors, J. Annan, E. Davis, J. T. Currie, E. W. Janson, T. H. Monk, R. C. Richards, J. S. P. Samborne and T. J. Seel.

STATUTORY RETURNS.

ADAMS-RANDALL TELEPHONE PATENTS CO. (LTD.)—In return to Jan. 30 capital is £60,000 in 50,000 ordinary shares and 10,000 preference shares of £1 each, of which 50,000 ordinary and 7,251 preference have been taken up. £1 per share called up and paid on 7,251 preference and seven ordinary. 49,993 ordinary shares are considered as fully paid. Mortgages and charges, £10,000.

COSTA RICA ELECTRIC LIGHT & TRACTION CO. (LTD.)—In return to Jan. 4 capital is £130,000 in 130,000 shares of £1 each, all of which have been taken up. £7 has been received, and 129,993 shares are considered as fully paid. Mortgages and charges £162,100.

DIRECT UNITED STATES CABLE CO. (LTD.)—Return to Feb. 7 gives capital as £1,300,000 in 65,000 shares of £20 each, of which 60,710 have been taken up. £1,214,200 is considered as paid. No mortgages or charges.

GARDNER ELECTRIC DRILL & HAMMER CO. (LTD.)—Return to Dec. 27, gives capital as £40,000 in £1 shares, all of which have been taken up. £1 per share has been called up on 2,000 and £2,000 has been received. 38,000 shares are considered as fully paid. No mortgages or charges.

MORLEY ELECTRICAL ENGINEERING CO. (LTD.)—In the return to Feb. 23 capital is £5,000 in 5,000 shares of £1 each, of which 1,524 have been taken up. £504 has been received and £1,020 is considered as paid. Mortgages and charges, 1,000.

MUNICIPAL ELECTRIC LIGHT & POWER CO. (LTD.)—In return to Jan. 13 capital is £25,000 in 2,400 ordinary shares of £10 each and 100 founders' shares of £1 each, of which 37 ordinary and 30 founders' have been taken up. £10 per share has been called up on ordinary and £1 on founders' and £400 has been received. Mortgages and charges nil.

MUTUAL TELEPHONE CO. (LTD.)—Return to Jan. 2 gives capital as £250,000 in 20,000 preference and 30,000 ordinary shares of £5 each, of which 6,288 preference and 10,348 ordinary shares have been taken up. 6d. per share has been called up and £1,184. 7s. 6d. has been received, including cash paid in advance of calls. Mortgages and charges nil.

PERTH ELECTRIC LIGHTING CO. (LTD.)—Return to Feb. 3 gives capital as £1,000 in £1 shares, of which seven have been taken up. No calls have been made. No mortgages or charges.

UNIVERSAL TELEPHONE AND ELECTRICAL CO. (LTD.)—Return to Feb. 21 gives capital as £10,400 in 2,000 ordinary shares of £5 each and 400 founders' of £1 each, of which 400 ordinary and 400 founders' have been taken up. £2. 10s. per share has been called up on 400 ordinary shares and £1,000 has been received. £400 is considered as paid on 400 founders' shares. No mortgages or charges.

MORTGAGES AND CHARGES.

BASTIAN METER CO. (LTD.)—Re-issue on Feb. 24 of £100 debentures part of series created by resolutions of April 22, May 23 and June 10, 1901, to secure £6,000 charged on certain land and premises known as Bartholomew Villas, Kentish Town, and company's other assets, present and future, including uncalled capital. Trustees, H. A. Saunders, Chesterfield, and D. J. Cowles, Manor House, Felixstowe. Previously issued of same series, £5,450.

KENT ELECTRIC POWER SYND. (LTD.)—A memorandum of satisfaction in full of a charge dated April 9, 1904, securing £1,000, has been filed

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Mar. 4	1,031	– 23	40	54,160	+ 5,738
Airdrie	Feb. 24	188	– 9	8	1,346	– 19
Ayr Corporation	Mar. 4	163	+ 26	42	12,432	+ 519
Barnsley	Feb. 24	152	– 11	8	1,160	+ 19
Barrow	" 24	176	+ 36	8	1,391	+ 98
Bath Electric Trams, Ltd.	Mar. 1	506	+ 35	9	4,770	+ 497
Birkenhead	" 5	960	+ 69	...	...	...
Birmingham Corporation	" 4	897	...	9	19,018	...
*Birmingham & Mid.	Feb. 24	1,679	+ 214	8	12,943	+ 1,428
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	Mar. 2	299	+ 30	49	46,212	+ 6,128
Blackpool and Fleetwood	" 4	217	+ 17	9	1,661	– 43
Blackp'l, St. Anne's & Lytham	" 3	136	– 4	18	2,326	...
Bolton Corporation	" 5	1,071	+ 148	49	48,502	+ 634
Bournemouth Corporation	" 1	570	+ 92	‡48	31,039	+ 2,261
Bradford Corporation	" 4	3,720	+ 483	48	210,709	+ 30,172
Brighton Corporation	" 5	753	+ 100	48	47,109	+ 3,716
Brisbane Tramways	Jan. 18	2,120	– 199	2	4,531	– 94
Bristol Trams & Carriage	Mar. 3	4,485	+ 296	4	17,699	+ 297
Buenos Ayres & Belgrano	Feb 5	8,056	– 286	16	44,891	– 706
Buenos Ayres Elec. Trams	Jan. 21 " 28 Feb. 4	1,045 1,020 1,125	... ...	5	5,367	...
Burnley Corporation	Mar. 4	942	+ 81	21	9,140	+ 3,776
Burton Corporation	" 5	217	+ 73	¶48	10,292	...
Calcutta Tramways Co.	" 4	R48,474	+ R7,719	9	R368,891	+ R41,011
Camborne-Redruth	" 6	98	+ 18	18	1,872	– 197
Cardiff Corporation	" 4	1,775	+ 78	48	86,038	+ 2,032
Carlisle Tramways Co.	" 4	137	– 20	9	1,228	– 278
Central London Railway	" 4	7,224	– 24	9	61,963	+ 1,049
Chatham & Dist. Lt. Rys.	" 2	648	+ 105	9	4,974	+ 351
*City of Birm'gh'm Tram Co	Feb. 24	5,955	+ 159	8	41,008	+ 1,033
City & South London Rly.	Mar. 5	2,064	– 321	10	21,179	– 1,995
Colchester Corporation	" 2	144	...	5	758	...
Cork Electric Trams Co.	" 2	809	+ 34	9	8,536	+ 316
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	Feb. 24	894	– 20	8	6,875	– 122
Dover Corporation	Mar. 4	163	+ 18	49	10,542	– 114
Dublin & Lucan Railway	" 3	89	+ 5	9	898	+ 18
Dublin Southern District	" 3	732	+ 71	9	33,815	+ 95
Dublin United	" 3	5,544	+ 173			
Dudley—Stourbridge	Feb 24	742	– 15	8	5,678	+ 54
Dundee Corporation	Mar. 1	779	+ 1	¶20	34,269	+ 312
East Ham Council	" 4	631	+ 74	48	28,243	+ 1,828
Gateshead & Dist. Trams	Feb. 24	878	+ 46	8	6,743	+ 146
Glasgow Corporation	Mar. 4	14,096	+ 1,178	¶31	467,672	+ 28,265
Glossop	...	...	...	...	...	...
Gloucester Corporation	" 1	207	...	48	12,499	...
Gravesend—Northfleet	Feb. 24	185	– 19	8	1,485	– 151
Gt. Northern & City Rly.	Mar. 4	1,637	+ 628	9	14,470	...
Greenock & Port Glasgow	Feb. 24	463	+ 41	8	3,957	+ 413
**Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	" 24	247	+ 11	8	1,863	– 17
Huddersfield	Mar. 4	1,207	+ 128	48	64,651	+ 4,141
Hull Corporation	" 4	2,090	+ 125	48	104,748	+ 11,210
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	" 1	102	– 19	22	2,565	– 392
Ipswich Corporation	" 4	310	+ 28	45	22,600	...
Isle of Thanet Co.	" 4	234	+ 69	22	9,145	+ 80
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	Feb. 24	67	– 5	8	700	– 11
Kilmarnock	Mar. 4	141	...	1	141	...
Kirkcaldy Corporation	" 1	196	+ 5	...	...	...
Lanarkshire Trams Co.	" 2	6 0	+ 62	9	5,614	+ 4 5
Leeds Corporation	" 4	5,308	+ 680	49	278,797	+ 16,869
Leicester Corporation	" 4	1,804	...	9	15,708	...
Liverpool Corporation	Feb. 25	9,827	+ 184	8	78,046	+ 2,278
Liverpool Overhead Rly.	Mar. 6	1,420	– 29	10	14,602	– 641
*London County Council	Feb. 25	12,091	+ 2,811	§47	600,448	+ 131,226
Lowestoft	Mar. 4	114	+ 1	9	1,009	...
Maidstone Corporation	" 2	92	...	88	4,387	...
Manchester Corporation	" 4	11,356	+ 984	48	562,241	+ 26,967
Mersey Railway	" 4	1,500	+ 113	9	14,427	+ 1,574
Merthyr	Feb. 24	174	– 14	8	1,341	– 111
*Metropolitan Elec. Trams	" 24	1,840	+ 725	8	14,885	+ 6,837
Middleton	" 24	152	+ 16	8	2,007	+ 175
Musselburgh	Mar. 2	153	...	11	2,327	...
Nelson Corporation	" 4	102	+ 14	49	5,659	+ 1,852
Newcastle-on-Tyne Corp.	" 4	3,517	+ 117	9	31,788	+ 691
Newport (Mon.)	" 4	500	+ 90	22	11,069	+ 1,478
Oldham, Ashton & Hyde	Feb. 26	474	+ 1	8	3,757	+ 29
Oldham Corporation	Mar. 5	1,351	+ 858	49	61,677	+ 6,064
Perth (W. A.) Elec. Trams.	" 3	1,501	+ 119	9	13,253	+ 1,066
Peterborough	Feb. 24	96	– 7	8	777	– 57
Poole and District	" 24	205	– 16	8	1,659	– 49
Portsmouth Corporation	Mar. 4	1,855	+ 101	§48	89,520	+ 6,529
Potteries	Feb. 24	1,628	+ 62	8	12,847	+ 851
Reading Corporation	Mar. 2	617	+ 26	...	...	...
Rochdale Corporation	" 4	412	+ 315	49	18,0 9	+ 6,783
Rothesay	Feb. 24	39	– 8	8	330	+ 21
Salford Corporation	Mar 6	3,779	+ 326	47	196,402	+ 9,605
Sheerness	Feb. 21	58	+ 15	8	405	+ 65
Sheffield Corporation	Mar. 5	4,442	+ 504	‡49	227,152	+ 6,507
Southampton Corporation	" 1	761	– 31	48	45,755	– 2,608
Southend Corporation	" 1	207	+ 31	45	16,833	+ 1,676
Southport Tramways	Feb. 24	215	– 1	8	1,728	– 82
S. Staffordshire Trams.	" 24	632	– 47	8	4,982	– 872
Stockport Corporation	Mar. 3	411	+ 33	43	20,594	+ 8,518
Sunderland Corporation	" 6	1,165	+ 89	49	69,164	+ 1,607
Swansea Trams	Feb. 24	455	– 12	8	3,457	– 47
Swindon	Mar 4	150	...	23	4,138	...
Taunton Trams	Feb. 24	84	– 6	8	803	– 58
Tynemouth and District	" 24	102	– 31	8	1,807	– 249
Tyneside Trams Co.	Mar. 1	334	+ 269	9	2,810	+ 882
Wallasey District Council	" 4	659	+ 107	§48	35,159	+ 2,491
Walsall	" 4	442	...	9	3,924	...
Warrington Corporation	" 2	8 6	+ 13	48	15,3 0	+ 5 7
West Ham Corporation	" 2	1,068	...	...	51,559	...
Weston-super-Mare	Feb. 23	28	+ 4	8	204	+ 30
Wigan Corporation	...	...	...	...	...	...
Wolverhampton Corpn.	Mar. 1	690	+ 256	48	33,084	...
Wolverhampton District	Feb. 24	355	+ 21	8	2,648	+ 119
Worcester	" 24	239	– 11	8	1,989	+ 622
Wrexham	" 24	94	– 2	8	718	– 29
Yorkshire Woollen District	" 24	544	+ 30	8	4,267	+ 458

(a) These comparisons are with the corresponding period last year. † Minus 6 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. ** Fortnight. * Partly electrical.

LANGDON-DAVIES MOTOR CAR (LTD.)—£5,000 debentures, created 8th and dated Feb. 20, 1905, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees. (These debentures are issued in exchange for debentures for a like amount issued by the vendor company.)

CITY NOTES.

MEMORANDA (March 9).—Bank rate 2½ per cent. (March 9, 1905). Price of silver 27$\frac{5}{16}$d. per oz. Consols 91⅛—91¼ for money, 91$\frac{7}{16}$—91$\frac{9}{16}$ for account; 2½ per cent. annuities 93½—90¾. Consols Pay Day, April 5. Stocks and Shares Continuation Days, March 13 and 28; Ticket Days, March 14 and 29; Pay Days, March 15 and 30; Mining Share Carry-over Days, March 10 and 27.

CORRECTION.—In the report of the annual meeting of shareholders of the Charing Cross & Strand Electricity Supply Corpn., which appeared in our issue of Feb. 24, it was stated that 6,968 lamps had been added during the past year to the company's City mains. This figure should have been 58,968.

CHANGE OF TITLE.—As from the 8th inst. the style and title of the Charing Cross & Strand Electricity Supply Corpn. (Ltd.) has been altered to "The Charing Cross, West End & City Electricity Supply Co. (Ltd.)"

DAVIS & TIMMINS (LTD.)—A dividend on the ordinary shares of 8 per cent. is recommended for the past year.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The directors have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, a dividend at the rate of 4 per cent. (tax free) on the ordinary shares, both for the half-year ended Dec. 31 and payable April 1.

RAND CENTRAL ELECTRIC WORKS (LTD.)—The result of working for February was 739,000 units generated, yielding a gross revenue of £6,950. For the corresponding period last year the result was 766,210 units and £6,800 gross revenue.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to appoint a special settling day in a further issue of 5,000 £5 fully-paid ordinary shares of *W. T. Henley's Telegraph Works Co. (Ltd.)* and to permit same to be quoted in the official list, and also to grant quotations to a further issue of 4,500 £10 fully-paid ordinary shares of the *Bournemouth & Poole Electricity Supply Co. (Ltd.)*, and a further issue of £44,435 4 per cent. debenture stock of the *Western Telegraph Co. (Ltd.)*

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., Mar. 8.	Rate per cent. yielded.	Dividend Due.	Business, Week to Mar. 8. High est.	Business, Week to Mar. 8. Low est.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
	2/0	Anglo-Argentine Ord. Shares	[illegible]	3 9 7	Ap, Oc	[illegible]	[illegible]
1	[illegible]	Do. 5% Cum. Pref.	[illegible]	4 5 1	—	[illegible]	[illegible]
St.	6%	Do. Permanent 6% Deb. Stock	140 –143	4 3 11	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 –106	4 15 8	—	105½	104½
10	6%	Barcelona Tramways Ord.	12 –12½	2 6 2	—	12$\frac{5}{16}$	12
10	5/0	Do. 5% Cum. Pref.	9½–10	5 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	98 –100	4 10 0	—	..	..
100	5%	Do. 5 per Cent. Debs.	99 –102	4 18 1	—	..	..
1	..	Brisbane Electric Trams. Invest. Ord.	1⅛–1⅜	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	[illegible]	5 17 8	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	94 –96	4 11 10	..	97	95½
St.	6%	British Columbia Elec. Rlwy Def. Ord.	103 –106	5 13 3	—	104	..
St.	5%	Do. Pref. Ord. Stock	100 –103	4 17 2	—	102	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 –10½	4 10 11	—	..	..
[illegible]	4½%	Do. 4½ per Cent. 1st Mort. Dbs	[illegible]	4 6 7	—	..	..
100	4½%	Do. Vancouver Power Debs.	99 –102	4 8 3	..	..	..
5	1/6	Buenos Ayres and Belgrano Ord.	[illegible]	5 12 6	—	[illegible]	[illegible]
5	2/0	Do. 6 per Cent. "A" Cm. Pref	[illegible]	5 2 2	—	[illegible]	..
5	2/0	Do. "B"	[illegible]	5 9 1	—	..	..
St.	6%	Do. 6 per Cent. Debs.	107 –109	5 11 8	—	..	—
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	102 –105	4 18 3	—	106½	..
St.	6%	Buenos Ayres Elec. Trams (1901) Ltd.	97 –99	6 1 0	..	..	..
5	3/0	Calcutta Tramways	[illegible]	[illegible]	—	[illegible]	[illegible]
100	4½%	Do. 4½% 1st Deb. Stock (red.).	106 –108	4 3 4	—	107½	..
1	0/6	Cape Electric Tram Shares	1⅛–1⅜	5 0 0	—	[illegible]	1⅛
St.	5%	Colombo Trams & Ltg. 5% 1st Mt Deb. (red)	102 –104	4 18 1	—	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	101 –103	4 17 3	Ja, Jul	..	..
100	5%	†Montreal St. Ry. St'g 5% Mort Debs. (1908)	101 –104	4 16 2	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922).	103 –105	4 5 9	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	104 –107	4 13 5	..	..	..
		ELECTRICITY SUPPLY.					
5	2/0	Calcutta Electric Supply Ord.	9 –9½	3 10 3	—	9½	[illegible]
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 Cum. Pref.	[illegible]	..	..	[illegible]	[illegible]
St.	5%	Do. 5% Debs.	86 –91	5 9 11	..	..	..
10	..	Havana Electricity Co. Shares	9½–10½	—	—	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	[illegible]	..	—	..	..
1	..	Rand Electric	1 –1¼	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	100 –102	4 8 9	Ap, Oc	..	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., Mar. 8.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to Mar. 8. High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
1	..	Bath Elec. Trams Pref. Ord.	⅜–⅝	..	..	..	..
1	11·40s.	Do. 5% Cum. Pref.	1⅛–1⁵⁄₁₆	4 14 1	..	1	..
St.	..	Do. 4½ 1st Mort. Deb. Stock (red.)	103 –104	..	..	103½	103
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	97 –99	..	..	98½	98
10	8%	†Bristol Tramways and Carriage Ord.	11½–11¾	5 18 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 –10½	3 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	105 –107	3 14 10	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	9½–9¾	6 2 11	..	9⁹⁄₁₆	9½
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾–11¼	5 7 10	Feb, Aug	11⅛	10¾
St.	5/0	Do. 5 per Cent. Perpetual Debs	121 –123	4 1 4	—	122½	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	97 –99	4 10 11	..	98½	98½
St.	4%	Central London Ordinary Stock	93 –95	4 4 2	June, Dec	94½	93½
St.	4%	Do. 4 per Cent. Pref. Stock	101 –103	3 17 8	—	102½	103
St.	4%	Do. Deferred Stock	83 –86	4 13 1	—	..	..
100	4%	Do. 4 per Cent. Debs.	110 –112	3 11 6	—	..	..
5	2/6	City of Birmingham Trams 5% Cm. Prf.	4¾–5¼	4 17 6	—	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	103 –104	3 17 8	..	..	..
St.	1½%	City and South London Rly. Con. Ord.	44½–45½	4 18 11	Feb, Aug	45½	44¾
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120 –123	4 1 4	Feb, Aug	121	..
St.	5%	Do. (1896)	118 –121	4 2 8	..	..	..
St.	5%	Do. (1901)	116 –119	4 4 0	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	107 –109	3 13 5	May, Nov	..	..
10	5/0	Dublin United Trams. (1896) Ltd., Ord.	13 –14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15½–16½	3 12 9	—	..	..
10	4 0	Gt. Northern & City Rly. Prf. Ord. (4%)	6 –6½	3 12 0	—	6¼	6¼
10	4/0	†Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 –13	..	..	..	..
10	10%	‡ Imperial Tramways Ord	18½–19½	5 2 10	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	15 –15½	3 18 4	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	111½–113½	4 0 0	Jan, July	..	..
5	2/6	†Isle of Thanet Elec. Trams & Lt. 5% Pf.	3 –4½	7 2 11	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89 –91	4 7 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3¼–3¾	5 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 –10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10 –10½	4 15 3	..	10⅜	10¼
St.	4%	Do. 4% 1st Mort. Deb. Stock	100 –103	3 18 5	—	103	102½
St.	..	Mersey Con. Ord. Stock	4 –7	..	—	..	..
St.	—	Do. 3 per Cent. Perp. Pref.	10 –13	..	—	..	..
1	..	Metropolitan Electric Trams Def	⅞–1⅛	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	1⅛–1³⁄₁₆	4 17 1	—	1	..
St.	4½%	Do. 4½% Deb. Stock	105 –107	4 5 6	..	106½	106¼
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½–1½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	9½–9¾	5 2 5	..	9¾	9½
10	5/0	Do. 5 per Cent. Cum. Pref.	8½–9½	5 5 3	Feb, Aug	8¾	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 –105	4 5 9	—	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London	98 –99	5 2 0	..	99	98½
St.	3½%	Waterloo and City Ord.	93 –94	3 6 5	June, Dec	—	—
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 –102	4 0 0	Jan, July	..	..
10	..	Amazon Telegraph	7½–8½	..	Jn, Dec ..	..	..
100	..	Do. 5% Debs. (red.)	70 –75	..	..	..	..
St.	17/6	Anglo-American	60 –62	4 8 9	F,My,Ag,N	60½	..
St.	25/0	Do. Preferred	107 –109	5 0 11	F,My,Ag,N	108	107
St.	2/0	Do. Deferred	15½–15¾	..	F,My,Ag,N	15⅝	14¾
100	$2	Commercial Cable Capital Stock	230 –240	3 6 8	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	98 –100	4 0 10	Jn,Ap,Jy,O	99½	98
10	5/0	Cuba Submarine Ord.	8¾–9¼	5 8 0	Feb, Aug	9⅛	8¾
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 1	Feb, Aug	17½	17½
5	2/0	Direct Spanish Ord.	3½–3¾	5 11 9	April, Oct	3½	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8 –8½	6 1 3	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	101%–103%	4 7 10	Jan, July	..	..
20	8/0	Direct United States Cable	11¼–11¾	4 13 2	Ja,Ap,Jy,O	11⁵⁄₁₆	11⁵⁄₁₆
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 –103	4 7 7	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	144 –147	4 15 3	Ja,Ap,Jy,O	145½	143½
St.	17/6	Do. 3½ per Cent. Pref. Stock	91 –93	3 15 3	Ja,Ap,Jy,O	91½	91½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 5	May, Nov	108½	108
10	2/6	Eastern Extension	14½–14¾	4 15 2	Ja,Ap,Jy,O	14½	14½
St.	4%	Do. 4 per Cent. Deb. Stock	104 –106	3 15 7	Feb, Aug	105	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	100 –102	3 18 5	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%–103%	3 17 8	May, Nov	..	..
10	6/0	Great Northern (of Copenhagen)	33 –37	4 10 11	Jan, July	33	32½
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100 –102	4 8 3	June, Dec	..	..
25	12/6	Indo-European	46 –48	5 4 2	May, Nov	47½	47½
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	98 –101	3 19 2	June, Dec	..	—
10	4/0	West African Telegraph Shares	8 –8½	5 17 8	—	..	..
2½	..	West Coast of America	⅜–⅞	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	100 –102	3 18 5	Jan, July	101	100½
10	—	West India and Panama	½ –1	..	May, Nov	1	..
10	7/0	Do. 6 1st Pref.	8½–9	7 4 5	May, Nov	8½	8½
10	—	Do. 6 per Cent. 2nd Pref.	5½–6½	..	May, Nov	5½	..
100	5%	* Do. 5 per Cent. Debs.	103 –105	4 15 3	Jan, July	..	..
10	3/0	Western Telegraph	13½–14	5 0 0	Mr,Jn,O,D	13½	13½
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 –103	4 17 1	June, Dec	101½	—
St.	4%	Do. 4% Deb. Stock (red.)	102 –104	3 16 11	—	103½	..
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	6½–6¾	5 1 9	August ..	6¾	..
1	0/7½	Monte Video Telephone Ord.	1⅛–1¼	2 11 9	..	..	..
St.	6%	National Co. Pref. Stock	112½–113½	5 5 9	—	112¾	111½
St.	5%	Do. Def. Stock	106 –108	4 12 7	..	107½	106½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 –14	4 5 9	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12 –13	4 12 4	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½ –6	4 3 4	Feb, Aug	5¾	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	99 –101	3 9 3	June, Dec	100	99½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104 –106	3 15 6	..	106	104
1	0/7½	Oriental	1¼–1⅜	4 4 2	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛–1³⁄₁₆	4 11 5	..	..	..
St.	20/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101 –104	..	..	..	..
5	5/0	United River Plate	7⅛–7⅝	6 3 3	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 17 9	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	107 –109	4 11 9	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	6/0	Elec. & Gen. Investment 6% Cum. Pref.	4½–5	6 0 0	—	..	..
10	7/0	Globe Telegraph and Trust	16½–16¾	4 18 7	Ja,Ap,Jy,O	16½	16½
10	3/0	Do. 6 per Cent. Pref.	14½–14¾	4 2 8	Ja,Ap,Jy,O	14½	14½
100	6%	Submarine Cables Trust (Cert.)	124 –127	4 16 6	April, Oct	..	..

Share.	Last Dividend.	Name.	Price Wed., Mar. 8.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to Mar. 8. High-est.	Low-est.
		ELECTRICITY SUPPLY.					
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	17½–17¾	6 5 6	..		
10	4/6	Do. 4½ per Cent. Cum. Pref	9½–10	4 10 0	..		
10	6/0	Do. 6% Cum. Second Pref.	11 –12	5 0 0	—		
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	105 –107	4 4 1	—		
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5½–5¾	3 9 7	..		
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 0	—		
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½–11	6 10 11	..		
5	3/6	Do. 7 per Cent. Pref.	10¼–10¾	3 5 1	Mar, Sept		
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105 –108	3 14 1	..		
5	4/0	†Charing Cross (W. End & City) El. Sup. Co.	7½–8	4 16 6	Feb, Aug		
5	2/3	Do. 4½ per Cent. Pref.	5¼–5¾	3 17 0	Feb, Aug		
St.	4%	Do. 4% Deb. Stock (red.)	103 –105	3 16 2	—		
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅞–5⅛	4 4 9	—		
5	2/3	Do. Do. (1903)	4⅞–5⅛	4 4 9	..		
5	3/9	‡Chelsea Electric Supply Ord.	6½–7½	4 2 8	March ..		
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109 –111	4 1 1	Jn, Dec ..		
10	5/0	City of London Electric Lighting Ord.	13½–13¾	3 15 6	Feb, Aug		
10	6/0	Do. 6 per Cent. Cum. Pref.	13½–14½	4 3 11	Jan, July		
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	125 –127	3 18 9	Jn, Dec ..		
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	103 –106	4 4 9	..		
10	4/0	County of London Elec. Supply Ord.	9½–10	4 0 0	—		
10	6/0	Do. 6 per Cent. Cum. Pref.	12½–12¾	4 15 1½	Mar, Sept		
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	110 –113	4 0 2	—		
St.	4½%	Do. Second Deb. Stock Prov. Certs.	103 –106	4 5 7	—		
5	2/0	Folkestone Electricity Supply Co. Ord.	5½–6	4 11 0	—		
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 –104	4 6 7	—		
5	3/6	Hove Electric Lighting Ord.	7½–8	5 6 3	..		
St.	4½%	I. of W. Elec Lt. & Power 4½% Db. St (red.)	101 –103	4 9 1	..		
5	7/0	Kensingtn. & Kngtsbdg. Ord. ex Account	13¼–13¾	4 10 7	..		
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July		
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 –104	3 17 8	—		
3	1/6	†London Electric Supply Ord.	2¼–2⅜	3 4 6	—		
5	3/0	† Do. 6 per Cent. Pref.	6½–6¾	4 18 0	..		
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	99 –102	3 19 3	Mr,Jn,S,D		
10	9/0	Metropolitan Electric Sup. Ord.	19 –19½	4 14 [illegible]	April, Oct		
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½–5¾	3 18 8	Jan, July		
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 –115	3 18 3	Jn, Dec ..		
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 –99	3 10 8	..		
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	98 –100	4 10 0	..		
10	[illegible]	†Newcastle & Dist. Elec. Ltg. Ord. £9 paid	15¼–15⅞	5 7 2	Feb, Aug		
5	5%	Newcastle Elec. Supply Ord.	8⅛–8⅜	4 18 9	Feb, Aug		
5	5%	Do. 5 per Cent. Non Cum. Pref.	6⅛–6½	3 [illegible] 9	Feb, Aug		
1	[illegible]	Northern Counties Elec. Sup. 17/- paid	14/9–15/3	3 6 0	Mar, Sep		
10	6/0	Notting Hill Electric Ord.	14½–15½	4 0 0	March....		
100	4%	Do. 4 per Cent. 1st Mt. Debs.	102 –104	3 17 0	..		
5	2/6	Oxford Electric Ord.	6¼–6¾	5 0 0	March ..		
St.	4%	Do. 4% Deb. Stock	98 –100	4 0 0	..		
5	7/6	†St. James' & Pall Mall Elec. Ord.	13½–14	6 3 7	Feb, Aug		
5	3/6	† Do. 7 per Cent. Pref.	8½–8¾	4 0 0	Feb, Aug		
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98 –100	3 10 0	—		
5	4/0	†Smithfield Markets Electric Sup. Ord.	2¾–3¼	6 19 7	—		
St.	4%	Do. 4 per Cent. Deb. Stock	79 –83	4 16 5	—		
5	3/0	South London Electric Supply Ord.	4¼–4¾	5 5 7	—		
1	..	South Metrop'n Elec. Lt. & Power Ord.	¾–1	..	—		
1	0/8¾	Do. 7% Cum. Pref.	1⅛–1¼	4 15 6	—		
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	107 –110	4 2 8	—		
5	2/6	Urban Electric Supply Ord.	5⅜–5⅝	4 17 0	—		
5	3/0	Do. 6% Cum. Pref.	6¼–6½	4 16 5	..		
St.	..	Do. 4½% 1st Mort. Deb.	106 –108	—	..		
5	7/6	†Westminster Electric Supply Ord.	11½–11¾	6 6 8	Mar, Sept		
5	2/6	Do. 5 per Cent. Cum. Pref.	6¼–6½	3 14 0	—		
		ELECTRIC MANUFACTURING, &c.					
1	6d.	†Alliance Elec. Co. 5% Cum. Pref.	½–¾	5 6 6	..		
1	6d.	Aron Elec. Meter 6% Cum. Pref.	⅜–⅝	..	..		
5	4/0	British Insulated & Helsby Cables Ord.	6½–6¾	6 3 0	July, Feb		
5	3/0	Do. 6 per Cent. Pref.	6½–6¾	5 4 4	Jan, July		
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 –104	4 6 6	—		
St.	4½%	†British Thoms'n-Houst'n 4½% 1st Mt. Db.	99 –101	4 9 1	—		
5	3/0	British Westinghouse 6% Pref.	5¼–5¾	5 11 5	—		
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	90 –93	4 7 11	..		
2	..	Brush Electrical Engineering	½–¾	..	March ..		
2	2/6½	Do. 6 per Cent. Pref. Non-Cum.	1½–2	6 0 0	Mar, Sept		
St.	4½%	† Do. 4½ per Cent. Perp. 1st Deb. Stock	92 –96	4 14 9	Mar, Sept		
St.	4½%	Do. Perpetual 2nd Deb. Stock	79 –82	5 9 9	Jan, July		
5	6/0	Callender's Cable Con. Ord.	11½–11¾	5 8 8	Jan, July		
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼–5¾	4 7 0	Jan, July		
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	106 –107	4 4 0	Nov, May		
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	¾–⅞	4 0 6	—		
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	91 –96	4 13 9	..		
1	0/3½	Chadburn's (Ship) Telegraph Ord.	¾–1¼	3 17 6	..		
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	2¼–2¾	3 8 4	Jan, July		
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95 –98	5 2 0	Jan, July		
5	10/0	Dick, Kerr & Co. Ord.	7½–8¼	6 1 3	Sept ..		
5	6/0	Do. 6% Cum. Pref.	6¼–6¾	4 18 0	Sept ..		
St.	4½%	Do. 4½% Deb. Stock	106–107	4 4 0	..		
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	¾–1	..	Feb, Aug		
5	..	Do. (£5 paid)	1 –1½	..	Feb, Aug		
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	77 –82	4 17 8	June, Dec		
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	81 –86	5 19 6	..		
5	2/6	Edmundson's Elec. Corp. Ord.	5½–6½	5 12 0	H'lf-yearly		
5	3/0	Do. 6 per Cent. Cum. Pref.	6¼–6¾	4 16 8	—		
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	108 –109	4 3 5	..		
2	1/7½	Electric Construction Co.	1½–1¾	6 8 0	July		
2	2/0¾	Do. 7 per Cent. Cum. Pref.	2½–2¾	5 [illegible] 2	July		
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 –99	4 0 10	Jan, July		
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	—		
10	5/0	General Electric (1900) 5% Cum. Pref.	9½–10	5 0 0	—		
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91 –96	4 3 4	..		
5	5/0	Henley's Telegraph Works Ord.	13 –13½	5 3 3	Feb, Aug		
5	2/3	† Do. 4½ per Cent. Pref.	5½–5¾	4 8 11	Feb, Aug		
St.	4½%	† Do. 4½ per Cent. Mort. Deb. Stock (rd.)	109 –111	4 1 1	Feb, Aug		
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	16 –17	2 18 10	Feb, Aug		
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	103 –108	3 17 5	Mar, Sept		
10	5/0	†Mather & Platt 5 per Cent. Cum. Pref.	11 –11½	4 7 0	Mar, Sept		
12	12/0	Telegraph Construction & Mainten'ce.	35 –38	6 7 8	Mar, July		
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	102 –104	3 16 11	Jan, July		
5	—	Willans and Robinson Ord.	1½–2½	..	Apr, Oct		
5	—	Do. 6 per Cent. Cum. Pref.	3 –4	—	Apr, Oct		
	4%	Do. 4 per Cent. 1st Mort. Debs	78 –83	4 16 6	May, Nov		

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote the

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NOTES.

PROF. J. J. THOMSON, at the Royal Institution on Friday last, gave a most interesting account of the modern electric theory of matter. A report of the discourse appears on another page. Here we would remark that, though to those who have not kept abreast with Prof. THOMSON'S ideas as they have developed, the hypothesis in question may, as a whole, seem but a wild speculation, yet with those who have watched more closely its inception and growth it ranks already as a valid theory carrying us nearer to the truth. Certainly, all who had the opportunity of listening to the explanation which fell from the lips of the prophet must have brought away the conviction that we are getting appreciably nearer the solution of the mystery of matter.

◆

ONLY two years ago, in the Silliman lectures at Yale, Prof. THOMSON first indicated how the electric theory of the atom, which had already proved useful in, for instance, optics, and especially in radio-activity, could be applied to explain the electro-positive and electro-negative characters of the elements. Just a year ago he showed by mathematical analysis that the periodic law of the chemical elements, hitherto an impenetrable mystery, fell to the rank of a deduction from the same theory. Now he has offered us, in a breath, an attractive reason for the existence of a finite rather than an infinite number of elements, and a plausible solution of the great problem of chemical valency which so greatly exercised FARADAY. The mental processes by which these long and rapid strides have been effected seem to be the same as those with which FARADAY himself was so pre-eminently gifted—a sort of glorified common sense, in fact; with, besides, that unfailing intuition which enabled its illustrious possessor to pick his way through puzzling mazes of complicated phenomena, and protected him from the pitfalls and the alluring by-paths ensnaring smaller intellects.

◆

WE publish to-day the gist of an excellent Paper dealing with temperature experiments on a series of insulating materials and on a number of field coils of dynamos. The tests in question were undertaken at the National Physical Laboratory on behalf of the Engineering Standards Committee. One of the most important facts emphasised by the experiments is the enormous influence of moisture on the insulation resistance of insulating materials commonly used in dynamo construction. For instance, the exposure to intermittent sunshine for 70 minutes on a day late in October was sufficient to raise the insulating resistance of a specimen of press-spahn by some 75,000 per cent. The experiments with the field coils bring out little that has not been known to dynamo designers before, but they are nevertheless valuable, as indicating the vast differences in temperature which may exist in actual cases at various depths of the coil.

◆

IN the first part of his Paper on "Temperature Curves and the Rating of Electrical Machinery," read before the Institution of Electrical Engineers last week and published in abstract elsewhere in this issue, Mr. RUDOLPH GOLDSCHMIDT draws attention to the fact that the temperature rise attained in electric apparatus which are used occasionally and for short periods at a time depends only on the energy lost in the apparatus and the specific heat of the material in which the losses occur, but not at all on the radiating surface of this material. This fact has, of course, long been known, and has, indeed, been applied by numerous designers, who have, for instance, embedded motor-starting resistances in sand, enamel and even water—*i.e.*, in substances with high specific heats. But Mr. GOLDSCHMIDT deserves merit for pointing out the way in which the temperature rise may be easily computed and for compiling handy tables of figures, worked out ready for immediate application.

THE second part of the Paper describes means for determining theoretically the temperature curve of electric machinery when the final temperature attained by the machine on constant load is known. But it is just this final temperature which is so difficult to determine beforehand, as any dynamo designer will testify, and this because it depends on a multitude of conditions, such as ventilation, form of magnet frame, coils and other machine parts, nature and thickness of insulating material, and so on. The author evades this difficulty by boldly assuming that unit radiating surface of any material, at a given temperature difference, will radiate in all cases the same amount of heat, and takes no account of the heat otherwise dissipated.

WE commence this week a full reproduction of the Paper on steel manufacture in electric furnaces which was recently read before the Faraday Society by Mr. HARBORD. The general conclusions have already been stated in this journal in the form of a leading article published immediately after the appearance of the report of the Canadian Commission, of which Mr. HARBORD was a member. The present Paper is an admirable summary of that report, and emphasises in a proper manner the strength and limitations of electrical methods. It shows in what directions profitable application of this mode of heating may reasonably be expected; it indicates the causes which forbid its utilisation under other conditions. It is a well-balanced document in its deductions, and as a description of what is modern practice it is a valuable record. Electro chemical work has often been full of suprises, but that part of it concerned with the metallurgy of iron has followed the lines of prediction. The probability of success in making special and high-class steels has been long foreseen by the expert; the impracticability of smelting pig except under quite unusual conditions has also been recognised. Such provision is in each case justified by experience and experiment.

A DISCUSSION on the use of electricity in mines took place on Tuesday at the Manchester Geological and Mining Society, and some exceedingly pertinent remarks were made by Mr. G. H. WINSTANLEY. This gentleman endeavoured to explain that there are more accidents with low than with high pressures, because colliers fancy that they can treat low-tension conductors with impunity. This is undoubtedly true to a certain extent, but it must also be remembered that, so far, the number of low-tension conductors underground which are accessible to unauthorised persons is very greatly in excess of the conductors carrying high-tension current. Nevertheless, it is notorious that mine operatives do not regard low pressures with sufficient respect. Conditions underground are so entirely different to those above ground that the same precautions cannot be applicable to both cases. In the former, men frequently work stripped to the waist, they are in a state of profuse perspiration, and sometimes they have to stand in or wade through water above the tops of their boots. Therefore, voltages that in ordinary circumstances would result in nothing more than a smart shock may be dangerous when received in a coal mine by a collier.

THE great strides made of late in the design of large gas engines for blast furnace gas is illustrated by the 1,000 H.P. engines used for the electric power plant at the Phœnix steel and iron works near Ruhrort in Germany. These engines, as well as similar ones of a smaller size using blast furnace gases, have been running successfully for some time. Another interesting fact in connection with the Phœnix works is that a 1,200 H.P. three-phase motor, for driving roughing-down and finishing rolls, is being installed at the present time, and is expected to do duty shortly. British ironmasters have been slow to move in either of these directions, and we recommend the article to their consideration.

THE contention that lighting by gas is more healthy than by electricity is not a new one, and Sir WM. CROOKES' speech, as Chairman, to the shareholders of the Notting Hill Electric Lighting Co. has been made the occasion of raising the point once more. Sir WM. CROOKES said: "You do not require me to tell you the injurious effect on health caused by the products of combustion of gas, oil or candles; and when it is realised that by substituting electric lighting we escape breathing these deleterious gases, we are removing one important factor in the cause of lowered vitality and ill-health." Our esteemed contemporary, the *Journal of Gas Lighting*, makes this passage the object of attack, and expresses surprise that the world has grown and thriven at such a rate while gas, oil and candles have been so much in use. Perhaps it may not be out of place to remark that many other evils, such as disease and war, have been rampant since the beginning of the world and yet there are few signs of deterioration. The mere fact that the use of gas has not proved absolutely disastrous does not alter the fact that it is detrimental to health. Referring to a letter by Admiral Sir ALGERNON DE HORSEY to the *Daily Graphic*, our contemporary says—

> . . . without some system of ventilation, steam or hot-water pipes, as a sole method of warming a room, are injurious to health, because the air remains unchanged and is breathed over and over again, its foul condition being soon shown by a close odour. The gallant Admiral goes on to speak of the occupants of a room being only saved from partial asphyxiation by air squeezing itself through the interstices of leaky sashes and doors, or by someone occasionally opening a window. The conditions are much the same in a room lighted electrically, and in which several persons are assembled. Unless there are proper means of ventilation contamination quickly ensues, and where proper ventilation is provided there gas lights are a greater assistance to ventilation and to a desirable condition of the atmosphere than electric lights, through the constant circulation and change of air the gas lights produce.

Our contemporary apparently contends that the atmosphere of an improperly-ventilated room, which becomes hot or "stuffy" when lighted and heated by a device neither consuming oxygen nor giving off injurious products of complete and incomplete combustion, is improved by the introduction of something that robs it of its oxygen and does give off these injurious products. Further, that if the room be properly heated and ventilated, the conditions of ventilation are made still better by the addition of heating appliances disposed without regard to the general scheme of ventilation, and consuming the oxygen introduced by the proper ventilation aforesaid. Gas lighting would indeed be doomed if no better arguments than this could be adduced in its favour.

* * *

MUNICIPAL engineers and municipal electricity committees will do well to notice the remarks, reported in our Parliamentary columns this week, by the Chairman of the Police and Sanitary Committee of the House of Commons during the consideration of the clauses of the Accrington Corporation Bill. A discussion arose as to the length of time which should be allowed for the repayment of loans for the reconstruction of the existing steam tramways at Accrington, and for the electrical equipment of them. The Corporation asked for 30 years in which to repay the former and 25 years for the latter. The Chairman of the Committee made it very clear that this question of repayment of loans is to receive strict attention in the future, and, while allowing 30 years for the reconstruction loan, refused to allow a longer period than 20 years for repayment of the loan for the electrical equipment. There is no doubt that with the omission of so many Local Authorities in the past to provide a depreciation fund, the periods for repayment of such loans hitherto granted have been excessive.

* * *

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne—Pinheiros	**Aug. 13, 1902**	—
Reissi-Issa (Yemen)—Camaran	**Oct. 22, 1902**	—
Tarifa—Tangier	**Jan. 18, 1904**	—
Cayenne—Paramaribo	**July 13, 1904**	—
Jamaica—Colon	Jan. 10, 1905	—
Oran—Tangiers	Feb. 24, 1905	**Mar. 13, 1905**
Suakim—Jeddah	Mar. 8, 1905	**Mar. 9, 1905**

Government Appointments.—Consequently on the resignation of the Right Hon. G. Wyndham from the Chief Secretaryship to the Lord Lieutenant of Ireland, a re-arrangement has been made in other official appointments. The Right Hon. Gerald Balfour has been transferred from the Presidency of the Board of Trade to the Presidency of the Local Government Board, in succession to Mr. Walter Long, who has been appointed Chief Secretary to Ireland, and the Marquis of Salisbury succeeds Mr. Gerald Balfour at the Board of Trade. Mr. Bonar Law will now represent the Board of Trade in the House of Commons.

Annual Dinner of the Manchester Local Section of the Institution of Electrical Engineers.—This function took place at the Midland Hotel, Manchester, on March 10th, when Mr. C. D. Taite occupied the chair. The chairman proposed the usual loyal toasts and Mr. H. A. Earle that of the Institution of Electrical Engineers, coupled with the names of the President of the Institution and the Chairman of the Manchester Section. Dr. E. Hopkinson proposed the Guests, to which the Mayor of Salford and Mr. L. B. Atkinson replied. "The trade and commerce of Manchester, Salford and District" was proposed by Mr. J. S. Raworth and replied to by the Mayor of Salford.

Electric Traction in Buenos Ayres.—The *Review of the River Plate* states that the electrical department of Buenos Ayres has reported on the question of adopting some other system than the overhead trolley for that city. It appears that some months ago a Mr. Gordon gave a series of demonstrations with an insulated wire running along the house fronts, to which contact studs were attached at definite intervals. This system seems to have been a sort of inverted surface-contact system, with the conductor and contact studs up in the air instead of under and on the ground. Since the demonstration was given every effort has been made to induce the authorities to adopt the system, but the electrical department has reported against it and in favour of the ordinary trolley wire.

Wireless Telegraph Notes.—It is reported that an agreement has been arrived at between the two Government departments concerned and the Marconi Wireless Telegraph Co. for the installation of instruments for transmission of messages to the mainland from six lightships in the neighbourhood of the Goodwin Sands. The receiving station will be at Dover, and messages will be forwarded by the land lines to the nearest lifeboat station in case of need.

The *Electrical World* of New York states that the General Electric Co.'s wireless telegraph service between Schenectady and Lynn was recently placed in regular operation. It was found that messages could be received at Schenectady from ships at sea, the messages being intended for the Marconi station at Cape Cod.

The aerial wires of the Marconi station at Crookhaven were blown down during the recent gale.

Opening of the Dalkeith Electricity Works.—On Saturday last the electricity works which have been erected at Dalkeith, N.B., by the Electric Supply Corporation were put into operation. The provisional order was obtained in 1901 by Messrs. Crompton & Co., who subsequently transferred it to the Electric Supply Corporation of which Mr. K. A. Scott Moncrieff is the chief engineer and general manager. The supply is on the three-wire system at 220 volts, and the generating station contains two Crossley gas engines driving Crompton 50kw. dynamos. The station also contains a 250-cell "A.B." battery having a capacity of 250 ampere-hours, and the mains have been laid on Messrs. Callender's solid system. There are at present connections equivalent to 1,600 8 c.p. lamps in addition to 27 10-ampere public arcs and 30 H.P. of motors. For lighting 6d. per unit is charged, and 3d. per unit for power. The price of gas in the district is 2s. 10d. Free wiring is carried out by the Electric Supply Corporation at 1s. per lamp per annum.

Faraday Society.—The annual general meeting of the Faraday Society was held on March 6th at the Institution of Electrical Engineers. The treasurer, Dr. F. Mollwo Perkin, occupied the chair, and moved the adoption of the annual report of the council and the statement of accounts and balance sheet for the period from June 1903 to December 1904. The motion was carried unanimously. No further nominations for officers and council in addition to those already announced having been made, the gentlemen already nominated were elected *en bloc*. The new council is constituted as follows:—

President, Lord Kelvin, O.M., G.C.V.O., F.R.S.; past-president, Sir Joseph Wilson Swan, F.R.S.; vice-presidents, Prof. A. Crum-Brown, F.R.S., Sir William Huggins, K.C.B., P.R.S., Sir Oliver Lodge, F.R.S., Dr. Ludwig Mond, F.R.S., Lord Rayleigh, O.M., F.R.S., Mr. Alexander Siemens, Pres.I.E.E., and Mr. James Swinburne; treasurer, Dr. F. Mollwo Perkin; other members of council, Messrs. George Beilby, Bertram Blount, W. R. Cooper, Sherard Cowper-Coles, Prof. A. K. Huntington, Dr. R. A. Lehfeldt, W. Murray Morrison, Dr. W. S. Squire, Dr. O. J. Steinhart, Prof. Ernest Wilson.

Votes of thanks were then passed to the retiring president, Sir Joseph Swan; to the honorary auditors, Messrs. L. Gaster and T. M. Lowry; and to the Institution of Electrical Engineers for their generous hospitality in granting the society the free use of their library for the monthly meetings.

Prof. J. J. Thomson on Radio-activity.—On Saturday afternoon, at the Royal Institution, Prof. J. J. Thomson delivered the first of a series of lectures on radio-activity. He first described, with experimental illustrations, the process of ionising a gas, and showed methods of detecting and of measuring the degree of ionisation produced by radio-active substances. Next he explained carefully the meaning of the term and the cause of the phenomenon, "saturation current." This he made very clear by a useful analogy of birth rate and death rate, which is here applicable. For, taking a gas exposed to radio-active influences, the birth rate of ions owing to the rays, and the death rate due to the re-combination of pairs of oppositely-charged ions tends to equality. If now the gas be submitted to an electric field, the ions are rescued from death by re-combination by being moved to the electrodes. The current their progression causes can at most only just equal the birth rate due to the radio-active influences, however much the field be increased short of actual sparking. The phenomenon was well illustrated by showing that an electric field of minus 66 volts between the plates of a condenser carried negative ions to a connected electroscope at the same rate as a field of plus 123 volts across a similar condenser carried positive ions, and so kept the electroscope unchanged.

Telephony.—The first of four Cantor lectures on "Telephony" was delivered by Mr. H. Laws Webb at the Society of Arts last Monday evening. In commencing, Mr. Webb explained the characteristics of the sound waves produced by the spoken word and illustrated, by means of a wave thrown on to the screen, to what extent the form of the wave depended on the "quality" and pitch of the voice of the telephone user. The problem of telephonic transmission was neatly expressed in the words that it consisted of sending over the telephone wires electric current waves commensurate with the sound waves. The lecturer then proceeded to give a historical sketch of telephony, interweaving in his remarks the reasons why a particular instrument or method was good or bad. In this way the hearers were led, step by step, to recognise the salient points in modern telephony, and gradually the historical sketch developed into a description of the most up-to-date apparatus. Next Mr. Webb passed on to a lucid description of the various systems of connecting up the telephone and bell circuits amongst themselves, and to the telephone network as a whole, finishing up the lecture with a description of the central battery system. Amongst the large number of pictures projected on the screen, none were more instructive and appreciated than that of the two working models, which brought home to the audience, more than any amount of words could have done, the action which takes place in magneto-electric and microphone transmitters.

Obituary.—We regret to announce the death of Mr. Stephen William Silver, in his 86th year, which took place on the 7th inst. Mr. Silver was one of the founders of the India Rubber, Gutta Percha & Telegraph Works Co. in 1864, and until his death he continued to remain in close connection with that corporation as director, chairman and latterly as extraordinary director. In the report of the Parliamentary Committee, which sat in 1859 to investigate the whole question of submarine cable construction, reference is made to the work done by Messrs. Silver in collaboration with Mr. C. West. In his evidence, Mr. West stated that in the year 1845-46 he laid an indiarubber insulated cable across Portsmouth Harbour, but the India Rubber Co. is unable to state whether this cable was manufactured by the Messrs. Silver or not. Mr. Silver's interests were manifold. The Linnæan Society, the Royal Botanic Society and others of a kindred nature claimed his attention. The Colonial Institute and the Royal Geographical Society lose an old friend, formerly one of the active members of Council, and travellers in Central Africa or elsewhere will be the poorer for the loss of Mr. Silver's sympathy, which, when necessary, took the practical turn of ready assistance towards the accomplishment of their aims. In recognition of the connection of the Silver family with the foundation of the industrial district in which their works are situated, this was given the name Silvertown, and the name was adopted by the postal authorities. At the funeral at Letcomb on Saturday, a large number of people from the district were present, and the Silvertown Company and other bodies with which Mr. Silver had been connected in London were also represented.

The Forthcoming Optical Convention.—An optical convention is to be held at the Northampton Institute, Clerkenwell, E.C., from May 31st to June 3rd. The president will be Dr. R. T. Glazebrook, Director of the National Physical Laboratory, and among the vice-presidents are the Earl of Rosse, the Earl of Crawford, Lord Kelvin, Lord Rayleigh, Lord Blythswood, Sir William Abney, Sir Howard Grubb, the Astronomer Royal, the Hon. Alban G. H. Gibbs, and Mr. Thos. Dallmeyer. The mornings will be devoted to Papers and discussions on optical subjects. Papers are promised by Lord Rayleigh, Profs. Poynting and Forbes, Dr. Watson, Mr. Dennis Taylor, Mr. T. H. Blakesley, Mr. J. W. Gordon, and others. Offers to read Papers should be sent to the secretary of the Papers sub-committee, Mr. S. D. Chalmers, Northampton Institute, E.C., who will be glad to submit them to the committee. During the Convention an exhibition of optical and scientific instruments and appliances will be held in the great hall of the Northampton Institute. It is hoped that many novelties of British manufacture will be shown, and the exhibition promises to be of great general and scientific interest. A large number of persons and firms have promised to send exhibits. It is hoped that all those interested will apply for membership of the Convention, the subscription for which will be five shillings. The hon. secretary, Mr. F. J. Selby, Elm Lodge, Teddington, will be glad to receive the names of those wishing to join. A guarantee fund has been opened, and the total of guarantees and contributions now amounts to over £700. Promises of guarantees or donations should be sent to the hon. treasurer, Mr. E. B. Knobel, F.R.A.S., 32, Tavistock-square, W.C.

Exhibition of Meteorological Instruments.—In former years the Royal Meteorological Society used regularly to hold annual exhibitions illustrative of the progress made in the art of indicating and recording all phenomena valuable to meteorologists. But after 1897 these annual exhibitions were discontinued until the present year. This year's exhibition, which opened last Tuesday and closes to-day (Friday) at 5 p.m., is arranged in the library of the Institution of Civil Engineers, Great George-street, Westminster. It includes 190 exhibits, and is all the more interesting as it indicates the ever increasing part played by electricity in connection with all kinds of meteorological instruments. In this connection there is Messrs. Negretti & Zambra's electrical self-recording rain gauge, in which the tilting of one of two buckets closes an electric circuit and causes the indicating device in the building to record the proper amount. The same firm also exhibits an electrical recording anemometer which indicates the wind velocity by electrical means at any desired distance. Similar apparatus is shown by Messrs. R. M. Lowne and J. J. Hicks. The Cambridge Scientific Instrument Co. have on view a Callendar temperature recorder which may be connected up to a thermometer of the electrical resistance type or to a sunshine receiver. The latter consists of two lengths of fine platinum wire of equal resistance, both wound in zig-zag fashion and arranged side by side in one plane. One length is embedded in black enamel, and the other is bright and uncovered. A glass bulb filled with dry air encloses both coils. The intensity of sunshine is measured by the difference of resistance between the embedded wire and the bare wire. Of considerable interest, too, is Messrs. Elster & Geitel's dissipation apparatus for determining the rate at which electricity is dissipated from a charged body exposed to the air. Mr. G. Simpson has on view Ebert's apparatus for finding to what extent the air is ionised, and an apparatus for measuring the amount of radio-active emanation in the atmosphere. The exhibition also contains numerous objects struck by lightning and a large collection of photographs illustrating lightning effects. A large map, by Mr. Alfred Hands, shows the distribution and severity of lightning effects in England and Wales.

The Belfast Tramways.—In spite of trouble owing to labourers' strikes, progress is being made with the large system of tramways now being converted from horse to electric traction by the Belfast Corporation. The system includes no less than 40 route-miles, all of which is double track. The track work is being carried out to the specifications and under the supervision of the city surveyor, Mr. H. A. Cutler, the cars and car depots will be under the supervision of the tramways manager, Mr. Andrew Nance, while Mr. V. A. H. McCowen, the city electrical engineer, is responsible for the overhead equipment, feeders, and, of course, the power supply. It will be remembered that the entire contract was awarded to Messrs. J. G. White & Co., who are themselves carrying out the outside work with the exception of the feeders, the contract for which has been sub-let to the Callender Cable & Construction Co. A centre-running trolley with swivel head will be employed, and ordinary double-deck cars without top covers. In order to supply the tramway load, large extensions are being carried out in the power station. At present the station contains six 400kw. Mather & Platt sets, one 400kw. Johnson & Phillips set, two 200kw. Parker sets and two 100kw. Parker sets, all these being driven by Belliss engines. Two of the 400kw. sets have triple expansion engines and the remainder compound engines. In addition, there is a 10kw. booster-balancer set, and a 25kw. balancer has recently been added, the field magnets of which have series fields so that the drop in the middle wire is automatically allowed for. Messrs. J. G. White & Co. have sub-let the contracts for the additional generating plant to Messrs. Coombe, Barbour & Coombe, of Belfast, and the Westinghouse Company. There will be three 1,000kw. sets, the engines for which will be fast-speed vertical machines built on the same lines as the Belliss type. A steam consumption guarantee has been given of $16\frac{3}{4}$lb. of steam per I.H.P.-hour at 170lb. pressure with 25in. vacuum, the steam being superheated to 550 F. The speed of the sets is 180 revs. per min. We understand that reciprocating engines were chosen in this case in preference to steam turbines owing to the fact that the turbine builders would not definitely guarantee so low a steam consumption as the above under like conditions. The additional boilers will be of Babcock & Wilcox make. To take this new plant the engine room and boiler house are being extended, and work on the foundations is now well forward, most of the piles having already been driven. Mirrlees Watson surface condensers with electrically-driven air pumps and centrifugal circulating pumps are to be employed. The circulating pumps will be placed in a pump house on the bank of the river about 550ft. from the station, the circulating water being returned to the river lower down. Current will be supplied directly to the line at 500 volts in the first instance, but a three-phase continous-current sub-station is to be provided at the end of one of the present routes, the intention being to transmit three-phase current to it at a higher voltage, in view of the probability of further extensions at greater distances from the centre

160,000 Volt Testing Transformer.--Two 50kw. 160,000-volt transformers, built by the General Electric Co. for testing the insulators on the transmission line of the Columbia Improvement Co., are described by Mr. J. J. Frank in the *Electrical World* of New York. They are of the core type, the windings being placed on the two vertical legs. The low-tension coils are placed next to the core, and consist of four coils supported on porcelain bases fastened to the bottom core clamp. The high-tension winding consists of 40 coils, each separately wound and each divided into two separate sections. This sub-division of the high voltage winding gives a maximum of 4,000 volts per coil, with not more than 200 volts between adjacent layers. Insulation between the two windings is provided by the oil, which flows through a duct sub-divided by cylindrical diaphragms of moulded insulation into a number of separate channels. This construction, by providing several enveloping layers of oil, gives an insulating barrier between the primary and secondary, which is comparatively thin but possesses exceedingly high dielectric strength. To insure safe transportation and installation, and to prevent accident to the operator by contact with any part of a tank that could become charged by static induction, the tank is made of wrought iron with rivetted and calked joints and rivetted to a cast-iron base. The cover is of cast iron secured to the tank by two large bolts, and may be readily removed together with the high-potential terminals. The low-potential terminals are of heavy insulated cables, brought through porcelain bushings passing through the cover. The bushings for the high-potential terminals are of a novel and most satisfactory construction, each consisting of a cylinder filled with oil, through the centre of which passes a copper terminal rod. These bushings are made of short sleeves or sections of moulded insulation, between which are placed discs of the same material, the whole being bolted together into an oil-tight structure and treated with "compound." The terminals thus formed are each fastened in a square marble base $1\frac{1}{2}$in. thick, and the two are supported on a cast-iron bracket bolted fast to the cover. The upper portion of the terminal extends for a sufficient distance above the cover to prevent discharge from the terminal to the cover through the air, and the series of discs provide sufficient length of insulation to prevent any leakage to the cover. The lower portion of the terminal reaches below the surface of the oil in the transformer. The above construction allows the terminals to be readily removed from the cover for safety in transportation or installation, or allows the cover to be removed with the terminals in place. While the full potential of this transformer is 160,000 volts, additional terminals, beneath the surface of the oil in the tank, are provided whereby the full rated capacity of the transformer may be used at either 40,000 or 80,000 volts. These terminals are similar in construction to the main terminals just described. Such high-potential transformers are used, not only for systematic testing of transformers, but for testing the effective insulation of transmission lines to ground. A General Electric Co. transformer, built on the same general lines, adapted to give 100,000 volts, has been used by the Hudson River Water Power Co. in testing its 33,000-volt transmission line from Spiers Falls to Schenectady. Following are some data abstracted from a report detailing tests that were made on this transformer :—Exciting current, 0·86 amperes, or 3·8 per cent. of total ; energy current, 0·72 amperes, or 3·2 per cent. of total ; core loss, 1,600 watts ; total loss at full load, 2,500 watts ; regulation at 100 per cent. power-factor, 2·2 per cent. ; efficiencies, $1\frac{1}{4}$ full load, 95·3 per cent. ; full load, 95·2 per cent. ; $\frac{3}{4}$ load, 94·6 per cent. ; $\frac{1}{2}$ load, 93·2 per cent ; $\frac{1}{4}$ load, 88·4 per cent. ; $\frac{1}{10}$ load, 75·8 per cent.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

To-day) FRIDAY, March 17th.

National Physical Laboratory.

3.30 p.m. Meeting of the General Board at Bushy House.

Institution of Electrical Engineers: Manchester Students' Section.

7.30 p.m. Meeting in the Municipal School of Technology. Paper to be read : "High-Tension Switch Gear," by C. R. St. John.

North-East Coast Institution of Engineers and Shipbuilders.

7.30 p.m. General Meeting at the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Included in the business of the evening is the discussion on Mr. J. F. C. Snell's Paper on "Application of Electricity to Industrial Purposes."

SATURDAY, March 18th.

Royal Institution.

3 p.m. Afternoon Lecture II. : "Electrical Properties of Radio-active Substances," by Prof. J. J. Thomson, F.R.S.

Glasgow Technical College Scientific Society.

7.30 p.m. Meeting at 38, Bath-street. Paper to be read : "Independent Condensing Plant," by C. Day.

MONDAY, March 20th.

Institution of Electrical Engineers : Newcastle Local Section.

7.30 p.m. Meeting at the Durham College of Science. The following Paper will be read : "Electrically-driven Lifts," by F. O. Hunt.

Society of Arts.

8 p.m. Cantor Lecture II. : "Telephony," by H. Laws Webb.

TUESDAY, March 21st.

Royal Institution.

5 p.m. Afternoon Lecture I. on "Vibration Problems in Engineering," by Prof. W. E. Dalby.

THURSDAY, March 23rd.

Wolverhampton and District Engineering Society.

7.30 p.m Meeting at the Wolverhampton Technical School. Paper to be read : "Pumping Machinery," by E. C. R. Marks.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting, when the discussion of the following Papers, read on March 9, will be taken : (1) "On the Effect of Heat on the Electrical and Mechanical Properties of Dielectrics," and "On the Temperature Distribution in the Interior of Field Coils," by E. H. Rayner, communicated by Dr. R. T. Glazebrook, F.R.S. ; (2) "On Temperature Curves and the Rating of Electrical Machinery," by R. Goldschmidt.

FRIDAY, March 24th.

Physical Society.

5 p.m. Meeting in the Pender Electrical Laboratory, University College, Gower-street, W.C., by the invitation of Prof. J. A. Fleming, F.R.S. Agenda. (1) "Note on the Voltage Ratios of an Inverted Rotary Converter." By W. C. Clinton. (2) "On the Flux of Light from the Electric Arc with varying Power Supply." By G. B. Dyke. (3) "The Application of the Cymometer and the Determination of the Coefficient of Coupling of Oscillation Transformers." By Prof. J. A. Fleming, F.R.S. (5) Exhibition of Cymometers and other instruments.

Rugby Engineering Society.

8 p.m. Meeting in the Benn Buildings, High-street, Rugby, when Mr. J. T. Milton will deliver the third and last of his course of lectures on "The Minute Structure of Metals."

Royal Institution.

9 p.m. Evening Discourse by Sir Oliver Lodge, F.R.S., on "A Pertinacious Current."

SATURDAY, March 25th.

Royal Institution.

3 p.m. Afternoon Lecture III :—"Electrical Properties of Rad active Substances," by Prof. J. J. Thomson, F.R.S.

WIRELESS TELEGRAPH LICENCES.

We give below the conditions of the model forms of licence which have been prepared by the Postmaster-General in accordance with the terms of the Wireless Telegraph Act, 1904. The text of the Wireless Telegraph Act was given in our issue for October 14, 1905. Three model forms of licence have been issued, entitled "Commercial," "Experimental," and "Private Business" respectively. The preamble of the "Commercial" licence gives the licensee authority to instal, work and use a system of wireless telegraphy, the "Experimental" licence authorises the use of a system of wireless telegraphy with the sole object of conducting experiments, whilst the "Private Business" licence authorises the erection of stations as specified in the schedule to the licence and for messages to be transmitted only between those stations.

The following is the full text of the "Commercial" licence :—

1. *Interpretation Clause.*—In these presents (and in the schedule hereto) the following words and expressions shall have the several meanings hereinafter assigned to them, unless there be something either in the subject or context repugnant to such construction (that is to say) :—

The expression "wireless telegraphy" has the same meaning as in the Wireless Telegraphy Act, 1904.

The term "telegraph" has the same meaning as in the Telegraph Act, 1869.

The expression "naval signalling" means signalling by means of any system of wireless telegraphy between two or more ships of His Majesty's Navy, between ships of His Majesty's Navy and naval stations, or between a ship of His Majesty's Navy or a naval station and any other wireless telegraph station whether on shore or on any ship.

The expression "the Admiralty" means the Commissioners for executing the office of Lord High Admiral of the United Kingdom of Great Britain and Ireland.

The expressions "the International Telegraph Convention" and "the International Telegraph Regulations" mean respectively the International Convention of St. Petersburg, dated the 10th/22nd July, 1875, and the Service Regulations made thereunder, and include respectively any modifications of the Convention or Regulations made from time to time.

2. *Licence to Establish a System of Wireless Telegraphy.*—(1) Subject to the provisions of this indenture the licensee shall, during the term or period commencing on the   day of   , one thousand nine hundred and   , and terminating on the thirty-first day of July, one thousand nine hundred and six, have licence and permission from the Postmaster-General.

(i.) To establish, instal and work, for the purposes hereinafter mentioned, at the stations on shore specified in the Schedule hereto, and on board British ships, apparatus for wireless telegraphy of the kind used in the system known as the   system of wireless telegraphy (which apparatus is hereinafter referred to as "the licensed apparatus"); provided that the apparatus installed at each station on shore shall be of the character specified in the said Schedule opposite to the name of such station.

(ii.) To transmit and receive messages by means of wireless telegraphy between the said stations and ships at sea and to transmit and receive between one of the said stations and another messages incidental to communications between the said stations and ships at sea, but no other messages.

(iii.) To receive money or other valuable consideration for or in respect of the use of the licensed apparatus or for or in respect of the transmission or receipt by means of the said apparatus of messages between the said stations and ships at sea.

(2) The licensee shall, before installing the licensed apparatus upon any British ship, give to the Postmaster-General notice of the name of such ship, the period for which the apparatus is to be installed and the several particulars in relation to such apparatus specified in the schedule hereto under the heading "Character of Apparatus."

3. *Restrictions on Use of Apparatus.*—The licensed apparatus shall not be used by the licensee, or by any other person either on his behalf or by his permission, for the transmission or receipt of messages, except messages authorised by this indenture, and in particular the licensed apparatus shall not be used for the transmission by wireless telegraphy of any telegram to or from any British possession or protectorate or foreign country, either directly or by means of any intermediate station or stations (whether on shore or on a ship at sea).

4. *As to Interference.*—(1) The licensee shall so work the licensed apparatus as not to interfere with the working of any wireless telegraph station established in the British Islands, or the territorial waters abutting on the coasts of the British Islands, by or for the purposes of the Postmaster-General, or any department of His Majesty's Government, or for commercial purposes, and, in particular, with the transmission or receipt of any messages between or at wireless telegraph stations established as aforesaid on land, and wireless telegraph stations established on ships at sea.

(2) With a view to preventing such interference as aforesaid, the licensee shall comply with all directions which shall be given to the licensee by the Postmaster-General, and with all rules prescribed by the Postmaster-General for observance by his licensees—

(*a*) With respect to all arrangements to be adopted for the purpose of syntony, or enabling the messages exchanged by means of the licensed apparatus to be distinguished from those emanating from any other wireless telegraph station ;

(*b*) With respect to any alternation of messages which the Postmaster-General may think necessary ; and

(*c*) Generally with respect to avoiding interference between one wireless telegraph station and another.

(3) The licensed apparatus shall not, without the consent of the Postmaster-General, be altered or modified in respect of any of the particulars mentioned in the schedule hereto.

(4) The licensee shall at all times indemnify the Postmaster-General against all actions, claims and demands which may be brought or made by any corporation, company or person in respect of any injury arising from any act licensed or permitted by these presents.

5. *Protection of Naval Signalling.*—(1) The licensee shall not by the transmission of any message by means of the licensed apparatus or otherwise by the use of the licenced apparatus interfere with naval signalling.

(2) The licensee shall, if so required, in writing, by the Admiralty, cease to use the licensed apparatus for such period (not exceeding two hours in any one day) as may be specified by the Admiralty.

(3) If the Admiralty are of opinion that the working of the licensed apparatus at any station specified in the schedule hereto is inconsistent with the free use of naval signalling, the licensee shall when required in writing by the Postmaster-General so to do close the said station.

(4) These provisions for the protection of naval signalling shall be construed to be without prejudice to the generality of any other provisions of this indenture.

6. *Licensee to Observe International Convention and Regulations.*—For the purpose of this indenture the licensee shall observe the International Telegraph Convention and the International Telegraph Regulations so far as the said Convention and Regulations apply to wireless telegraphy in common with ordinary land and submarine telegraphy, but the provisions of the said Regulations in relation to semaphore telegraphy shall not be held to apply to wireless telegraphy.

7. *Messages to be Transmitted without Favour or Preference.*—Subject to the provisions of this indenture the licensee shall transmit messages by means of the licensed apparatus on equal terms without favour or preference, whether as regards rates of charge, order of transmission or otherwise.

8. *Messages on His Majesty's Service to have Priority.*—(1) If and whenever any department of His Majesty's Government shall require the licensee, his servants or agents to transmit by means of the licensed apparatus any message on His Majesty's service (including messages to and from ships of His Majesty's navy) such messages shall have priority over all other messages, and the licensee, his servants and agents shall, as soon as reasonably may be, transmit the same, and shall, until transmission thereof, suspend the transmission of all other messages.

(2) In respect of messages transmitted on behalf of His Majesty's Government, the licensee shall charge rates not in excess of half of the rates charged to the ordinary public.

(3) The licensee shall not be entitled to claim any compensation in respect of the suspension of the transmission of messages as aforesaid.

9. *Licensee to Receive Signals of Distress.*—The licensee shall, so far as possible, receive from ships and light stations all requests for assistance and all signals of distress, and re-transmit them with the least possible delay to the proper authorities by means of the licenced apparatus or any other means in his power.

10. *Licensee to Employ British Subjects.*—The licensee shall employ British subjects only at his stations on shore.

11. *Provisions as to Secrecy.*—The licensee shall not divulge to any person (other than properly authorised officials of His Majesty's Government or a competent legal tribunal), or make any use whatever of any message coming to the knowledge of the licensee, and transmitted by naval signalling or by any system of wireless telegraphy provided or maintained by or for the purposes of the Postmaster-General or any department of His Majesty's Government or by any licensee of the Postmaster-General (other than the licensee).

12. *Registers of Messages to be Kept.*—All messages transmitted by means of the licensed apparatus shall be copied in full in registers to be kept by the licensee for that purpose, and in such registers each of such messages shall be accompanied by its identifying number and date and full particulars of its places of origin and ultimate destination and such further particulars as the Postmaster-General shall from time to time reasonably require to be shown, messages on His Majesty's service being in such registers distinguished from other messages. The licensee shall preserve all used message forms, written and printed, and transcripts of messages and all other papers for such period as is from time to time prescribed by the International Telegraph Regulations, and such registers and message papers shall be open to the inspection of the Postmaster-General or his officers thereto authorised at the head office of the licensee in   between the hours of 10 a.m. and 5 p.m. on every day except Sunday or a statute or general holiday.

13. *Power to Postmaster-General to Inspect Apparatus.*—The Postmaster-General and his engineers and agents may from time to time and at all reasonable times enter upon all or any of the stations, offices and works in the possession or occupation of the licensee, either solely or jointly with any other person or persons, for the purpose of inspecting, and may inspect any apparatus fixed or being in such places respectively for the purpose of sending and receiving messages by wireless telegraphy and all other telegraphic instruments and apparatus fixed or being in such stations respectively, and the working and user of such apparatus and telegraphic instruments respectively.

14. (1) *Interference with Telegraphic Lines of Postmaster-General.*—All apparatus used or intended to be used by the licensee shall be so erected, fixed, placed and used as not either directly or by reason of the working or user thereof to interfere with the efficient or convenient maintenance, working or user of any telegraphic line of the Postmaster-General which may from time to time exist, or which it is probable that the Postmaster-General may have occasion to erect, place, fix or use, or to expose any such line to risk of damage or to risk of interference with the efficient or convenient working or user thereof.

(2) In case any telegraphic line of the Postmaster-General shall be damaged or the efficient working or user thereof shall be wholly or partially interrupted or otherwise interfered with, and the engineer-in-chief for the time being of the Post Office shall certify in writing under his hand that such damage, interruption or interference has been caused directly or indirectly by any apparatus used or intended to be used by the licensee, or by anything done by or on behalf of the licensee in relation thereto, the licensee shall on demand pay to the Postmaster-General all costs that shall be reasonably incurred by him in repairing such damage and in removing or altering such telegraphic line so as to restore the same to efficient working order, and in adding thereto or substituting therefor, either temporarily or permanently, any other telegraphic line if the said engineer shall certify that such addition or substitution is reasonably required.

(3) For the purposes of this article the expression "telegraphic line" has the same meaning as in the Telegraph Act, 1878, and the expression "telegraphic line of the Postmaster-General" includes a telegraphic line belonging to or worked or used by the Postmaster-General, or constructed or maintained by him for any department of the Government or other body or person.

15. *Provisions of any Wireless Telegraphy Convention to be Observed.*—If His Majesty's Government adhere for the United Kingdom to any International Convention on the subject of wireless telegraphy the licensee shall observe at all his stations, whether in the British Islands or on British ships, the provisions of such Convention, and of any detailed regulations made thereunder for carrying such provisions into effect.

16. (1) *Royalties.*—The licensee shall pay to the Postmaster-General for and in respect of the licensee hereby granted a royalty of £1 per annum in respect of each station and a royalty of 5s. per annum in respect of each British ship at or on board of which the licensed apparatus is installed.

(2) All royalties payable under this indenture shall be payable upon the quarter day first ensuing after the date when the licensed apparatus has been installed at any station or on board any British ship and on the same quarter day in each succeeding year.

17. *Licence not to be Assigned.*—Except with the consent in writing of the Postmaster-General the licensee shall not assign, underlet or otherwise dispose of or admit any other person or body to participate in the benefit of the licences, powers or authorities hereby granted, or any of such licences, powers or authorities.

18. (1) *Power to take Possession of or Control Apparatus upon Emergency.*—If, and whenever in the opinion of one of His Majesty's Principal Secretaries of State, an emergency shall have arisen in which it is expedient for the public service that His Majesty's Government shall have control over the transmission of messages by the licensed apparatus, it shall be lawful for the said Secretary of State by warrant under his hand to direct and cause so much of the licensed apparatus as is within the United Kingdom or the territorial waters thereof, or any part of the licensed apparatus to be taken possession of in the name and on behalf of His Majesty, and to be used for His Majesty's service and, subject thereto, for such ordinary services as to the said Secretary of State may seem fit, and in that event any person authorised by the said Secretary of State may enter upon the stations, offices and works of the licensee or any of them and take possession thereof and use the same as aforesaid.

(2) One of His Majesty's Principal Secretaries of State may when he considers such an emergency as aforesaid to have arisen, instead of taking possession of the stations, offices and works of the licensee, or any of them, direct and authorise such persons as he may think fit to assume the control of the transmission of messages by the licensed apparatus, either wholly or partly and in such manner as he may direct, and such persons may enter upon the licensee's premises accordingly, or the said Secretary of State may direct the licensee to submit to him or any person authorised by him all messages tendered for transmission or arriving by the licensed apparatus or any class or classes of such messages, to stop or delay the transmission of any messages or deliver the same to him or his agent, and generally to obey all such directions with reference to the transmission of messages as the Secretary of State may prescribe, and the licensee shall obey and conform to all such directions.

(3) In any such case as aforesaid, if the licensee shows that during the exercise of any of the powers aforesaid his receipts for the licensed apparatus with respect to which the said powers have been exercised, have been less than his receipts from the same source during a corresponding period, His Majesty's Government shall pay to the licensee, as compensation for any loss of profit sustained by the licensee by reason of the exercise by the Secretary of State of any of the powers hereby reserved, such sum as may be settled between the Secretary of State and the licensee by agreement or as in case of difference may be determined by arbitration. Provided always that no such compensation as aforesaid shall be paid if and so far as the powers hereby reserved to the Secretary of State are exercised for the purpose of preventing direct communication with any of His Majesty's enemies and, save with the consent of the Secretary of State, no such compensation shall be paid if and so far as the powers aforesaid are exercised for the purposes of preventing indirect or suspected communication with any of His Majesty's enemies or of protecting the interests of His Majesty under the apprehension of impending war.

(4) In estimating such compensation as in the last sub-clause provided the arbitrator shall take into account all the circumstances of the case, including not only any such loss as aforesaid, but also any additional profit accruing to the licensee (whether from the use of the licensed apparatus so taken possession of or controlled, or from any other apparatus used by him) from the emergency which gave rise to the exercise of the powers aforesaid. And as regards the licensed apparatus with respect to which the said powers have been exercised, the receipts of the licensee during a period corresponding to that of the exercise of the said powers shall be deemed to be the receipts which the licensee would have taken during the period of the exercise of the said powers had the powers not been exercised.

19. *Provisions for Determination of Licence in Certain Events.*—In any of the following cases (that is to say):—

(*a*) In case any sum of money which ought to be paid by the licensee to the Postmaster General, under or by virtue of these presents, shall be in arrear and unpaid for one calendar month after the time at which the same ought to be paid under or by virtue of the covenants herein contained, or

(*b*) In case of any breach, non-observance or non-performance by or on the part of the licensee of any of the covenants (other than a covenant for the payment of money) or conditions herein contained and on the part of the licensee to be observed and performed

then and in any such case the Postmaster-General may, by writing under his seal, revoke and determine these presents and the licences, powers and authorities hereinbefore granted and each and every of them, and thereupon these presents and the said licences, powers and authorities and each and every one of them shall absolutely cease, determine and become void.

Provided always that no such revocation or determination as aforesaid shall prejudice or affect any right of action or remedy which shall have accrued or shall thereafter accrue to either of the parties hereto under the covenants herein contained.

20. *Licence not to affect Postmaster-General's Rights.*—Nothing in these presents contained shall prejudice or affect the right of the Postmaster-General from time to time to establish, extend, maintain and work any system or systems of telegraphic communication (whether of a like nature to that hereby licensed or otherwise) in such manner as he shall in his discretion think fit, neither shall anything herein contained prejudice or affect the right of the Postmaster-General from time to time to enter into agreements for, or to grant licences relative to the working and user of telegraphs (whether of a like nature to those hereby licensed or otherwise) or the transmission of messages in any part of the United Kingdom by means of wireless telegraphy, or by any other means with or to any person or persons whomsoever upon such terms as he shall in his discretion think fit. And (save as in this indenture expressly provided) nothing herein contained shall be deemed to authorise the licensee to exercise any of the powers or authorities conferred on or acquired by the Postmaster-General by or under the Telegraph Acts or any of them.

21. *Arbitration.*—All matters which in pursuance of the provisions herein contained are to be determined by arbitration shall be referred to arbitration in accordance with the provisions of the Arbitration Act, 1889, or any then subsisting statutory re-enactment or modification thereof.

Notices, &c.—Any notice, request, or consent (whether expressed to be in writing or not) to be given by the Postmaster-General under these presents may be under the hand of any one of the secretaries or assistant secretaries for the time being of the Post Office, and may be served by sending the same by registered post letter to the licensee, and any notice to be given by the licensee under these presents may be served by sending the same by registered post letter addressed to the secretary of the Post Office at the General Post Office, London.

The Schedule before referred to.

1.	Character of apparatus.					
Name of station.	2. Maximum range of signalling.	3. Mean range of signalling.	4. Description of receiving apparatus.	5. Wave length.	6. Power (current & voltage.)	7. Source of power.
	With the licensee's own apparatus.					

The points of difference between the "Commercial" licence given above and the "Experimental" licence are as follows:—

The last paragraph of clause 1 is omitted.

Clause 2 prescribes that the experimental stations which it is proposed to erect are to be specified in the schedule.

Clause 5 has an extra sub-section as follows:—"Whenever the operators at any signal station of the licensee perceive through the medium of the instruments used by them that naval signalling is proceeding, they shall refrain from using the licensed apparatus until all indication that naval signalling is proceeding shall have ceased."

Clauses 6, 7, 8, 9, 10 and 12, 15, 16 and 21 are omitted.

Sub-sec. 2, 3 and 4 of sec. 18 are omitted.

An additional clause (11) is included, entitled "Determination," which reads as follows:—"The Postmaster-General may, at any time in his absolute discretion, give notice in writing to determine these presents and the licence or permission hereby given at the end of one calendar month from the date of such notice, and at the expiration of that period the licence or permission hereby granted shall cease and determine accordingly, but without prejudice to any remedy of the Postmaster-General under any covenant or provision herein contained on the part of the licensee to be observed or performed."

The schedule to the "Experimental" form is as follows:—

	Character of apparatus.		
1. Name of station.	2. Maximum range of signalling with the licensee's own apparatus.	3. Power. (Current and voltage.)	4. Source of power.

The "Private Business" form is very similar to the "Experimental" form in its comparison with the "Commercial" form. As before stated, authority is merely given to erect certain specified stations as set out in the schedule.

An addition is made to clause 3 stipulating that no money or other return shall be received by the persons working the stations for any messages transmitted.

The extra sub-section to clause 5 of the "Experimental" form is included, as is also the "Determination" clause given above.

Secs. 6, 7, 8, 9, 10, 12 and 15 and 21 of the "Commercial" form are omitted, as well as sub-secs. 2, 3 and 4 of sec. 18.

In the clause relating to "Royalties" the amount to be paid is left blank, there being a marginal note to the effect that where the telegram licensed come within the first and second exception to sec. 5 of the Telegraph Act, 1869, this clause should be omitted.

The schedule to the form is the same as that attached to the "Commercial" licence, with the deletion of column 3.

BLAST FURNACE GAS ENGINES FOR ELECTRIC POWER GENERATION.

One of the largest generating stations in which the motive power is supplied by gas engines using the waste gases from the blast furnaces is that erected at the Phœnix iron and steel works in Laar, near Ruhrort (Germany). By the courtesy of the management we are able to publish a brief description of the installation. At present the generating plant consists of three 1,000 H.P. sets, while three other sets of 800 H.P. each are in course of erection and are expected to run this spring. These gas engines are directly coupled to three-phase alternators, built by the Allgemeine Elektricitäts-Gesellschaft of Berlin. The larger sets run at a speed of 100 revs. per min., but the three 800 H.P. sets are to run at 140 revs. per min., this speed being chosen to enable the use of existing dynamos.

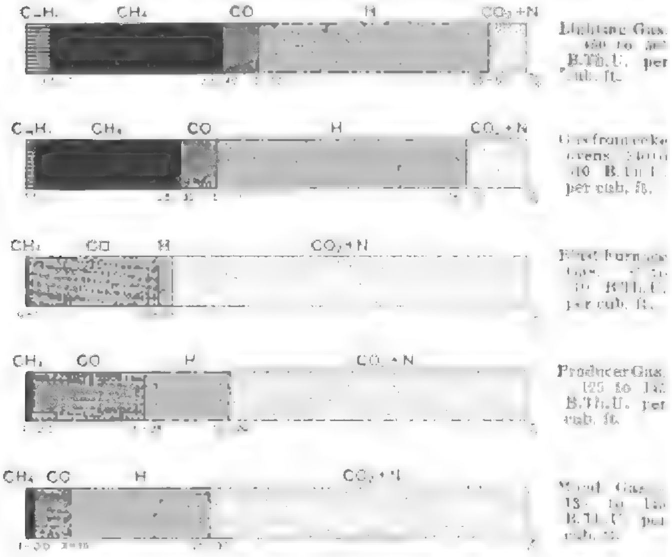

FIG. 1.—CHARTS SHOWING COMPOSITION OF VARIOUS GASES.

Fig. 1 shows the approximate calorific value and composition of various kinds of power gases used for gas engines. The production of every ton of crude iron liberates, we are informed, about 88,000 cubic ft. of blast furnace gas, having

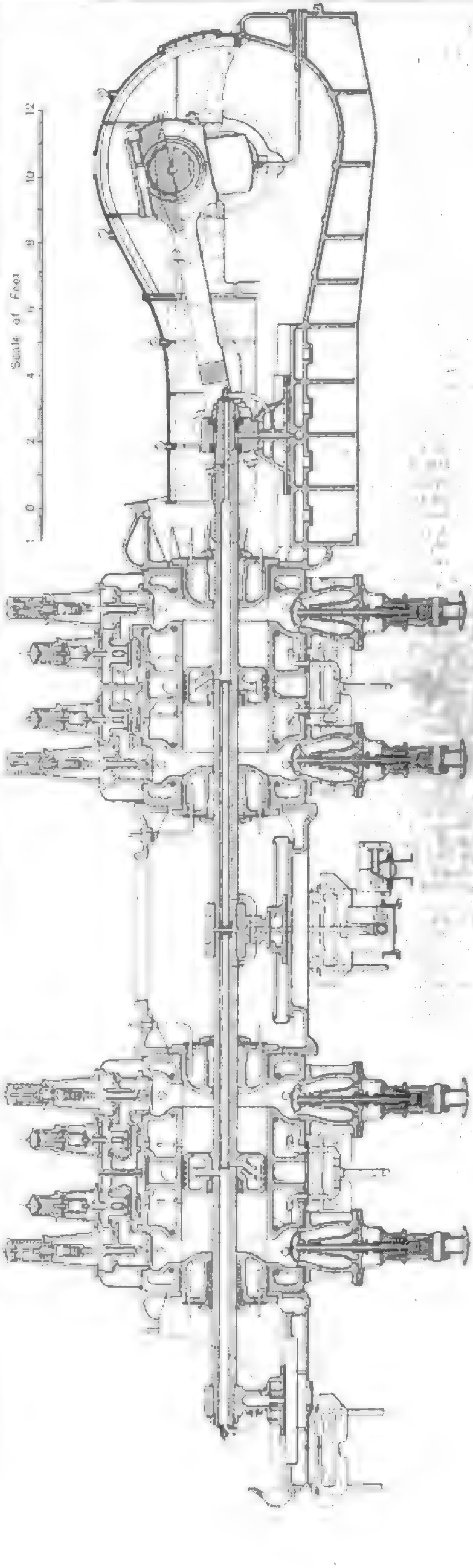

FIG. 2.—SECTION THROUGH PHŒNIX GAS ENGINE.

the composition shown in the diagram and a calorific value of some 85 to 110 B.Th.U. per cubic foot.

After leaving the furnace, the gas is freed from its coarser impurities by passing through a number of ventilators into which water, in form of a spray, is injected. The gas is then forced by two other ventilators into the scrubber plant, where it first passes through two cylinders against a finely divided stream of water, and then flows through two coke scrubbers into the main gas pipe. After leaving the scrubber plant, it is stated that 1 cubic ft. of gas contains only about 0·00875 grains of dust and from 4 to 6·5 grains of water.

The gas main runs along one side of the engine room, a separate pipe connecting it with each of the gas engines, which are placed side by side in the building. Each of these short connecting pipes terminates in an iron receptacle, interposed for steadying purposes. From these the gas flows to the mixing chambers on top of the engine. Fresh air is drawn into the mixing chamber from a system of underground tunnels. Current for the electric ignition is normally taken from the continuous-current lighting mains, but a storage battery is provided as a stand-by, and may readily be switched on to the ignition device by a two-way switch.

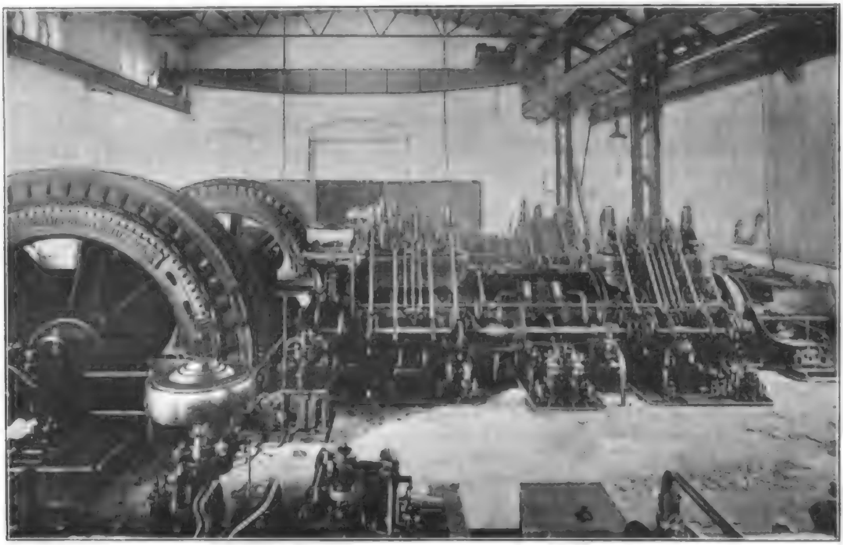

Fig. 3. 1,000 h.p. Generating Sets at the Phœnix Steel and Iron Works.

The engines were built by the Nürnberger Maschinenbau-Gesellschaft, and are illustrated in Figs. 2, 3 and 4. They work on the Otto cycle, but with two double-acting cylinders mounted in tandem. In order to diminish the thickness of the piston rods as much as possible they are machined in such a way as to be curved slightly upwards before weighed down by the pistons. The weight of the latter is just sufficient to straighten the rod when the piston is at the centre of its stroke. In order to facilitate access to the crosshead the cast-iron frame which supports the crank shaft bearings is built low, but is strengthened by substantial stays of round iron, as shown. Since the principal pressure on the crosshead has a downward direction, it was only necessary to provide lower slide bars, but any upward motion of the crosshead is made impossible by suitable guides. To avoid all deformation the cast-iron cylinders are symmetrical in form, and the water jackets are provided with a number of large openings for facilitating the removal of deposits. To obtain perfect cooling the water jackets are so arranged and dimensioned that the incoming cooling water first flows quickly past the hottest parts of the engine, and then gradually slows down as the cooler parts are reached. The covers at each end of the cylinders are also water-cooled, but they can be easily removed, leaving the interior of the cylinders and the valves open for inspection and cleaning. At each cylinder end there is an inlet valve at the top and an exhaust valve at the bottom, the latter being water-cooled. The piston is as short as compatible with safety, and is fitted with piston rings of cast iron. It, too, is artificially cooled, the water being conducted to and from it through the piston rod, which is hollow and of crucible steel. The bearings of the crank shaft, the glands of the piston rods, and the slide bars are lubricated by oil under pressure. Each gland has its own oil pump. The main bearings as well as the motion block of the crosshead are lined with white metal. All the valves are of the "poppet" type and the speed of the engines is governed by varying the explosive mixture. The valves are actuated by a lever arrangement, which itself is set in motion by a number of eccentrics. These eccentrics are keyed to the half-time shaft, which carries a small flywheel of its own and is driven through gearing from the main shaft. There are special oil pumps for lubricating the cylinders and for lubricating the spindle of the exhaust valve. The lubrication of all the external parts, however, is done by gravity, the oil being fed to the different parts through large-sized tubes from a common tank fixed in a high position. All superfluous oil is collected in a tank in the cellar, cleaned from all coarse impurities and pumped back into the oil tank in the engine room. Grease is used for lubricating the eccentrics and parts of the governing mechanism.

The cooling water is fed to the different parts under a pressure of about 20ft., but special pumps are required for forcing the water into the moving shaft and piston. The cooling water which flows out of the engine at various points may be regulated in volume at these different points so as to obtain the desired cooling with the minimum of water. There is also a valve in the main water pipe which is used when starting or stopping the engine. For an initial temperature of the water of about 60°F. and a final temperature of some 105°F. the quantity of cooling water required per brake horse-power-hour is stated to be about 6¼ gallons.

The engines are started with compressed air.

It is claimed that every brake horse-power-hour produced by the engines corresponds to an expenditure of from 8,700 to 10,300 B.Th.U. only.

The dynamos driven by these gas engines generate three-phase current at 2,000 volts and 47 ∾ per second. They work in parallel and supply electricity for power and light to the various parts of the works, where the pressure is reduced to 200 volts by transformers. A 1,200 H.P. motor (capable of withstanding 50 per cent. overload) is being installed, in addition, for driving the rolling mills. It will be supplied with current directly from the 2,000-volt mains, and will run at 130 revs. per min. at full load. The motor is directly-coupled to the finishing rolls, but drives the roughing-down mill by ropes. The rolls—which produce light mining rails, sleepers, angle iron and joists of all descriptions, from blooms weighing 800lb. to 2,200lb. and of 8 sq. in. section—consist of roughing-down rolls and one finishing train. The roughing-down trains are of the three-high type with one housing, and have rolls 2ft. in diameter which rotate at 100 revs. per min. The finishing train, on the other hand, is of the three high type with three housings. Its rolls have a diameter of 1ft. 8in., and rotate at 130 revs. per min. as already mentioned.

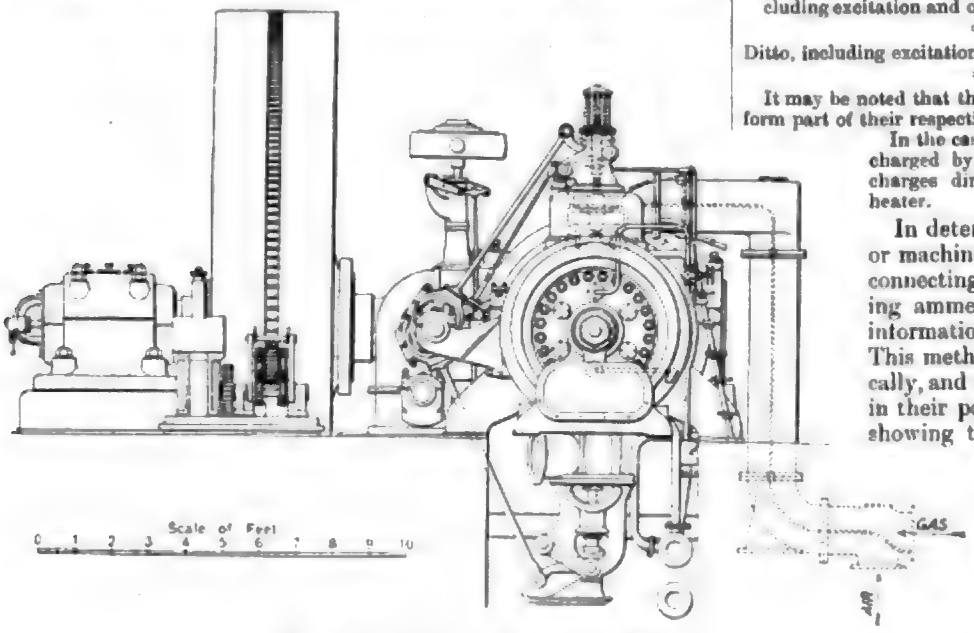

Fig. 4.—End View of Phœnix Gas Engine.

ELECTRICAL EQUIPMENT OF MESSRS. HARLAND & WOLFF'S SHIPBUILDING WORKS.

(Continued from p. 832.)

Before proceeding with a description of the applications of the motors in the shops, we may mention the results of the tests of the generating plant, taken after erection last November. The full-load and over-load trials proved satisfactory with regard to temperature rise and so on, and we need not give full particulars of these. The most interesting of the trials was the steam-consumption test taken on one of the combined continuous-current and three-phase sets. The following table gives the conditions and the results of the tests :—

Engine.—Steam pressure at engine stop valve	200lb. per sq. in.
Steam pressure at intermediate cylinder receiver (39·75 max), mean	36lb. " "
Steam pressure at low-pressure cylinder receiver, mean	1lb. " "
Vacuum, left-hand condenser, 27·25in. Vacuum, right-hand condenser, 26·75in. } mean	27in.
Barometer	30·35in.
Revs. by counter (not taken by tachometer) approx.	107 R.P.M.
Continuous-current Generator.—Kilowatts	269·95
Excitation kilowatts (separate)	3 1
Three-phase Generator.—Kilowatts	365·8
Power factor	0·78
Excitation kilowatts (separate)	9·0
The total kilowatts as measured	635
Indicated H.P. (calculated)	1,030
Indicated H.P. (as per cards taken)	1,045
Total steam consumption for 30min.,	5,775lb. = 11,550lb. per hour.

Results.

Steam consumption as measured on test, with saturated steam at 200lb. per sq. in. having a percentage of moisture not ascertained and 27in. vacuum, based on the I.H.P. calculated from the kilowatts

= 11·2lb. per I.H.P.-hour.
= 18·2lb. per kw.-hour.

The above includes the power taken to drive the air pumps, and the water discharged by the traps draining intermediate and low-pressure cylinder jackets, but is exclusive of the power required by excitation and to drive circulating pumps. The actual consumption, including excitation and circulating pumps was

= 19·1lb. per kw.-hour.

The generators, when above tests were taken, were not working at their maximum efficiencies, and if one were fully loaded, the results would be slightly better—*i.e.*, at 623kw. and 1,000 I.H.P. with saturated (not dry) steam at 200lb. pressure per sq. in. and 27in. vacuum. (Excluding excitation and circulating pump.) :

= 17·75lb. per kw.-hour.

Ditto, including excitation and circulating pumps

= 18·65lb. per kw.-hour.

It may be noted that the jackets of the low and intermediate cylinders form part of their respective receivers.

In the case of the high-pressure cylinder the water discharged by the steam trap is not included, as this discharges direct to the hot-well through the exhaust feed heater.

In determining the size of motor for each shop or machine, an actual test was made in all cases by connecting a motor to the machine through a recording ammeter or wattmeter, and thus obtaining information as to the power required for driving. This method of testing was carried out systematically, and as a result Messrs. Harland & Wolff have in their possession a most valuable set of records showing the power required for driving a large number and variety of machines and machine tools. In the course of these tests, an instructive observation was made of the power wasted in the countershafting of a shop of average size, and this is shown in Fig. 4. The shop in question was one half of one of the plater's sheds, and contained punching, shearing, planing machines, &c., and bending and straightening rolls. We reproduce the readings between 11 a.m. and noon, but it may be mentioned that the record for the remainder of the day is of a similar character. The shaded portion is the energy utilised in driving the shafting, which is now saved with individual electric drive for each machine, there being now about 20 motors in this portion of the shop. To appreciate this saving fully, it must not be forgotten that with shafting drive the percentage additional consumption of energy is much larger than the percentage increase of the maximum power required, for the waste goes on continuously throughout the day, whether only a single machine or all machines are running. The loss due to the transformation of electrical into mechanical

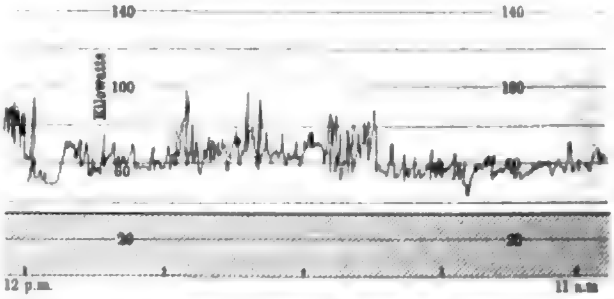

Fig. 4.—Record of work done by 100 H.P. Induction Motor driving north platers' shed. Three-phase squirrel-cage rotor, 420 volts. Maximum Power Factor 0·86. Minimum Power Factor 0·75. Mean Power Factor 0·81. Shaded portion represents energy absorbed in shafting.

energy by the motors, on the other hand, and the loss in the mains feeding the shops—and to a large extent the losses in the generating station itself—are merely a percentage of the load at any moment, and do not continue at the same value whether the tools are doing their maximum amount of work or standing still.

Figs. 5, 6, 7 and 8 are specimen tests on various classes of machine tools. They have been reduced one-half from the original records taken with an Elliott recording ammeter.

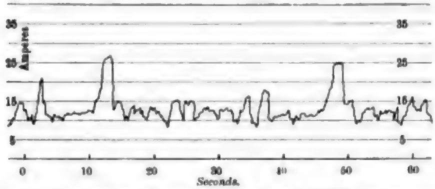

FIG. 5.—Test made on Planer Roughing 4-crank Web Slabs, aggregate weight 6 to 7 tons (fairly heavy load). Speed of cut 18·5ft. per min., return 46ft. per min. Two tools in use each cutting $\frac{3}{8}$in. with $\frac{1}{4}$in. feed High Peaks represent reversal to quick return. Wavy curve line is due to irregular cut depth and spaces between slabs. Reading in amperes at 440 volts.

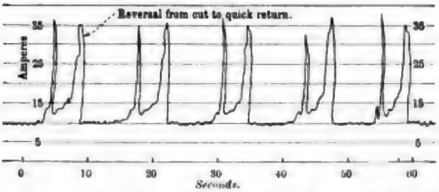

FIG. 6.—Test made on Horizontal and Vertical Planing Machine. Wall creeper: Speed of cut 16ft. per minute. Return 32ft. per minute. Weight of column and tool box reversed about 10 tons. $\frac{3}{4}$in. cut, with one roughing tool $\frac{1}{16}$in. feed. Reading in amperes at 440 volts.

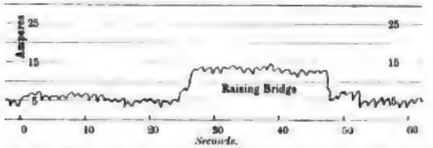

FIG. 7.—Test made on 7ft. Vertical Turning and Boring Mill. Material: Cast iron. Diameter of job 36in. Table running $2\frac{1}{2}$ R.P.M. Two tools working. Cut $\frac{1}{2}$in. each tool. Reading in amperes at 440 volts. Note: The ripples on curve are caused by intermittent nature of cut.

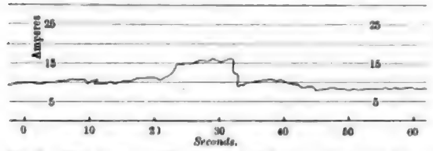

FIG. 8.—Test made on 70in. Crankshaft Lathe. Two tools $\frac{3}{8}$in. cut, with $\frac{1}{4}$in. feed on steel tunnel shaft 16in. diameter. Readings in amperes at 440 volts.

Full particulars of the work done by the machine are given beneath the curve in each case, so that the diagrams are self-explanatory. In the case of Fig 8 the cut at the portion of the curve shown was limited by the belt slipping. The belt was tightened when the current rose to about 30 amperes. This machine, when direct driven, will, it is estimated, easily absorb 60 to 80 amperes on heavy work.

The largest number of the tools that have been converted to electric driving up to the present are those for which three-phase motors with wound rotors have been chosen. For these, in the majority of cases, the motors have been supplied by the Allgemeine Elektricitäts Gesellschaft. In accordance with Messrs. Harland and Wolff's specification, the motors have in most cases outside bearings, that is to say, the pinion does not overhang the bearing, but is inside it. The firm's long experience has shown that this arrangement diminishes largely the wear and tear, and thus reduces the repair bill. In cases where the tools are subject to shocks, the motor is mounted on helical springs in the manner shown in Figs. 9 to 11, an arrangement suggested by Herr Lasche of the A.E.G. Co. The details of this method of support will be apparent from Fig. 9, which shows one of the few cases in which a motor is employed for driving a line of shafting. For three-phase motors up to 100 B.H.P., squirrel-cage rotors are used, this type being mostly of the Westinghouse make. Messrs. Vickers, Sons & Maxim, W. H. Allen, Son & Co., Laurence Scott & Co. and the A.E.G. Co. are supplying the continuous-current motors.

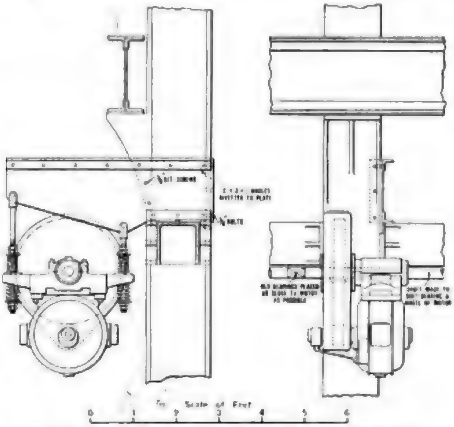

FIG. 9.—ARRANGEMENT OF MOTOR FOR DRIVING LINE SHAFTING.

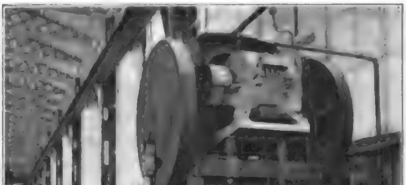

FIG. 10.—BAND SAW DRIVEN BY TWO 22 H.P. A.E.G. MOTORS.

In all dusty situations such as the foundry and sawmill, the motors are totally enclosed and elsewhere semi-enclosed, the end covers having, as a rule, hooded apertures to prevent foreign matter from dropping through; the exceptions are some of the squirrel cage three-phase motors, with the usual perforated end plates, which can be readily cleaned. A portable electrically-driven air compressor, with hose-pipe and nozzle, is used for blowing out the dust.

Fig. 10 is a heavy band saw, and illustrates one of the great advantages of electric driving. It is employed for sawing up long planks, and consequently a long distance must be left between the machines. A second machine is seen in the background in the figure, the distance between the two machines being about 82ft. As each machine takes some 40 H.P. to drive it, the saving in countershafting losses is very great; and this is enhanced when account is taken of the time required to bring the heavy logs to the machine and for the adjustments before starting. During this time the machine stands idle, but the countershafting would be running continuously. There are four heavy band saws in this shop, and three of them were standing still when we inspected it.

As illustrating the amount of energy taken by shops with individual motor drives, it may be mentioned that in the new saw mill there are 26 motors, aggregating 416 B.H.P., at, say, 85 per cent. commercial efficiency, 489 E.H.P. The average weekly energy demand measured by meter at the generating station, and therefore including transmission losses for the nine weeks ending March 4, 1905, was 2,705 units = 67·5 E.H.P. for 54 hours.

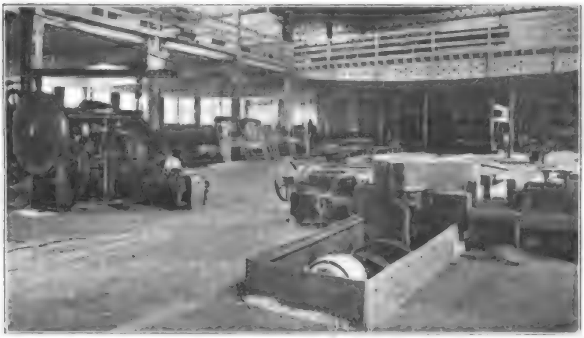

FIG. 11.—BEAM-BENDER DRIVEN BY 10 H.P. A.E.G. MOTOR.

This gives a ratio of

$$\frac{100 \times \text{average E.H.P. demand}}{\text{connected E.H.P.}} = 13{\cdot}8$$

per cent., whilst during the heaviest week the proportion was less than 18 per cent.

The motors displaced seven steam engines, aggregating 326 I.H.P. in the old saw mill.

Two continuous-current motors, rated at 22 H.P. each, are fitted to the machine shown in Fig. 10, and series parallel control is employed. The spring suspension of one of the motors is clearly seen in the figure. It is difficult to give an average figure for the rate at which the saw will do its work, but, as an example, working on pitch pine logs 14¼ins. deep it will turn out 50ins per min. with six saws cutting.

Fig. 11 is a beam bender in another shop driven by a 10 B.H.P. motor. In this case the motor and gearing is boxed in beneath floor level, and the advantage of this over mechanical drive is again evident, for heavy iron beams of considerable length have to be brought to the machine.

(To be continued.)

Thunderstorms.—Severe thunderstorms have occurred at various parts of the country during the week. Damage to property is reported from Colchester and Truro. On Wednesday there were thunderstorms in the neighbourhood of London.

ELECTRICITY METERS.*

BY C. H. W. GERHARDI.

(Continued from page 834.)

The K.G. type meter of the same make is of the oscillating type and is finished in the usual good style. It is a watt-hour meter, and consists of a fixed main coil, H (Fig. 45), in front of which a vertical spindle, carrying a small shunt coil, S and an arm, K, is capable of oscillating, the distance being made definite by the arm K swinging against the two contact stops K_1, K_2.

The shunt circuit is somewhat complicated and comprises two parts; the one is the shunt coil, and the other a relay which reverses the current in the shunt coil and works the counting mechanism. In Diagram 45, M_1, M_2 are the relay magnets which attract the relay armature R; this armature is alternately pulled towards M_1 and M_2, making electrical contact respectively with the contact pins C_1,C_2. By means of a ratchet gear, R also works the toothed wheel W, which is the first wheel of the counting gear. The contact arm K alternately strikes the contact pins K_1, K_2, and in doing so short-circuits M_1 or M_2. When M_1 is short-circuited, M_2 pulls R over, and owing to it being so much nearer M_2 it remains there until M_2 is short-circuited, when it returns to M_1. Thus, each time K touches K_1 or K_2 the direction of the current in S is reversed by R making contact at C_2 or C_1. It will be noticed that the shunt current is never actually broken, as the contact points only short-circuit parts of the circuit; the changes are thus effected without sparking, and, consequently, the contacts should remain in good condition for a considerable time.

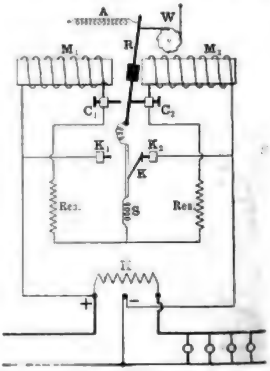

FIG. 45.—DIAGRAM OF THE ELECTRICAL COMPANY'S K.G. METER.

The actual connections, as arranged in the meter, are shown in Diagram 46. The meter is provided with the usual Foucault brake, as seen at the top in Fig. 47. The magnet is not movable, so that adjustment at high load must be made by altering the length of path of the oscillating member, the speed being increased by shortening the path. For this purpose the contact pins are screwed.

A compounding coil is provided, being supported on a slotted brass strip, seen to the right in Fig. 47. The counting train, which is of the cyclometer pattern common to other meters of this make, is in this case not worked by the main moving part; consequently any irregularity in its friction will not affect the accuracy—except by jamming and thus preventing the action of the relay, in which case the meter would stop altogether.

The speed of these meters is low (about 80 single oscillations in 100 seconds at full load), the travel of the contact arm being only through a small angle. The moving portion, therefore, should be very accurately balanced and the meter installed plumb, otherwise the oscillation in one direction would take a much longer time than in the other, making the meter slow at low loads and increasing the starting current.

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* From a forthcoming book to be published by "The Electrician" Printing and Publishing Co. All rights are reserved.

The object of the oscillating meter is to provide a continuous-current watt-hour meter not having a commutator or other rubbing parts, and so reducing the friction. The current is carried to the moving coil by two very small spirals of fine wire. The length of these wires is great, so that their torsional effect is negligible. The angle through which the moving coil oscillates being small, no practical difference is discernible in the torque, which is very low. The full-load torque of a 200 volt 10-amperes meter of this type was found to be just under 1 gramme-centimetre. The only friction is the top and bottom bearing friction, but a damaged jewel would, owing to the lowness of the torque, have a large effect on the accuracy of the meter.

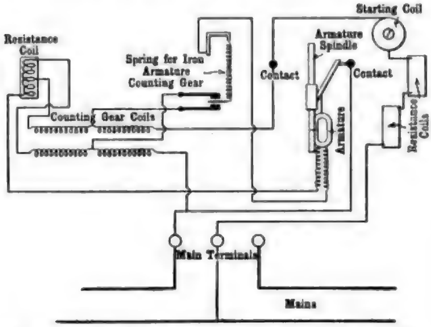

FIG. 46.—CONNECTIONS OF THE ELECTRICAL COMPANY'S K.G. METER

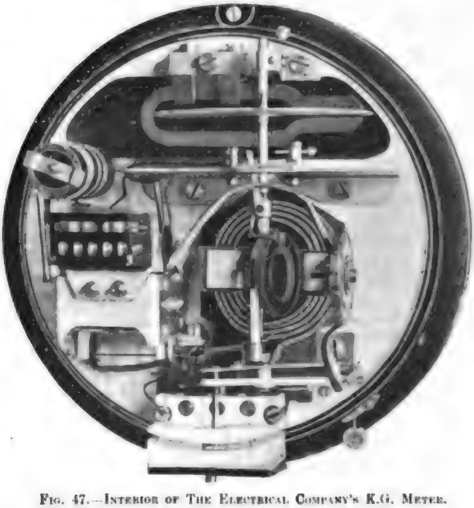

FIG. 47.—INTERIOR OF THE ELECTRICAL COMPANY'S K.G. METER.

The Electrical Co.'s "S" type meter is a modification of the K.G. meter just described, and is intended for switchboard and heavy power circuits. Fig. 48 illustrates the switchboard type, from which it will be seen that the meter is astatic. The main and moving coils are doubled, so as to be unaffected by stray fields. A particular advantage possessed by this meter is that its registering gear is not contained in the meter case proper, the relay and dials being enclosed in a small case, the two portions requiring only to be electrically connected by the five small wires. These are supplied with the meters in the shape of a flexible cable, thus it is possible to have the recording gear on the switchboard, where it takes up very little room (the case being about 8½in. in diameter), while the meter proper is erected at any convenient point up to 100ft. or 200ft. away. This type is made in sizes of from 300 amperes to 1,500 amperes for various pressures.

The Ferranti Continuous-current Meter.—This meter, which was first brought out several years ago, has been improved from time to time, and in its present form is seen in section in Fig. 49. Its action depends on the principle that if a mass of mercury has a current passed through it from its centre to its circumference, or in the reverse direction, and is in the field of a magnet, so that the lines of force are at right angles to the direction of the current, the mercury will revolve at a speed proportional to the current and to the field. Thus, if the same current which flows through the mercury excites the field, the speed may be proportional to the square of the current. The fluid friction of the mercury against the sides of the vessel which contains it increasing nearly as the square of the velocity, the resultant speed is practically proportional to the current. The meter is really a small series motor consuming a very little power. In Fig. 49, T + and T − are respectively the positive and negative terminals. From T + the current passes up through the steel pole SP and into the mercury bath MB at its centre, C, through the mercury to the circumference, where it leaves by the circular iron ring IR to enter the coil CC, leaving by the negative terminal T −. The magnetic circuit is closed except at the gap, which forms the mercury bath. The iron at the top and bottom of the gap is insulated by vulcanised fibre. A very light fan, F, having four blades immersed in the mercury, transmits the motion of the mercury by means of the worm W on its spindle to the wheel train. As the speed of the mercury cannot be predetermined, in order to make the meter direct-reading in Board of Trade units, the train is divided into two portions—the fixed portion and the adjustable portion—the latter (called the swing train, S.T.) being fixed on the back of the former.

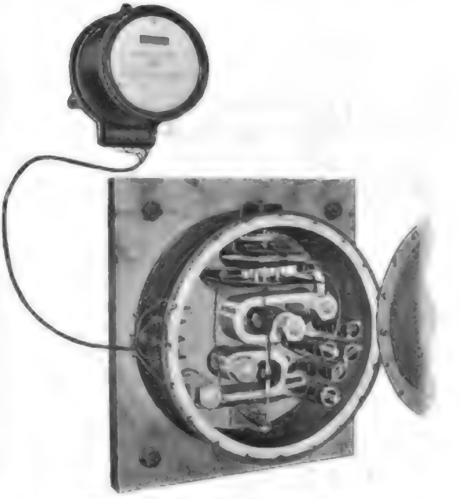

FIG. 48.—THE ELECTRICAL COMPANY'S S TYPE METER.

The swing train has two adjustments. One allows the worm and worm-wheel to be brought into exact gear, which is effected by means of the swing plate P. The second adjustment allows the swing train to be turned round the centre of its first wheel to permit of pinions and wheels of different ratios being inserted, in order that the front dial hands may read Board of Trade units without having to be multiplied by a constant. A substantial cast-iron case encloses the meter, the live portion being insulated from the case by a pressphan washer, P.W., on the top, and by an insulating block between it and the bottom of the case. In the older type meters a rush of current, such as would occur on a short-circuit, over-magnetised the steel pole, thus causing the meter to over-register for some time afterwards. To avoid this a soft iron sleeve, S, has been put over the steel pole forming a shorter return path than through the mercury bath.

After short-circuiting a 5-ampere meter through a 20-ampere fuse on a 100-volt supply, the author has found a difference in the constant of 0·4 per cent., showing that no appreciable alteration is caused by an abnormal short-circuit. A certain amount of residual magnetism left in the steel pole enables the meter to start on very low currents and causes the meter to read rather higher on descending than on ascending loads.

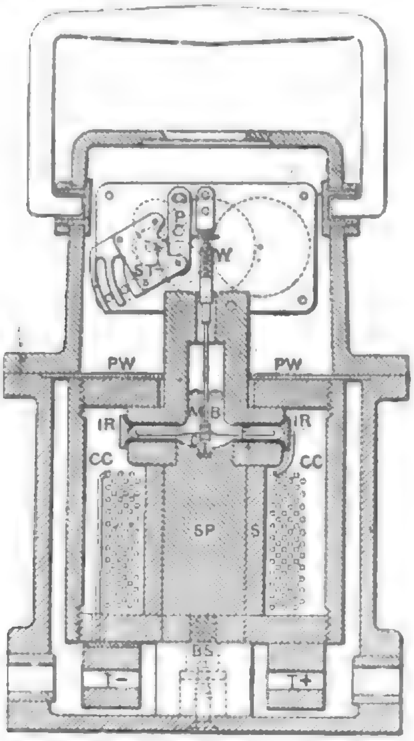

Fig. 49.—Section of Ferranti Meter.

The spindle with its fan is extremely light, probably the lightest main moving part of any meter; moreover, it tends to float partially in the mercury, thus wear of the jewel must be practically nil.

The full-load torque of a 5-ampere 100-volt meter was found to be about 2 gramme-cm. and the full-load drop 1·5 volts. It seems a pity that no means is provided for closing the chamber containing the mercury during transport, as this would avoid the necessity of carrying the meter upright, to encourage which a handle is provided. One can never be sure that the meter is kept in an upright position on its journey from the test room to the consumer's premises, and upon this depends its accuracy. Another objection might be made to the variable speeds of different meters, which renders tests in situ rather more complicated, as does the fact that the quick-moving parts are at the back of the meter. The numbers on the lable attached to the top corner (at the back) of each train are the voltage for which the meter has been calibrated and the ratio of the change wheel and pinion.

(To be continued.)

RECENT DEVELOPMENTS IN ELECTRIC SMELTING IN CONNECTION WITH IRON AND STEEL.*

BY. F. W. HARBORD.

Last year, as is probably well known to most of the members of this society, the Canadian Government appointed a Commission to investigate the different thermo-electric processes for the smelting of iron ores, and the manufacture of steel at work in Europe. The author acted as metallurgist to that Commission, and was asked by your Council to give a Paper embodying the principal results of the investigations. The Paper he has the honour of submitting to the Society this evening is in the main a resumé of the report of the Commission, giving descriptions of the furnaces employed, particulars of the methods of working, and the conclusions arrived at.† The Commission visited five different works—two in Sweden, two in France, and one in Italy—and saw various types of furnaces in operation, and obtained a good deal of information respecting other processes which had not passed beyond the experimental stage.

Electric smelting furnaces may conveniently be divided into three main classes—(1) The induction furnace; (2) the resistance furnace; and (3) the arc furnace—and all these three are now being employed in the metallurgy of iron and steel.

The first type of furnace is *especially* adapted for melting, as distinct from smelting—that is to say, for melting down mixtures of different metals to form certain definite alloys, rather than for the reduction of the metals from their ores, although under certain conditions it can be used for the latter purpose. The second type can be used either as a melting or smelting furnace by varying the construction, and the third type, although generally especially designed for the direct smelting of ores, can also be adapted to either purpose. In all cases, whatever the type of furnace employed, the object is to supply the heat necessary for the particular operation by means of electric energy, the latter not being used to assist directly in the chemical reactions, such as reduction or oxidation; in this way the electric energy replaces the coal, coke, or gas, used for heating, and it will readily be realised that in countries where fuel is cheap, as it is in England, the circumstances are comparatively few where it can be commercially employed. For certain purposes, however, where it is important to obtain a finished product of great purity, where intense local heat and a non-oxidising atmosphere are required, electric energy enables us to meet the conditions more economically than can be done in any other way.

Steel Making.—Under existing conditions, the electric furnace can compete with only two methods of steel manufacture. (1) The crucible steel furnace. (2) The open hearth, or Siemens, furnace for the production of *high-class carbon and special steels.* The crucible steel process, as is well known, consists in selecting the purest materials, and mixing them in such proportion that, when melted in pots or crucibles, they will give a steel containing the required amount of carbon, and the highest qualities are made from selected cemented bars, which latter are made from the best Swedish Walloon iron. In this process practically all the impurities present in the original materials will be found in the finished steel. The open hearth, or Siemens, process consists in melting pig iron and scrap steel in a gas-fired regenerative furnace, and in the gradual elimination of the impurities present by the oxidising action of oxides of iron, and the addition of suitable fluxes to retain these in the slag; during the operation the greater part of the carbon is removed, and the amount required in the finished steel is obtained by adding pig iron and alloys of manganese containing carbon to the bath of metal towards the end of the operation. The elimination of impurities in the bath of metal is never quite complete, and, in addition, the metal is liable to pick up certain impurities from the gas burnt in the furnace, and also to absorb or occlude certain proportions of different gases. The result is that although extremely high-class steel can be made in a Siemens furnace, it is not equal to the best crucible steel.

THE INDUCTION FURNACE.

This type of furnace is a large crucible in which the steel is melted by an induced current out of contact with any electrodes, completely protected from the action of any furnace gases, and practically protected from oxidation. It gives, from a metallurgical point of view, by far the nearest approach to the conditions of the crucible process, and provided the same care is taken in the selection of the raw materials, a finished product, equal in all respects to crucible steel, is obtained. The best known furnace of this type is the Kjellin furnace, which has been in operation at Gysinge, Sweden, since 1900. Fig. 1 shows a plan and sectional elevation of this furnace. This furnace is in effect a step-down transformer, in which the contents in the hearth or crucible form the secondary circuit of the transformer. The furnace is of 225 H.P. capacity, and to the primary DD is delivered an alternating current of 90 amperes and 3,000 volts, which induces a current in the secondary AA of 3,000 amperes and 7 volts. The primary DD consists of an insulated copper wire wound round one leg of the laminated core CC, which forms the magnetic circuit. When an alternating current is passed through the coil, it excites a magnetic flux in the core, and the intensity of the current induced in the steel is then almost the same as the primary current multiplied by the turns of the wire in the primary coil. The tension of the current is naturally reduced in almost the same ratio as the intensity is increased. In this way it is possible to use an alternating-current generator of high tension, and to obtain a current of low voltage and great intensity in the furnace.

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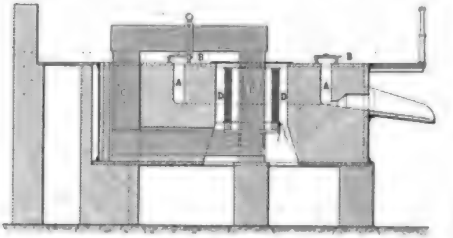
* Paper read before the Faraday Society on March 6.

† [See also *The Electrician* for November 18, 1904, p. 180.—Ed. E.]

In starting the furnace, a little molten pig iron is poured into the circular trough A to form the secondary circuit, and at the finish of each heat, sufficient molten steel is left in the furnace to maintain this circuit. The circular hearth or crucible has movable covers on the top, of a size which can be easily raised by means of a bar, and the materials are charged in at the top by removing these covers. The charge at Gysinge usually consists of best Swedish pig iron, Walloon iron, and steel scrap, and the proportions of pig iron and steel scrap are varied according to the grade of steel it is desired to produce. Any grade of steel can be produced in this furnace from 0·10 to 1·50 per cent. or more of carbon, the only thing necessary being to have ample power to insure rapid melting and to obtain a sufficiently high temperature to enable the steel to be cast into ingot moulds. During the melting there is practically no elimination of impurities, with the exception of a slight oxidation of the carbon, and to obtain a high-class product high-class materials must be used. The charge carefully calculated to give the required content of carbon is charged gradually during the operation as the materials melt down, the pieces of pig and scrap being of any convenient size. When the charge is completely melted, additions of ferro-manganese, ferro-silicon, or other materials which it may be desirable to alloy, are made, and when these are completely melted the charge is held in the furnace for a short time to raise the temperature to a good "tapping heat," when it is tapped in the usual way into a ladle placed under the spout.



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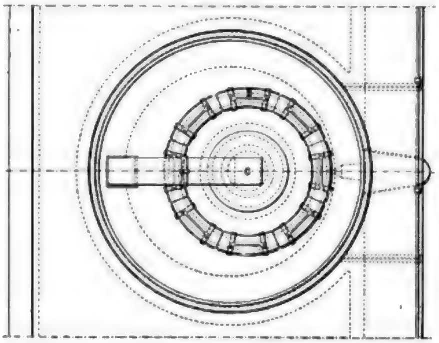

Plan.

FIG. 1.—KJELLIN FURNACE.

The amount of energy consumed will vary with the grade of steel desired, a high carbon steel requiring less than a low carbon steel, as the former has a lower melting point, and does not require to be raised to such a high final temperature to enable it to be cast into ingot moulds without "skulling," *i.e.*, partially setting in the ladle. The average time for producing about 1 ton of steel ingots is six hours for high carbon steel and from seven to eight hours for dead soft or nearly carbonless steel. At Gysinge the current for operating the furnace is obtained from a single-phase revolving-field alternator, which is rated at 3,000 volts and 90 amperes. It has 24 poles and a nominal speed of 15 cycles per second. It is arranged with a vertical shaft, and is directly connected with a water wheel. The amount of energy consumed per ton of steel was very carefully determined by Mr. Brown, the electrician accompanying the Canadian Commission, by following various charges through, and taking readings regularly at short intervals during the working of the charge. The following, taken from Mr. Brown's report, gives particulars of the instruments used and the final results obtained in two charges :—

"The voltage was measured with a Weston portable alternating-current voltmeter, having a scale reading up to 150, and connected in series with multiplying resistance giving a ratio of 25 : 1. The current was read on two Hartmann & Braun ammeters, connected in parallel and having scale readings 50 and 60 amperes respectively. These ammeters were calibrated by comparison with a Siemens & Halske standard ammeter and the readings corrected accordingly. Calibration curves are given in the report of the Commission. The power was measured by means of a Weston portable indicating wattmeter having a scale reading up to 150. The current coil used was arranged for 120 amperes, and multiplying resistances were connected in series with the voltage coil to make it suitable for 3,000 volts. This gives a ratio of 24 : 1 to obtain the results in kilowatts. The standard instruments were obtained from David Bergman, consulting engineer, of Stockholm."

Results of Charge 546.

High Carbon Tool Steel Carbon, 1·062 per cent.

Length of run in hours	6
Mean kilovolt-amperes	217·3
Total kilovolt ampere-hours	1304·0
Mean kilowatts	142·8
Total kilowatt-hours	857
Mean horse-power	195
Total horse-power-hours	1,165
Total horse-power-years	0·132
Output of ingots, kilos	1,030
Horse-power-year per ton of ingots (2,240lb.)	0·13
Cost of electric energy at 41s. 8d. per horse-power-year	5s. 5d.
The mean power-factor for the run	0·672
Do. for 2½ hours of full-load current	0·685

Results of Charge 547.

Medium Carbon Steel Carbon 0·417 per cent.

Length of run in hours	6⅔
Mean kilovolt amperes	232
Total kilovolt ampere-hours	1,546
Mean kilowatts	149
Total kilowatt-hours	994
Mean horse-power	208
Total horse-power-hours	1,350
Total horse-power-years	0·154
Output of ingots obtained, kilos	955
Horse-power per ton of ingots (2,240lb.)	0·16
Cost of electric energy per ton of ingots at 41s. 8d. per horse-power-year	6s. 8d.
Mean power-factor for the run	0·649
Do. for 3 hours' full load	0·587

It will be noticed that the energy required for the 0·470 carbon steel was somewhat greater than for the 1 per cent. carbon, which is what would be anticipated, and was confirmed by the other charges when making lower carbon steel. Although this furnace is more particularly adapted for "crucible" metal melting, it can be, and has been, used for smelting the ore direct, and since my visit to Gysinge further experiments in this direction have been attended with considerable success. Mr. Kjellin has sent me particulars of recent developments in a letter dated January 7, 1905, which is as follows :—

"Having at last got a new turbine, we are able to increase the power at the furnace to 175kw. (239 electric H.P.) instead of the maximum being 165, and this increase of power, together with a diminished area of contact between steel, masonry and slag, has increased the output of the furnace from 4 tons to from 5·2 to 5·5 tons in 24 hours, which naturally makes the melting costs lower. Another reason for these good results is that, owing to some slight alterations, I have got the power applied more uniformly over the whole time of the charge. In future I shall be able to build the furnaces so that they shall consume the maximum power of the turbine or engine all the time. I have already done so in the case of a small trial furnace, put up last summer in the South of France. The capacity of the Gysinge furnace with 175kw. is now 1,450kg., of which 900kg. are tapped each time. I have recently used pig and ore instead of pig and scrap, and this seems to answer very well. The ore used is briquettes from Herrang concentrates, containing about 70 per cent. of iron, and consequently practically no gangue, so that the wear-and-tear is not increased to such an extent as would be the case if the ore contained much gangue. The briquettes being very low in phosphorus, I can in this way get a high quality steel cheaper than by using scrap and pig, though the production of the furnace is only 60 to 65 per cent. of the production from cold scrap and pig. If using molten pig and ore I should get the same output from a given power as from cold pig and scrap, but the waste would be much lower, as the iron of the ore would be almost perfectly reduced."

It will be seen from above that pig and ore can be used in the furnace, but to obtain a high-class product none but extremely pure materials can be employed, and at present Swedish materials are probably the only suitable ones which are available. This furnace in its present form can only be used for the manufacture of tools and other high-class steels, and in the majority of cases, at all events outside Sweden, it will probably pay better to use pig and scrap only, as the saving effected by ore and pig when the reduced output is considered, cannot be very great.

(To be continued.)

TEMPERATURE CURVES AND THE RATING OF ELECTRICAL MACHINERY.*

BY RUD. GOLDSCHMIDT.

1. *Short Time Rating.*—In many cases in practice an instrument is used for a few minutes only at a time, for instance, with starting transformers, the choking coils of single-phase motors, the small motors used for starting synchronous motors, &c. In these cases it is useless to apply the well-known "watts per square inch" rule for calculating the temperature, and it is a mistaken idea in designing these machines, to take into consideration the providing of any cooling surfaces. The heat developed during the time the apparatus is in use is almost entirely spent in heating up the material, and the time is too short to dissipate any appreciable amount. Given the specific heat of the material, the calculation of the temperature rise is a simple matter and in the case of two materials, copper and iron, since their specific heat is nearly the same, we may assume an average value. On the assumption that no radiation takes place, it has been found that 3·5 watts lost per cubic centimetre of copper or iron raises the temperature of the material by 1°C. per second, or in British units—32 watts lost in one cubic inch of copper or iron raises its temperature 1°F. per second. The temperature increase per second is given by the formula: Temperature increase per second = Watts lost in unit volume/Rise constant, or, in symbols, $V=W/C_r$, in which C_r, the "Rise Constant," is 3·5 in C.G.S. units and 32 in British units.

We may suppose a choking coil or starting transformer to be so dimensioned that, if used only occasionally for a period of, say 5 minutes (=300 seconds) as a maximum, the temperature rise in any part will not exceed 16½°C. The frequency is to be 100 cycles per second. The temperature increase per second is 16½/300 =0·055°C. Since a rise of 1°C. per second is caused by 3·5 watts per cubic centimetre, the energy lost in 1 cubic cm. must in this case be 3·5×0·055=0·19 watts.

Considering first the question of the heating of iron parts, we have only to look at a hysteresis curve, showing the hysteresis loss per cubic centimetre at different flux densities for the particular iron we are going to use. This curve shows that at 100 ∼ per second the flux density corresponding to 0·19 watts loss per cubic centimetre (3·1 watts per cubic inch) is about 15,000 C.G.S. per cm.² (16 Kapp lines per square inch).

With regard to the heating of the copper winding, we must consider the following facts: A copper wire 100cm. in length and 1mm.² section has a resistance of about $\frac{1}{55}$th ohm; its volume is 1 cubic cm. To cause a rise in its temperature of 0·055deg. per second 0·19 watts must be lost in the wire. The current causing this loss in $\frac{1}{55}$th ohm can be obtained directly by Joules' law:

$$c^2 \times \tfrac{1}{55} = 0{\cdot}19, \text{ or, } c = \sqrt{0{\cdot}19 \times 55} = 3{\cdot}2 \text{ amperes.}$$

This corresponds to a current-density of 2,000 amperes per square inch. We have, therefore, with the aid of an example, been enabled to formulate the following rule: "Machines, which are to work only for a short time, with interruptions sufficient to allow them to cool down to the temperature of the atmosphere, must be so designed that the flux-density and copper density do not exceed a certain amount, independent of size and cooling surface."

We can further conclude from our example that with short-period apparatus, the flux density is practically only limited by the permeability of the iron, and not by the heating, since it is possible even under the severe conditions of a frequency of 100, a five minutes' starting period and a permissible temperature increase of only 16½°C. to work at the high flux density of 15,000 C.G.S. per cm². Tables I., II., and III., give the temperature rise per min. at different current densities for various materials.

Table I.—*Copper-Heating.*

Amps. per sq. mm.	Temp. rise °C. per min.	Amps. per sq. in.	Temp. rise °F. per min.	Amps. per sq. mm.	Temp. rise °C. per min.	Amps. per sq. in.	Temp. rise °F. per min.
0·5	0·08	250	0·09	3·5	4·0	3,000	13·0
1·0	0·33	500	0·36	4·0	5·3	4,000	23·0
1·25	0·50	750	0·82	5·0	8·8	5,000	36·0
1·5	0·75	1,000	1·45	6·0	12·0	6,000	52·0
1·75	1·0	1,250	2·25	7·0	16·0	8,000	93·0
2·0	1·3	1,500	3·25	8·0	21·0	10,000	145·0
2·25	1·5	1,750	4·4	10·0	30·0	20,000	210·0
2·5	2·0	2,000	5·8	15·0	75·0	..	..
2·75	2·5	2,250	7·2	20·0	130·0	..	..
3·0	3·0	2,500	9·0	25·0	205·0	..	..

Table II.—*Heating of Nickeline.*

Amps. per sq. mm.	Temp. rise °C. per min.	Amps. per sq. in.	Temp. rise °F. per min.	Amps. per sq. mm.	Temp. rise °C. per min.	Amps. per sq. in.	Temp. rise °F. per min.
0·2	0·34	100	0·37	3·0	77·0	5,000	920·0
0·4	1·35	300	3·3	3·5	105·0	7,000	1,800·0
0·6	3·1	500	9·2	4·0	135·0	9,000	3,000·0
0·8	5·5	700	18·0	5·0	210·0	..	..
1·0	8·5	1,000	37·0	7·5	480·0	..	..
1·5	19·0	1,500	83·0	10·0	850·0	..	..
2·0	34·0	2,000	150·0	15·0	1,900·0	..	..
2·5	53·0	3,000	300·0	20·0	3,400·0	..	..

Table III.—*Heating of Iron.*

Amps. per sq. mm.	Temp. rise °C. per min.	Amps. per sq. in.	Temp. rise °F. per min.	Amps. per sq. mm.	Temp. rise °C. per min.	Amps. per sq. in.	Temp. rise °F. per min.
0·5	0·5	250	0·55	5·0	50·0	4,000	140·0
1·0	2·0	500	2·2	7½·0	112·0	6,000	315·0
1·5	4·5	750	5·0	10·0	200·0	10,000	880·0
2·0	8·0	1,000	8·8	15·0	450·0	15,000	2,000·0
2·5	12·5	1,500	19·7	25·0	1,250·0	20,000	3,500·0
3·0	18·0	2,000	35·0	35·0	2,450·0	..	..
4·0	32·0	3,000	79·5	50·0	5,000·0	..	..

Table II. relates to nickeline wire with a specific resistance 25 times that of copper, and Table III. is for iron with a specific resistance six times that of copper. The figures will be found useful in the calculation of starting resistances, the formula being $V=8{\cdot}5\times i^2$ deg. C. of temperature rise per minute for nickeline wire, and $V=2{\cdot}0\times i^2$ deg. C. for iron. In determining the section of the wire by means of these data we are sure of an ample margin of safety, as the loss of heat by dispersion has not been taken into account. To be quite accurate, however, a slight increase should be allowed in the temperature values in these tables to compensate for the increase of resistance with rising temperature. There is still to take into account the effect of the insulation. In a field coil, consisting of averaged sized wire, the cotton insulation forms about 5 per cent. of the total weight, and owing to the close contact between the wire and the insulation both will quickly attain the same temperature. Considering the field coil as a whole, we have no longer to deal with the specific heat of the copper alone, but with that of copper plus, say, 5 per cent. cotton. Assuming cotton to have six times the specific heat of copper, the average value of the specific heat for the coil is 1+0·05×6=1·30 times higher than that of copper alone. The average temperature increase per second will, therefore, be found to be 1/1·30=0·77. It should be noted that the temperature is lower with field coils of thin wire containing much insulation, and having a higher average specific heat than with those having thick wire.

Up to the present it has been assumed that the apparatus gives out no heat to the surrounding atmosphere, but the extent to which this assumption is permissible depends on the kind of machine. With a totally enclosed stationary machine the heat dissipated is only a small percentage of that stored in the heated body itself, say during the first hour of heating. The temperature curve up to this point is an absolutely straight line, or, practically speaking, the temperature increase for the second half-hour is very nearly the same as that during the first half-hour. The following are approximate values for the time during which the apparatus can be considered as giving out no heat:—

Revolving machines, open, 20min., totally closed 40min.; stationary machines open ½ hour, totally enclosed 1 hour; starting resistances, and, generally, single wire, ½—2min.

2. *The Temperature Curve.*—After a certain time the temperature of the apparatus becomes practically constant, and the temperature reached by the heated body is sufficient to dissipate all the heat developed. This constant temperature is dependent on the lost watts, on the ventilation, on the cooling surface, and on the tem-

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* Abstract of a Paper read before the Institution of Electrical Engineers on Thursday, March 9th.

perature of the surrounding atmosphere. It has been found that in a field coil of an ordinary continuous-current generator a difference in temperature of 90°F. dissipates 0·21 watts from every square inch of surface. To state this in C.G.S. units: 1/1,500 watt is dissipated by 1 sq. cm. of surface for a difference in temperature of 1°C.

Henceforward we shall only employ C.G.S. units, and thus apply the factor 1/1,500, which we will denote by the sympol C_h (heating constant). The watts dissipated per unit of surface we will call "surface watts," symbol (W_s). Then $W_s = C_h \times t$, t being the temperature difference. The surface watts are assumed to be $W_s = 0{\cdot}033$ watts per square centimetre, corresponding to a final temperature $t_f = 0{\cdot}033/(1/1500) = 50°$C. The current density may be 1·7 amperes per square millimetre.

The initial temperature increase according to Table I., without taking into account the cotton insulation, would be 0·71°C. per minute. We have assumed in this case that the cotton insulation raises C_h in the ratio 4·5/3·5. Consequently $V = (0{\cdot}71 \times 3{\cdot}5)/4{\cdot}5 = 0{\cdot}55$ C. per minute.

When the final temperature of $t_f = 50°$ C. is reached, the whole of the 0·55°C. rise per min. is neutralised by the cooling action. From this fact we may deduce a method for calculating the temperature at any desired instant. For example, at a given moment the body may have a temperature of say $t = 35°$C. in excess of that of the atmosphere. Then the cooling action is less than that in the final state in the ratio 35/50, and thus compensates for $35/50 \times 0{\cdot}55 = 0{\cdot}39°$ increase per minute. These 0·39deg. are completely neutralised by the cooling action, therefore, at the instant when the temperature of the body is 35°C. in excess of the air temperature, the temperature increase per minute is $0{\cdot}55 - 0{\cdot}39 = 0{\cdot}16$ C. Thus we obtain the rule: "If the temperature of the body has attained say a per cent. of the final temperature, the increase of temperature per minute is $(100 - a)$ per cent. of the initial increase."

Assuming that the temperature at a certant instant was known to be 35°C., this rule enables us to calculate the temperature, say 20 minutes later. At the beginning of this 20 minutes period the rise is, as we have just seen, 0·16 deg. per minute. If the rate of increase were the same right through, after 20 minutes the temperature would be $0{\cdot}16 \times 20 = 3{\cdot}2$ C. higher, that is, it would now be 38·2deg., but the average temperature during the 20 minutes would be $(38{\cdot}2 + 35)/2 = 36{\cdot}6$deg., so that the corrected rise is $\frac{0{\cdot}55}{50}(50 - 36{\cdot}6) = \frac{1}{91} \times 13{\cdot}4 = 0{\cdot}15$ per minute, or a total of $0{\cdot}15 \times 20 = 3$deg. The corrected temperature after 20 minutes would accordingly be $35 + 3 = 38$deg. This value differs so little from the uncorrected one (38·2deg.) that further correction is unnecessary. It is obvious that by following this method the temperature at any time may be obtained. A simple graphical way of obtaining the temperature curve is as follows: Draw line OA (see Fig.) to represent the initial rise, which in our case is 11deg. per 20 minutes, and BC, at a distance OB equal to the final temperature (50°C. in our case) parallel to the axis of the abcissæ. The lines cut one another at the point D. We next divide both the axis of the abcissæ and line DC (starting from point D) into intervals of 10 minutes, and draw verticals through every division point on this axis. The first of these verticals cuts OD at the point e'. Join point e' with point 10′ on line DC. Line e' 10′ cuts the 20 vertical at f', then join f' with 20′ on line DC. Line f' 20′ cuts the 30 vertical at g'. Join g' with 30′ on DC, and so on In this manner we get a number of lines which "envelop" the temperature curve. The form of all curves is similar, and having once plotted one it is applicable to all other cases. The only alterations necessary are the scales of temperature and time.

To find the time in which the field coil considered above will reach 47½deg., starting with a temperature of, say, 30°C., we need only consider the air temperature to be 20deg. higher, or the field temperature to be 20deg. less, that is, $50 - 20 = 30$ C. = total range of rise $= t_f$. The temperature under consideration—viz., 47½deg., becomes $47\frac{1}{2} - 20 = 27\frac{1}{2}$deg. The latter, as a percentage of the new $t_f = 27\frac{1}{2}/30 = 0{\cdot}92$. From the curve below we observe at once that 0·92 of the final end temperature is reached in $2\frac{1}{2} \times T_s = 2\frac{1}{2} \times 1\frac{1}{2} = 3\frac{3}{4}$ hours.

Dynamos with stationary field coils, which are designed for about 50°C. measured by resistance rise, reach their final temperature within 2deg. or 3deg.

At the end of	1	hour with field current density of	3,000	amperes per sq. in.
"	3	" " "	1,500	" "
"	6	" " "	1,000	" "
"	9	" " "	800	" "

3. *Crane Rating.*—The characteristic qualities of crane rating are as follows:—(1) The load has a more or less regular periodic character. This distinguishes crane rating from the short-time rating. (2) The time of use and the time of interruption is so short that during the former the temperature obtained does not come anywhere near the final temperature, and during the time of interruption the apparatus does not cool down to anywhere near the air temperature. In fact, after some hours' run the maximum and minimum temperature attained must remain within a few degrees per cent. of the average temperature.

We will first assume that the cooling conditions when the machine is shut down are the same as when the machine is running, and study the question of crane rating on our field coil, the data for which are—Current density 1·35 amperes per square millimetre. Final temperature for continuous run, 50°C.

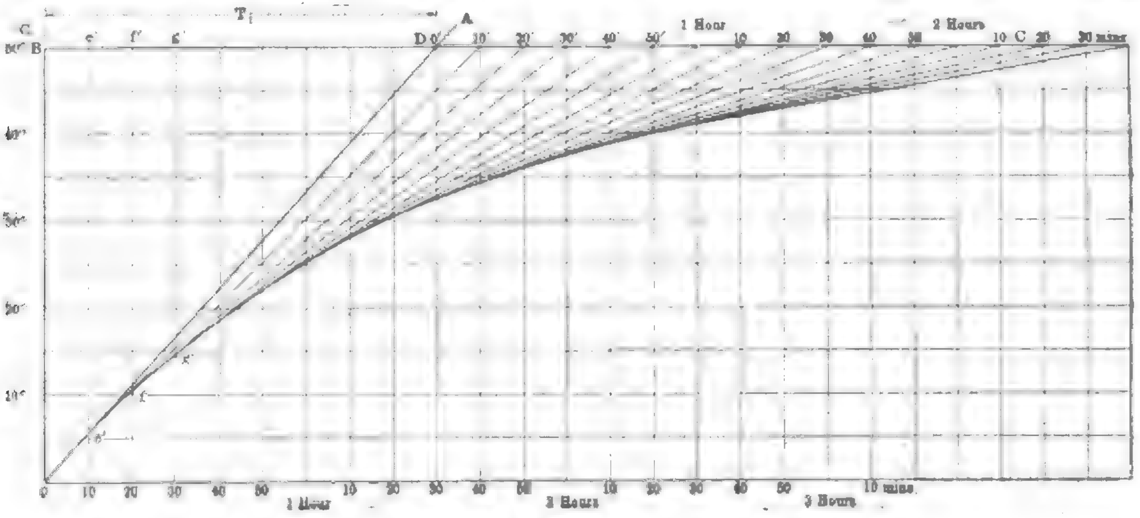
As we found from the current density, the initial rise is 0·55deg. per minute, and the ideal heating time $T_s = 50/0{\cdot}55 = 90\frac{3}{4}$ minutes. If we submit the coil to a crane load, consisting of periods of 3 minutes heating and 7 minutes being shut down, the total period lasting 10 minutes, then in order to obtain the average temperature curve round which the actual temperature fluctuates, we have only to consider that a heating time of 3 minutes is followed by a cooling time of 7 minutes. Since during these short spaces of time the temperature increase or fall in the unit of time can be considered constant, the 7 minutes cooling is as effective as a 3 minutes cooling with $\frac{7}{3}$ times increased intensity. To find the final average temperature we have only to multiply the final temperature for continuous run, 50°C. by $\frac{3}{10}$, and so obtain $\frac{3}{10} \times 50 = 15$ C.

As stated above the cooling is much worse while the machine is shut down, because an approximate reduction of the ventilation of the field coil in the ratio of $\frac{2}{3}$ occurs.

Taking this into account we have—3 minutes heating, 3 minutes cooling with full intensity, 7 minutes cooling with $\frac{2}{3}$ of full intensity, which is equivalent to $(2 \times 7)/3 = 4{\cdot}7$ cooling with full intensity.

Total equivalent time of cooling with full intensity $4{\cdot}7 + 3 = 7{\cdot}7$ minutes. Final temperature $\frac{3}{7{\cdot}7} \times 50 = 0{\cdot}39 \times 50 = 19{\cdot}5$ C.

The ventilation of the *armature* is, at full speed, three to five times better than when it is stationary, so here we have—three minutes heating, three minutes cooling with full intensity, seven minutes cooling with, say, ¼ of full intensity, equivalent to $\frac{1}{4} \times 7 = 1{\cdot}8$ minutes cooling with full intensity. Total equivalent time of cooling with full tensity $= 3 + 1{\cdot}8 = 4{\cdot}8$ minutes. Final temperature $(3 \times 50)/4{\cdot}8 = 0{\cdot}63 \times 50 = 31$ C.



CONSTRUCTION OF TEMPERATURE CURVE.

DIELECTRIC STRENGTH, CAPACITY AND RESISTANCE OF CERTAIN SPECIMENS OF MICA.

BY ERNEST WILSON AND T. MITCHELL.

The dielectric strengths of certain specimens of mica have already been published,* and Messrs. Wiggins & Sons have supplied one of us with another series of the same kinds of mica of suitable area and thickness for the determination of their specific inductive capacities and specific resistances. The areas vary from 21in. by 18in. in the largest, to 9in. by 9in. in the smallest specimens, and the thicknesses are set forth in the table. The method of test for capacity was to clamp the specimen between the plates of a guard-ring condenser and to compare the capacity so found with the capacity of the condenser in air. The frequency was due to the vibration of a weighted Rhumkorff-coil hammer and was of the order 20 periods per second. There are slight indications that high dielectric strength might be associated with low specific inductive capacity.

The specific resistances were obtained by gumming two sheets of tinfoil, each 81mm. diameter, opposite one another on either side of the specimen, and measuring the resistance between them by the ordinary deflections method. There is some evidence to show that high dielectric strength may accompany high specific resistance.

This opportunity is taken to correct a clerical error in the former Paper. Specimen No. 6 was described as a *green* mica; whereas it was a much-stained ruby mica.

No. of Specimen.	Description and place where found.	Dielectric strength experiments. Max. volts per cm. in 10^5.				Capacity and resistance experiments at 9°C.		
	Thickness in mm.	0·1	0·2	0·3	1	Thickness in mm.	Spec. inductive cap.	Sp. resis in 10^{12} ohms per cub. cm.
1	Madras, brown spotted	1·6	1·2	0·9	..	2·77	2·5	22·0
	,, brown very slightly ,,	..	..	..	..	1·93	3·4	67·0
2	,, green spotted A ..	1·3	1·1	0·9	..	2·1	4·8	16·0
3	,, ,, ,, B ..	1·0	0·75	0·5	0·27	1·7	5·1	15·0
4	,, ,, ,, C ..	1·3	1·1	0·94	..	1·43	3·9	91·0
5	,, ,, stained	1·6	1·2	0·95	..	1·3	5·5	25·0
6	,, ruby much stained	1·9	1·3	1·0	..	2·4	4·4	65·0
7	,, clear green B	1·7	1·2	0·95	..	1·73	4·4	133·0
8	,, ,, ,, C	1·7	1·2	0·9	..	1·61	4·5	81·0
9	,, ,, pale green D	2·0	1·3	0·8	..	1·8	3·9	125·0
10	Bengal spotted	1·1	0·6	0·2	..	2·04	4·3	45·0
11	,, ruby much stained	1·6	1·4	1·2	..	2·5	4·7	20·0
12	,, white	2·5	1·3	0·4	..	1·4	4·2	7·0
13	,, yellow	2·1	1·4	0·9	..	1·4	2·8	80·0
14	,, ruby clear	2·1	1·4	0·9	0·72	1·9	4·2	118·0
15	Canadian amber A	1·5	1·1	0·8	0·5	2·1	2·9	3·4
	,, ,, B	..	..	..	..	5·0	3·0	0·44
	,, ,, C	..	..	..	..	1·4	2·9	22·0
16	S. American spotted ..	1·0	0·6	0·4	..	1·22	5·9	39·0
17	,, ruby, clear	2·1	1·4	0·9	..	..	..	..

PHYSICAL SOCIETY.

At a meeting of the Physical Society held March 10th, 1905, Dr. R. T. Glazebrook, past-president, in the chair, a Paper

"On Direct Reading Resistance-Thermometers, with a Note on Composite Thermocouples,"

was read by Mr. A. CAMPBELL. The Paper describes two methods by which the reading of a resistance-box in connection with a platinum resistance-thermometer gives directly the actual temperature without the use of any formula or table. In the first method the variable resistance in the measuring arm of the Wheatstone's bridge is shunted by a suitable resistance. When this shunt has the proper value, the change of resistance in the measuring arm necessary to give a balance is proportional to the change of temperature of the platinum to a good degree of accuracy up to 1,000 C. A more exact method (that of the "Rectifying Loop") is somewhat similar. In it the measuring arm consists of a closed loop of resistance, one end of the arm being a fixed point on the loop, while the other end is a slide which can be moved along the loop. The total resistance of the arm is connected by a simple parabolic law with the excess X of the slider reading over a zero reading. Thus $R = A + BX + CX^2$. The author shows how the resistance of the loop and the zero reading may be calculated so as to make this parabolic formula identical with that giving the temperature-resistance variation of any specimen of platinum. When the resistances have these values, the reading X will be proportional to the temperature (Centigrade) of the platinum. In an appendix the author points out that for measuring small temperature differences up to 100deg. or 150deg., the most useful thermocouples are iron-nickel or iron-constantan. The voltages given by these are nearly, but not quite, proportional to the differences of temperature. In order to make the proportionality more exact, he proposes to use a "composite" (triple) junction by putting in parallel with one of the usual wires a wire of a third metal (*e.g.*, copper); by adjusting the relative resistances of the branches of this parallel circuit the temperature-voltage curve of the combination can be practically rectified.

Mr. W. DUDDELL expressed his interest in the Paper, and asked the author if he had considered the question of putting a constant resistance in series with the rectifying loop. By so doing, it would be possible to simplify the mathematical processes involved in the method. With reference to the author's note on composite thermocouples, he asked if Mr. Campbell could give any information regarding the variation of the thermoelectric properties of constantan with the percentage of nickel and copper present in the alloy.

Prof. CALLENDAR said he admired the rectifying-loop method of reducing the direct readings to the gas-scale, and thought it would be useful in practical work, especially at high temperatures, but for the most accurate scientific work at moderate temperatures he thought the corrections would be too complicated, and that trouble would be saved by adopting the ordinary method. It was most important in practice to secure accurate compensation of the leads, which could be insured in a satisfactory manner only by making the leads and the ratio arms equal. Instead of making the loop-resistance equal to kR as proposed in the Paper, it would be necessary to make it equal to R, and to write $x = c + nt$ or its equivalent. The method suggested by Mr. Duddell of adding to the loop a resistance in series equal to R_0, would simplify the algebraic relations of the coefficients, giving $m = aR_0$ and $n = a^2R_0/b$, but would prevent the thermometer reading on the loop below 0°C. For many purposes this would not matter seriously. Neither the loop method nor the three-lead arrangement subsequently proposed by the author, could be used with a bridge-wire, as both involved plug or sliding contacts of negligible resistance. The three-lead arrangement also precluded the possibility of making an insulation test of the leads at any time. With regard to composite thermocouples, he did not think the arrangement would be useful except for very moderate ranges of temperature on account of the irrationality of the curves, which could not be satisfactorily represented by parabolic formulæ. He had himself employed a similar arrangement with resistance-thermometers, combining wires of different materials in series, such as platinum and gold, or platinum and iron, so as to eliminate the b term. This was a simple and fairly reliable way of rectifying the curve, since the resistance-variation of most metals followed approximately parabolic formulæ, and the sign of b was positive for many metals but negative for platinum. It was difficult, however, to find a suitable metal capable of standing high temperatures without change.

Dr. CHREE pointed out that the resistance of the coils and shunt would vary somewhat with temperature unless made of some material with a neglible temperature coefficient. This would presumably necessitate some correction to the reading in the ordinary case. He asked Mr. Campbell whether a change in the total resistance of the wire due to temperature affected in any way the accuracy of the calculations.

The CHAIRMAN expressed his interest in the Paper and in the usefulness of the methods described for ordinary work, but pointed out that for the most accurate work it was advisable to work with the simplest possible form of apparatus and to apply the necessary corrections at the end. With regard to the question of compensation raised by Prof. Callendar, the mathematics given in the Paper would embody his suggestion if x_0 were given a suitable value instead of being made equal to unity. The constantan wires referred to by Mr. Campbell had been tested over a large range of temperature, and it had been found that a constantan-iron couple gave a linear formula.

Mr. CAMPBELL, in reply to Prof. Callendar, said it would be possible to arrange the rectifying loop with plug contacts instead of sliders; with 25 ohms in the measuring arm, sliders cannot cause serious error. In reply to Mr. Duddell's second question, he did not know if any of the other copper-nickel alloys gave better thermo-electric results (against iron) than constantan. In both of the rectifying methods the temperature-coefficient of the measuring arm caused no more error than in the ordinary method. In further answer to Prof. Callendar's and Mr. Duddell's remarks, he mentioned that for both methods he had indicated clearly in the Paper that when once the ratio of the resistances of the zero-reading and the total loop (or the shunt) was found from a and β, then the absolute values of these resistances may be altered in any ratio desired. The bridge can thus have equal or unequal arms at will.

Royal Society.—Among the Papers down for reading yesterday were the following:—"A New Radio-active Element which evolves Thorium Emanation," by Dr. O. Hahn. Preliminary communication, and "A Determination of the Amounts of Neon and Helium in Atmospheric Air," by Sir William Ramsay, F.R.S.

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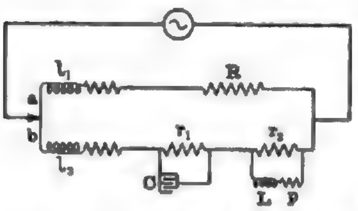
* See *The Electrician*, December 16, 1904.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Differential Transformer.—The principle of the differentially-wound current-detecting instrument, of which the differential galvanometer is the type, has been adopted by H. Ho, and later by Duane and Lory, for the comparison of inductances and capacities by means of alternating currents. The instrument described by each of these authors is a telephone, the bobbin of which is twin-wound in such a way that, when equal and opposite currents are sent through the coils constituting the twin winding, no magnetic field reaches the diaphragm of the telephone. The self-induction of the coils must also be equal. Under suitable conditions, the telephone behaves as a perfectly non-inductive resistance, and gives out no sound even when carrying relatively strong currents. Thus we obtain an exceedingly sensitive device to detect whether or no two alternating currents are equal in amplitude and are in phase with each other. The most serious fault of the differential telephone as hitherto constructed is that the inductances of the systems are not zero when in the balance condition. This has now been remedied by A. Trowbridge, who winds a Faraday ring with a double primary in twin and a fine wire secondary to connect to an ordinary telephone by means of non-inductive lead wires. The condition of resonance either in a series or parallel arrangement of capacity and inductance is determined not only by the values of the capacity, inductance and resistance, but also by the frequency of the alternating current. The author describes a scheme of connections for use with the differential transformer or telephone which makes it possible to compensate the lead due to the capacity C by the lag due to the inductance L so that the current will flow in phase with the impressed E.M.F., as through a non-inductive resistance, and, in addition, the balance is sensibly independent of the frequency. This connection is shown in the diagram, where l_1 and l_2 are the twin coils of the differential transformer, *a* and *b* variable resistances and R, r_1 and r_2 non-inductive resistances.



[A. Trowbridge, *Physical Review*, February, 1905.]

Demagnetisation of the Earth.—A somewhat sensational announcement is made by L. A. Bauer on the basis of a mathematical analysis of the secular variation of the earth's magnetism between 1890 and 1900, as determined from observations made at a series of land stations fairly uniformly distributed over the earth, and lying between the parallels of 60° N. and 60 S. The analysis shows that at the present rate the earth's magnetic moment will have dwindled to half its present value in 1,600 years. This result is confirmed by an analysis of the magnetic charts for 1843 to 1885, although these are less reliable owing to the paucity of oceanic data. It must now be recognised that the secular variation of the earth's magnetism results, not only from a change in the direction of the axis of magnetisation, but also from a change in the intensity of magnetisation. The change must be attributed to the working of systems of magnetic or electric forces superimposed upon the earth's uniform magnetism. One of these systems is situated below the earth's surface, having a potential and tending to the demagnetisation of the earth. Its axis is being displaced towards the west. Another system is situated above the earth's surface. It has also a potential, and its magnetic axis is directed nearly transversely to the earth's axis of rotation. This system plays a most important part in the secular variation of the magnetic declination.

[L. A. Bauer, *Physical Review*, February, 1905.]

Action of Radium on the Electric Spark.—Radio-active substances, when placed near a spark, in general cause the discharge to pass more readily by the formation of ions in the electric field. The action on a long spark is, however, different, and appears somewhat irregular. R. S. Willows and J. Peck have observed that in some cases the discharge passes more readily, in others with greater difficulty. They produced the sparks between two brass spheres of unequal diameters by means of a Wimshurst machine. The action of 5 milligrammes of radium bromide was altogether different according to the direction of the discharge. Using a spark-gap longer than 2cm., and making the larger knob positive, the radiations had practically no influence. With the smaller sphere positive the radium in most cases extinguished the spark, the visible portion of the discharge being confined to a glow at the surface of both electrodes. As the knobs were gradually pulled apart, a good deal of brush discharge became mixed with the spark, and the effect was more easily observed. With still longer discharges there appeared only a positive brush, beyond this a dark space, and on the surface of the cathode a faint glow. In this condition the discharge is very susceptible to influence. It may be extinguished instantaneously by the radium held at a distance of 1 metre. When the anode consisted of a piece of No. 22 wire, with which the discharge passed nearly entirely in brush form, the radium had no visible effect. Both this and the fact that the radiation has no influence when the discharge passed from the larger to the smaller sphere are consistent with the theory that a minimum discharge potential is necessary for the effect to be produced. In each of these cases, the mean potential gradient is less than it is when the spark is in its sensitive condition. Although the visible discharge is extinguished, it does not follow that the current actually passing is diminished; the conductivity might be so largely increased that a non-luminous discharge takes place. The results obtained cannot be ascribed to the γ-rays, nor do they depend directly on the number of ions produced by the ionising agent, but they are most likely due to a special action of the β-rays.

[Willows and Peck, *Philosophical Magazine*, March, 1905.]

A High-frequency Alternator.—In view of the increasing interest taken in high-frequency alternating currents, especially in connection with wireless telegraphy, W. Duddell describes a small alternator designed in 1900. The alternator was made for some experiments on the resistance of the electric arc. As the experiments progressed, and it was found that with each increase of frequency the solid arc behaved more and more like an ordinary resistance, the alternator was altered until finally the very high frequency of 120,000 ~ per second was attained. The inductor type of alternator was chosen. The pulleys on the alternator spindle were of steel, having a diameter of only 10mm. at the bottom of the V-grooves in them. The ratio of the belt-drive—that is, the number of turns of the alternator spindle for each revolution of the motor—was found experimentally to be 42·5. To measure the frequency, a Young's speed indicator was used, geared down from the inductor spindle by means of worm and wheel, having a ratio of 20 : 1. Although the spindle was constantly run at speeds of between 30,000 and 40,000 revs. per min., no trouble was experienced with this gear. As the highest speed of the inductor was only 600 revs. per second, whereas the limit at which it was considered safe to run the inductor, owing to considerations of bursting, was 1,000 revs. per second, attempts were made to increase its speed, but these failed owing to the large power required seriously overloading the motor. In spite of every care, all attempts to run the inductor at 1,000 revs. per second failed owing to the heating of the bearings; but on removing the inductor from the spindle, this latter could be run at 1,000 revs. per second with comparative ease. This was evidently due to the axis of inertia of the inductor not coinciding with its mechanical axis. All attempts to adjust this, such as making new inductors, &c., failed. Experiments were next started to see whether the efficiency of the alternator could not be increased so as to allow the small amount of power required for the experiments to be obtained with an inductor having more than 90 teeth. An inductor having 204 teeth was therefore constructed. With this inductor, and the coils wound right on to the pole tips, it was finally possible to obtain a root-mean-square current of 0·1 ampere at frequencies up to 120,000 ~ per second.

[W. Duddell, *Philosophical Magazine*, March, 1905.]

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LICENCES FOR WIRELESS TELEGRAPHY.

Last year the Government passed a "Wireless Telegraph Act," restricting the use of wireless telegraphy to persons who are properly licensed by the Post Office. The issue of these licences has been considerably delayed, owing to the necessity of safeguarding the interests of the four Government departments concerned in the use of wireless telegraphy. The Post Office, the Trinity House Board, the War Office, and—most important of all—the Admiralty, must exert every vigilance to prevent any injurious effect upon their own services by the wireless telegraph installations of private individuals and commercial companies, while, on the other hand, it is evident that it is against the interests of the country to hamper private enterprise unduly in connection with a new scientific industry; thus the preparation of the licences has been a difficult matter, necessitating some deliberation. The draft licences are now ready, however, and have been submitted to those who applied for licences last year. We publish the complete form of the licence in this issue.

Three classes of licence have been prepared: "Commercial," "Experimental," and "Private Business." The first of these is for companies desiring to carry on the business of transmitting messages by wireless telegraphy. Licensees are to state definitely the system they are employing at each of their stations, whether on ships or on land, they are to specify the maximum and minimum range of their signals, the wavelength that will be employed and the source of power, together with current and voltage, and they may not modify it without the consent of the Postmaster-General. They must undertake not to use their systems for the transmission of wireless telegraphic messages, either directly or by means of intermediate ship and shore stations, to or from any British possession, protectorate or foreign country, a condition that will apparently prevent a company from carrying on the business of telegraphing across the Atlantic with Hertzian waves, or even from establishing a commercial cross-Channel wireless message service; in fact, it limits wireless telegraphy to communications between ships and shore stations and to overland work. It is further provided that the licensee shall not work his apparatus so as to interfere with the working of other stations used for commercial purposes or for communicating with ships at sea or belonging to a Government department. The means of preventing interference must apparently be devised by the licensee himself. It may be noticed that no penalty is provided for an infringement of this clause of the agreement, except the revocation of the licence. In addition to this clause, a special clause is inserted for the protection of naval signalling: the Admiralty may require that the station be shut down for two hours a day, and, moreover, if they are of opinion that the working of any station "is inconsistent with the free use of naval signalling," they may (through the Posmaster-General) order it to be shut down. The licensee must accept messages without preference, except in the case of signals of distress from ships and Government messages, both of which take precedence over ordinary messages, the latter at half rates and the former gratuitously. The licensee pays a royalty of £1 per annum for each land station and 5s. per annum for each ship station, sums which cannot be deemed excessive.

Strict provisions are inserted in the licence with respect to secrecy. Only British subjects are to be employed on shore stations licensed for commercial messages (so Mr. MARCONI will have to become a real Englishman—or Irishman). In all cases the licensee is not to divulge the contents of any message transmitted by or for any Government department (including, of course, naval signalling) or by any other licensee. No suggestion is added, however, as to how the operator at the station is to know whether such messages are intended for him, and doubtless some additional regulations will have to be issued establishing code signals. As a further precaution, the Government may take possession or control of the station, "on emergency," and for the purpose of "protecting the interests of His Majesty under apprehension of impending war," or "preventing direct, indirect or suspected communication with any of His Majesty's enemies."

The other licences resemble in general form the "Commercial" licences. In the case of those for Experimental work as well as the Private Business licences, the licensee undertakes to refrain from using his apparatus whenever he perceives on his instruments that naval signalling is in progress. The clause stipulating that only British subjects be employed at the stations is omitted both in Experimental and Private Business licences. The "Experimental" licensee is not called upon to pay royalty, but the user of wireless telegraphy for private business may have to do so in certain cases. Experimental licences may at any time be withdrawn by the Postmaster-General at a month's notice. In these two classes of licence, a description of the installation and a statement as to wave-length is not included in the licence itself, but in some instances the licensee has been asked to furnish these data to the Post Office.

Taken as a whole, the conditions of these licences are certainly rigorous, but, in view of the importance of adequate Government control, we are not prepared to say that they are too stringent. In construing the obligations imposed upon those who are allowed to practise wireless telegraphy and to pursue their experimental investigations in this science, the Government will, we trust, allow a fair amount of latitude. A certain amount of control will be beneficial so long as it is not allowed to become burdensome.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Smoke Prevention and Fuel Economy. By WM. H. BOOTH, M.Amer.S.C.E., and JOHN B. C. KERSHAW, F.I.C. (London: Archibald Constable & Co.) 6s. net.

The original intention of the authors was to present a simple translation of the German book of Ernst Schmatolla, but in order to fit their book to English practice they found it necessary to make considerable alterations. After tracing the development of the steam boiler and methods of firing from the days of James Watt, the chemistry of the process of combustion and the existing methods of burning fuels and their defects are lucidly dealt with. The furnace construction in various types of boilers is considered and the good and bad features are pointed out. Emphasis is laid on the fact that, owing to the large space available for the grates, the under-fired boiler is much better adapted for the perfect combustion of fuel than is the internally-fired boiler. Unfortunately, the principal makers of water-tube boilers in this country continue to set them in the regular American manner, as if they were to be fired with Pennsylvanian anthracite, notwithstanding the necessity for a reverbatory furnace and large combustion chamber is now almost generally recognised. Probably the belief that mechanical stokers are an infallible cure for smoke production, an erroneous belief for which the manufacturers of such appliances are largely responsible, has delayed the demand for a properly-constructed furnace. The merits of hand firing and machine stoking are carefully compared, the authors' conclusion as regards the latter being that, although a fair amount of success is secured by them, and they cannot be regarded as altogether unsatisfactory, a perfect mechanical stoker is not known. Still they think it difficult to imagine anything much better than the inclined-step grate—a type of furnace which has not at present been much used in this country. In considering improvements in the methods of burning fuel the inclined grate and the firing of the boilers from gas producers receive most attention, although the use of liquid fuel and dust firing are described.

In many respects the most valuable chapter in the book is that dealing with the examination of the waste gases and the control of the combustion process. The directions for sampling and analysing these are clear and complete, and are followed by descriptions of various instruments for recording continuously the percentage of carbon dioxide in the flue gases.

In an appendix appear abstracts of English, German and American patents granted in recent years for fuel consuming appliances designed to promote more perfect combustion, also several useful tables of fuel analyses and waste gas losses.

The book is one which every steam user might study with advantage, and especially every engineer who recognises the necessity for conserving the country's coal supplies and the extinction of the "smoke nuisance." E. T. R.-M.

Handbuch der Physik. Part II., Optik I. By Dr. A. WINKELMANN. 2nd edition. (Leipzig: Ambrosius Barth.) 14s.

The subjects discussed in this small subdivision of a general treatise on physics may be described as those departments of geometrical optics which affect the practical construction of optical instruments. Even so, the chapters are not written by the same hand. Most of them are by S. Czapski, but O. Eppenstein writes on the Diaphragm and Illuminating Systems, and M. von Rohr on Vision, Photographic Objectives and Spectacles. The photographic chapter is very full, and it is significant, and also intelligible from the authors' nationality, that a separate section deals with "the time after the opening of the Jena glass works." The chapter on illumination is somewhat stinted. It is near the end of the book, and gives the impression that space was running short. The copious references given there are perhaps intended to make up for the compression of miscellaneous matter into a single paragraph.

Motors and Motoring. By HENRY J. SPOONER. (London: T. C. & E. C. Jack.) 1s.

This book is superior in many respects to some others sold at several times its price. With regard to the information on the mechanical parts of motor cars we do not propose to offer any criticism, but the electrical portion is all that could be desired for the purpose. Not only are the particulars given in popular language which may be easily understood by the veriest amateur, but, what is more important, they are accurate, theoretically as well as practically. It is a book we can cordially recommend to motor car owners and drivers.

The Construction of Cranes and other Lifting Machinery. By E. C. R. Marks. 3rd edition. (Manchester: The Technical Publishing Co.) 3s. 6d. net.

This book has been considerably added to in the new edition. The new matter consists of descriptions, more or less in detail, of numerous steam, hydraulic and electric cranes, winches and hoists manufactured by well-known firms. Descriptions of most of these have appeared in the technical journals from time to time, but being collected in book form they enhance the value of the earlier chapters, and the net result is a handy volume likely to prove of considerable utility.

THE CONSTITUTION OF MATTER.

A large audience gathered on Friday evening last to hear Prof. J. J. Thomson's discourse on the Constitution of Matter. The learned professor, to whom is due so large a proportion of the modern conception of the structure of the atom, related succinctly the recent history of the electrical theory of matter, and sketched his own views on the subject. With much of the theory our readers are no doubt already familiar; but to what is already common knowledge Prof. Thomson added, as was to be expected, some new and very important developments. The theory of the atom now almost universally accepted supposes that a number of negative corpuscles are held balanced in orbital motion by the attraction of a positive nucleus to which, therefore, the corpuscles are satellites. The number of satellites determines the nature of the element, about 1,000 corpuscles, for instance, going to the making of an atom of hydrogen. Now the potential energy possessed by each corpuscle in an atom has been found by Prof. Thomson to depend on the number of corpuscles present, and is thus different for different atoms; in fact, if a curve be drawn expressing as heights the potential energy per corpuscle and as horizontal distances the number of corpuscles present in an atom, this curve has crests and hollows. If number of corpuscles and atomic weight be taken as identical, a crest thus represents an atom which can exist for but a moment, while a hollow represents a stable element.

Thus we get a glimpse of the reason why in the evolution of the universe only a certain number of elements of very definite atomic weights remain in permanent existence. The reason is, in fact, analogous to that of the gathering of boulders in the hollows and not on the summits of a hill and dale country. The lecturer explained, however, that the calculation of the potential energy per corpuscle gives different numerical results on different assumptions as to the behaviour of positive electricity when two atoms coalesce to form a new element. If positive electricity be supposed, for example, to behave as an incompressible fluid, then with increasing atomic complexity the potential energy per corpuscle on the whole increases, and thus the general tendency in atomic evolution will be towards smaller and smaller atoms. Further, if the generalisation be permissible, the universe probably began (if the above assumption regarding positive electricity is correct) as a single vast atom which has in the course of the ages broken down to the state in which we now know it. Another new development announced by the lecturer lies in the introduction of the idea that in such a system as he imagines the atom, there is a number of directions along which the combined actions of the positive and negative charges give an electric field which possesses the peculiarity that near in an electric charge will be repelled, further out will be attracted. This theorem was effectively illustrated by a variation of that magnetic model of the atom used a year or more ago by Prof. Thomson. In that model movable magnets are gathered into definite geometrical patterns, in spite of the mutual repulsions, by a central attracting pole. The central pole represents the positive nucleus, the attracted poles the negative satellites. The new variation of this experiment consisted in representing a certain atom by three like magnet poles placed at the corners of an equilateral triangle at whose centre were gathered the opposite poles. With this arrangement distant floating poles were repelled when nearer in, attracted when further out, and thus came to rest in perfectly definite positions. But all this happened only along certain lines of symmetry radiating from the atom. These directions round the atom are the valency bonds of the chemist, now for the first time materialised. Thus the electric atom brings into consideration two types of field of force existing round it. There is the ordinary electric field which it creates when it becomes electrically charged through possessing a corpuscle or two too many or too few; and there are the valency attractions which promise stable combinations between atoms to form molecules. Pushing this idea further Prof. Thomson showed that it gave to the atom precisely those properties Van 't Hoff and Le Bel have demanded in their theory of the asymmetric carbon atom, which, developed out of a consideration of the rotation given by certain compounds to plane polarised light, plays now so large a part in stereochemistry.

TEMPERATURE EXPERIMENTS WITH INSULATING MATERIALS AND FIELD COILS.*

BY E. H. RAYNER, M.A.

The Paper describes the results of two investigations undertaken on behalf of the Engineering Standards Committee.

In Part I., dealing with the effect of heat on the electrical and mechanical properties of dielectrics, it is stated that from experiments on cotton-covered wire there appeared no serious alteration in the cotton up to 125°C. (which temperature may be taken as approximately the safe limit); above 125°C. the cotton gradually became darker, but retained its good electrical (but not mechanical) qualities up to the highest temperature employed—viz., 160°C.

The mechanical tests consisted of a punching test and bending test. For the punching test a steel punch, $\frac{1}{8}$in. in circumference, was used. Punching appears to afford an excellent criterion of the mechanical properties of the specimens, and may be considered to give a fair measure of the increase of brittleness with temperature. In the bending tests the specimen was bent round cylinders of gradually decreasing diameters, varying from 12in. to $\frac{1}{16}$in. until it broke or was badly cracked. If a specimen was capable of being bent round a cylinder $\frac{1}{16}$in. diameter without breaking, it was bent backwards and forwards round this. A very large number of insulating materials were tested as to disruptive strength, which was observed to vary from 3,300 volts per millimetre for dynamo tape to 85,000 volts per millimetre thickness for Excelsior paper Nos. 1 and 2. These figures refer to the unheated condition. When the materials tested were heated, their disruptive strength first increased and then usually decreased, the maximum being attained—for most of the insulating materials experimented with—at a temperature of approximately 100°C. The highest value of disruptive strength was 53,000 volts per millimetre, and referred to Excelsior paper No. 1 heated to about 100°C. Oiled linen, however, is a notable exception to the general rule, inasmuch as its disruptive strength diminishes from the very first with increase in temperature.

It was thought that there might be some relation between the ohmic resistance and disruptive pressure, but tests showed this not to be the case to any great extent. The insulation resistances were determined with an applied pressure of both 200 and 1,000 volts, the figures obtained being generally smaller with the higher voltage. Oiled linen had, in one case, an insulation resistance of only 40 kilo-megohms per cubic centimetre after one minute's electrification, and this figure represents the lower limit. The highest insulation resistance recorded reached 25,000 kilo-megohms per cubic centimetre and was observed for waterproof board heated to 75°C. Moisture has an important effect upon the insulation resistance, as will be seen from the following experiments:—

A specimen of press-spahn, 1·07mm. thick, which had been in the desiccator for 12 days, had reached the high figure of 800,000 megohms, having started with an initial insulation resistance of 0·42 megohms. A similar piece which had been heated for an hour reached a figure above 4,000,000 megohms, showing that the desiccated specimen still contained an appreciable amount of moisture. If the temperature were suddenly raised the resistance should decrease and then steadily rise again as the moisture was driven off. Another piece of press-spahn, also 1·07mm. thick, was exposed to intermittent sunshine out of doors (October 23rd). During the previous days there had been much rain, and the air could not be termed dry. Resistance before exposure was 0·84 megohms, and the resistance after 70 minutes' exposure was 680 megohms.

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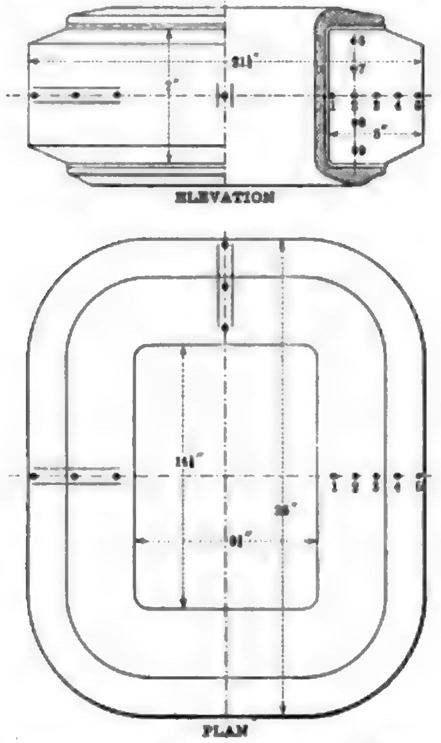
* Brief summary of a Paper entitled "Report on Temperature Experiments carried out at the National Physical Laboratory," read before the Institution of Electrical Engineers on Thursday, March 9. Communicated by Dr. R. T. Glazebrook.

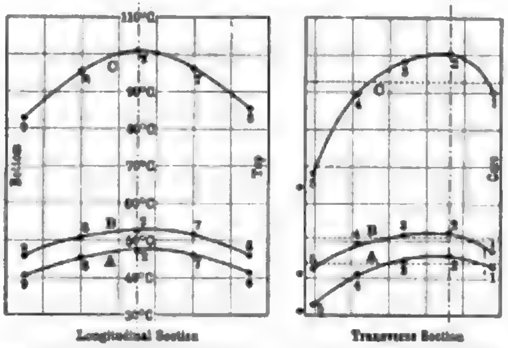
A very interesting series of tests relating to the disruptive voltage of various substances which had been treated with Berrite varnish proved that very high disruptive strengths may be attained in this way. The highest disruptive strength quoted is 65,000 volts per millimetre for Excelsior Paper No. 8, heated to about 80°C. Nearly all the materials thus tested could be bent around a cylinder $\frac{1}{16}$in. in diameter without breaking.



Layers 1·8·8·8·8·1, total 34. Cast-iron Former. Coil varnished on the outside.

Thermo-junctions indicated thus ·· were only employed to check the results shown in the accompanying curves.

Fig. 1.—Coil No. 6.



Curve.	Conditions.	Amperes.	Mean Temp. in °C.	Max.-Mean in °C.
A.	Running loaded.	7·07	44·0	2·4
B.	Standing.	7·09	50·2	2·1
C.	Standing.	11·12	92·5	8·0

The points shown to the left of the Curve above represent readings of temperature taken by thermometer outside the coil.

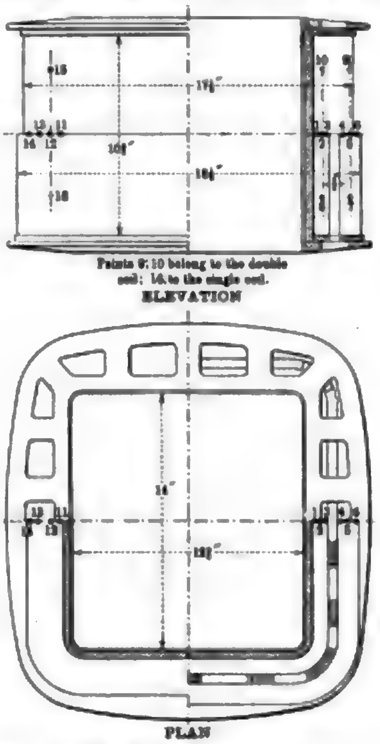
Mean temperature of the Whole Coil shown by Horizontal dotted lines.

Fig 2.—Temperature Tests with Coil No. 6.

Part II. of the Paper deals with an investigation undertaken at the request of the committee on electrical plant of the Engineering Standards Committee, who desired to know what, in actual practice, was the difference between the maximum temperature reached in field coils and the mean temperature calculated from the increase of resistance of the coil. Thermo-couples were used for measuring the temperatures. Nine different forms of coil were tested, and we give below two typical tests.

Fig. 2 represents the results of temperature tests carried out with coil No. 6 (Fig. 1). This coil belonged to a 200kw. 220-volt generator running at 350 revs. per min. The load on test was alittle over half-load. The rated full-load shunt-current was 11·4 amperes, and whilst running the current was 7 amperes. The coil was also tested at 7 amperes with the armature not revolving (curve B, Fig. 2).

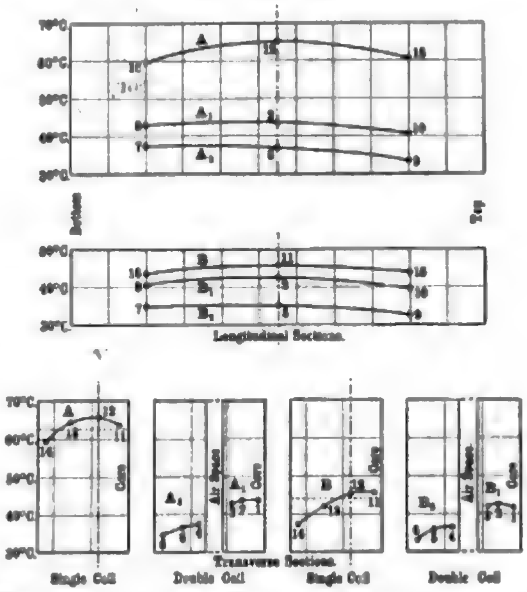
Coil No. 9. was a field coil of a 500kw. 200 volt generator running at 200 revs. per min. It was covered with canvas, fullerboard,


17½"
10½"
16½"
14"
12½"
Points 9, 10 belong to the double coil; 14 to the single coil.
ELEVATION
PLAN

Layers 1·3·3·3·1 (Single Coil). Layers, Inner Coil, 1·2·1·1; Outer Coil, 1·2·2·1.

The Coil was in one case a Single Undivided Coil; in the other case a Double Coil with Air Space between the Windings.

Fig. 3.—Coil No. 9.



Curve.	Conditions.	Amperes.	Mean Temp. in °C.	Max.-Mean in °C.
A.	Single coil, normal covering.	19·0	63·2	2·2
B.	Single coil, covering removed.	19·0	44°C.	1·7

Fig. 4.—Temperature Tests with Coil No. 9.

millboard and string. Fig. 4 gives the results of temperature tests. In addition to this coil wound in the ordinary manner, a second coil on the same machine was wound with an air space in the middle of the winding, in order to see if any economy might be effected in the amount of copper used. The total layers on the coil were 11, with ½in. air space between the fifth and sixth layers. The curves A_1 and A_2 give the figures for the heat distribution in the inner and outer portion respectively. As this coil had no external covering a second test (B) on the other test coil was made with the covering removed so as to make a fair comparison between the two.

The entire report, which covers 47 pages and contains a number of tables and curves, should be in the hands of every dynamo designer. It is obtainable from the Engineering Standards Committee, with whose permission the above summary has been published.

MANCHESTER TRAMWAYS—POWER SUPPLY*.

BY H. C. GUNTON AND S. L. PEARCE.

(Continued from page 847.)

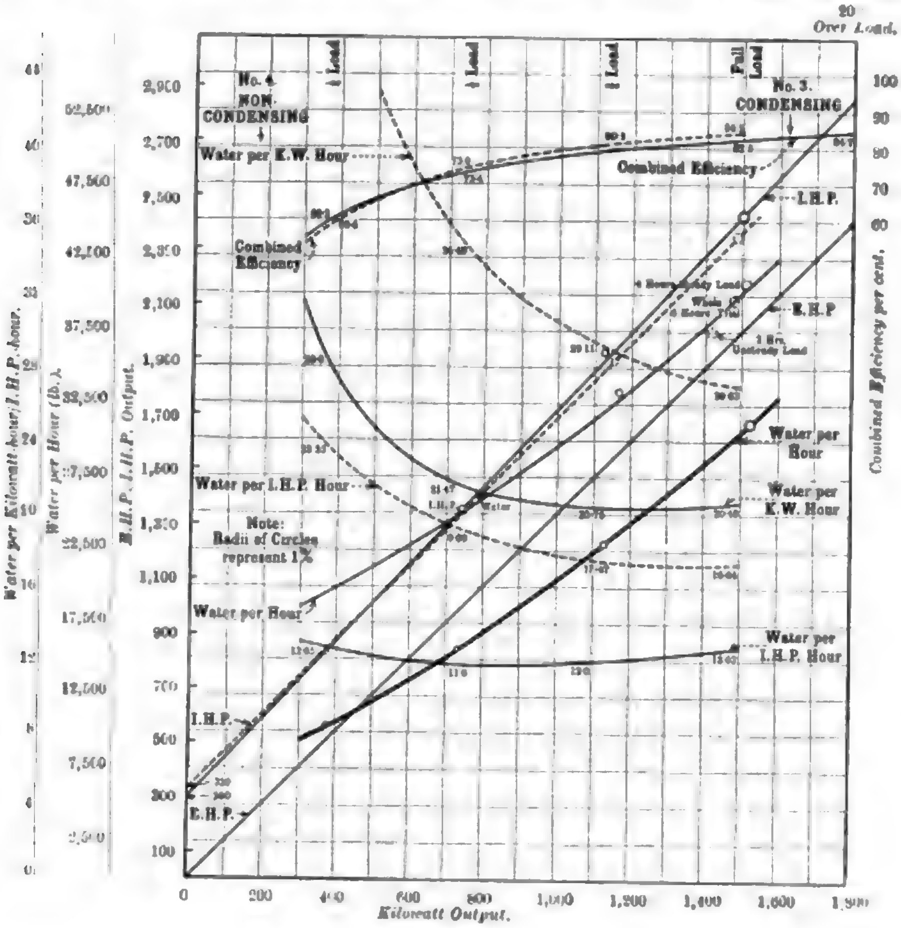


FIG. 3.

Engine Set No. 4. Non-condensing. 160lb. Pressure, March, 1903. (Dotted lines.)
Engine Set No. 3. Condensing. 160lb. Pressure 25·5in. Vacuum (Full Load), Jan. 1904. (Field Line.)
N.B.—In both cases results include correction for excitation from motor-generator. (H.T. input.)

Fig. 3 shows a series of curves embodying the results of two steam consumption tests carried out at full load, three-quarter load, half-load and quarter-load on two of the Yates & Thom—Electrical Co.'s 1,500kw. three-phase sets at Stuart-street in March, 1903, and January, 1904. The full lines give the results obtained from No. 3 set running condensing, and the dotted lines those obtained from No. 4 operating non-condensing. Saturated steam was used in each case, the water being measured on the supply side to the boilers, and the drainage water, except that from the cylinder jackets, was deducted. The engine sets were run on an artificial water load. The following data were also obtained during the condensing tests on the above plant, showing the pounds of coal burnt per unit generated, &c.

Coal.	Load.	Duration of test.	Total units generated.	Total coal consumption.	No. of boilers in use.	Lb. of coal per unit generated.
Washed slack & washed peas..	Full.	3 hours,	4,550	9,268	4	2·03
Do.	¾	Do.	3,420	8,512	3	2·4
Do.	½	Do.	2,220	4,928	2	2·2
Do.	¼	Do.	1,110	3,920	2*	3·5

* One boiler on range but not working. No deductions made for wetness of coal, or for residue left over.

Curves of efficiency of the 220kw. and 250kw. motor generators are given in Figs. 4 and 5. In Fig 6 are given the curves of—

(*a*) Combined traction and lighting high-tension output from Stuart-street for Tuesday, January 3rd, 1905.

(*b*) Combined traction and lighting high-tension input at substations for same date.

from which two is deduced, the (*c*) efficiency of transmission, which for top load reached 98 per cent. approximately. The average length of high-tension feeders in this case was considerably less, and the section of feeders for a given load greater than in the test made at an earlier date, to which Table III. at the end of the Paper refers.

Figs. 7 and 8 show the curves of conversion efficiency for particular days for the Polygon and Oldham-road sub-stations. The average monthly conversion efficiency of all traction sub-stations—*i.e.*, L.T. output H.T. input = 78·5 per cent.

In Fig. 9 are given particulars of the total weekly units generated at the Stuart-street station since the commencement of supply, the units sent to sub-stations, also the coal and water consumption. The change from non-condensing to condensing took place in February and March, 1904. Owing to a reduction in the plant-factor of the station, the full effects of the change are somewhat masked.

In arriving at the weekly load-factor and plant-factor, the follow-formulæ have been used:—

Load-factor: (Units generated × 100)
(Momentary maximum load × 168 hrs.)

Running Plant-factor: (Units generated × 100)/(Capacity of running plant × 168 hrs.)

The load-factor for the Stuart-street station for the past 12 months works out at 47·8 per cent., and for the Bloom-street station at 29·3 per cent.

In Fig. 10 are given the 24-hour load curves for the Bloom-street and Stuart-street stations on Thursday, October 27, 1904.

The lowest costs of production for any month in 1904 were as follows:—

(1) *Generation.*	Stuart-street.		Bloom-street.		Dickinson-street.
	d.		d.		d.
Coal	0·17	..	0·161	..	0·216
Oil...............	0·006	..	0·003	..	0·008
Water	0·011	..	0·011	..	0·015
Waste and stores..	0·009	..	0·007	..	0·015
Repairs..........	0·028	..	0·029	..	0·059
Salaries and wages	0·046	..	0·069	..	0·119
Totals	0·270	..	0·280	..	0·432

(2) *Distribution Costs.* { Salaries and wages .... Repairs and maintenance } 0·103d.

The above cost figures are per unit generated, and are not to be taken as a guide to the *cost per unit sold.* It is interesting to compare the above costs for Stuart street with those for the eight months ending November 30, 1903, when the station was operated non-condensing. The average costs were then as follows;—

Coal	0·26d.
Oil Water Waste and stores	0·04d.
Repairs	0·03d.
Salaries and Wages	0·05d.
Total	0·38d.

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* Abstract of a Paper read before the Manchester Local Section of the Institution of Electrical Engineers on February 21st.

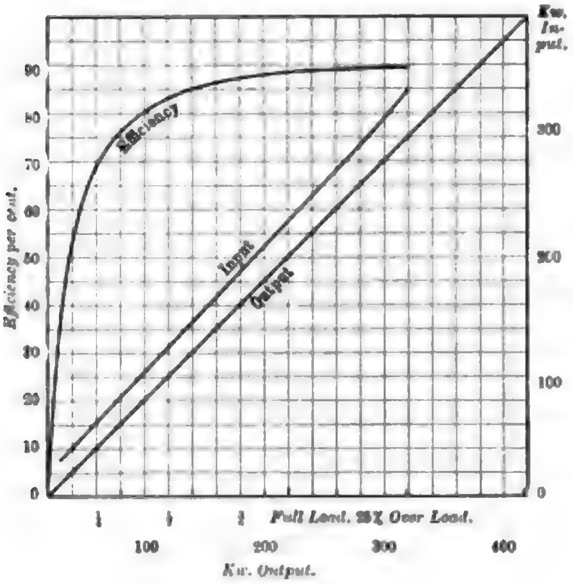


Fig. 4.—Efficiency Curves.

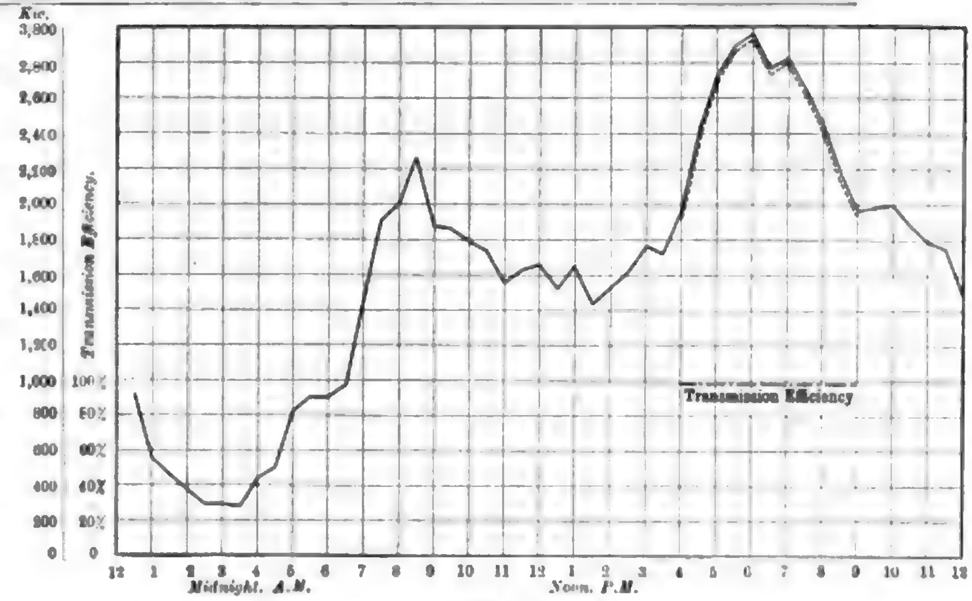


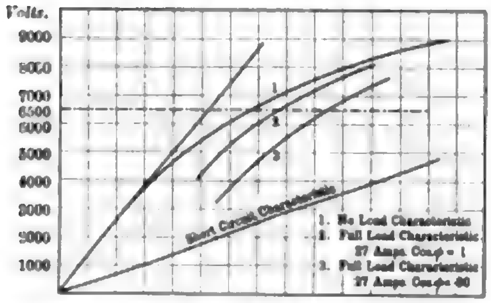
Fig. 6.

Stuart Street Output, Combined Lighting and Traction, Half-hourly Readings, Integrating Wattmeters. From 12.30 a.m., Tuesday, Jan. 3rd, until 12 p.m. Tuesday, Jan. 3rd, 1905.

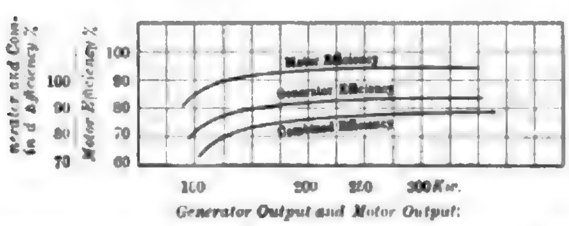
Sub-stations Input, Combined Lighting and Traction, Half-hourly Readings, Integrating Wattmeters. From 4 p.m., Tuesday, Jan. 3rd, until 9 p.m., Tuesday, Jan. 3rd, 1905.

Stuart Street Output marked ——————— Sub-stations Input marked ....

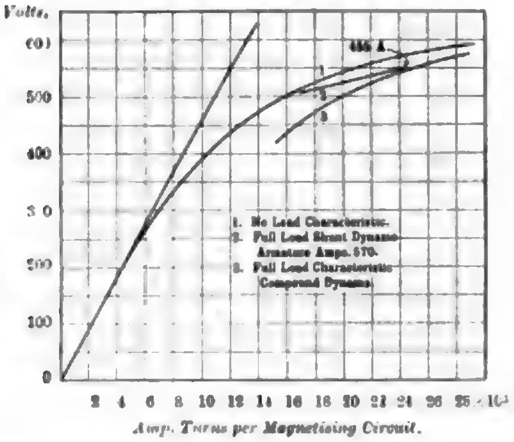
Efficiency Curve over the Peak marked — — — — — — —



Manchester Syn. Motor. The Machine as Generator, 6,500 volts, 360 h.p., 50 cycles, 427 revs., 27 amps.



Motor Generator, 250kw., 427 revs., 400/550 volts, 360 h.p., 50 ∼, 6,500 volts.



Manchester Motor Generators. C.C. Generator, 250kw., 427 revs., 400/550 volts.

Fig. 5.

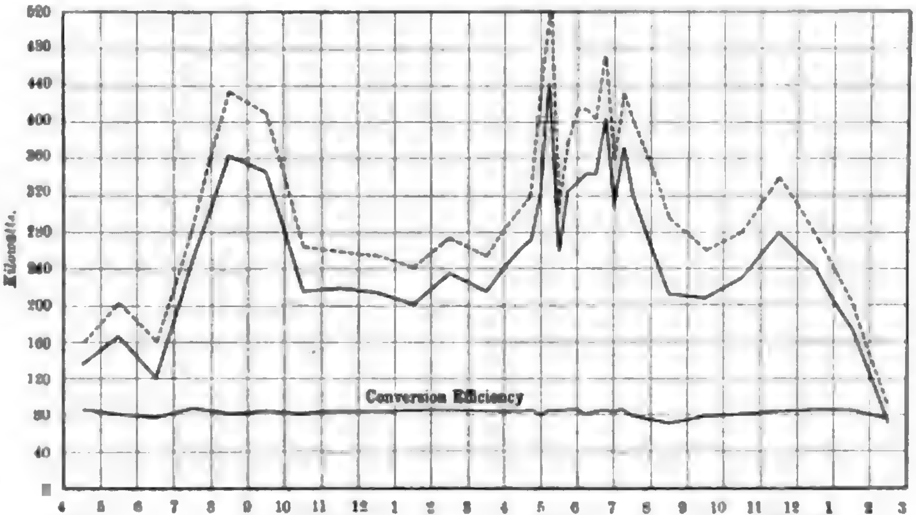


Fig. 7.

Polygon Traction Load Curves. From 4.30 a.m., Monday, Oct. 31st, 1904, until 2.30 a.m., Tuesday, Nov. 1st, 1904.

Polygon Input marked .... by Integrating Meters.

" Output " ——————————— " " "

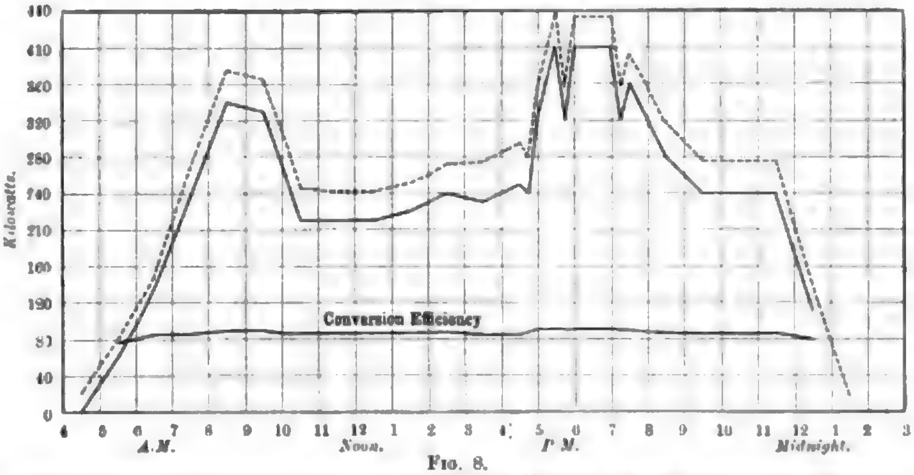


Fig. 8.

Oldham Load Traction Load Curve. From 4.30 a.m., Monday, Oct. 31st, 1904, until 1.30 a.m., Tuesday, Nov. 1st, 1904.

Oldham Road Input marked .... by Integrating Wattmeters.

" " Output " ——————————— " " "

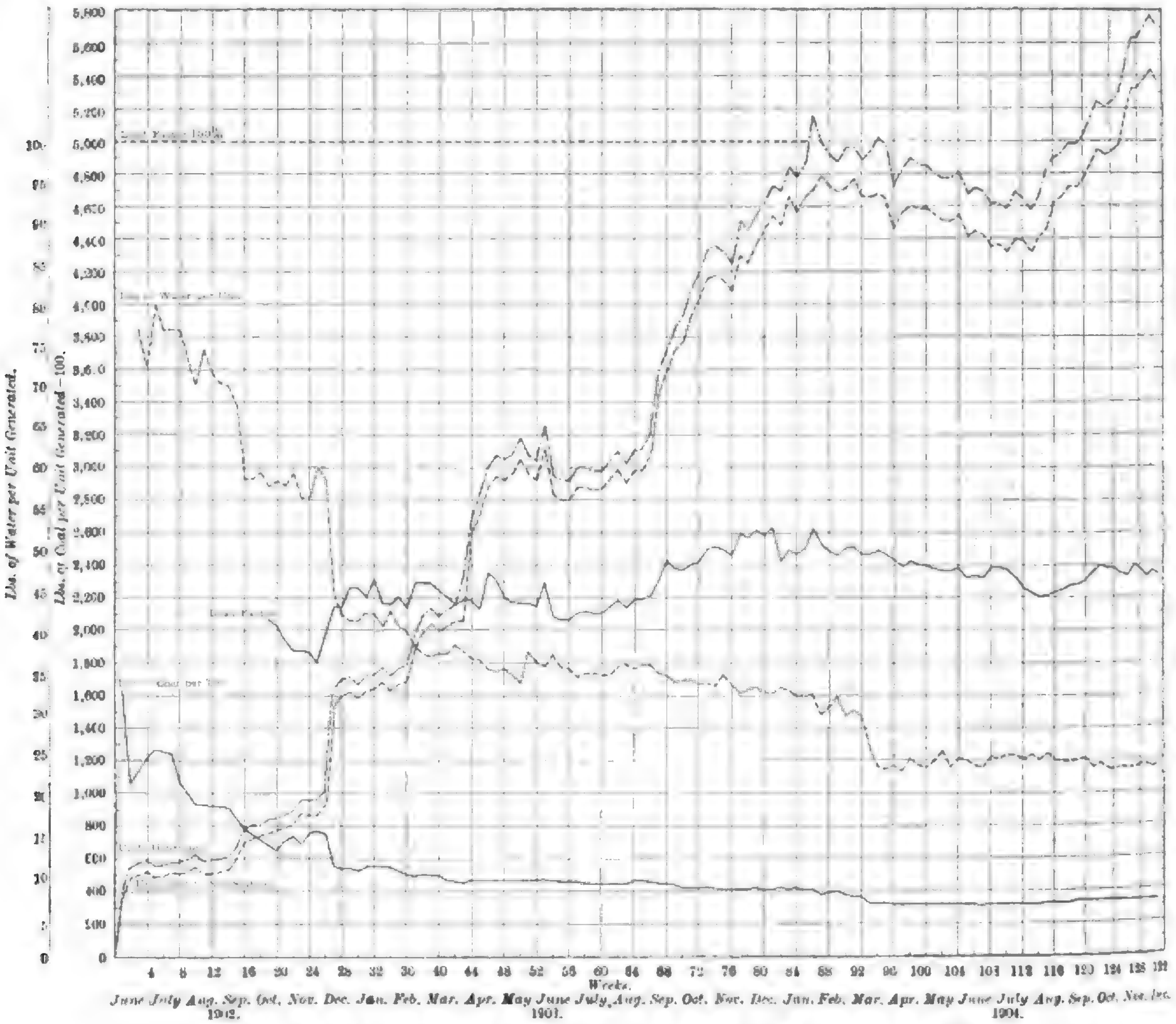


FIG. 9.—Weekly Records, Stuart Street Station. From June 1st, 1902, to January 1st, 1905.

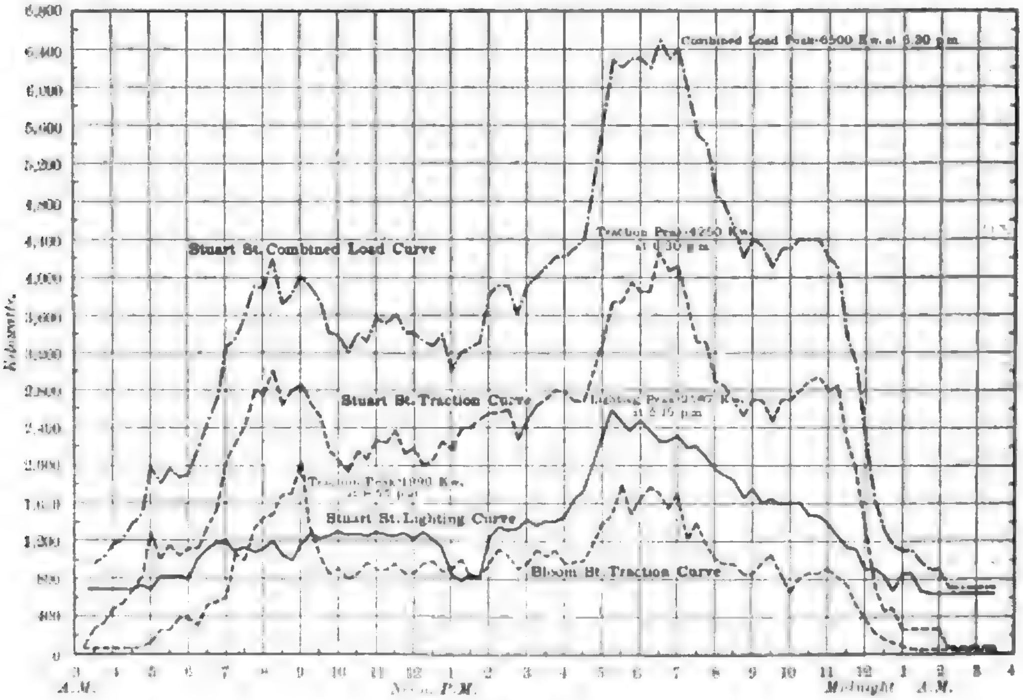


FIG. 10.

Analysis for Week Ending November 21st, 1903, Stuart-street.

Units Generated, &c.—

A. Total output to sub-stations (H.T.) for traction and lighting .... 430,152kw. hours.

Auxiliary Plant—

B. Excitation	10,730kw. hours	
C. Works lighting & power.	7,189 „ „	
Special*	1,108 „ „	
	19,027	19,027 „ „
D. Total units generated		449,179 „ „
E. Momentary maximum output (H.T.)		5,000 „ „

$$\frac{\text{Units used for excitation}}{\text{Units generated by main generators}} = \frac{B}{A} = 2{\cdot}5\% \text{ approx.}$$

$$\frac{\text{Total output (H.T.)}}{\text{Total units generated, including excitation, lighting and power, but not "special"}} = \frac{A}{A+B+C} = 96\%$$

Weekly load-factor = (A × 100)/(E × 168) = 51·2%

Water—

F. Feed water (as measured by feed-water meter, 1,445,700 gallons)

Feed water per unit generated (non-condensing) = 10F/D = ... 32·2lb.

Coal—

G. Total coal consumption .... 822 tons

Pounds of coal per unit generated G × 2,240/D = ... 4·1lb.

The above week, ending November 21st, 1903, includes November 17th, for which the load curves are included under Section II. of the Paper.

The average daily consumption of energy per car-mile over the whole system for the past 12 months is as follows :—

October, 1903, 1·240 ; November, 1·258 ; December, 1·271 ; January, 1904, 1·326 ; February, 1·287 ; March, 1·283 ; April, 1·491 ; May, 1·234 ; June, 1·222; July, 1·240 ; August, 1·260; September, 1·292 ; October, 1·306.

(*To be concluded.*)

APPLICATION OF ELECTRIC POWER IN COLLIERIES.†

BY G. M. BROWN.

The use of electricity in the form of direct current in mines is in many cases restricted to lighting and driving pumps and haulage gears located close to the down-cast shaft. The tests of Heise and Thiem have shown that incandescent lamps broken in an explosive atmosphere are not a source of danger unless the current exceeds 0·6 amperes. The result holds good for both direct and alternating current at pressures up to 220 volts. Tests by the same authorities have also indicated that slight sparking and glowing at the brushes of a direct-current motor will not ignite an inflammable mixture, but if a motor is subjected to sudden overloads or the commutation is bad there will certainly be an explosion.

Whether totally enclosing a direct-current motor will make it absolutely safe it is impossible to say with certainty, although there are many reasons to believe so, even when, as is generally the case, the motor is not designed with the idea of making it absolutely gas-tight. On the other hand, switches and fuses of the type ordinarily used on direct-current circuits are decidedly dangerous. It may be safely asserted that any type of unenclosed commercial fuse is capable of causing an explosion, and the same remark applies to open switches, which are only safe for dealing with current up to 3·0 amperes at a pressure of 100 volts on non-inductive circuits, such as those supplying incandescent lamps. Practically, the only circuit which can be broken safely by an open switch is one supplying lamps which take not more than 0·6 ampere. All other switches must be totally enclosed in strong cast-iron cases, made as nearly gas-tight as possible. Even then switches and fuses are a source of danger when used for carrying large currents. They are no doubt comparatively safe under normal conditions, but are useless in case a bad ground occurs on the circuit they are used for controlling. An enclosed switch and fuse of a good make, and designed for a capacity of 100 amperes at 500 volts, was recently tested under normal conditions, and also under the abnormal conditions that would obtain if there were a bad ground on the circuit controlled by the switch. Under normal conditions the switch broke the circuit without any apparent disturbance, and if the current was gradually increased the fuses blew without causing the emission of any flames from the joints of the case, but when tested with a current of 1,200 amperes suddenly switched on, a condition of affairs which might easily occur in the event of a bad accident to any motor or cable connected to the switch, a violent emission of flames from the joints of the case was seen, although they were made with indiarubber packing and tightly screwed up.

In the final test, the case was made gas-tight and fused with the same asbestos-covered wire used in the previous experiments, the result was that on switching on the current it was blown to pieces. There is no doubt that in such cases the amount of energy to be dissipated at the moment the circuit is broken is very large, with the result that the air in the case is heated and its pressure raised to a degree sufficient, in many instances, to be highly dangerous. Tests have been made of enclosed magnetic blow-out circuit-breakers with similar results: and it would seem almost impossible to produce an enclosed switch or fuse of the ordinary type capable of opening an inductive circuit and carrying a larger current with safety.

The greatest advance in the application of electricity for mining purposes has been due to the introduction of the polyphase alternating-current induction motor. The slip-rings (in cases where squirrel-cage motors are out of the question) do not present any great element of danger if they are kept in good order, and the current-density in the brushes is not excessive. If such motors are provided with two brushes for each slip-ring it is practically impossible to produce a dangerous spark by any ordinary means short of lifting both brushes at the same instant, and this is not likely to happen under ordinary circumstances, even if the slip-rings are in very bad condition. It is advisable, however, to have the slip-rings totally enclosed, if only to afford mechanical protection. Such a motor is practically as safe as one with a squirrel-cage rotor, and has the advantage that full-load torque can be obtained at starting with a current not greatly in excess of the normal full-load current.

One of the chief advantages of alternating-current plant for mining work lies in the fact that all the switches can be of the oil-break type, and the use of fuses is not necessary. When used on alternating-current circuits, oil-break switches will operate perfectly under the most trying conditions ; but when used on direct-current circuits, there is considerable carbonisation of the oil every time the circuit is opened with a heavy current. This is no doubt due to the fact that on alternating-current circuits there is no electrolytic action, and any arc formed between the switch-blade and contacts is extinguished at the instant when the current passes through zero, whereas when used on a direct-current circuit the full amount of energy which can be stored in the circuit is to be dissipated in the switch.

The simplest method of utilising alternating current for winding, is to connect an induction motor to the winding drum, either directly or through reduction gearing. The control of large induction motors for this class of work is best effected by liquid rheostats which have the advantage of presenting a simple and ready means of regulating automatically the maximum speed with which the motor can be started. Smaller motors can be quite readily operated by ordinary controllers and metallic resistances, but it is desirable to provide suitable devices for limiting the speed with which the controllers can be brought into the full running position, and the controllers themselves should have a large number of points ; both resistances and controllers should, in fact, be so designed that in case of emergency, the motor can be used as an electric brake.

The largest plant of this kind of which the writer has knowledge is one of the Société Charbonnages de Grand Hornu, Belgium. The motor is supplied with current at 2,000 volts and 23·5 cycles per second, and is mounted on the same shaft as the winding bobbin ; its maximum speed is 42 revs. per min., and the maximum winding speed is 51·7ft. per second. The net weight of coal lifted is 5,720lb., and the depth of the shaft is 546 fathoms, the total weight of coal raised per hour being 85 tons. A flat rope is used, and the initial diameter of the bobbin is 8ft., the final diameter being about 24ft. 6in. ; by the use of this bobbin the torque required at starting, and consequently the maximum demand for current are kept considerably lower than they would be with either a Koepe pulley or double drum gear.

In this country winding engines are sometimes required to deal with as much as 250* tons per hour, from depths up to 800 fathoms, and in such cases the mechanical difficulties which present themselves are very great. The Koepe pulley is in such cases not favoured on account of the excessive load it throws on the head-gear, and also on account of the fact that in case of failure of the rope both cages are liable to be precipitated to the bottom of the shaft, and the ordinary cylindrical drum is not to be recommended on account of the large unbalanced forces to be overcome at the beginning of each wind, and on account of the load it throws on the headgear, and also because it is liable to cause trouble at high speeds by vibration, a tail rope is not permissible. The only alternative is to adopt the well-known conical drum. In order that the rope and the drum may not be of excessive diameter it is necessary to limit the useful load and adopt higher winding speeds than would otherwise be the case, and therefore electrical plant of larger capacity. As in most mechanical problems, the best solution is simply a compromise between the various conflicting conditions.

In the case of large winding gears connected to a power station, situated very near the shaft, the most promising and most economical plan seems to be the installation of a separate engine and dynamo for supplying current to the winding gear motors. The engine should, if possible, be of the high speed type, arranged to work with constant steam admission and provided with a governor which will come into action only when the speed of the set exceeds a certain safe limit. This engine practically replaces the induction motor in the case of the Ilgner set, the other parts, including the heavy flywheel, compensated generator and exciter, remaining the same. In the case of very large winding gears, excessively large generators and flywheels could be avoided by duplicating those parts and in the same way two motors could be used for driving the winding drum. The generators would have to be adjusted so that their characteristics were similar, and it would appear advisable to connect their fields in series, so that one rheostat could be used for the simultaneous control of both. Economical as the Ilgner combination is, a considerable saving both in capital cost and working charges can be effected by the adoption of this plan, for the losses in the alternating-current generating plant, and in the induction motor of motor-generator set are both avoided, so that a saving of about 20 per cent. may be fairly anticipated.

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* "Special" includes power used for testing, &c.

† Abstract of a Paper read before the Rugby Engineering Society on February 2nd.

* The steam winding engine just installed at the New Williamthorpe Colliery, in North Derbyshire, is easily capable of dealing with 3,000 tons of coal per day of 8½ hours. The depth of the shaft is 548yds.

An early installation of this character is to be seen at the Arnimsche Steinkohlenwerke at Planitz in Saxony.* There are two equal winding engines, each driven by a pair of direct-current motors directly coupled to the drumshaft and capable of raising a net load of 1,320lb. from a depth of 121 fathoms. The hourly output of each is 36 tons, and the winding gears are mounted directly above the shafts, a plan which for small machines offers considerable advantages, more especially as regards the wear of the ropes, which is less than it would be were the usual head pulleys installed.

Steam engines for winding are usually non-condensing, and on account of the very intermittent and unfavourable conditions of service are most uneconomical. The results of various tests made on the Continent show that the steam consumption per horse-power-hour reckoned on material raised varies from 120lb. to 57lb., the latter being with twin tandem engines running condensing and under special skilled supervision. For large winding engines running under favourable conditions it would not seem out of place to assume a steam consumption of 75lb. per horse-power-hour reckoned on material raised. With a well-designed Ilgner plant the corresponding figure would be 25lb., but against this saving we have to put the extra interest on the increased capital cost, and make a slightly larger allowance for depreciation and repairs, but in any case can expect a nett saving of 80 per cent. of the working charges of the steam plant. With a large plant of the more direct type in which the generator is directly driven by a steam engine, as just described, a steam consumption of 20lb. or 21lb. could be obtained without trouble, unless the working conditions were exceptionally unfavourable, and the capital cost would be considerably below that of the corresponding Ilgner combination, and not much, if any, greater than for an ordinary steam winder of similar capacity.

One of the principal applications for electricity in mines is to the driving of pumps. In all the earlier installations, the pumps were of the slow-speed reciprocating type with plunger speeds ranging from 70ft. to 100ft. per minute, necessitating the use of a double reduction between the motor and the pump. The efficiency of such a pump is generally from 70 to 75 per cent, so that a combined efficiency of 60 to 68 per cent., according to the capacity, may be reasonably expected. At the present time, it is possible to obtain reciprocating pumps of the Express, or high-speed type, having very much higher efficiencies and running at such speeds that reduction gearing may be dispensed with, and the motor mounted directly on the crankshaft. The speeds of such pumps range from 160 to 300 revs. per min., and their efficiencies may be from 75 to 85 per cent., according to size. Within the last three or four years the use of high-lift turbine pumps has increased considerably. These pumps have several advantages which recommend them for mining work; they run at high speeds, and consequently both pump and motor can be made very compact; they have a continuous flow, and therefore no air vessels are required, and water hammering in the pipes is quite avoided; the cost of excavating rooms and making foundations for them is very much less than for reciprocating pumps of similar capacity, and, further, the discharge can easily be varied within wide limits by simple regulating valves fitted on the discharge pipes. Their efficiency is, however, smaller than that of the better class of reciprocating pumps, and is much more dependent on the size, and for dealing with very small quantities of water and high lifts reciprocating pumps are preferable; for ordinary sizes, however, it may be taken as 70 to 76 per cent. Such pumps are especially suitable for connection to three-phase induction motors, and the ordinary speed about 1,450 revs. per min. for coupling to 50-cycle four-pole motors.

Gebruder Sulzer, of Winterthur, and Mather & Platt in this country have played a prominent part in the introduction of this class of pump. One of the most notable installations is that at the Zeche Viktor, where there are two pumps on the lower level which deliver 1,500 gallons per minute to a height of 1,700ft. The guaranteed combined efficiency is 58 per cent., but from actual tests the efficiency of the whole plant, including generators, is 63 per cent., and the efficiency of the pumps alone 77 per cent.

In a case of this sort where the pumps are very large, it is advisable to instal a separate generator for driving them, and start them up with the generator, thus dispensing with the use of costly starting devices for the motors. This is more especially necessary when a number of motors are used in series, and fixed on different levels. This remark also applies to large reciprocating pumps, and in either case a separate source of excitation for the generator is required.

For three-phase alternating current the best cable is the ordinary three-cored stranded cable with waterproof dialite or bitumen insulation, heavily braided and armoured overall. It has been found by experience in many mines that the use of lead covering is not advisable. On account of its inability to resist tension, the armouring should not be of steel tape, but of galvanised steel or iron wire. The laying of cables on the solid system along the main roads has very often been advocated, but is inadvisable on account of the possibility of the cable being torn or injured through the road sinking.

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* "Gluckauf," No. 29, 1902.

CORRESPONDENCE.

THE LIFE OF NERNST BURNERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I send you herewith records I have kept of two installations in Gloucester where Nernst lamps are used. The lamps are ¼ ampere B type, on 220 volts continuous current. Corporation supply. The results obtained with the new type U-filament burner, as compared with the old type burner, are very marked.

In both cases the lamps hang perpendicularly and are well out of reach. Taking the installation with the old type burners first. The records date from June 1, 1903, to March 7, 1905. Nine lamps are in use, with 200-volt burners and 30-volt resistances, and all renewals have been made with old-type burners. Four of the lamps have been lighted 1,056 hours, and five lamps for 2,420 hours, during the above period of 88 weeks. This gives a total of 16,324 lamp-hours, and 20 burners have been renewed. $\therefore \frac{16,234}{20} = 816\cdot2$ hours average life of burner. Five resistances have also been renewed within the period.

We now come to the installation (a church) with the new U-type burners. The record dates from the first use of the lamps, October 2nd, 1904, to March 7th, 1905. Thirty lamps are in use, with 210-volt burners and 20-volt resistances. The lamps have been lighted a total of 66 hours during the above period of 22 weeks. This gives a total of 1,980 lamp-hours, and 21 burners have been renewed. $\therefore \frac{1,980}{21} = 94\cdot3$ hours average life of burners. Two resistances have also been renewed. More than half of the burners in this case had the heating coil broken, and in the remainder the filament had shorted on to the heating coil.

The Nernst lamps will have to be discarded in the latter installation if they do not give better results, and high efficiency incandescent lamps will be put in their place. A remedy is badly wanted, or the makers will have reason to deplore their substitution of the U-type burner for the earlier burner, which had proved its serviceable qualities. I would also add that, even if old-type burners could be obtained, they cannot be inserted in the new pattern B lamp, as the casing of the latter is not sufficiently large in diameter to take them.—Yours, &c. W. A. WALTON.

Gloucester, March 15.

Spark Prevention in Dynamos.—The Hon. C. A. Parsons has been granted an American patent, issued on February 14th, which relates to means for reducing the sparking of continuous-current dynamos. This object is to be achieved by winding the armature with a flat conductor of thin cross-section and formed of insulated strands having a lay of one complete turn, or two or more complete turns, in the length of the core of the armature. It is claimed that the spiral lay prevents local currents in the copper conductor.

PARLIAMENTARY INTELLIGENCE.

LONDON ELECTRIC POWER BILLS.

All the bills which have been deposited in Parliament this session seeking powers to supply electrical energy throughout London, came before a Committee of the House of Lords yesterday. The Committee is constituted as follows:—Earl Camperdown (chairman), Earl Lytton, Lord Aberdare, Lord Romilly, and Lord Zouche of Haryngworth.

The bills are:—

Administrative County of London & District Electric Power Co.
Central Electric Supply Co.
Charing Cross & Strand Electricity Supply Corpn.
City of London Electric Lighting Co.
County of London Electric Supply Co.
East London & Lower Thames Electric Power Co.
Metropolitan Electric Supply Co. (Acton.)
Metropolitan Electric Supply Co (Various Powers.)
North Metropolitan Electric Power Supply Co.

The Administrative County of London Bill and the East London and Lower Thames Bill seek the incorporation of new companies, the remaining applications being for extensions of powers by companies already in existence. The total number of petitions against the whole of the bil's runs into three figures, and were given in our issue for February 24.

The proceedings yesterday were to decide the question of future procedure.

The CHAIRMAN said that as the various bills involved a very complicated issue, he would ask the opinions of the various counsel interested as to the method of proceeding with them. The Administrative County of London Co.'s Bill was first on the list, and as Mr. Fitzgerald was leading for this, he would ask for his views first.

Mr. FITZGERALD, K.C., said that after careful consideration he had come to the decision that there was likely to be considerable difficulty in the way of adopting a course of procedure. Briefly, however, there were two ways of dealing with the matter—(1) to treat all the bills as competing measures, and to hear them all before giving any decision; (2) to hear the Administrative County of London Bill, and decide on it at once. The latter course, however, might be unfair to the promoters of the other bills, although naturally he was quite content for the Committee to adopt it. The main issue for the Committee to decide was whether they would grant the whole of the area scheduled in the first bill to the Administrative County of London Co. or whether they would cut it up into small areas as proposed in the remaining bills.

Sir RALPH LITTLER, K.C., for the City Corporation, Mr. FREEMAN, K.C., for a large number of London boroughs, and Mr. VESEY KNOX, for some local authorities outside London, asked that a decision should be given on the main principles of the Administrative County of London Bill as soon as possible.

Mr. BALFOUR BROWNE, K.C., who is appearing for the whole of the bills excepting the Administrative County of London Bill said that the effect of the first proposal of Mr. Fitzgerald would be to give him (Mr. Fitzgerald) the final speech after all the bills had been considered. He would, therefore, suggest that the Administrative County of London Bill should be proceeded with, and that in the meantime the Committee should not make up its mind as to whether it would give a decision when the case for this bill was finished or not. With regard to Mr. Fitzgerald's remarks as to cutting up London, he must point out that it was already cut up, for all the companies which he represented were already in existence.

The CHAIRMAN said the Committee would adopt Mr. Balfour Browne's suggestion as the best course to follow.

The Committee then adjourned until to-day (Friday).

MUNICIPAL COMPETITION WITH ELECTRIC POWER COMPANIES.

Accrington Corporation Bill.

The Police and Sanitary Committee of the House of Commons, of which Mr. J. W. Wilson is now chairman, considered the Accrington Corporation Bill on Tuesday. The opponents to the bill were the Accrington Corporation Steam Tramways Co. and the Lancashire Electric Power Co. Counsel for the promoters were Mr. Wedderburn, K.C., Mr. W. H. Leese and Mr. W. J. Jeeves. After some discussion the Accrington Corporation Steam Tramways Co. withdrew its opposition to the bill in the present stage, and the tramway part of the bill proceeded unopposed. It seeks power to reconstruct for electric traction certain steam lines within the Borough of Accrington, which will be acquired by the Corporation in 1907, and to construct some short lengths of new lines outside the borough. Mr. W. H. Aitken, town clerk, gave evidence as to the growth of the district, and Mr. Stephen Sellon, consulting engineer, said he considered the estimates in the bill were ample for the work. Local evidence was then called in favour of the bill, and the preamble of the tramway portion of the bill was passed.

Mr. WEDDERBURN, K.C., then opened the portion of the bill relating to the supply of electrical energy. The Accrington Corporation, he said, already possessed a generating station, which had cost £40,000, and it was their desire to supply electrical energy to the tramways proposed both inside and outside Accrington, and also to supply the outside districts, served by the tramways, with electrical energy for lighting purposes. These districts would be Clayton-le-Moors, Altham, Huncoat, Oswaldtwistle and Haslingden. The only thing that the Lancashire Electric Power Co., which was authorised in 1900 and which opposed this portion of the bill, had done was to erect one generating station—which, however, was not yet complete—and which was 14 miles away. The main point of the petition of the Lancashire Electric Power Co. was competition, and really the company was asking for a monopoly, and sought to avoid competition.

A MEMBER OF THE COMMITTEE: It is rate-aided competition that they object to.

Mr. WEDDERBURN said this did not affect the company as they were not ratepayers in Accrington. The question he raised was public necessity. The company's station was 14 miles off and the Corporation station 1 mile off, and he thought it was reasonable that the Corporation should compete in these outside districts with the company. So far as the tramways were concerned he took it that the previous decision of the Committee gave the Corporation power to supply these.

Mr. STEPHEN SELLON said that the feeders would have to be laid to the outside districts for the tramways, and, therefore, the Corporation would be in a position to supply cheaply. On the other hand, before the company would supply these districts, the various local authorities would have to enter into an agreement to take a supply for seven years and to pay 20 per cent. on the capital cost incurred by the company. As precedents for these powers, he mentioned the Lanarkshire tramways, the Chatham tramways and the Falkirk tramways: in all these cases there were powers to supply electrical energy for lighting. These were all companies, although Manchester and Huddersfield Corporations also had power to supply lighting along the route of tramways outside the borough boundaries.

Cross-examined by Mr. C. BAGGALLAY, K.C., for the Lancashire Power Co.: The bill did not force the Accrington Corporation to supply in the districts named. They could pick and choose. He admitted that the Power Co. was obliged to supply everybody upon terms specified in the company's act, but the terms were such that many local authorities were unable to accept them. He did not know whether the Accrington electricity works incurred a loss last year. He did not think there was much of a speculative nature in the proposals. The feeders for the tramways would have to be laid anyway, but he admitted that tramway feeders were not used for lighting purposes.

By the CHAIRMAN: Accrington was at present supplying certain customers outside its area without authority.

Mr. W. H. AITKEN, said that the Power Co. could only erect generating stations upon the lands scheduled to their act of 1900, and, therefore, could not come nearer to the area of supply than 14 miles.

Mr. BAGGALLAY said the Company's Act of 1904 gave it power to erect generating stations anywhere.

Mr. AITKEN, in answer to the Committee, said that the Corporation would be willing to be compelled to supply these outside districts on the same terms as those contained in the Lancashire Power Co.'s Act of 1900.

Mr. T. HIGHAM, chairman of the Electricity committee, said that the Lancashire Power Co. had quoted Haslingden a price of 1½d. down to ¾d. per unit. But this was for "bulk" supply, and there would have to be added the cost of distribution, which would probably bring the price up to the 3·31d., which was the average charge per unit in Accrington.

This concluded the case for this part of the bill.

Mr. BAGGALLAY, for the Power Co., said that they were not authorised to supply customers with electrical energy in detail, but only in bulk. He had never claimed a monopoly, but he maintained that Parliament had never intended that unequal competition should take place with the company. Such a competition would be introduced were this bill to be passed. Already the Police and Sanitary Committee had refused these powers, except where there were very special circumstances. There were two objections to allowing such powers—first, that continually to allow local authorities to supply electrical energy outside their districts would make the carrying on of power companies an impossibility, and secondly, there was the general objection to municipal trading beyond certain limits. In Accrington last year the cost price was over 4d. per unit, and the average selling price 3·31d. So long as Corporations were allowed to pick and choose the districts in the area of an electric power company, it would be difficult for power companies to raise their capital, because it would never be known from year to year what portions were to be cut away from their areas.

Mr. JEEVES, for the Corporation, said he was prepared to have the names of the places to which they wished to supply inserted in the bill. The Corporation did not wish to supply everywhere around Accrington.

The CHAIRMAN said the Committee was not disposed to give the Accrington Corporation power to supply lighting as well as tramways in Haslingden, but allowed the remaining districts, with the proviso that the Lancashire Power Co. was not to be compelled to obtain the consent of the Accrington Corporation, as the distributing authority, in these new districts in order to supply therein. The prices in the outside districts must be the same as in Accrington.

Clauses to give effect to this decision were brought up on Wednesday.

The clauses were afterwards considered seriatim.

With regard to the loans, Mr. WEDDERBURN asked the Committee to grant a loan of £86,000 for the reconstruction of tramways, repayable in 30 years, and a loan of £35,555, repayable in 25 years, for the electrical equipment.

The CHAIRMAN said it was the intention of the Police and Sanitary Committee to go very carefully into the question of municipal loans this session. Anyone cognisant with electrical machinery know that 20 years was too long a period for such machinery.

After consulting in private,

The CHAIRMAN announced that in view of the fact that some money had already been spent upon a car depot they would grant 30 years in which to repay the loan for reconstruction of the tramways. With regard to the loan for electrical equipment, this was more or less of a perishable nature and in some cases the period had been fixed as low as 15 years. In this case the Committee specified that 20 years was the utmost they could allow for it. The loan for £7,000 for electrical fittings would be repaid in 10 years.

TELEGRAPH (CONSTRUCTION) BILL.

In the House of Commons on Thursday last week the Postmaster-General introduced a bill to amend the Telegraph Acts, 1863 to 1904, with respect to the construction and maintenance of telegraphic lines. It is as follows :—

1. If the owner, lessee or occupier of any hedge or bank which forms the boundary of any street or public road along which the Postmaster-General is constructing or maintaining a telegraphic line, or of any land (being within 20ft. of any such street or road and not being common land) which is not enclosed on the side of the street or road, refuses or fails to give his consent to the construction of the line on, over, along or across the hedge, bank or land within *twenty-one* days after being required to do so by notice from the Postmaster-General, a difference shall be deemed to have arisen between the Postmaster-General and that owner, lessee or occupier, and secs. 3, 4 and 5 of the Telegraph Act, 1878, shall apply accordingly as if it were a difference arising under that act.

2. Those provisions of sec. 21 of the Telegraph Act, 1863, which (as amended by sec. 3 of the Telegraph Act, 1892) are not of general application, shall be of general application, and extend to rural districts and to public roads as well as to streets ; but in the case of a street or public road in a rural district the publication of notice required under sec. 23 of the Telegraph Act, 1863, shall be substituted for the publication of notice under sec. 21 of that act.

3. Where any tree overhangs any street or public road so as to obstruct or interfere with the working of any telegraphic line constructed along that street or road, the Postmaster-General may give notice to the owner of the tree or to the occupier of the land on which the tree is growing, requiring him to lop the tree so as to prevent the obstruction or interference, and in default of compliance the Postmaster-General may himself caused the tree to be lopped for that purpose, and sec. 7 of the Telegraph Act, 1863 (which relates to compensation), shall apply to the exercise of that power by the Postmaster-General.

4. (1) In this Act any expressions to which a special meaning is attached under the Telegraph Acts, 1863 to 1904, or any of them, shall have the same respective meanings in this Act ; and the expression "hedge" or "bank" includes any ditch adjoining to the hedge or bank as if it was part of the hedge or bank.

(2) Sec. 12 of the Telegraph Act, 1878 (which relates to the printing, authentication and service of notices and other documents), shall apply for the purposes of this Act as it applies for the purposes of that act.

(3) This act may be cited as the Telegraph (Construction) Act, 1905, and may be cited with the Telegraph Acts, 1863 to 1904.

OTHER ELECTRICAL BILLS.

The *Chelsea Electricity Supply Bill*, the *South Wales Electrical Power Bill* and the *Ulster and Connaught Tramways Bill* were read a second time in the House of Commons on Monday.

The *Hastings Tramways Bill* and the *Wellingborough and District Tramroads and Electricity Supply Bill* were read a second time in the House of Lords on Monday.

Before the Court of Referees on Monday, Mr. Moon, K.C., for the Bradford Corporation Tramways committee, applied for a locus to appear against the *North-Eastern Railway Bill* in respect of clause 38, which gave the railway company power to run motor omnibuses to or from any place served by the company's railways. The locus was contested by the company, but in view of the ambiguity of the wording, the chairman allowed the locus.

The Gordon Hotels on Tuesday applied to the Court of Referees for a *locus* to appear against the *Baker Street and Waterloo Railway Bill*, on the ground that a subway proposed to be constructed would affect their property injuriously. The subway was 85ft. away from the petitioners' buildings, and a locus had been granted to them in respect of a previous bill of the railway company concerning works 175ft. away. The locus was disallowed.

The London County Council applied to the Court of Referees on Tuesday for a locus to appear against the *Edgware & Hampstead Railway Bill*. Mr. Pollock, K.C. for the London County Council, said he only desired to be heard in respect of clause 14 of the bill, which empowered the railway company to "enter into and carry into effect agreements for the construction, working, use or management of the railways and works" with the Edgware & Watford Railway Co., the Charing Cross, Euston, & Hampstead Railway Co., and the Underground Electric Railways Co. of London. The County Council believed that it was the intention of the promoters to alter the effect of the Charing Cross, Euston & Hampstead Co.'s Act of 1903. If this were done it would be possible to hand all the undertakings over to the Underground Company, which was a limited company and not subject to any control by Parliament. Mr. Balfour Browne, K.C., for the railway company, contended that he already possessed the power which the London County Council seemed to think he desired to obtain now, but all the liabilities of the subsidiary companies would have to be taken over by the Underground Company. The locus was allowed.

In connection with the recent municipal opposition to the application by several of the railway companies to run motor omnibuses, Mr. Whitley has given notice in the House of Commons that he will move, on the second reading of the *Midland Railway Co.'s Bill*, that clause 38 (giving this power) be omitted or that it be limited to carrying passengers, &c., to and from the company's railway stations.

PURCHASE OF THE NATIONAL TELEPHONE CO.

In the House of Commons on Monday,

Sir CHARLES DILKE asked the Postmaster-General, whether, in view of the fact that the wording of the purchase agreement between the Government and the National Telephone Co. in relation to the staff of the company was causing uncertainty amongst the employés and might check the entrance of qualified candidates during the next seven years, thus affecting the efficiency of a future Government service, he could give any definite assurance that the members of the staff would be taken into the Government service upon the transfer in 1911 provided by the agreement.

Lord STANLEY, in a printed reply, said that when, as provided by the agreement, the National Telephone Co.'s system was purchased in 1911 it would be necessary for the Post Office to provide a staff to carry on the service. It seemed probable, therefore, that employment would be offered to qualified members of the National Telephone Co.'s staff whose services were necessary for that purpose. The reasonable probability of employment in the Post Office service with its many advantages would he felt sure be sufficient to attract qualified candidates during the next seven years ; and he was convinced that any definite assurance or undertaking given now as to the transfer of staff or the conditions of service under the Post Office would be found very embarrassing by his successor in 1911.

METROPOLITAN DISTRICT RAILWAY.

In the House of Commons, on Thursday last week,

Mr. ATHERLEY-JONES asked the President of the Board of Trade whether, under the proposed electrical equipment on the District Railway, there would only be one motorman to each train, and whether, having regard to the safety of the public, he would take steps to secure that there be two motormen to each train.

Mr. GERALD BALFOUR, in a printed reply, said he was informed by the railway company that every electrical train, whether of seven, four or three cars, on the District Railway would, in addition to the motorman, have one or more men upon it who would be thoroughly instructed in the control of the motors. It might be added that the effect of the withdrawal of the motorman's hand from the lever would simply be to cut off the current and stop the train. As a further precaution, if a train passed a signal set at danger it would instantly be stopped through the automatic application of the brakes. He saw no reason to take any action in the matter.

THE GREAT WESTERN RAILWAY CO. AND THE CENTRAL LONDON RAILWAY CO.

Rumours have been current to the effect that the Great Western Railway Co. has acquired an interest in the Central London Railway, in connection with the new line which it is seeking powers this session to make between Ealing and Uxbridge-road station. These were definitely contradicted on Monday by Mr. Moon, K.C., who was appearing for the Great Western Railway Co. before the Court of Referees in opposition to an application for a locus to appear against the Great Western Railway Co.'s Bill by several other railway companies. The Metropolitan District Railway Co., the Great Northern, Piccadilly & Brompton Railway Co., and the London United Tramways Co. each applied for a discretionary locus on the ground of competition, and Mr. Balfour Browne, K.C., for the first-named repeated the statement above referred to, which Mr. Moon at once contradicted. The Court allowed a locus in each case.

THE NORTH-EASTERN RAILWAY.

In the House of Commons on Tuesday, in reply to Mr. Weir,

Mr. BONAR LAW said that the Board of Trade was not prepared to say that the North-Eastern Railway Co. had been guilty of any irregularity in electrifying a certain portion of its lines without special statutory authority. There was no necessity, therefore, to call the attention of railway companies generally to this matter. There were 32 miles of the North-Eastern Co.'s undertaking worked by electricity. Up to the present time 28 accidents had occurred, of which four were fatal. The railway company had carried out the recommendations of the inspecting officers of the Board of Trade in so far as they had been made at present.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Steam Turbines ; with an Appendix on Gas Turbines and the Future of Heat Engines." By Dr. A. Stodola. Translated by Dr. L. C. Loewenstein. (London : Archibald Constable & Co.) 21s.

"Science and Hypothesis." By H. Poincaré. With a Preface by Prof. J. Larmor, F.R.S. (London : Walter Scott Publishing Co.). 3s. 6d.

"Haustelegraphie und Privat-Fernsprechanlagen." By J. Noebels. (Leipzig : S. Hirzel.) 5m.

"Gross-Gasmaschinen." By Dr. A. Riedler. (Berlin : R. Oldenbourg.) 10m.

"Proceedings of the Royal Society of Edinburgh." No. VI. Vol. XXV., pp. 401-464. (London : Williams & Norgate.) 3s. 6d.

"British Standard Specification for Structural Steel for Marine Boilers ; Report by the Engineering Standards Committee." (London : Crosby Lockwood & Son.) 2s. 6d.

"Journal of the Institution of Electrical Engineers." February, 1905. Vol. XXXIV. Part I. (London : E. & F. N. Spon.) 5s.

"Gleichstromerzeuger und-Motoren Ihre Wirkungsweise Berechnung und Konstruktion." By W. Winkelmann. (Hanover : Gebrüder Janecke.) 3.40m.

LEGAL INTELLIGENCE.

Automatic Telephone Co. v. Margowski.

This case was heard in the High Court last week before Mr. Justice Walton and a common jury.

Mr. RAWLINSON, K.C., for the liquidator of the company, said the question in dispute was as to whom certain electrical machinery and plant at the company's Greenwich works belonged. The machinery, &c., had been sold for £460 and £86, and these were the sums in question. The goods were claimed by Mrs. Margowski, wife of Mr. Max Margowski, managing director of the company, under a mortgage deed on account of money said to have been advanced. The case for the company was that Mrs. Margowski's claim was an impudent and barefaced fraud, and the mortgage a fraudulent document. There was now no doubt the machinery in question was bought with the company's money.

After plaintiff's evidence had been submitted,

Dr. COUNSEL, for the defence, urged that there was no evidence to go to the jury either as to the ownership of the plant, or in support of the charge of fraud, at any rate against Mrs. Margowski.

Mr. MAX MARGOWSKI having tendered evidence,

The jury found in favour of the liquidator for the proceeds of the sales under the mortgage, and His LORDSHIP entered judgment for plaintiff for £547. 4s. 7d. with costs. He further ordered all documents in the case to be impounded.

On Tuesday defendant applied for a stay of execution in order to allow of an appeal. His LORDSHIP granted a stay of 10 days, and if within 10 days the appeal was set down £100 to be paid as security for costs on the usual undertaking by plaintiff's solicitors.

Ogden and Another v. Gas Light & Coke Co.

The hearing of this action commenced on Wednesday, before Mr. Justice Darling and a special jury, and was brought by Miss Ogden and Mr. A. P. Smith to recover damages from defendants for personal injuries alleged to be due to their negligence, which defendants denied.

The case was that on the afternoon of Oct. 15, 1903, an explosion took place in several of the telephone conduits and boxes in Regent-street, London, with the result that both plaintiffs were seriously injured. For some time before the accident there had been an escape of gas, the attention of the company having been called to it on July 30, 1903. A search was made, but plaintiffs alleged that no proper steps were taken to stop the leak, or the accident could not have happened.

A jointer named EDWARDS, in the employ of the Post Office, said he was working at the box that first exploded, and he had to use a blow-pipe lamp. The box had been opened every day for some time before the accident.

Mr. G. E. WEST, sub-engineer to the Post Office, said the boxes were fairly well ventilated, the lids being put on as a protection to the public.

Mr. WILLIAM NOBLE, assistant superintendent engineer to the Post Office, said periodical examinations had been made of the boxes in the neighbourhood of the explosion since the accident, and traces of gas were discovered, showing there was a leak.

Mr. DANCKWERTS, K.C., for defendants, submitted that there was no case, and that even if defendants had been guilty of some negligence, it had not been the effective cause of the accident.

His LORDSHIP ruled that there was a case to go to the jury, and

Mr. DANCKWERTS then argued that it was the act of the Post Office servants that had produced the catastrophe.

Evidence having been given on behalf of defendants,

The jury returned a verdict for both plaintiffs, and judgment was entered for them for an agreed amount, with costs.

Underground Telegraph Cables.

At the Sheriff Court, Hamilton, last week, Sheriff Thomson sat to hear particulars of a difference which had arisen between the Postmaster-General and the District committee of the Middle Ward of Lanarkshire in connection with laying the underground telegraph cable from London to Glasgow in the highway at Bothwell. Recently the Middle Ward committee endeavoured to get an interdict against the Lord Advocate and the Postmaster-General, the question between the parties being as to the position in which the telegraph cable pipes should be laid, while the actual point to be now decided was whether or not a difference had arisen which should be decided by the Sheriff or settled by an action in court.

The Sheriff advised arbitration, and it was subsequently announced that the dispute had been settled. The settlement consists of an arrangement between the parties that certain of the pipes in the roadway shall be shifted, and that the new pipes shall be laid in a position to give the water pipes a sufficient clearance. This work is to be done by the District committee's officials at the expense of the Post Office. The remaining pipes to be laid by the Post Office authorities are to be in such a position as may be agreed upon with the water superintendent, or, in the event of any difference with him, with the committee,

Re Brooker & Goss (Ltd).

This was a debenture-holder's action (Puxon v. The Company) heard before Mr. Justice Farwell on Friday on a motion to appoint a receiver and manager. It was said that the property was in jeopardy. The company was a small one and carried on business as electrical engineers at Enfield Wash with offices in London. Debentures for £900 had been issued. Plaintiff held one debenture for £300. No interest had been paid since last October, and the company was (said Mr. Wilkinson for plaintiff) hopelessly insolvent. There was goodwill and also plant, stock in trade and other effects which would probably be sufficient to pay the debentures.

The company opposed the motion, as did the other debenture holders.

His LORDSHIP ordered the motion to stand over for a week as two-thirds of the debenture holders were against it.

Airdrie Town Council v. Airdrie & Coatbridge Tramways Co

In the Small Debt Court, Airdrie, last week, Sheriff Mackenzie heard an action by Airdrie Town Council for the recovery of £8. 0s. 7d., being cost of clearing away accumulations of snow on the street caused by defenders using a snow-plough when running their cars on Dec. 11. Defenders, who counter-claimed £10 damages owing to the Council's failure to clear away the snow themselves, as provided by sec. 112 of the Burgh Police Act, pleaded irrelevancy of the action.

The Sheriff deferred judgment.

Tramway Award.

Col. Sir Colin Scott Moncrieff, the referee appointed by the Board of Trade to determine the value of the lines, buildings, works, materials and plant of the City of Birmingham Tramways within the Handsworth district, which the Council is desirous of purchasing, has issued his award and adjudges that if, in the opinion of the High Court (to which this point is referred), the Council is required by the Tramways Act to pay for 12 engines and 11 carriages, his award is £14,776, if only required to pay for five engines and five carriages £11,705, and if not required to pay for any of the engines and carriages £9,406, the Council to pay the company's costs of and incident to the reference. The Council do not want to purchase more than five engines and five carrriages.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Bermondsey (London) Council invite applications for the position of electrical engineer at a salary of £425, rising by annual increments of £25 to £525 per annum, without pension. Applications to the town clerk (Mr. Fredk. Ryall), Town Hall, Bermondsey, S.E., by noon 22nd inst.

A junior assistant for physics is required at Merchant Venturers' Technical College, Bristol. Salary £130 to £160. Particulars obtainable from registrar until March 28. See advertisement.

London County Council require two divisional inspectors (at £600 per annum, rising by annual increments of £25 to £800), one possessing special qualifications in mathematics and science and the second in technology, including electrical and mechanical engineering; also an inspector in wood and metal work at £400, rising to £500. Applications by 10 a.m. April 1.

A lecturer in civil and mechanical engineering is required at the University of Leeds. Salary £800 per annum. Applications by March 25.

A lecturer in civil engineering is required at Leeds University, £300 per annum, with liberty to take up outside consulting work. Applications by March 25.

A working electrician is wanted for a country house installation. Applications to Mr. Peter May, Estate Office, Bawdsey, Suffolk.

Darlington Corporation require a junior shift engineer. Applications by 25th inst.

Mr. W. B. Worthington, engineer-in-chief of the Lancashire & Yorkshire Railway, has been appointed engineer-in-chief of the Midland Railway in succession to the late Mr. J. A. McDonald.

Mr. Archibald Page, superintendent of the generating stations and sub-stations of Glasgow electricity department, has been appointed chief assistant engineer, in succession to Mr. Lackie, at a salary of £500 per annum.

Mr. R. B. Mitchell, who has been in the service of Glasgow Corporation electricity department for seven years, and is at present resident engineer at Port Dundas station, has been appointed superintendent of mains at £250 per annum.

Mr. John Mitton, A.M.I.E.E., hitherto mains superintendent at Southend-on-Sea, has been promoted to the position of chief assistant. Mr. E. Scott Rivett, shift engineer, has been promoted mains superintendent; Mr. W. L. Vitty (West Bromwich) and Mr. R. Jones, shift engineers, and Mr. R. Ernest Dawson switchboard attendant at Southend.

Mr. John Lambert, burgh electrical engineer at Perth, has been appointed also manager of the tramways, and his salary is to be increased from £275 to £350 per annum.

Mr. Wm. Dundas (of Callender's Cable and Construction Co.) has been appointed mains superintendent at Carlisle Corporation electricity works.

Mr. T. Medcalf has been appointed traffic manager of Swindon tramways.

Mr. J. Hawes, of London, has been appointed assistant electrical engineer at Whitby.

Mr. John Wilson, manager of Leith horse tramways, has been appointed manager of the Corporation electric tramways at present in course of construction.

Technological Scholarships.—The West Riding of Yorkshire County Council offer four technological scholarships, each of the value of £60, open to residents within the administrative area of the West Riding and available for courses of instruction in connection with engineering (mechanical or electrical), metallurgy, textiles, dyeing or other approved industries. Application forms and full particulars from the Education Department (Technical Branch), County Hall, Wakefield. See also an advertisement.

Argentina.—The "Review of the River Plate" says:—

It is stated that the Compañia Alemana de Electricidad intend to introduce 500 electric cabs into Buenos Ayres.

Tucuman (city) has been without a tramway service for 12 months, and a good opportunity is offered for an electric traction scheme.

The contract for the acquisition of the Government electricity works at La Plata by the River Plate Electricity Co. has been signed. The company will pay the Government $89,000 m.n. The company will erect a new station, for which they have already ordered plant.

Electricity works for public and private lighting are to be erected at Esperanza (Santa Fé).

Señor José Olmi has been appointed inspector-general of Argentine Government telegraphs in succession to Señor P. Lopez.

Asylum Lighting.—The inauguration of the electric light installation at the Enniscorthy (Ireland) District Lunatic Asylum took place on 7th inst. Current is generated at Mills, about 1½ miles from the town, by a 60kw. turbine-driven dynamo. Bare overhead copper mains are employed for the transmission of current. There is also a battery of accumulators. Electric motors are used for driving the laundry machinery and for pumping, &c. British Insulated & Helsby cables are used and British Westinghouse motors Porte & Co., of Dublin, carried out the wiring work.

Automobile Exhibition.—The annual exhibition promoted by Messrs. Cordingley & Co., proprietors of the "Motor Car Journal," will be opened at the Agricultural Hall, London, to-morrow (Saturday), and will remain open up to and including Saturday, March 25.

Barking.—An inquiry was held here last week into the application of the Council for permission to borrow £8,500 for electric lighting extensions.

The clerk (Mr. H. Hargreaves) said the loan was required for a new boiler and pumps, a steam generator, switch gearing, travelling crane, &c. The borrowing powers were £46,702, and the present application had become necessary owing to the large increase in the number of applications for electricity, for both lighting and power. They would require electric energy for traction when the light railway was complete.

The engineer (Mr. Seabrook) gave technical details.

Bradford.—On Tuesday a discussion took place at the Council on the question of the appointment of an electrical expert to report upon the scheme recently prepared by the city electrical engineer (Mr. Alfred Blackman) for the extension of the electricity undertaking, and for the adoption of the three-phase system. It was suggested that Mr. H. R. Burstall (Messrs. Burstall & Monkhouse) should be called in, but ultimately an amendment that the services of an expert be dispensed with was adopted.

Canadian Telephones.—The Postmaster-General of the Dominion (Sir W. Mulock) has given notice to move for the appointment of a committee to enquire into the organisation of a national telephone system for Canada.

Customs Changes.—On July 1 next a revised customs tariff will come into operation in Italy. Under this revision electric wires and cables, composed of one or more metallic conductors covered with textile materials and varnished, or with gutta-percha or india-rubber, will be subject to a reduced duty of 50 lire per 100 kilogs. compared with the present duty of 60 lire. The rate of duty upon electric clocks and watches will also undergo a slight change. The duty on dynamos, electric transformers and detached electrical machinery will remain as at present, 25 lire per 100 kilogs.

Dalkeith.—The electric lighting of the main streets was inaugurated on Saturday last.

Dartford.—The Council have made arrangements for raising a loan of £93,000 at 4½ per cent. for the construction of electric tramways. The contract has been let to J. G. White & Co., who will take a lease of the lines when completed, the Council retaining the option of determining the lease at 5, 10 or 15 years. Under the lease the Council receive a payment equivalent to the interest and annual sinking fund, plus 20 per cent. of surplus profits.

Dover.—Sanction to the borrowing of £21,000 for the construction of the River tramway extension and purchase of cars for same has been obtained by the Corporation.

Dublin.—The Council last week approved the recommendation of the Lighting committee that current be supplied to churches at 4½d. and to rectories and libraries at 4d. per unit.

East Ham.—Sanction has been received for the borrowing of £3,125 for five additional electric tramcars.

Eccles.—An inquiry was held here on Wednesday into the application of the Council for power to borrow £500 for purchase of electric motors to be let on hire.

Electrical Contractors' Association.—The second annual conference of the Scottish section of this association is taking place this week at Glasgow.

The chairman of the section (Mr. Thomas Wright) presided at the dinner on Tuesday, and the company included the president of the association (Mr. W. R. Rawlings), the chairman of the London section (Mr. E. L. Berry), the chief engineer of the Corporation electricity works (Mr W. W. Lackie), and Mr. E. G. Tidd. The latter proposed the toast of the association, and in reply the chairman referred to the question of municipal trading, pointed out how it affected the contractors' interests, and the necessity of opposing all bills of municipal authorities which conferred trading powers likely to have an adverse effect upon their interests. At the same time he urged the need of thoroughly honest work, which alone would defeat the demands of the municipalities and inspire confidence in the community.

On the following day the members visited the R.M.S. "Virginian," the art galleries, the Pinkston power station, and the City Chambers, where they were received by the Lord Provost (Sir John Ure Primrose). Councillor Willock introduced the members, and the Lord Provost said he had great pleasure in welcoming the deputation to the city. It was a feature of present-day commercial life that all bands of workers recognised that in union there was strength. The result was that they were able to produce better work. Some years ago, with the growing increase of production of electrical energy, the Corporation proposed to hire motors. He understood that at that time the contractors very properly thought there might be a line drawn in municipal enterprise in that direction, and as a result of a conference the Corporation dropped the proposal. In his opinion individual enterprise should have its full swing, and they should not let the great Goliath of the Corporation enter into competition with every sphere of business life. The outcome of that conference had been that over 100 motors had been supplied by various firms on the hire system, and the quality of the work had been brought to a very high standard. The Corporation were legitimately the producers of energy and the distributors of that energy; but from that important point the matter should be left to individual enterprise. He was heart and soul for individualism.

Electricity in Potteries.—Longton Council are supplying electric current to the British Anchor Pottery Co. for oven-heating purposes.

Electricity in Shipyards.—At the meeting on Monday of Wm. Beardmore & Co. (Ltd.), Mr. Albert Vickers said that the company's new shipyard at Dalmuir was now practically completed and ready for building a large fleet of battleships and cruisers. The yard had been equipped with the very latest type of electric generating plant, entirely driven by large Oechselhäuser gas engines, of which the company had the right of manufacture. Duff ammonia recovery plant was utilised in conjunction with the installation, admitting of great economy in fuel. The new dock, perhaps the largest in the world, was now ready for receiving vessels from the smallest merchant ship to the heaviest modern first-class battleship.

Exeter.—April 8 has been provisionally fixed for the inauguration of the Corporation electric tramway service. The Board of Trade inspection was carried out by Major Pringle and Mr. A. P. Trotter on Wednesday.

"Fair Trade" Conditions.—At a meeting of Leicester Guardians last week, the clerk read correspondence relating to the dispute between Messrs. Gent & Co., electricians, Leicester, and the Leicester and District Operative Building Trades Federation, as regards the wages paid by the firm, which the Federation had alleged were not in accordance with the "fair trade conditions" resolutions of the board.

Messrs. Webb & Son, contractors, wrote stating that, in consequence of the difficulty, they had had to withdraw their workmen, and they were being put to extra expense, work being at a standstill.

Mr. H. Parsons, managing director of Gent & Co., pointed out that Mr. W. Moore, at the meeting of the Guardians on Feb. 7, made a statement that his firm were not paying the local standard rate of wages. That statement was privileged, and as Gent & Co. had no locus standi there, it was impossible for them either to admit or refute it. They had already made and again reiterated the statement that they as a firm did comply with the fair wage clause of the Leicester Guardians, and if the Leicester and District Operative Building Trades Federation, who had interested themselves in the matter, would make a definite statement in writing to the board on that one point, they would at once take such steps that they would have to prove their statement or withdraw it. They had already had two interviews with Mr. Smith and his colleagues, and had plainly asked them to point out where they transgressed the fair wage clause, but could get no definite statement on the point. They challenged the federation to make a definite statement, and in default they asked that the board should allow the contractors to proceed with the installation of their instruments in accordance with the resolution of the committee.

A communication from Mr. Smith, secretary of the Leicester Operative Building Trades Federation, was read, in which he stated that the difficulty from the commencement had been that Gent & Co. in their system of wage payment had not in the least fallen in with a recognised standard, and had only treated with, and paid accordingly, their employés from the individual standpoint, they themselves, as employers, determining what that should be. They had refused to have anything to do with their idea that a recognised wage (instead of individual bargaining) should come into operation. The spirit of the fair wage clause required the recognition on the part of contractors and sub-contractors of a standard wage and conditions which were consistent and equal to those of other firms. He (Mr. Smith) alleged that since December, 1903, and up to the present time, members of the Electrical Trades Union had not been able to accept employment under Gent & Co. He quoted certain wages alleged to have been paid by the firm which were below the standard, and contended that the onus was placed upon firms tendering for public work of themselves proving that they were in every way observing the conditions laid down.

Mr. Kemp (a guardian) pointed out that the board were put in a difficult position. The work was at a standstill, and additional expense was being incurred. One of the directors of Gent & Co. had told him, he believed in all good faith, that they were paying more than the rate of wages of other firms in the district who were doing similar work. The difficulty seemed to be, from what he was able to gather, that there was no standard rate of wages for the work in question. He did not see what could be done unless the order for telephones was placed with some other firm, and the difficulty was left to be fought out between Gent & Co. and the federation, for the former, he supposed, would then be able to claim damages from the federation for the loss of the order. What was certain was that the present state of things could not go on much longer.

Mr. Moore moved that the committee substitute in the place of the instruments ordered from Gent & Co. those of the General Electric Co. (Ltd.), and this was carried, after a motion by Mr. Kemp, seconded by Mr. Chamberlain, that the Board had decided not to purchase Gent & Co.'s telephones in consequence of representations made by the Building Trades Federation.

Formosa.—The moment the important island of Formosa came into the possession of the Japanese engineering work of all kinds was put in hand. Early in 1904 the Formosan Government authorities commenced work on the construction of an extensive electric transmission plant on the upper Shinten River, 10 miles south east of Taihoku, where water power of considerable extent is available. The capacity of the station will be about 1,000 H.P., of which 650 H.P. is sufficient for present requirements. The equipment of the station will include two 884 H.P. McCormick turbines working at 450 revs. per min., two three-phase 250kw. Westinghouse generators and a 49 H.P. McCormick exciter turbine working at 950 revs. per min. It is anticipated that the plant will be working about July next and will cost about £36,000. It is intended to supply current for lighting the cities of Taihoku and Daitotei (Tamsui) and to supply power for ice plants, saw mills and other works in the first-named city.

It is announced that inquiries have recently been made to the Consuls at Tamsui (Formosa) for catalogues of boring machinery for sinking petroleum and artesian wells, and for batteries for telephone and telegraph working.

Fulham (London).—The Council have decided to substitute arc for incandescent lighting at the public baths.

Glasgow-Paisley Tramways.—Glasgow Corporation Tramways department will commence a through service of cars between Glasgow and Paisley on Monday.

Government Purchase of the Telephone.—A conference called by the National Association of Telephone Operators was held on Wednesday "to consider the terms of agreement of the Government purchase as it affects the staff of the National Telephone Co., with the object of safeguarding their interests by formulating proposals and of bringing them forward at an early date in the House of Commons." Mr. J. P. Nannetti, M.P., presided.

Miss Williams (National Telephone Co.) moved a resolution expressing regret at the unsatisfactory nature of the purchase agreement between the Postmaster-General and the National Co. in the clauses relating to the position of the staff, and urged both parties to secure to the staff continuity of engagement and superannuation based upon the whole period of service, so that at the transfer in 1911 the operating staff of the company should receive the same salaries and same conditions of employment as the Government telephone staff at that date; that seniority qualification for promotion or other purposes should be based upon the whole period of service; that the company institute a medical test identical with the Government service test for new candidates; and that they should not undergo a special medical examination before transference to the Government service.

Mr. H. J. Tennant, M.P., supported the resolution, which was carried unanimously.

Hackney (London).—In reply to the inquiry of the Highways committee of London County Council whether the Borough Council would permit the use of the overhead system on the Lea Bridge-road tramways, it has been again resolved not to allow the use of this system in the borough.

Hove.—The Town Council have decided to appoint a resident electrical engineer in connection with the electric lighting of Aldrington, to be under the general superintendence of the borough surveyor.

Huddersfield.—The Board of Trade have notified that they see no objection to the tramway at Outlane being extended to Gosport Mills for coal haulage "pending the next application of the Corporation to Parliament."

Islington (London).—Mains extensions to cost £275 have been approved.

Japan.—It is announced that the Japanese taxes on steam and electric plant are to be abolished at an early date.

King's Lynn.—The borough electrical engineer (Mr. J. Pilling) has reported to the Council that 82 Nernst lamps are now used for public lighting, each giving about 66 c.p. (against 32 c.p. by the displaced incandescents). The Nernsts are said to consume about 15 per cent. less current.

Mr. Pilling estimates that if all the public incandescents are replaced by Nernsts the extra cost will be £190 per annum for renewals and £30 for extra attendance, the conversion costing 10s. to 12s. per lamp (about £250). On the other hand, the saving in current will be equal to £158 per annum.

On Mr. Pilling's recommendation current is to be supplied for heating and cooking at 1½d. per unit, plus 1s. per quarter meter rent.

Leicester.—The accounts of the electricity department for the past year show that £27,581 has been repaid out of £240,455 capital borrowed. The income for the year was £16,850, and working expenses £6,210. After payment of interest and sinking fund charges there is a net profit of £8,947, an increase of £1,000 over the previous year. The accounts were approved at Tuesday's meeting of the Council, and the purchase of an additional engine and dynamo was authorised.

Lewisham (London).—On Wednesday the Council decided to apply to the South Metropolitan Electric Light & Power Co. for payment of £1,019. 19s. 4d. for reinstating roads and footpaths, owing to cable laying, &c., during the past year.

Light Railways.—An inquiry was opened on Tuesday into the application for an order to authorise the construction of a light railway between Knutsford and Warrington. The engineer (Mr. R. H. Scotter) gave particulars, but after hearing some evidence, the application was withdrawn.

An inquiry was held at Tarporley (Cheshire) on Wednesday into an application for an order to authorise the construction of a light railway from Tarporley to the Cheshire Lines at Mouldersworth. The total length of the line will be over 7 miles and the estimated cost £46,000.

The Llandudno & Colwyn Bay Light Railway Co. are applying for an extension of six months to construct the line.

Lighting of Royal Palaces.—The estimates of the Commissioners of H.M. Works and Public Buildings for the ensuing year include £2,000 on account for electric light at Hampton Court Palace and £1,330 for an extension of the electric lighting at St. James's Palace.

Liverpool.—A discussion took place at the City Council meeting last week upon the question of the charges to be made for electrical energy.

The chairman of the Electric Power and Lighting committee (Mr. R. Dart) moved the adoption of the report of the consulting engineer (Mr. A. Bromley Holmes) abstracted in our issue of March 3.

Mr. Byrne pointed out that while there was a reduction in the cost per unit for traction nothing could be done for the ordinary consumer. He moved that the report be referred back.

Mr. W. Ellis Jones did not consider it right that consumers of electricity for lighting should have no relief, while power consumers were benefited by a reduction in charge.

Mr. H. Miles urged that the time had arrived when every consumer of electrical energy for lighting should not pay more than 3½d. per unit, and urged that large consumers should have no advantage over small consumers.

Sir Charles Petrie pointed out that it was the capital charges which made the price of electricity for lighting so high. Necessarily the charges for lighting must be higher than those for power.

The committee's recommendation was adopted.

London County Council.—At Tuesday's meeting the following members were elected the Highways committee for the ensuing year:—Sir R. M. Beachcroft, Sir H. W. Bliss, Capt. F. Hemphill, Messrs. J. A. Baker, J. W. Benn, E. Browne, J. W. Cleland, N. W. Hubbard, W. C. Johnson, S. Low, L. H. Mitchell, R. C. Phillimore, D. S. Waterlow, T. Wiles and T. Mackinnon Wood.

Tramways Purchase Award.—The Board of Trade arbitrator has made his award in respect of the purchase of Woolwich and South-East London Tramways by London County Council. Negotiations with reference to the purchase of the undertaking, which consists of 4½ miles of narrow-gauge tramways, commenced in October, 1901. The company claimed £57,206, and £25,000 in respect of cost of certain street widenings, the latter claim being, however, subsequently abandoned. The arbitrator now awards £46,152. 3s. 1d., representing the tramways, lands, buildings, works, materials and plant. The Council's valuation was £30,000. The Council will take over the company's undertaking on March 31, 1905, and at the next meeting a vote of £50,000 will be submitted to the Council in regard to this purchase.

Louth.—After discussing the electric lighting scheme prepared by their consulting engineers (Messrs. Handcock & Dykes), the Council decided on Tuesday by 10 votes to 9 not to proceed at present.

Luton.—Sanction to a loan of £5,000 for extension of the electricity undertaking has been applied for.

Marylebone (London).—The account of the Metropolitan Electric Supply Co. for capital expenditure during December (amounting to £3,208. 14s. 6d.) has been received by the Borough Council, and the borough treasurer recommends a payment of £2,800 on account, leaving £408 odd to be dealt with subsequently.

The report of the treasurer states that the company have for the first time brought into account a charge for maximum demand indicators, supplied to power consumers, a new tariff having been adopted, apparently 18 months ago, for this class of consumer, on the basis of 3d. per unit for the first two hours' maximum load daily, and 1½d. per unit for all in excess of this quantity. The number of indicators charged for is 153, fixed during 1904. As the capital expenditure to July 5 last has been agreed and incorporated in the formal transfer of the undertaking it would seem that the expenditure, so far as it has been incurred prior to that date, can be successfully objected to. For the following reasons it is urged that this course be adopted: (1st) The prices charged vary from 10 to 20 per cent. above that at which the Council are buying; (2nd) expense will be incurred in altering the instruments for the increased voltage; (3rd) expense will be incurred in removing the instruments from power circuits, for which it is probable the Council will fix a flat rate for current, and refixing for lighting consumers. The charge for fixing indicators is 12s. 6d. each, which compares with 15s. which the company are charging. The total amount included in the account for indicators is £395. 0s. 2d.

Regarding the November account, the report stated that a balance of £767. 9s. still remained to be dealt with. With regard to £500 of this, Mr. Arthur Wright advised that payment be withheld for the present.

The Electric Supply committee approved the report.

Monmouth.—The Council has decided to reduce the charge for current to private consumers from 6d. to 5½d. per unit.

Motor Boats in China.—It is said that the outlook for the employment of motor boats on a large scale in Chinese waters is very bright. The whole of China is a network of canals and rivers upon which motor boats, especially of low draught capacity, can be operated. There is a growing favour for power boats both for private ownership and for those who are compelled to travel about the country on public and private business. It is considered that the present time is favourable to pushing this business, and it is pointed out that the most effective method of creating trade in this branch is by personal representation on the spot. Facilities exist for building the hulls of such boats at very low cost.

Municipal Telephony.—Hull Telephone committee have arranged with the consulting engineer (Mr. A. R. Bennett) to carry out the proposed extension of the municipal telephone system and to supervise the execution of the work, &c., at a commission of 2½ per cent. on the actual cost, which is not to exceed £20,000.

New Malden.—The District Council have entered into a contract with the Post Office for telephone fire alarms and electric call bells for the fire brigade at £73. 15s.

New Postal Telegraph Stores.—It is stated that new stores are to be erected by the Postmaster-General in Islington (London) to meet the requirements of the telephone and electric light departments of the Post Office.

New South Wales Tramways.—The report of the N.S.W. Railway Commissioners for last December quarter states that the total earnings of the tramway system (which is 125¾ miles in length and is mostly electrical) were £209,926, an increase of £2,259 over the corresponding quarter of 1903, but working expenses, &c., increased by £10,471. 36,119,118 passengers were carried, an increase of over half a million.

Post Office Telegraphs.—An account showing the gross amount received and expended on account of the postal telegraph service for the year ended March 31, 1904, and the balance of expenditure over receipts, has been prepared and issued. This account shows that the total sum received for the year was £4,208,426. 16s. 2d., of which £529,520. 4s. 9d. was the amount due to the telegraph and cable companies for international messages, &c., making (after other deductions) the net receipts on account of telegraphs £3,674,157. 18s. 1d. The value of telegraph services performed for other public departments without remuneration represents £61,957. The total expenditure on the same account for the same period was £4,693,897. 8s. 10d. The balance of expenditure over receipts was, therefore, £957,782. 10s. 10d. In addition, there was the amount expended on account of capital charges (£278,483. 7s. 6d.), making the total deficiency of telegraph revenue in the year to meet expenditure and interest £1,236,265. 18s. 4d.

Post Office Telephone Wires and the Assessment Committees. London County Council, supported by seventeen assessment committees, recently asked the Postmaster-General for contributions in lieu of rates in respect of all post office telephone wires. The Postmaster-General, however, again expresses his willingness to move for the appointment of a Select Committee to inquire into the whole question of Government contributions in lieu of rates. Meanwhile, no charge can be made.

Presentation.—Mr. W. S. Smart, engineer of postal telegraphs at West Hartlepool, who has been transferred to Darlington, was recently the recipient of a presentation from his fellow postal telegraph colleagues at West Hartlepool.

St. Pancras (London).—The estimates of the requirements of the electricity undertaking for the six months ending Sept. 30 next are as follows:—Engine room supplies, £390; repairs and up-keep of buildings and machinery, £1,900; meters and indicators, £400; house service switches, £150; joint boxes, connectors, &c., £75; cables for service lines, £100; general stores, tools, &c., £100; wood, &c., £30; repairs of meters, &c., £150; total, £3,295. This does not include cables and materials for mains extensions, arc lighting, &c.

South Africa.—The "British and South African Export Gazette" states that—

The Van Ryn and Robinson Deep mines have adopted rubber-belt conveyors driven by electric motors.

At Geldenhuis Deep a central station supplies electric energy for several mines for lighting and for driving hoists, drills, pumps, locomotives, &c.

Twenty-one of the electric cranes for the Table Bay Harbour, made by Stothert & Pitt, and driven by motors supplied by the A.E.G. Electrical Co. of South Africa, have been delivered. The whole electric crane equipment will, when completed, have cost £334,700, and will be one of the largest installations of the kind in the world. The same company have orders for an electric crane installation for East London harbour (similar to that at Table Bay) and for an electric hoist for the Village Main Reef mine, where three-phase generating plant is being put down for hauling and hoisting.

The adoption of electric power plant at the Adamanda gold mine (Barberton district) is contemplated.

Southwark (London).—The County of London Electric Supply Co. have offered to supply electric current for public lighting in this district at 2d. per unit. The offer is under consideration by the Council.

Stockport.—The reconstruction of the Hazelgrove tramway route for electric traction will be commenced in about a fortnight. A contract amounting to £10,326 has been let to a local firm for carrying out the work.

Swindon.—The profit on the past year's working of the Electricity department was £706, or £443 more than the estimated amount.

Telephone Installation for India.—The Electric & Ordnance Accessories Co., Stellite works, Cheston-road, Aston, Birmingham, have recently executed an order for a complete telephone equipment for the new Strand Hotel at Rangoon, India. The equipment consists of a 100-line central battery exchange switchboard at present fitted for 50 stations and arranged for extension up to 100 stations at any time without interference to existing service. Also 50 subscribers' instruments, all convertible for wall or table use. The equipment includes two sets of speaking batteries with the wiring and accessories.

A special feature of the equipment is that the switchboard is fitted with an additional indicator and connection so that calls may be received from the public telephone system and transmitted to any of the rooms in the hotel. In the same way any of the instruments in the hotel can be connected to the public exchange for communication with outside subscribers.

The method of working the apparatus is as follows:—When a call is received the indicator falls. The operator inserts one of the front row of plugs into the jack bearing the number to correspond with the indicator, which act cuts off the current from the indicator, and the latter restores automatically. When the speaking key of the operator's handset is pressed it is directly connected to the calling instrument. Taking up from the back row of plugs the one corresponding with that already in use the operator inserts it into the jack bearing the number asked for. This number is then called by the operator depressing the black button on the desk corresponding with the plug just inserted and turning the handle of the generator. The operator now controls the circuit by means of the ring-off indicators, and immediately the conversation is finished, and the two stations have replaced their instruments, the corresponding indicator is restored automatically, and a single stroke given on the bell and the operator withdraws the plugs. The operator may, by means of tapping keys fitted to the board, tap in and see that the conversation is going on satisfactorily. The calls received from the public exchange will be indicated by a special shutter fitted at the top of the switchboard, and connections between the public exchange and the hotel instruments are made in the same way as between two of the hotel instruments. When a hotel station desires to ring up the public exchange it is only necessary to remove the handset from the cradle. This automatically signals to the switchboard operator. In answering a call, it is only necessary to take the telephone off the cradle and speak. The handset is fitted with interchangeable transmitters and receivers, so that should any fault be suspected with one of these components it may at once be removed and replaced by a spare one and the supposed faulty one tested at leisure.

This replacement can be made without any wire connections having to be broken and re-made, as the fact of screwing in the receiver or transmitter automatically completes the contact.

Tramways and Electricity Works Assessment.—Sunderland Council recently decided to appeal against the assessment of their tramway undertaking, but as the result of conferences between representatives of the Council and the Assessment committee, an amicable arrangement had been arrived at.

The original valuation of the tramways for the year ended March, 1903, was based upon that year's receipts (£69,284) the amount of the assessment being £14,129. The Council disputed this figure, but before the question was settled the figures for year ended March, 1904, were obtained. They gave the gross receipts as £62,597, and the assessment on that return was £13,650, expenses having been greater than in the previous year. As no settlement could be arrived at the Council appealed to the Assessment committee, with the result that the assessment was reduced to £11,000. The Council, being still dissatisfied, intimated their intention to take initiatory proceedings for an appeal to Quarter Sessions, but at the request of the Assessment committee there was a re-hearing of the whole subject, with the result that an assessment on ascertained figures, and a properly defined basis of reduction (which will afford a settled mode of automatically fixing the assessment from year to year according to the annual receipts and expenses) was made. The amount fixed, based upon the revenue for the year to March, 1904, is £7,653.

Negotiations are proceeding for a settlement of a like appeal in respect of the Corporation's electric lighting undertaking.

Transvaal Imports.—The total value of the electric cables, wires and fittings imported into the Transvaal in 1904 was £77,000, compared with £65,000 in 1903.

Tredegar.—The Council have applied to the Tredegar Coal and Iron Co for terms for supply of electricity in bulk.

Uruguay.—The "Review of the River Plate" states that the report of Montevideo municipal electric light department for 1904 shows receipts $129,184, expenditure $95,496, profit $33,688, compared with $107,257, $157,777 and (deficiency) $50,520 in 1903.

University College Past and Present Students' Dinner—The annual dinner takes place at the Criterion Restaurant, London, on March 24 at 7:30 p.m., Prof. J. D. Cormack will occupy the chair. All old students should communicate with the hon. sec., Mr. P. T. J. Estler, 25, Laurence Pountney-lane, London, E.C., at once.

West Riding Tramways.—The British Electric Traction Co. have notified their intention of applying to the Board of Trade for approval of the transfer of a portion of the undertaking authorised by the Spen Valley Light Railway Orders, situated in Dewsbury, to Dewsbury Corporation, and the remainder of the undertaking to the Yorkshire Woollen District Electric Tramways (Ltd.).

Notice has also been given by the company of intention to apply for extension of time until March 4, 1907, for the completion of the Morley and District Light Railway.

The Wakefield & District Light Railway Co. propose to double their existing (single) line from Wakefield (through Lupset and Horbury) to Ossett.

Whitby.—The Council have decided to let out electric motors, &c., on hire purchase, the motors to be supplied by the General Electric Co.

Yarmouth.—The Yarmouth and Gorleston tramways passed into the hands of the Corporation on Saturday. The lines are to be converted to electric traction at an estimated cost of £45,000.

The profits on the electric lighting undertaking for 1904-5 will, it is reported, be sufficient to justify £800 being voted in relief of rates.

24 tenders have been received for additional generating plant, and have been forwarded to the consulting engineers (Messrs. Preece & Cardew) for analysis and report.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Hammersmith (London) Borough Council invite tenders for supply of boiler flues and economisers, high-pressure steam pipes, steam and feed-water pipes, exhaust steam water heater and circulating water pies, steam valves and feed water heaters and coal elevator. Specification from the borough electrical engineer (Mr. G. Gilbert Bell), Electricity Works, 85, Fulham Palace-road, W. Tenders to the Town Hall, Hammersmith, by 4 p.m. April 5. See also advertisement.

Bradford Corporation invite tenders for supply, erection and setting to work of 2,500kw. of motor generators, or rotary transformers for transforming l.t. c.c. to e.h.t. a.c., and vice versa, together with the necessary controlling gear. Specifications, &c., at the electricity offices, Whitaker-buildings, Bradford. Tenders to the town clerk (Mr. Frederick Stevens) by first post March 30. See also an advertisement.

Manchester Electricity committee invite tenders for supply, delivery and erection at Dickinson street generating station of high and low-tension switchboards. Specifications, &c., from the secretary Electricity department (Mr. F. E. Hughes), Town Hall, Manchester, and further information from the chief engineer (Mr. S. L. Pearce), Dickinson-street Works. Tenders, addressed to chairman of Electricity committee, Town Hall, Manchester, April 4. An advertisement gives further particulars.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1905 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date (to Feb. 22), and the Directorial Division of the new volume has been corrected up to February 11th, 1905. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. The number of large sheet Tables, &c., has been increased, and the 1905 Edition of this indispensable work is offered as the most complete book of the kind ever published.

Among the chief features of the Handbook Division are Notes of the Year on Electric Traction and Electric Power, Turbine Notes, Electric Lamp Notes, Wireless Telegraph Notes (very full), Parliamentary Summary, Legal Decisions, and a complete set of all the chief documents used by Government Departments affecting the Electrical Industry (including the new "Special Mining Rules," issued Feb. 22).

Johannesburg Municipal Council invite tenders for electric tramway and lighting materials and for erection of same to specification No. 18 of their consulting engineers, Messrs. Mordey & Dawbarn, 82, Victoria-street, London, S.W. Tenders will be considered for one or more of the following complete sections:—(*a*) Tramway poles and brackets, (*b*) feeder pillars, controllers, insulators and all overhead material, (*c*) glow lamp fittings, ornamental lamp-posts, automatic switches, &c., (*d*) erection of material included in sections (*a*), (*b*) and (*c*), (*e*) motor tower waggon. Copies of specification after 18th inst. at the Council's offices, Johannesburg, and from the consulting engineers in London. Tenders to Messrs. Mordey & Dawbarn by noon of May 7. See also an advertisement.

Derby Tramways committee require tenders for materials and construction of works, in connection with the permanent way and electrical equipment of a portion of their authorised electric tramways, and the supply and delivery of cars. Tenders to the town clerk (Mr. G. Trevelyan Lee), 15, Tennant-street, Derby, by 9 a.m. March 21.

Marylebone (London) Borough Council invite tenders for the carrying out of certain installation work and alterations to existing consumers' installations in the Marylebone district. Tenders to the town clerk, Mr. James Wilson, Town Hall, Marylebone-lane, London, W., before 4 p.m. March 21.

Hoylake and West Kirby District Council invite tenders for supply and erection of one 250kw. steam alternator, with piping and accessories. Tenders to chairman of Electric Supply committee before 10 a.m. March 21.

Norwich Corporation invite tenders for rubber-covered wires and accessories, underground cables and incandescent lamps. Tenders to Chairman of Electricity Committee, Electricity Works, Duke-street, Norwich, by 10 a.m. March 20.

Great Yarmouth Corporation invite tenders for delivery of surface condenser, with steam-driven air and circulation pumps. Tenders to the Town Hall by noon March 29.

Hornsey Town Council invite tenders for the supply of cables, junction boxes, fuse boxes and meters. Tenders to the town clerk (Mr. F. D. Askey), 99, Southwood-lane, Highgate, N., by 27th inst.

Torquay Electric Lighting committee invite tenders for 1,200 to 1,500 tons of smokeless coal. Tenders to town clerk (Mr. Frederick S. Hex) by noon March 20.

Peterborough Corporation require tenders by 23rd inst. for electric lighting set, Lancashire boilers, superheaters, engines, pumps, feed-water softener, &c.

Keighley Electricity committee require tenders by 10 a.m. 27th inst. for 800kw. direct-current dynamo, high-speed engine and Lancashire boiler.

Birmingham Public Works committee invite tenders (by March 20) for special tramway castings and works in manganese steel, with fishplates, anchor pieces and connecting rails.

Chorlton Guardians require tenders by 9 a.m. 22nd inst. for wiring four new infirm blocks at Withington workhouse. Specifications from Mr. G. R. Peers, 16, John Dalton-street, Manchester.

The Clyde Navigation Trustees require tenders by April 10 for electric power generating and lighting plant for *Clydebank Dock*. Particulars from Mr. G. H. Baxter, 16, Robertson-street, Glasgow.

Glasgow Corporation require tenders by 10 a.m. 23rd inst., for three 1½-ton lorry-chassis suitable for tower waggons for tramway overhead work.

Glasgow Corporation also invite tenders by 10 a.m. April 5 for tramway stores for one year from June 1.

Batley Corporation require tenders by April 5 for electrical engineers' work at the new Carnegie Free Library.

Gillingham Corporation require tenders by noon 27th inst. for 12 months' supply of coal to electricity works.

West Derby Guardians want tenders (from local firms only) by 21st inst. for 12 months' electric supplies.

Bray District Council require tenders by 10:30 a.m. 20th inst. for 12 months' supplies for the electricity works.

Bolton Corporation invite tenders by March 30 for cooling tower and condensing apparatus.

Swindon Corporation invite tenders by March 21 for stores for the electricity and tramways department.

Aston Manor Corporation require tenders by noon 24th inst. for reconstruction of existing tramways and construction of other works.

Salford Corporation require tenders by 31st inst. for wiring their new school at Seedley.

Rathmines and Rathgar (co. Dublin) District Council require tenders by 27th inst. for condensing plant.

The *Belgian* State Railway authorities (La Bourse, Brussels) are inviting tenders until 22nd inst. for plant for the electric lighting of the south station at Antwerp.

The Director-General of Spanish Telegraphs, 10, Calle de Carretas, *Madrid*, will open tenders on April 11 for 20,000 pine telegraph posts impregnated with sulphate of copper by the Boucherie system. The posts will be of the following sizes:—100 12 metres high, 600 10 metres, 13,000 8 metres, 6,300 6½ to 7 metres. The maximum price at which tenders will be received is 35 pesetas, 24 pesetas, 16.50 pesetas, and 12.10 pesetas per post respectively. A deposit of 5 per cent. of the value of the goods at the upset price is necessary to qualify any tender, and local representation is necessary.

TENDERS RECEIVED AND ACCEPTED.

West Ham Corporation Tramways department have approved and ordered 85 of Messrs. Mountain & Gibson's improved M.G. double-deck trolley standards, with poles and heads complete, for the new cars which they are having built. The order has been placed with Mountain & Gibson by the Brush Co., who are building the car bodies.

Messrs. Isaac Storey & Sons have just executed a very smart piece of work. On Feb. 25 the firm received an order by telegraph for an auxiliary condenser of 900 sq. ft. required by a large shipbuilding company, delivery to be made by March 13. The firm had no finished parts of any description in stock for the work, and had to make the entire condenser from raw material, but delivery was made on March 10, two working days earlier than required.

Among recent orders obtained by Bruce Peebles & Co. are the following;—

600kw. steam dynamo for Leith Corporation; 12 months' supply of alternating-current motors of 15 H.P. and above for the hire purchase department of the Lancashire Electric Power Co.; three 500kw. motor converters for Dickinson-street station of Manchester Corporation.

Marylebone (London) Council have placed an order with the St. Helens Cable Co. for 9 miles of 0·15 lead-covered distributor cable at £495 per mile, 7 miles of 0·25 lead-covered distrbutor cable at £670 per mile, and 500 house cables and connections at £2. 10s. per connection.

Whitehaven Council have accepted the following tenders for electrical stores for the ensuing year:—

Edison & Swan Co., low-voltage glow lamps; J. Defries & Sons, high-voltage ditto; General Electric Co., glass globes; Callender's Co., joint-box compound; Reason Mfg. Co., meters and fuse boxes.

Durban Corporation have placed orders with the Lancashire Dynamo & Motor Co. for a booster, and with the Tudor Accumulator Co. for a battery of 250 cells of 770 ampere-hours' capacity for the tramway department.

Tynemouth & District Electric Traction Co. have let the following contracts for the Whitley Bay tramway extension:—

G. Freeman & Sons, permanent way construction; Brush Co., overhead equipment; British Insulated & Helsby Cables (Ltd.), cables.

Stalybridge, Hyde, Mossley and Dukinfield Tramways Board have accepted the tender of the British Westinghouse Co. for 10 tramcars, with Hurst-Nelson bodies.

Messrs. Monté-Callow & Co. notify us that they have obtained the contract for supply of motor-starting switch gear of Barnsley Corporation for the ensuing year.

Ashton-under-Lyne Council have accepted the tender of the Lancashire Electrical Co. for the supply of steel-wire cable for arc lamps.

Deptford (London) Council have accepted the tender of F. & C. Osler for electric fittings for the town hall at £533. 4s. 4d. Drake & Gorham tendered at £547. 4s., and Faraday & Son at £636.

Burslem Town Council have accepted the tender of the Glasgow Patents Co. for a water softener at £362.

R. J. Nicholson & Co. have received an order for a system of telephones at Leftwich (Northwich) Isolation Hospital.

West Sussex Education committee have accepted the tender of Sendall & Co. for wiring the boys' and girls' schools at Horsham.

London United Tramways.—J. G. White & Co., 22A, College-hill, Cannon-street, London, E.C., have recently obtained a contract for the construction of two additional sections of the tramways system of the London United Tramways (Ltd.). The total value of the contract is about £165,000.

The first section of the new tramways is in the Kingston, Surbiton, Malden and Wimbledon districts. The total route length of this line is about 10¼ miles, and the length of single track is about 18¾ miles. The second section is in Hanwell and Brentford, and the route length is about 2⅝ miles, the length of single track being 5¼ miles.

The type of construction of the track consists generally of No. 3 B.S. rails with cross girders spaced 9ft. apart throughout, and the joints supported by anchors of H section, secured to rails with bolts and clips. The concrete underbed is 6in. thick, finished off with a layer of 1in. fine concrete, and over this a floating coat of 1in. cement and sand to form bed for wood paving. The paving throughout is of Jarrah wood, finished, in the Kingston section, with an edging of granite setts, and in the Hanwell and Brentford section the margins are entirely of granite setts.

The overhead construction is span wire throughout, the poles being 33ft. long, and the ornamental character of the remainder of the tramway company's system will be preserved on the new sections. The trolley wire will be 2/0 B. & S. gauge grooved copper wire, and will be supported by mechanical ears. The height of the trolley wire above rail-level will be 23ft., which is greater than usual, owing to special London conditions.

W. T. Henley's Telegraph Works Co. (Ltd.) have been entrusted by London United Tramways (Ltd.) with the contract for the cable work in connection with the above extensions of their tramways to Wimbledon, Surbiton, Kingston, &c. This contract, which is claimed to be one of the largest ever placed for cables in connection with tramway work, includes about 30 miles of three-phase 11,000-volt E.H.T. cable and about 45 miles of L.T. feeder, distributor and telephone cables, &c.

BUSINESS NOTICES.

The London offices and laboratory of the Harris Feed Water Filter (Ltd.) have been removed from 78, Queen Victoria street, E.C., to larger and more convenient premises at 82, Victoria-street, Westminster, S.W. The company's telephone number is now 576 Westminster.

Mr. P. A. Paris has been appointed sole representative of the Rhodes Electrical Mfg. Co. (Ltd.) for Manchester (including the counties of Cheshire and Lancashire). Mr. Paris's temporary address is 42, Yarburgh-street, Alexandra Park, Manchester, and his telegraphic address is "Rhodi ue Manchester."

The business of Harris, Lee & Co., Johannesburg and London, has been converted into a company with limited liability under the style of Harris, Lee & Co. (Ltd.), registered under the companies acts of the Transvaal. The company hold, among others, the sole agencies for South Africa for Crompton & Co., the St. Helen's Cable Co., Electric & Ordnance Accessories Co., Evershed & Vignoles, Zurich Incandescence Lamp, Gilbert Arc Lamp Co., &c.

The registered office of the Electric Lighting & Traction Co. of Australia, Ltd., has been removed to Finsbury Pavement House, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

The trustee (Mr. F. Stone, 47, Full-street, Derby), in the bankruptcy of Harold Powell, electrical engineer, Derby, has been released

Claims against the Thames Valley Electric Launch Co. (Ltd.), in liquidation, must be sent by 28th inst. to Mr. F. J. Saffery, 14, Old Jewry-chambers, London, E.C.

The British Electric Separating Co. (Ltd.) is to be wound up voluntarily. Claims by April 24 to Mr. J. F. Harvey, 3-5, Goat-street, Swansea.

A meeting will be held on April 20, at 1, Lichfield-street, Hanley, to receive an account of the winding-up of the Porcelain Electrical Fittings Co.

Winding-up Petition.—A petition for the winding-up of the Acetylene Gas and Electric Smelting Co. (Ltd.) will be heard in the High Court, London, on March 21.

Sale by Tender.—Messrs. Mellors, Basden & Mellors, chartered accountants, Nottingham, have been instructed to sell by tender the stock-in-trade of an electrical engineer, consisting of electrical fittings, accessories, cables, motors, &c. See also advertisement.

Plant for Sale.—Messrs. White Bros. & Co., High-street, Stratford, have for sale an electric lighting generating set. See an advertisement.

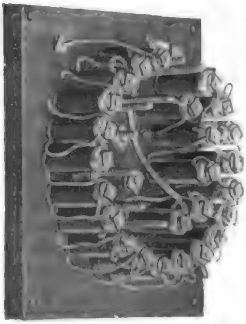
Duplicate electric lighting plant is advertised for sale by Mr. Arthur T. Earnshaw, 95, Mile End-road, London, E.

Premises for Sale, &c.—John W. Collis & Co., 143-4, Holborn Bars, E.C., have for sale or to be let on lease some conveniently situated factory premises at Belvedere, Kent. See advertisement.

Messrs. Woodhouse & Davidson, 10 and 11, Lime-street, London, E.C., have some conveniently-situated freehold factory sites for sale within 11 miles of London. See an advertisement.

David Burnett & Co., 15, Nicholas-lane, London, E.C., have two-storey factory premises to let. See advertisement.

Catalogues.—A new catalogue of Ward Leonard field rheostats, motor starters and circuit breakers has been issued by Messrs. Geipel & Lange, Vulcan Works, St. Thomas-street, London, S.E. In addition to the well-known patterns of this apparatus, a large number of new items is included in the list. These are high-resistance field rheostats for variable speed motors, solenoid-controlled motor starters, automatic pressure regulators, motor-starting panels of various types and lift controllers. The appended illustration represents a field rheostat of the UF type, which is built for resistances up to 20,000 ohms. It is clear that, with the construction shown, the replacement of any one coil, should this ever become necessary, can be effected with the least possible trouble and delay. The ventilation, too, is very well provided for. Among the starting resistances there is one which makes use of sand for storing up the heat which is generated in the metal-resistance coils during the periods of starting. It is well known that sand has a large specific heat, and it follows that starters of this type can be made considerably smaller and also cheaper than resistances which contain metal only. These starters are designed for motors ranging in size from ¼ H.P. to 200 H.P. There is a large amount of useful and interesting information scattered throughout the catalogue. A large stock of practically every pattern in the catalogue is kept, and Messrs. Geipel & Lange offer prompt delivery.



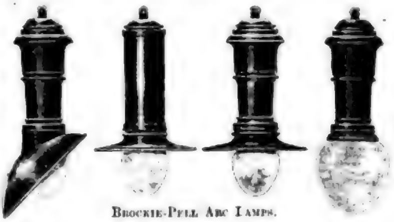
Showing Unit Construction of Ward-Leonard UF Type Field Rheostat.

The Harris Patent Feed Water Filter (Ltd.) have prepared a new illustrated catalogue descriptive of the Harris-Anderson water purifier for the absolute removal of all oil (to the last trace) and of other impurities from feed water. The list, which is accompanied by some fine illustrations, describes the process of filtration which is accomplished by the use of the Harris-Anderson purifier, and the various parts which go to complete the apparatus are shown. The illustrations include the water-softening plant erected at the Neasden works of the Metropolitan Railway Co. (of 13,000 gallons per hour capacity), the plant erected at the Smethwick power station of the Birmingham & Midland Tramways, and excellent views of the purifier plants supplied to Sunderland, Cardiff and Rotherham Corporations. At the Canning Town electricity generating station of West Ham Corporation plant of this type of a capacity of 16,000 gallons per hour is erected, and at Pinxton station of Glasgow Corporation tramways for 22,000 gallons per hour. The particulars given of these installations are instructive reading, and show the economy and certainty of the process. We may mention here the removal of the company's London offices from 78, Queen Victoria-street, E.C., to 82, Victoria-street, Westminster, S.W.

Messrs. Vickers, Sons & Maxim, River Don Works, Sheffield, have issued section 1 of their new catalogue of continuous-current constant-speed motors, and hope to have ready in a few weeks section 2 of the catalogue, dealing with continuous-current variable-speed motors. The constant-speed motor manufactured by this firm is constructed to give full load continuously for long periods, and requires a minimum of attention, even when working under disadvantageous conditions. They are manufactured in several standard sizes and all parts are to gauge. A tabulated form accompanying the list gives particulars of dimensions and weights. An illustration of a 15 H.P. size motor is also given.

The British Westinghouse Co. have forwarded us a copy of their new detail catalogue B, which contains, at present, some 12 sections (to which more will, no doubt, be added) dealing with automatic circuit-breakers for all purposes, integrating wattmeters for poly-phase and single-phase currents, dead-beat indicating instruments for continuous and alternating-currents (including instruments with illuminated dials), drum-type controllers and resistances, switch-boards for lighting, power and traction plants, knife switches of the D type with rear connections, oil switches and circuit-breakers. All these instruments are described in detail and well illustrated. The contact brushes of the circuit-breakers are of laminated copper, and the break takes place on carbon terminals well removed from the metal parts of the circuit-breaker, the construction being such as to assist the natural tendency of the arc to rise. A time-limit relay may be attached to any of these circuit-breakers, so that the current is only broken after the over-load has lasted a certain pre-determinable time.

The Brockie-Pell Arc Lamp (Ltd.), 60, Worship street, London, E.C., have prepared an excellent catalogue of open type and new enclosed Brockie-Pell arc lamps. In this catalogue the merits of the well known Brockie-Pell lamps are set out and illustrations are given of several types of these lamps. The accompanying illustrations show (Fig. 1) new single enclosed type lamp (show window pattern) for throwing the light direct on to goods in the window. In these lamps a name can be saw-pierced in the reflector and the lamp in this way be made an excellent advertising medium. Fig. 2 shows the ordinary pattern lamp for street and other public and open lighting; Fig. 8 the twin-carbon pattern lamp for railway stations, mills, workshops, &c., and Fig. 4, the ornamental pattern with inner and outer globes, the outer globe being provided to protect the inner from draughts or mechanical damage and to comply with fire office regulations. Spare parts and accessories for enclosed lamps are also listed, and instructions are given for arc lamp installation, trimming and cleaning.

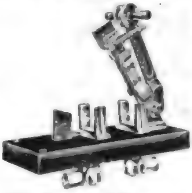


BROCKIE-PELL ARC LAMPS.

Fig. 1. Fig. 2. Fig. 3. Fig. 4.

A new type of swivel syphon and pressure gauge is illustrated and described in a list sent out by J. Hopkinson & Co., Huddersfield.

Cecil Hodges & Co., Balfour House, Finsbury-pavement, London, E.C., have ready a description of a heavy traction knife switch which they are placing on the market, and the construction of which is shown by the accompanying illustration. The contacts in this switch are adjustable. The wear on the heavy laminated copper brushes is taken up by spare liners, which can be readily inserted.



Fancy glass shades and globes, a new type of pull switch and terminal type high-voltage fuse boards are listed in a series of sheets issued by the Edison & Swan Co.

The Electrical Co., 121-125, Charing Cross-road, London, W.C., have now ready a number of new price lists, including (No. 11) rubber wires and cables, (16B) E.C. ampere-hour meters, (139) electric Nernst lamps B type, (140) Nernst lamps D type and (141) double tariff meters of the double index type. These lists are all fully illustrated.

An illustrated list of Sun arc lamps and accessories is to hand from the Sun Electrical Co.

"Measuring Instruments for Continuous Current" (sector and illuminated dial types) is issued by Ernest F. Moy (Ltd.), Camden Town, London, N.W.

Cyclone fans for induced draught are treated in a new pamphlet issued by Matthews & Yates, of Swinton, Manchester.

Everett, Edgcumbe & Co.'s New Hendon Works.—The firm of "Everett, Edgcumbe & Co." was established 4½ years ago, and has steadily progressed since that time until to-day the company have the satisfaction of entering into possession of their new factory premises on the Edgware-road, near Hendon. It was not long after the starting of the firm in 1900 that the Charterhouse-square premises then occupied became too small, and a move was made into Great Saffron-hill, and now, after three years' further work, another move is necessitated. At Hendon, London, N.W., the new Collindale Works occupied 4½ months in completion, the whole of the work of building and equipment being carried out by the firm. Here, after March 25, the manufacture of electrical measuring, testing and controlling instruments will be carried on. The firm have taken offices at 87, Victoria-street, Westminster, where show rooms will also be provided for the display of their manufactures. It is announced that Mr. G. J. Lemmens has now joined the firm, and brings with him extensive experience in all matters relating to the manufacture and management of electrical instruments. After the 25th inst. all communications should be addressed either to the works at Hendon or to 87, Victoria-street. The works telephone No. is 136 Hampstead.

"**West Australian Mining Industry**."—We have received from the Agent-General for Western Australia a copy of a publication with the above title, consisting of over 250 pages of interesting and useful information relating to the mining settlements and townships of Western Australia. There is an article on "Electricity in the Mines," which includes an illustrated description of the station of the Kalgoorlie Electric Power & Lighting Corpn., said to be the largest and most important electric power supply system on the fields. The Kalgoorlie electric tramways are also described, and particulars are given of the Boulder City tramway scheme, now in course of construction. The several towns lighted electrically are also described, and include Kookynie, situate 4½ miles from "Niagara," and Collie (lighted by the Collie Proprietary Coalfields, Ltd., who have installed electric pumps and an electrical chain-cutter in their mines). The publication under notice has been issued as a special edition of the "Australian Mining Standard," price 5s. It weighs for postage 2lb. If a similar British publication were sent to W. Australia, for distribution there, it would presumably be subject to a tax of 8d. per copy! A striking example of "Colonial preference."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from March 8 to 14, with the ports of destination:—

Aden, £7. ***Africa***—Alexandria, £517; Cape Town, £826; Chinde, £8; Durban, £2,267 (including £1,267 telegraph material); East London, £1,628 (including £1,441 telegraph material); Port Elizabeth, £97; Port Said, £15; Sierra Leone, £10 (telegraph material); Saukim, £829 (including £802 telegraph material). *Argentina*—Rosario, £135. ***Australasia***—Adelaide, £54; Auckland, £200; Melbourne, £534; Napier, £165; Perth, £31; Sydney, £2,993 (including £148 telegraph material); Wellington, £391. *Belgium*—Brussels, £30. *Borneo*—Sarawak, £11. *Canada*—St. John (N.B.), £11. *Ceylon*—Colombo, £70. *France*—Paris, £926. *Germany*—Hamburg, £960 (including £150 telegraph material). *Holland*—Amsterdam, £149. *Hong Kong*, £119 (including £60 telegraph material). *India*—Bombay, £491; Calcutta, £1,215; Karachi, £10; Madras, £144. *Italy*—Leghorn, £15. *Japan*—Yokohama, £1,378. *Portugal*—Lisbon, £48. *Russia*—Reval, £1,745; Windau, £10. *Siam*—Bangkok, £34. *Straits Settlements*—Singapore, £91 (including £57 telegraph material). *United States*—New Plymouth, £550. *Uruguay*—Monte Video, £20. Total £18,734, against £15,471 in the corresponding week last year (March 9 to 15).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

January 2, 1905.

33 G. Teuber. Germany. Electric cooking apparatus.*
40 J. J. Attridge. Bournemouth. Plough for electric conduit.
66 C. Smith. Switches.
80 B.T.-H. Co. (G.E. Co., U.S.). Arc lamps.

January 3, 1905.

123 W. L. Wise (Thomson Electric Welding Co., U.S.). Electric welding
136 F. Conrad. Transformers. (Date applied for, Jan. 21, 1904, date of application in U.S.)*
164 F. H. Glew. Electroscope for radio-active substances.

January 4, 1905.

167 H. G. Longford. Birmingham. Insulation of wires.
171 Steel, Peach & Tozer (Ltd.) and H. E. Bowes. Sheffield. Electro-magnets used with cranes for lifting rails ingots, or the like.
177 E. H. Pickford. Rotherham. Device for notifying when a circuit fails.
184 E. Arnold and J. L. La Cour. Liverpool. Compensated single-phase alternating-current commutator motor. (Date applied for, Jan. 4, 1904, date of application in Germany.)*
185 E. Arnold and J. L. La Cour. Liverpool. Leading in and taking off armature current of compensated single-phase commutator motors.*
191 S. Quincey and C. Harrison. Adjustable flexible connections for conductors.
206 J. A. Cole. Electric ignition for internal combustion engines.
209 E. De M. Malan. Electro-magnetically-controlled fluid pressure motors.
810 W. R. Ridings. Arc lamps.
211 La Société Leperche & Cie. Arc lamps. (Date applied for, May 2, 1904, date of application in France.)*

January 5, 1905.

235 F. C. Orr and T. C. Roberts. Dublin. Sparking arrangements of internal-combustion engines.
250 M. Lorenz and H. Crane. Solution for formation of accumulator plates.
254 B.T.-H. Co. (G.E. Co., U.S.). Electric lighting.
255 B.T.-H. Co. (G.E. Co., U.S.). Electric resistance units.
256 B.T.-H. Co. (G.E. Co., U.S.). Magnetic separators.
257 B.T.-H. Co. (G.E. Co., U.S.). Arc lamp electrodes.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each

1904.

135 Zani. Alternating-current generators and motors.
2,066 Armstrong and Orling. Electric receiving apparatus.
2,096 Berry. Apparatus for distribution of alternating currents.
2,269 Barber. Sparking plugs.
2,277 Sugrue. Electric low-water alarm.
2,471 Latour. Alternating-current machines. (Date applied for, Feb. 2, 1903.)
2,580 Weintraub. Rectifying alternating current. (Date applied for Feb. 2, 1903.)
2,734 Gati. Telegraphy.
3,000 Laird and Todd. Controllers for electric motors.
3,244 Ducretet. Induction transformer for wireless telegraphy receiving stations.
3 460 Andrews. Circuit-breakers and indicators.
4,176 Field. Multiplex telegraphy.
4,512 Nehmer. Generating electricity by moist chemicals mechanically pressed upon zinc.
6,748 and 8,714 Gore. Switches.
7,324 Pillans. Fire alarms or detectors.
7,627 Sanders. Electroliers.
12,332 Boult (de Kandó). Speed control of high-pressure motors.
12,707 Thompson. (Chemische Elektrische Fabrik Prometheus, G.m.b.H.). Electrical resistance bodies.
12,729 Sayer. Electric railways and motor vehicles.
13,483 Fauvin Amiot & Chenbach. Combined electric regulating and measuring apparatus. (Date applied for, Nov. 20, 1903.)
15,802 Stone and Fenwick. Conduits for wires or cables.
19,482 Finnigan. Electric automatic block signal and safety systems.
21,138 Bachelet. Electromagnetic therapeutic apparatus. (Date applied for, Oct. 2, 1903).
27,903 Gardiner. Secondary batteries and grids therefor.

COMPANIES' MEETINGS AND REPORTS.

Metropolitan Electric Supply Co. (Ltd.)

The eighteenth ordinary general meeting was held on Tuesday under the presidency of Mr. W. Harrison Cripps.

The SECRETARY (Mr. E. Cunliffe Owen, C.M.G.) read the notice calling the meeting.

The CHAIRMAN said: I will deal briefly with the capital account, which is a little complicated. At the end of 1903 our capital expenditure amounted to £2,090,000. During 1904, we have spent £208,000, so that the total capital outlay amounts to £2,298,000. Of this sum £759,000 represents money we had spent in Marylebone and on our Sardinia-street station. If we write off this amount it will leave £1,540,000, which represents the capital we have expended to the end of last year. This is the explanation: the total amount of money we received from the Marylebone award and the Sardinia-street arbitration was £1,895,000. Out of this we have credited back to capital £759,000, so that at the present moment our actual capital is represented partly by our various stations, mains, land, machinery and all the rest of it, and partly by investments, so that the balance of capital account is available to us in the future to draw upon and spend on the business from time to time without asking the shareholders for any new capital. Of course, it seems at first rather a large sum to leave in these 3½ and 3¾ per cent. securities; but we hope, as year by year goes by, that this money will be readily absorbed in the business, and then it will pay you a very much better percentage. As regards the balance of the Marylebone and Sardinia-street award money, after crediting back the amount I have mentioned to capital, there remained a sum of £680,000. You know what has become of the bulk of that: £600,000 was returned to you in the form of a £6 bonus. The remainder of the money we have carried to reserve. I will now leave the capital account and come to the revenue account. During the year our gross revenue was £306,540. The working costs—for coal, wages, &c.—to produce this amount came to £129,703, deducting which we have £176,837 left. This amount, with the balance we brought forward from last year and with other receipts, brings us a total of £190,982. From this we have to deduct the debenture interest and preference share dividend and the rent we are now paying to the Marylebone Borough Council; leaving a sum of £128,157, of which the Directors have carried £20,000 to the reserve. There remains £108,157. We have already paid away to our shareholders £45,000 of this by way of interim dividend at the rate of 9 per cent., and we now propose, with your sanction, to pay you the completing dividend at the rate of 11 per cent. per annum for the half-year, so that the total dividend works out at 10 per cent. for the year. I am glad to hear expressions of satisfaction at that result, because we are proud of it, of course, as well as you. We think it shows a very substantial advance in the business of our Company. The payment will absorb £100,000, and will leave £8,157, which we propose to carry on to this year, which compares with a very much less sum than that which we carried forward a year ago. The progress of the Company has been very gratifying during the year. In that period we have added the equivalent of 89,000 lamps, so you see that our business, although it has got to nearly its 17th year, is not only showing substantial progress, but greater progress, I think, than it has ever done before. At the present moment the total of our lamps is 939,000, and I only hope that when I meet you this time next year, the number will go into seven figures. No inconsiderable importance is attached to the fact that in the past year a substantial amount of the current has been taken for motor purposes, and that is a line of advance which we are looking to in the future as, perhaps, one of our principal sources of revenue. We are in a position to supply any amount of power required. Let any customer come to us, little or big, and we shall be very glad to put him on to-morrow. And not only are we in a position at the present moment to supply any demand which may be made upon us, but we have a very large reserve of land at Willesden--something like four or five times the size of our present station, and therefore we have the means of supplying almost indefinitely any amount of power that may be required. In the past year we produced or sold current amounting to £24,000 more than we did in the previous year, while our costs in producing that extra current--the whole costs--were £12,000 less. You must remember that that was an increase of income and a decrease of costs following on what occurred in 1903, which gave almost as good results. If you take those two years together you will find that in that period our increased current sold amounted to £40,000, and that there was a diminution in the expenses of producing the current of £27,000. In other words, there was really a difference in favour of the Company of £67,000 in those two years. One of the reasons--perhaps, one of the chief reasons--of this result was that we are now getting the benefit of the capital spent at Willesden on our magnificent new engines, condensing plant, and things of that kind. In the second place, there was the great economy which has been brought about by the excellent management of our engineer in the consumption of coal. In 1898 we produced 7½ million units, and the amount we spent on coal that year was almost exactly the same as we spent in the past year, when we produced 15½ million units. You, therefore, see that we produce for every ton of coal we now use double the amount of electricity we did before. Before concluding I should like to say one word about the staff. Speaking on my own behalf and on behalf of my brother directors, I desire to say how very much we have been indebted in the past year to the excellent, energetic, and conscientious work of the whole of our staff. One hardly likes, where all have so thoroughly done their duty to promote the real interests of the Company, to pick out individual names, but I cannot help mentioning how greatly we are indebted to Mr. Cunliffe Owen, our secretary, to Mr. Highfield, our chief engineer, and to Mr. Conacher, our general manager. I now move the adoption of the report and accounts and the payment of the dividend therein recommended.

Mr. F. LEVERTON HARRIS, M.P., seconded the resolution, which was carried unanimously.

The retiring directors (Mr. John Verity, Mr. Frank Bailey and Mr. W. H. Crippe) were re-elected, as were the auditors (Messrs. Deloitte, Dever, Griffiths & Co.).

At an extraordinary meeting which followed a resolution approving the division of the existing £10 shares into two £5 shares was carried unanimously, and a cordial vote of thanks to the chairman, directors and staff terminated the proceedings.

South London Electric Supply Corpn. (Ltd.)

The ordinary general meeting was held on Friday last under the presidency of George Ellis, Esq., J.P.

The SECRETARY (Mr. Herbert H. Boyer) read the notice convening the meeting and the report of the auditors.

The CHAIRMAN said: The Company has made satisfactory progress. From our report you will observe that the expectation expressed at our last annual meeting as to the probable increase in lamps connected has been fulfilled, the exact number at Dec. 31, 1904, being 107,000. Since then a large number of additional lamps have been connected to the mains and applied for, there still remaining a balance of nearly 7,000 lamps of 8 c.p. awaiting connection. The supply of power to London County Council has continued without interruption. This traction load will remain with us certainly through the present year and possibly longer. This load, together with the increase in the Company's own business, has been the means of again still further reducing the total costs of generation, which are still the lowest obtained by any electricity supply company in the metropolis, being no more than 1·07d. per unit sold against 1·32d. obtained in 1903, which reflects great credit on the Company's staff. 9,205,342 units of current have been sold, an increase of 4,399,861 units over 1903. As the increase in the number of lamps on our own mains continues and as we hope to obtain this year one or two large lighting contracts, we have put on order, for delivery and erection before September next, a 900 kw. steam alternator in order that during next winter our spare plant may bear a proper proportion to the anticipated demand. The capital expenditure on additional mains, plant, &c., during 1904 was £17,665, but we do not anticipate that in the present year even this figure will be reached. To meet this capital expenditure we do not think it will be necessary to raise further capital, although as I told you at the last general meeting, if we do require to place any more debentures, the shareholders will have the first opportunity of subscribing. Turning to the revenue account, it will be seen that the available balance on the year's working is £31,348, and this carried forward to the net revenue account, with interest £265 and the balance of £411 brought forward from 1903, makes the total available £32,024. Deducting from this £2,437 interest on borrowed capital, we have £29,587 left for distribution. In accordance with the scheme which you adopted at the last meeting for the extinction of the preliminary expenses over a period of 10 years, a second instalment, amounting to £4,140, has been written off. Further, we have dealt with the very important matter of depreciation on a liberal scale, as we have set aside for that purpose the sum of £6,000. We feel sure you will all agree with us in the wisdom of this policy. It is important to bear in mind that the amount written off under these two heads alone represents on the capital expended nearly 3 per cent. Although the balance then left--namely, £19,447, would have allowed of a dividend of at least 5 per cent. for the year, we consider that it would be more prudent to pay a smaller dividend, and carry forward a larger balance, and consequently we recommend the payment of a dividend of 4 per cent. for the year, which will absorb £13,000, leaving £6,447 to carry forward. The only other matter I need refer to is the proceedings commenced against us by Lambeth Corporation for not consuming refuse which the Police Magistrate, at their instance, ordered us not to consume. They commenced these proceedings about four years ago, and have now revived them after allowing more than two years to elapse without taking any steps. I now move that the report and accounts be adopted.

Mr. MADGE (a shareholder) seconded the motion, which was carried unanimously.

Resolutions authorising the payment of the dividend, re-electing the retiring directors and auditors, and according a hearty vote of thanks to the chairman, were carried, and the proceedings terminated.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—The directors' report for the year ended Dec. 31 states that the capital expended during the year amounted to £31,404. 18s. 5d., bringing the total to £318,294. 9s. 8d. The share capital is to be increased from £300,000 to £500,000 by the creation of a further 10,000 preference and a further 10,000 ordinary shares, both of £10 each. The borrowing powers of the company are to be increased from £150,000 to £300,000. The balance to credit of net revenue is £15,764. 13s. 9d. Out of this sum full dividends on the 4½ and 6 per cent. preference shares have been paid, and the directors recommend a dividend on the ordinary shares at the rate of 7 per cent. per annum (less tax). £1,043. 0s. 6d. is carried forward. Application has been made for a provisional order for Wimborne and surrounding districts, and current will be supplied same from the company's station in the Bourne Valley. The total applications for current reached the equivalent of 121,589 8 c.p. lamps, an increase of 21,051 for the year, compared with an increase of 19,542 for the previous year. The total units sold for all purposes was 1,703,329, an increase of 183,327 units on the year.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—The directors' report for 1904 states that the credit balance was £28,270. 12s. 7d., which, with £4,179. 8s. 1d. brought forward and other items, makes £32,944. 1s. 7d. After deducting the interim dividends on the cumulative preference and ordinary shares, the directors recommend that £8,000 be placed to depreciation, £1,909. 19s. 4d. to payment of balance preference dividend, £7,973. 4s. 1d. to balance dividend on ordinary shares (making 10 per cent. for year). £5,984. 4s. 2d. is carried forward. At the end of 1904 the equivalent of 169,869 8 c.p. lamps (3,575 consumers) were connected, an increase of 15,016 8 c.p. lamps (249 consumers) on the year. Owing to the reduction in the charge for current the net profits show a slight decrease for the first time in the history of the company.

COUNTY OF DURHAM ELECTRICAL POWER DISTRIBUTION CO. (LTD.)—At the meeting on Monday (presided over by Mr. W. L. Madgen) the directors' report was adopted. During 1904 the company acquired from the British Electric Traction Co. the whole of the shares held by that company in the County of Durham Electric Power Supply Co. Capital expenditure on works at end of year amounted to £97,004. 15s. 3d., including £11,545. 15s. 6d. expended during the year. In order to meet the increasing demand for electric energy this additional capital expenditure has been necessary at Gateshead and Durham City on extensions of mains, additional motors, meters, &c., and at Jarrow on machinery, mains, &c. Total revenue was £26,981. 14s. 11d., and expenditure (including interest) £25,951. 2s. 9d., leaving net profit £1,030. 12s. 2d., to which is added £3,657. 16s. 5d. from last account, making £4,688. 8s. 7d. available for distribution. The directors recommended payment of the preference dividend, a dividend of 7s. 4½d. per share on 5,000 ordinary shares and a dividend of 3s. 8¼d. per share on 5,000 ordinary shares for half-year. £422. 16s. 1d. is placed to credit of depreciation and reserve.

The consumers at Dec. 31 at *Gateshead* represented a demand equivalent to 142,232 8 c.p. lamps connected, an increase of 19,794 on year. The units sold during 1904 were: Lighting 160,510, power 1,845,268, traction 2,174,811; total 4,180,589, compared with 3,442,125 for 1903.

At *Jarrow* the past satisfactory progress is maintained. As the requirements of the district are now beyond the capacity of the existing station, arrangements have been made with the County of Durham Electric Power Supply Co. for an early delivery of a supply in bulk from their Gateshead station. The requisite transforming plant is on order and will shortly be delivered. The Jarrow consumers at Dec. 31 represented a demand equivalent to 11,052 8 c.p. lamps connected, an increase of 5,441. The number of units sold increased from 77,276 to 129,003.

Steady progress has been maintained at *Durham City*, where the consumers at Dec. 31 represented a demand equivalent to 9,757 8 c.p. lamps connected, increase 1,498, and the number of units sold increased from 111,440 to 128,007.

COUNTY OF DURHAM ELECTRIC POWER SUPPLY CO.—The report for the half-year ended Dec. 31 states that the capital expenditure at the end of the half-year amounted to £91,967. 12s. 10d. Revenue amounted to £10,010. 2s. 3d. and working expenses to £8,426. 4s. 4d. The arrangements for the provision of a high-tension bulk supply to the Jarrow substation of the County of Durham Electrical Power Distribution Co. (Ltd.) are well forward. The laying of the trunk mains has been commenced. The extension of the buildings at Gateshead to accommodate the additional plant required is nearing completion. The output during the year totalled 5,020,992 units, compared with 4,152,428 units during 1903. The shareholders will be asked at the forthcoming meeting to approve an agreement with the Newcastle-upon-Tyne Electric Supply Co. (Ltd.) and the County of Durham Electrical Power Distribution Co. (Ltd.) for supply of electricity and for the operation of the undertaking of the company.

CORK ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—Receipts during 1904 were £45,143. 17s. 11d. and expenses £28,128. 10s. 7d. After adding £704. 19s. 9d. from 1903 and deducting debenture interest (£4,302. 10s.) the balance was £13,427. 17s. 1d. After paying £5,500 in preference dividend, writing off £542. 12s. 2d. plant on loan, &c, placing £1,000 to reserve for depreciation and insurance and applying £5,500 in paying 5 per cent. dividend on the ordinary shares, £885. 4s. 11d. is carried forward. 252 additional consumers have been connected during the year, being more than in any previous year. Capital expenditure during the year was £10,346. 14s. 6d. on cable extensions, connecting up additional consumers and completion of power station extensions.

DAVIS & TIMMINS (LTD.)—Sir H. Mance, at the meeting on Tuesday, said it was satisfactory that the company had been able to hold its own in the present industrial circumstances. He had been associated with industrial enterprises for 20 years, and all round he found there had never been such a bad time as at present.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The directors' report for the year ended Dec. 31 last shows, afte providing for interest on and redemption of debentures, a balance revenue credit of £10,201. 2s. 2d. After adding £5,000 to reserve, the balance of £5,201. 2s. 2d., together with £385. 1s. 10d. taken from contingencies account, enables the directors to recommend a dividend of 10 per cent. on the preference and of 4 per cent. (tax free) on the ordinary shares for the year. Balance to credit of contingencies account will then be £795. 1s. 11d. The company's Barcelona-Marseilles cable has been three times interrupted during the year, and owing to the frequency of these breaks the directors took steps to put the cable into a thorough state of repair, which work has now been satisfactorily carried out. The Bilbao cable broke down on Dec. 13 about 25 knots from the Spanish end. Communication was restored on Dec. 20. The cost of these four repairs, amounting to £8,092. 8s. 1d., has been charged against reserve.

ERNEST F. MOY (LTD.)—The report of the directors for the year ended Dec. 31 last states that a profit of £831. 4s. 7d has been earned. 7½ per cent. dividend on the ordinary shares absorbs £588. 2s. 5d., and the 6 per cent. preference dividend £80. 12s. 8d. £100 is placed to reserve. The works have been kept fully employed, notwithstanding keen competition and depressed trade.

MERSEY RAILWAY CO.—For the half-year ended Dec. 31 the train-mileage run was 415,625 miles, compared with 401,046 for the corresponding six months of 1903, and the number of passengers carried 4,657,870, against 4,153,777 (exclusive of season-ticket holders). The total receipts were £41,788. 16s. 6d., compared with £37,357. 19s. 8d. Working expenses (exclusive of exceptional charges for pumping, ventilation and lifts) were £29,029. 1s. 9d. (equal to 69·17 per cent.), against £28,203. 11s. 10d. (equal to 75·50 per cent.) for the corresponding six months. Exceptional charges for pumping, ventilation and hydraulic lifts for the past half-year were £3,864. 7s. 2d. (equal to 9·22 per cent.), compared with £4,237. 8s. 10d. (or 11·34 per cent.) for the corresponding period of 1903.

NATIONAL ELECTRIC CONSTRUCTION CO. (LTD.)—For 1904 the gross profit was £29,351. 3s. 1d., from which is deducted expenses of administration, &c. (£9,411. 15s. 1d.), leaving £19,939. 8s. From this is deducted the balance forward (£3,537. 10s. 4d.), leaving £16,401. 17s. 8d. The directors recommend that £10,111. 18s. 5d. be applied as provision for reserves, depreciation, &c., £6,007. 4s. in payment of dividend at the rate of 6 per cent. on the paid-up capital, and £282. 15s. 3d. in payment of dividend of 1¼ per cent. on the vendors' shares. The inauguration of the Musselburgh tramways and lighting undertaking took place on Dec. 12 last, and from that date to March 9, 425,334 passengers have been carried, the receipts being £2,181. 8s. 3d. These returns should be considerably improved upon during the summer months. With regard to lighting, applications for the equivalent of over 4,000 8 c.p. lamps have been received, the majority of which are connected to the mains. These results are considered satisfactory, and the directors look upon the company's holding in the Musselburgh Construction Synd. as a valuable asset. The inauguration of the Bo'ness electric light undertaking took place on Feb. 6, and that of the Carnarvon undertaking on Feb. 23. The directors are satisfied with the applications for current received so far.

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—At the meeting on Friday Mr. J. D. Milburn said that during the first two months of this year they had sold 189,616 more units than in the corresponding period of 1904. After liberal provision for reserve, &c., they were able to pay a dividend of 3 per cent. He thought that very satisfactory, considering the magnitude of the construction works they had had to undertake.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY (LTD.)—The directors' report for the period to Dec. 31 last states that the total revenue amounted to £29,349. 12s. 2d., and expenditure (including interest) to £22,877. 8s. 6d., leaving £6,472. 3s. 8d., which, added to £170. 1s. 4d. brought forward, makes £6,642. 5s. available for division. The directors propose placing £1,000 to depreciation and reserve, to pay the dividend on the 5 per cent. cumulative preference shares, and a dividend on the ordinary shares at the rate of 7 per cent. for the six months to Dec. 31 (making 6 per cent. for the year). A satisfactory agreement has been entered into with the Corporation of Ashton-under-Lyne for the latter to continue to supply electrical energy for the working of the tramways.

NEW COMPANIES, LIENS REGISTERED, &c.

NEW COMPANIES.

ELECTRICAL SAFETY APPLIANCES CO. (LTD.) (83,864.)—Reg. March 9, capital £2,000 in £1 shares (300 founders'), to adopt an agreement with J. W. Manley, to acquire benefit of an invention relating to apparatus for use on electric circuits, to turn the same to account and to manufacture and deal in electrical appliances, &c. First directors, J. W. Manley and E. F. Daye. Reg. office, Eldon-street House, Eldon-street, London, E.C.

FOLKESTONE DISTRICT ELECTRIC LIGHT & POWER CO. (LTD.) (83,839.)—Reg. March 8, capital £50,000 in £1 shares (25,000 6 per cent. cumulative preference), to acquire the business of electricity supplier carried on by C. P. D. Payer at Folkestone, and to carry on the business of generators, accumulators, purchasers and suppliers of electricity, electricians, mechanical and electrical engineers, &c.

LONDON, DEPTFORD & GREENWICH TRAMWAYS CO. (LTD.) (83,880.)—Reg. March 11, capital £170,000 (being a re-incorporation under the Companies Acts, 1862 to 1900, of the concern originally constituted by the Southwark and Deptford Tramways Act, 1879, and further governed by the Southwark and Deptford Tramways Acts, 1881 and 1889, and the London, Deptford and Greenwich Tramways Acts, 1891 and 1893). These acts provide for the optional working of the tramways by electrical or other mechanical power. Reg. office, Blomfield House, London Wall, London, E.C.

NATIONAL CARBIDE CO. (LTD.) (83,881).—Reg. March 11, capital £50,000 in £1 shares (5,000 preference, 35,000 ordinary and 10,000 as may be decided), to adopt agreement with the Mann George Depôts (Ltd.), to undertake industrial, experimental and commercial exploitation of chemical and electro-chemical processes and the manufacture, purchase and sale of all products and apparatus relating thereto, to manufacture and deal in electro-chemical products and apparatus and electrical or mechanical plant, to carry on business as electricians and engineers, &c. The company may at any time enter into an agreement with the Cordoba Light & Power Co. (U.S.A.). Reg. office, 11, Queen Victoria-street, London, E.C.

MORTGAGES AND CHARGES.

ELECTROLYTIC ALKALI CO. (LTD.)—Issue on March 1 of £3,750 first mortgage debentures, part of series created July 9, 1904, to secure £50,000, charged on company's undertaking and property, including uncalled capital. Trustees, Liverpool Mortgage Insurance Co. Previously issued of same series, £13,750.

MALAGA ELECTRICITY CO. (LTD.)—Reissue on Feb. 14 of £16,034 debentures, part of series created by resolutions of March 29, 1897, Feb. 7 and 28, 1898, and Oct. 13 and 20, 1899, to secure £50,000, charged on company's undertaking and property, present and future, including uncalled capital and electrical station at Malaga. No trustees. Previously issued of same series, £44,738.

CITY NOTES.

MEMORANDA (March 16).—Bank rate 2½ per cent. (since March 9, 1905). Price of silver 26[illegible]d. per oz. Consols 91[illegible]—91[illegible] for money, 91[illegible]—91[illegible] for account; 2¾ per cent. annuities 90[illegible]—90[illegible]. Consols Pay Day, April 5, Stocks and Shares Ticket Days, March 29 and April 12; Pay Days, March 30 and April 13; Mining Share Carry-over Days, March 27 and April 10.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—£50,000 5 per cent. first mortgage debenture stock of this company is offered to the public at par by the Consolidated Electrical Co., Canonbury, London, N.

BRITISH INSULATED & HELSBY CABLES (LTD.)—The directors recommend a dividend of 4 per cent., making 8 per cent. for 1904, placing £21,000 to depreciation, £5,000 to debenture redemption, £5,500 to special reserve and carrying forward £7,100.

DEUTSCHE EDISON-AKKUMULATOREN CO. (G.m.b.H.)—A company has been formed in Berlin with an authorised capital of 3,000,000m. (£150,000) (of which about 25 per cent. is paid up) for the manufacture and exploitation of Edison accumulators. Herren. Berthold & Kammerhoff are business managers, and Mr. T. A. Edison and Herr S. Bergmann (of the Bergmann Elektrizitäts-werke) are directors.

KOBE (JAPAN) ELECTRIC LIGHT CO.—For the latter half of 1904 the net profit was 55,710 yen (£5,571). A dividend of 17 per cent. per annum has been declared.

METROPOLITAN RAILWAY CO. (PARIS).—During 1904 the number of passengers carried on this electric tube railway was 140,247,223, against 118,201,772 in 1903. During the first two months of this year 30,867,709 passengers were carried.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Mar. 11	1,052	− 13	41	55,221	+ 5,725
Airdrie	,, 8	166	− 12	9	1,732	− 11
Ayr Corporation	,, 11	176	+ 17	42	12,608	+ 616
Barnsley	,, 8	162	+ 19	9	1,322	+ 35
Barrow	,, 8	194	+ 55	9	1,535	+ 153
Bath Electric Trams, Ltd.	,, 8	528	+ 21	10	5,298	+ 517
Birkenhead	,, 12	949	− 10	...	...	...
Birmingham Corporation	,, 11	856	...	[illegible]	19,874	...
*Birmingham & Mid.	,, 8	1,690	+ 318	9	14,641	+ 1,741
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 9	816	+ 45	49	66,528	+ 6,178
Blackpool and Fleetwood	,, 11	179	− 44	10	1,841	− 102
Blackp'l, St. Anne's & Lytham	,, 9	149	− 4	19	2,486	...
Bolton Corporation	,, 12	1,679	− 25	50	90,182	+ 598
Bournemouth Corporation	,, 8	940	+ 35	‡49	51,943	+ 2,795
Bradford Corporation	,, 11	3,764	+ 400	47	214,638	+ 30,540
Brighton Corporation	,, 12	727	− 85	49	47,227	+ 3,681
Brisbane Tramways	...	...	...	...	...	...
Bristol Trams & Carriage	,, 10	4,486	+ 142	5	29,185	+ 439
Buenos Ayres & Belgrano	...	...	...	...	...	...
Buenos Ayres Elec. Trams	Feb. 11	1,018	...	6	6,410	...
Burnley Corporation	Mar. 11	916	+ 79	23	10,046	+ 3,649
Burton Corporation	,, 12	806	+ 28	¶49	16,598	...
Calcutta Tramways Co.	,, 11	a41,720	+ a6,564	10	a411,611	..
Camborne-Redruth	,, 18	199	+ 26	19	2,000	− 171
Cardiff Corporation	,, 11	1,871	+ 65	49	98,910	+ 2,067
Carlisle Tramways Co.	,, 11	140	− 15	10	1,4[illegible]	− 228
Central London Railway	,, 11	7,195	+ 75	10	72,069	+ 1,165
Chatham & Dist. Lt. Rys.	,, 9	596	+ 106	10	5,571	+ 689
*City of Birm'gh'm Tram Co.	,, 8	5,449	+ 763	9	46,457	+ 1,798
City & South London Rly.	,, 12	5,005	− 96	11	53,184	− 2,091
Colchester Corporation	,, 9	156	..	6	918	...
Cork Electric Trams Co.	,, 9	421	+ 71	10	3,956	+ 136
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams.	,, 8	407	− 18	9	3,781	− 140
Dover Corporation	,, 11	169	+ 8	50	10,701	− 110
Dublin & Lucan Railway	,, 10	98	− 3	10	921	+ 18
Dublin Southern District	,, 10	787	+ 111	10	48,192	+ 415
Dublin United	,, 10	8,620	+ 166			
Dudley—Stourbridge	,, 8	747	+ 62	9	6,425	+ 116
Dundee Corporation	,, 8	790	+ 40	¶21	35,179	+ 352
East Ham Council	,, 11	658	+ 44	49	34,556	+ 1,012
Gateshead & Dist. Trams.	,, 8	8[illegible]9	+ 61	9	7,616	+ 206
Glasgow Corporation	,, 11	13,107	+ 988	[illegible]	581,570	+ 29,234
Glossop	...	...	...	...	...	...
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 8	184	− 15	9	1,619	− 167
Gt. Northern & City Rly.	,, 11	1,633	+ 641	10	16,058	...
Greenock & Port Glasgow	,, 8	578	+ 90	9	4,555	+ 511
†*Halifax Corporation	,, 5	2,389	+ 191	49	69,775	+ 5,393
Hartlepool Tramways	,, 8	208	+ 14	9	2,101	− 3
Huddersfield	,, 11	1,200	+ 140	49	65,852	+ 4,269
Hull Corporation	,, 11	3,139	+ 170	49	106,886	+ 11,880
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	,, 2	106	− 12	22	2,470	− 404
Ipswich Corporation	,, 11	316	+ 98	49	22,387	...
Isle of Thanet Co.	,, 11	215	− 9	22	9,100	− 117
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	...	89	− 3	9	789	− 14
Kilmarnock	,, 11	125	...	2	277	...
Kirkcaldy Corporation	,, 8	193	...	1	193	...
Lanarkshire Trams Co.	,, 9	661	+ 140	10	6,275	+ 565
Leeds Corporation	,, 11	5,456	+ 657	50	274,952	+ 17,144
‡Leicester Corporation	,, 11	1,917	...	10	17,635	...
Liverpool Corporation	,, 4	9,529	+ 524	9	57,574	+ 3,108
Liverpool Overhead Rly.	,, 12	1,460	− 65	11	16,071	− 607
†London County Council	,, 4	12,230	+ 3,091	§13	6[illegible]2,674	+ 117,318
Lowestoft	,, 11	119	− 9	10	1,212	...
Maidstone Corporation	,, 9	95	...	54	4,472	...
Manchester Corporation	,, 11	11,662	+ 1,038	49	503,909	+ 38,015
Mersey Railway	,, 11	1,576	+ 14	10	15,543	+ 1,099
Merthyr	,, 8	176	− 4	9	1,5[illegible]7	− 115
‖Metropolitan Elec. Trams	,, 8	1,796	+ 789	9	16,642	+ 7,316
Middleton	,, 8	250	+ 25	9	2,288	+ 195
Musselburgh	...	...	...	...	...	...
Nelson Corporation	,, 11	106	+ 9	49	5,764	+ 1,391
Newcastle-on-Tyne Corp.	,, 11	3,549	+ 19	10	35,837	+ 710
Newport (Mon.)	,, 11	517	+ 82	23	11,576	+ 1,554
Oldham, Ashton & Hyde	,, 8	480	+ 22	9	4,287	+ 51
Oldham Corporation	,, 12	1,379	+ 316	50	63,066	+ 5,370
Perth (W. A.) Elec. Trams	,, 10	1,483	+ 142	10	14,709	+ 1,908
Peterborough	,, 8	99	...	9	876	− 57
Poole and District	,, 8	222	+ 12	9	1,891	− 31
Portsmouth Corporation	,, 11	1,[illegible]	− 51	§49	91,219	+ 6,496
Potteries	,, 8	1,579	+ 37	9	14,206	+ 379
Reading Corporation	,, 9	525	− 7	...	...	...
Rochdale Corporation	,, 11	412	+ 218	50	18,422	+ 1,048
Rotherham Corporation	,, 9	604	+ 19	49	22,286	+ 2,025
Rothesay	,, 8	51	+ 12	9	390	+ 83
Salford Corporation	,, 18	2,571	+ 251	49	199,273	+ 9,846
Sheerness	,, 1	52	+ 10	9	457	+ 71
Sheffield Corporation	,, 11	4,516	+ 69	§50	251,[illegible]	+ 6,596
Southampton Corporation	,, 8	775	− 10	49	[illegible]265	− 2,678
Southend Corporation	,, 8	925	+ 24	49	16,531	+ 1,603
Southport Tramways	,, 8	265	+ 28	9	1,963	− 54
S. Staffordshire Trams.	,, 8	649	+ 19	9	5,611	− 253
Stockport Corporation	Mar. 10	444	+ 60	49	26,338	+ 5,578
Sunderland Corporation	,, 13	1,117	− 5	50	61,181	+ 1,597
Swansea Trams	,, 8	463	+ 46	9	3,930	− 2
Swindon	...	...	...	...	...	...
Taunton Trams	,, 8	40	− 2	9	342	− 55
Tynemouth and District	,, 8	109	− 14	9	1,476	− 202
Tyneside Trams Co.	,, 8	852	+ 76	10	8,162	+ 438
Wallasey District Council	,, 11	696	+ 64	‡49	36,035	+ 2,555
Walsall	,, 11	444	...	10	4,335	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 9	1,076	...	...	52,688	...
Weston-super-Mare	,, 1	22	+ 6	9	228	+ 25
Wigan Corporation	...	...	...	...	...	...
Wolverhampton Corpn.	,, 8	330	+ 156	48	33,654	...
Wolverhampton District	,, 8	330	+ 96	9	2,978	+ 146
Worcester	,, 8	243	+ 31	9	2,172	+ 663
Wrexham	,, 8	97	− 5	9	810	− 25
Yorkshire Woollen District	,, 8	510	+ 80	9	4,307	+ 582

(a) These comparisons are with the corresponding period last year. † Minus a day. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. ** Fortnight. * Partly electrical.

MONTREAL LIGHT & POWER CO.—It is announced that an English syndicate has acquired a controlling interest in this company, which has a practical monopoly of electric power supply of the city. The syndicate has purchased 20,000 shares.

RAILWAYS AND TRAMWAY COMPETITION.—The directors of the Great North of Scotland Railway Co. attribute the reduction in the passenger revenue mainly to the competition of Aberdeen city and suburban tramways.

At the meeting of the Caledonian Railway Co. on Tuesday, Sir James Thompson said the company's loss in both ordinary passenger revenue and season tickets was largely attributable to the extension of the Glasgow tramway system beyond the bounds of the city. He held that this was not a legitimate form of municipal enterprise. Apart from the fact that the Corporation was utilising the credit of the city (in which the company was the largest ratepayer) for competing with the company for the conveyance of passengers to and from the suburban and country districts, the effect of these tramway extensions was that the Corporation was offering inducements to the population of Glasgow to reside outside the bounds of the city, thereby reducing the assessable value of the city, and increasing the ever-growing burden of taxation on those whose works and property remained within the city. The more money spent in taking the tramways to the less populous districts outside the city, the smaller would be the revenue in proportion to the capital expended, and if this policy was persevered in it was likely to result in a serious injury to the tramway service within the legitimate area of operations.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to appoint special settling days in fully and partly-paid scrip for £800,000 4 per cent. perpetual debenture stock of the *Charing Cross, Euston & Hampstead Railway Co.*, and fully and partly-paid scrip for £1,200,000 4 per cent. perpetual debenture stock of the *Great Northern, Piccadilly & Brompton Railway Co.*, and to allow same to be quoted in the official list. The committee have also been asked to grant quotations to a further issue of £50,000 4 per cent. debenture stock of the *Charing Cross, West End & City Electricity Supply Co. (Ltd.)*, 500,000 £1 fully-paid ordinary shares, 500,000 £1 fully-paid 6 per cent. cumulative preference shares and £500,000 5 per cent. mortgage debentures of the *Lisbon Electric Tramways (Ltd.)*; a further issue of £25,000 4½ per cent. debenture stock of the *Potteries Electric Traction Co. (Ltd.)*, and £537,351 5 per cent. assented extension preference stock and £962,649 5 per cent. unassented extension preference stock (in lieu of the £1,500,000 5 per cent. extension preference stock now quoted) of the *Metropolitan District Railway Co.*

SUDDEUTSCHE KABELWERKE A.G. (MANNHEIM).—The past year's net profit was 317,360m. (about £15,800), against 230,220m. (£11,500) in 1903. A dividend of 5 per cent. has been declared (against 4 per cent. last year.)

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., Mar. 15.	Rate per Cent. Yielded.	Dividend Due.	Business Week to Mar. 15 High est.	Business Week to Mar. 15 Low est.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
	3/0	Anglo-Argentine Ord. Shares	5¼–5¾	3 5 6	Ap, Oc	5½	5⅜
	2/6	Do. 5% Cum. Pref.	5¼–5½	4 5 1	..	5⅜	5⅜
St.	6%	Do. Permanent 6% Deb. Stock	140 –145	4 3 11	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	105 –107	4 14 4	—	105½	105
10	6%	Barcelona Tramways Ord.	12 –12½	4 16 2	—	..	..
10	5/0	Do. 5% Cum. Pref.	9½ –10	5 0 0	—	..	..
100	4½%	Do. 4½% Deb. Stock (red.)	98 –100	4 10 0	—	..	..
100	5%	Do. 5 per Cent. Debs.	99 –102	4 18 1	..	..	..
1	..	Brisbane Electric Trams. Invest. Ord.	1⅛–1⅜	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾–4¼	5 17 8	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	94 –98	4 11 10	..	..	..
St.	6%	British Columbia Elec. Rlwy Def. Ord.	103 –106	5 13 3	—	..	..
St.	5%	Do. Pref. Ord. Stock	100 –103	4 17 2	—	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 –10½	4 10 11	—	10⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Dbs	105 –107	4 5 9	..	106½	106½
100	4½%	Do. Vancouver Power Debs.	99 –102	4 8 3	..	100½	..
5	1/6	Buenos Ayres and Belgrano Ord.	3½–4	5 12 6	—	..	..
5	2/0	Do. 6 per Cent. "A" Cm. Pref	4½–4¾	5 2 2	—	4⅝	..
5	2/0	Do. "B"	3¾–4	5 6 8	—	..	..
St.	5%	Do. 5 per Cent. Debs.	107 –109	4 11 8	—	107½	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	103 –106	4 15 8	—	104	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	97 –99	5 1 0	..	..	..
1	2/0	Calcutta Tramways	3½–3¾	2 17 7	—	3⅝	3½
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 –108	4 3 4	—	..	..
1	7/6	Cape Electric Tram Shares	1½–1¾	5 0 0	—	1⅝	1½
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red.)	102 –104	4 18 1	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	101 –103	4 17 3	Ja, Jul	..	..
100	6%	Montreal St. Ry. St'g 6% Mort Debs. (1908)	101 –104	4 16 8	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 –105	4 5 9	..	..	..
St.	5%	Perth (W.A.) Elec. Trams, 1st Mt. Deb. Stk.	104 –107	4 13 5	..	..	..
		ELECTRICITY SUPPLY.					
5	2/0	Calcutta Electric Supply Ord.	9 –9½	3 10 3	—	9¼	..
1	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2 –2½	..	..	..	..
St.	5%	Do. 6% Debs.	86 –91	6 9 11	..	..	..
10	..	Havana Electricity Co. Shares	9½–10½	—	—	9¾	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	1½–1¾	..	—	..	..
1	..	Rand Electric	1 –1¼	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	100 –102	4 8 0	Ap, Oc	..	...

* In calculating the yield, allowance has been made for accrued interest but not for redemption.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., Mar. 15.	Rate per Cent. Yield. £ s. d.	Dividend Due.	Business, Week to Mar. 15. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
1	..	Bath Elec. Trams Pref. Ord.	¾—⅞	..	..	..	..
1	1½d.	Do. 5% Cum. Pref.	1⅛—1³⁄₁₆	4 14 1	..	..	..
St.	..	Do. 4½ 1st Mort. Deb. Stock (red.)	103 —106	..	..	104½	104½
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	99 —101	..	..	100	..
10	9%	†Bristol Tramways and Carriage Ord.	18 —19	4 14 4	Feb, Aug	..	—
10	6%	Do. Cum. Pref. (fully paid)	10 —10½	5 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	105 —107	3 14 10	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	9¼—9¾	6 2 11	..	9½	9⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾—11¼	5 7 10	Feb, Aug	11	10¾
St.	5/0	Do. 5 per Cent. Perpetual Debs	122 —124	4 1 4	—	123½	121½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	97 —99	4 10 11	..	98½	98¼
St.	4%	Central London Ordinary Stock	93 —95	4 4 2	June, Dec	93½	92¾
St.	4%	Do. 4 per Cent. Pref. Stock	101 —103	3 17 8	—	..	..
St.	4%	Do. Deferred Stock	83 —86	4 13 1	—	..	..
100	4%	Do. 4 per Cent. Debs.	110 —112	3 11 5	—	5	..
5	2/6	City of Birmingham Trams 5% Cm. Prf.	4⅞—5⅛	4 17 6	—	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	101 —104	3 17 8	..	..	..
St.	1½%	City and South London Rly. Con. Ord.	44½—45½	4 18 11	Feb, Aug	45½	45
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120 —123	4 1 4	Feb, Aug	122½	..
St.	5%	Do. (1896)	118 —121	4 2 8	..	121½	119½
St.	5%	Do. (1901)	114 —117	4 5 6	..	115	..
St.	4%	Do. 4 per Cent. Perpetual Debs	108 —110	3 12 9	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13 —14	4 5 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	16¼—16¾	3 12 9	—	..	..
10	4 0	Gt. Northern & City Rly. Prf. Ord. (4%)	6 —6½	3 13 0	—	..	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —13	..	..	9	..
10	9%	†‡Imperial Tramways Ord	18 —19	4 14 4	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—15½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	110 —112	4 0 2	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3 —3½	7 2 10	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89 —92	4 7 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	2¾—3¼	5 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10 —10½	4 15 3	..	10¼	10¼
St.	4%	Do. 4% 1st Mort. Deb. Stock	99 —102	3 19 2	—	101½	100
St.	..	Mersey Con. Ord. Stock	4 —7	..	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10 —13	..	—	..	..
1	..	Metropolitan Electric Trams Def	⅜—⅝	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	1—1⅛	4 17 1	—	1	..
St.	4½%	Do. 4½% Deb. Stock	106 —107	4 5 6	..	106½	106½
5	..	New Gen. Tract. 5 per Cent. Cum. Pref.	½—1½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	9½—9¾	5 2 6	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9 —9½	5 5 3	Feb, Aug	9⅛	9½
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 —105	4 5 9	—	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	—	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
	5%	Underground Elec. Rys. Co. of London	98 —99	5 2 0	..	100⅛	98½
St.	1½%	Waterloo and City Ord.	92 —94	3 6 5	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —102	4 0 0	Jan, July	..	..
10	..	Amazon Telegraph	1½—1⅞	..	Jn, Dec ..	..	..
100	..	Do. 5% Debs. (red.)	70 —76	..	..	..	..
St.	17/6	Anglo-American	61 —63	4 7 3	F,My,Ag,N	63½	60
St.	35/0	Do. Preferred	105½—107½	6 0 6	F,My,Ag,N	106½	106½
St.	2/0	Do. Deferred	16½—16¾	..	F,My Ag,N	17½	15½
100	$2	Commercial Cable Capital Stock	230 —240	3 6 8	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	98 —100	4 0 10	Jn Ap,Jy,O	98½	99½
10	5/0	Cuba Submarine Ord.	8½—9½	5 8 0	Feb, Aug	9⅛	..
10	10/0	Do. Preference 10 per Cent.	17 —18	5 11 1	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3½—3¾	5 11 9	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8½—8¾	5 10 5	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	101%—103%	4 7 10	Jan, July	..	..
20	3/0	Direct United States Cable	11½—12½	5 5 5	Ja,Ap,Jy,O	11⅞	11½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 —102	4 7 7	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	146 —148	4 14 7	Ja,Ap,Jy,O	147½	146
St.	17/6	Do. 3½ per Cent. Pref. Stock	92 —94	3 14 5	Ja Ap,Jy,O	93½	91½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 —109	3 13 5	May, Nov	108½	108
10	2/6	Eastern Extension	14½—15	5 0 0	Ja,Ap,Jy,O	14½	14½
St.	4%	Do. 4 per Cent. Deb. Stock	105 —107	3 14 9	Feb, Aug	106½	106
100	4%	* Eastern & S. African 4% Mrt. Deb, 1900	100 —102	3 18 5	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%—103%	3 17 8	May, Nov	101	101½
10	5/0	Great Northern (of Copenhagen)	32½—33½	4 9 8	Jan, July	32½	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100 —102	4 8 3	June, Dec	..	..
25	12/6	Indo-European	47 —49	5 2 0	May, Nov	47½	47½
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	98 —101	3 19 2	June, Dec	..	—
10	4/0	West African Telegraph Shares	3 —3½	5 17 8	—	..	..
2½	—	West Coast of America	⅛—³⁄₁₆	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	100 —102	3 18 5	Jan, July	..	..
10	—	West India and Panama	½ —1	..	May, Nov	½	..
10	7/0	Do. 6% 1st Pref.	8½—9	7 4 5	May, Nov	9	..
10	—	Do. 6 per Cent. 2nd Pref.	8½—8¾	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	103 —105	4 15 3	Jan, July	..	..
10	3/0	Western Telegraph	14 —14½	4 16 6	Mr,Jn,O,D	14½	14¼
100	5%	* Do. 5% Debs. (2nd Series, 1900)	101 —106	4 17 1	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	106 —108	3 16 11	—	108½	..
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	6½—6¾	5 1 9	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	½—⅝	2 11 9	..	..	..
St.	6%	†National Co. Pref. Stock	110 —111	5 8 1	—	112½	109½
St.	5%	‡ Do. Def. Stock	103 —106	4 14 4	..	107½	106
10	6/0	† Do. 6 per Cent. Cum. 1st Pref.	[illegible]	4 5 11	Feb, Aug	..	..
10	6/0	† Do. 6 per Cent. Cum. 2nd Pref.	12 —13	4 12 4	Feb, Aug	13½	..
5	2/6	† Do. 5 per Cent. Non-Cum. 3rd Pref.	6½—6¾	4 8 11	Feb, Aug	[illegible]	[illegible]
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	100 —102	3 8 7	June, Dec	101½	100
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104 —106	3 15 5	..	105	104
1	0/7½	Oriental	1½—1¾	4 4 2	April, Oct	1½	1¼
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛—1³⁄₁₆	4 11 5	..	1⅛	..
St.	10/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101 —104	..	..	..	—
5	3 0	United River Plate	7½—7¾	5 8 3	July......	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 17 9	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	107 —109	4 11 9	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	1/3	Elec. & Gen. Investment 5% Cum. Pref.	4½—5	5 0 0	—	..	..
10	3/0	Globe Telegraph and Trust	10½—11	5 0 0	Ja Ap,Jy,O	11	10½
10	3/0	Do. 6 per Cent. Pref.	14½—14¾	4 0 8	Ja Ap,Jy,O	14½	14½
100	6%	Submarine Cables Trust (Cert.)	125 —128	4 13 9	April, Oct	..	..
		ELECTRICITY SUPPLY.					
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½—13½	5 5 5	..	12⅞	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 7 10	..	10⅛	10¼
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	105 —107	4 4 1	—	..	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5½—5¾	3 9 7	..	..	..
St.	4½%	Do. Do. 1st Debs	101 —104	4 7 0	—	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—11½	4 13 0	..	10½	10⅛
5	3/6	Do. 7 per Cent. Pref.	10¼—10½	3 6 1	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105 —108	3 14 1	..	..	..
5	4/0	Charing Cross (W. End & City) El. Sup. Co.	5 —5½	4 14 2	Feb, Aug	5⅛	5
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	3 17 0	Feb, Aug	5½	5½
St.	4%	Do. 4% Deb. Stock (red.)	104 —106	3 15 6	..	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5⅛	4 4 9	—	..	..
5	2/3	Do. Do. (1903)	4½—5⅛	4 4 9	..	5⅛	..
5	3/9	Chelsea Electric Supply Ord.	6¾—7¼	4 2 3	March ..	7⅛	7
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109 —111	4 1 1	Jn, Dec ..	110	..
10	7/0	†City of London Electric Lighting Ord.	15½—15¾	4 15 1	Feb, Aug	15½	15½
10	6/0	† Do. 6 per Cent. Cum. Pref.	13½—14	4 5 8	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	125 —127	3 18 8	Jn, Dec ..	..	—
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	103 —105	4 5 9	..	104½	..
10	4/0	County of London Elec. Supply Ord.	9½—10	4 0 0	..	9⅞	9¾
10	6/0	Do. 6 per Cent. Cum. Pref.	12½—13½	4 16 1½	Mar, Sept	13⅛	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	110 —113	4 0 2	—	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	104 —106	4 6 7	—	105½	105½
5	2/0	†Folkestone Electricity Supply Co. Ord.	5½—6	4 11 9	—	5⅞	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 —104	4 6 7	—	..	—
5	3/6	Hove Electric Lighting Ord.	7½—8	5 6 2	..	8	7⅞
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	101 —103	4 9 1	..	..	..
5	7/0	Kensingtn. & Kngtsbdg. Ord. [illegible] bonus	11½—12½	4 10 7	..	—	—
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	—
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	103 —104	3 17 3	—	..	..
3	1/6	London Electric Supply Ord.	2⅛—2¼	3 4 6	—	..	..
5	3/0	Do. 6 per Cent. Pref.	5½—6	5 0 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	99 —101	3 19 2	Mr,Jn,S,D	101½	100
10	11/0	†Metropolitan Electric Sup. Ord.	18½—19	4 17 4	April, Oct	18⅞	19
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½—5¾	3 16 8	Jan, July	5½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —115	3 18 3	Jn, Dec ..	113	—
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 —99	3 10 8	..	97½	96½
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	99 —101	4 9 1	..	..	..
10	7½%	†Newcastle & Dist. Elec. Ltg. Ord. £9 paid	15½—17½	4 18 9	Feb, Aug	16½	..
5	8%	Newcastle Elec. Supply Ord.	8¼—8½	4 15 9	Feb, Aug	..	..
5	6%	Do. 6 per Cent. Non-Cum. Pref.	6⅛—6¼	4 0 0	Feb, Aug	6⅛	6½
1	[illegible]	Northern Counties Elec. Sup. 17/- pd.	15/6—15/9	3 5 11	Mar Sep	15/6	15/-
10	5/0	†Notting Hill Electric Ord.	14½—15½	4 0 0	March....	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	103 —106	3 17 0	..	..	..
5	4/6	†Oxford Electric Ord.	6 —6½	5 12 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 —100	4 0 0	..	..	..
5	9/6	St. James' & Pall Mall Elec. Ord.	13½—14½	5 1 9	Feb, Aug	14½	14
5	3/6	Do. 7 per Cent. Pref.	5½—6½	6 0 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98 —100	3 10 0	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	7½—8½	5 10 7	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	79 —83	4 16 5	..	..	..
5	4/0	†South London Electric Supply Ord.	4½—4¾	3 8 7	—	4⅛	4½
1	..	South Metrop'n Elec. Lt. & Power Ord.	½—1	..	—	..	..
1	0/8½	† Do. 7% Cum. Pref.	1⅛—1³⁄₁₆	4 17 0	—	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. Econ.)	107 —110	4 2 2	—	..	..
5	2/6	Urban Electric Supply Ord.	5⅛—5⅜	4 17 0	—	5⅞	5⅞
5	2/6	Do. 5% Cum. Pref.	5½—5¾	4 16 3	..	5½	..
St.	..	Do. 4½% 1st Mort. Deb.	106 —108	—	..	108	..
5	7/6	Westminster Electric Supply Ord.	15½—17¼	3 5 8	Mar, Sept	17⅛	17
5	2/6	Do. 5 per Cent. Cum. Pref.	6½—6¾	3 14 0	—	6⅛	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	½—⅝	5 6 6	..	..	..
1	6d.	Aron Elec. Meter 6% Cum. Pref.	1⅛—1¼	..	..	—	—
5	4/0	British Insulated & Helsby Cables Ord.	5½—6½	6 3 3	July, Feb	6¼	—
5	3/0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101 —104	4 6 6	—	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	99 —101	4 9 1	—	..	..
5	3/0	British Westinghouse 6% Pref.	7½—7¾	3 17 5	—	7⅝	7⅝
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	91 —94	4 6 0	—	91½	91½
2	..	Brush Electrical Engineering	½—¾	..	March ..	½	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½—2	6 0 0	Mar, Sept	1⅞	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	92 —96	4 14 9	Mar, Sept	..	—
St.	4½%	‡ Do. Perpetual 2nd Deb. Stock	79 —82	5 9 9	Jan, July	81	..
5	5/0	Callender's Cable Con. Ord.	11 —11½	4 8 5	Jan, July	11½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—6½	4 7 0	Jan, July	5¾	5⅝
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	105 —107	4 4 0	Nov, May	106	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	2—2⅛	4 9 6	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	91 —96	4 12 9	—	..	..
1	0/4½	Chadburn's (Ship) Telegraph Ord.	¾—1⅛	3 17 9	..	..	—
2	1/6	Crompton and Co. (Nos. 1 to 64,000)	2¼—2¾	5 3 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	93 —98	5 2 9	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	8 —8½	6 1 3	Sept	8¼	..
5	3/0	Do. 6% Cum. Pref.	5½—6¼	4 18 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	106—108	4 3 4	..	..	..
5	—	Edison & Swan United ("A" Sh.) (£3 pd.)	¾—1½	..	Feb, Aug	—	..
5	..	Do. (£5 paid)	1½—2	..	Feb, Aug	2	1
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	80 —85	4 14 2	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	56 —61	8 9 11	..	61	59
5	2/6	Edmundson's Elec. Corp. Ord.	6½—6¾	3 13 0	H'lf-yearly	6⅛	6
5	3/0	Do. 6 per Cent. Cum. Pref.	6½—6¾	4 15 8	—	6½	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106 —108	4 3 5	..	..	..
2	1/7½	Electric Construction Co.	1½—1¾	6 8 0	July	1½	..
2	1/9½	Do. 7 per Cent. Cum. Pref.	1⅞—2⅛	5 12 3	July	1⅞	2
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —99	4 0 10	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	—	..	—
10	6/0	General Electric (1900) 6% Cum. Pref.	9½—10	6 0 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91 —96	4 3 4	..	..	..
5	10/0	†Henley's Telegraph Works Ord.	13½—14½	5 17 6	Feb, Aug	14½	13½
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4 5 11	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (re.)	109 —111	4 1 1	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	16 —17	2 18 10	Feb, Aug	16⅛	16
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	103 —105	3 17 5	Mar, Sept	103	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11 —11½	4 7 0	Mar, Sept	..	..
12	24/0	†Telegraph Construction & Mainten'ce.	35 —37	6 7 6	Mar, July	37	35
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	103 —106	3 16 2	Jan, July	..	..
5	—	Willans and Robinson Ord.	1½—1¾	..	Apr, Oct	..	..
5	—	Do. 6 per Cent. Cum. Pref.	3 —4	—	Apr, Oct	3½	3½
	4%	Do. 4 per Cent. 1st Mort. Debs.	78 —83	4 16 5	May Nov	79	79

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

A large portion of our present issue is taken up by our Parliamentary and Legal Intelligence. Both in the Grand Committee Room of the House of Lords and in the Law Courts, matters of extreme importance to the electrical industry have been considered. The House of Lords Committee, to whom the London Power Bills have been relegated, have been hearing the evidence given in support of the Administrative County of London Electric Power Supply Bill. The objects of the Bill have already been dealt with at some length in our columns, but a new feature is introduced this week by the extraordinary and almost incredible estimates of the promoters as to the capital cost and works costs. Mr. C. H. Merz, who is engineering the project, and the Hon. C. A. Parsons, who is to supply the generating sets, estimate that the capital cost of the station (excluding mains and distributing system) will amount only to £8·4 per kilowatt. This low cost, the promoters aver, is to be due chiefly to the employment of boilers and generating sets of sizes hitherto unattempted, and by placing them in iron buildings, the new company seeking to be absolved from the bye-laws made under the London Building Acts. The boilers are to be supplied by Messrs. Babcock and Wilcox, and are to have an evaporative capacity of 30,000lb. per hour each, and the three-phase turbo-generators are rated for an economical capacity of 10,000kw. each, with 100 per cent. overload capacity, the alternators as well as the turbines being designed to work economically at 10,000kw., and to supply 20,000kw. if necessary for long periods. It may be mentioned that the largest turbo-generator sets yet built by Messrs. C. A. Parsons & Co. hitherto have been the 3,500kw. units at the Carville station of the Newcastle-on-Tyne Electric Co. Another feature in the economies is to be the extremely small expenditure upon mains, for it is put forward that everybody will take a supply in bulk or on a large scale, so that only short mains will be requisite. Detailed figures are given in our report.

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The works costs are estimated at 0·154d. per unit generated, the promoters apparently preferring to put their costs on this basis instead of on the more usual basis of units sold, in order to make comparison a little more difficult. In this connection it may be pointed out that the Newcastle-upon-Tyne Electric Supply Co. generated 24½ million units in 1904 but sold only 17 millions. These low works costs are also to be one of the results of the experiment with extremely large units if this proves successful, additional economies being gained by the use of an unlimited supply of water from the River Thames for condensing purposes, and a cheap supply of coal owing to the favourable sites chosen for the generating stations. The main reason for the low works costs, however, is, of course, the high load-factor which would accrue from power supply. The case for the opposition will be opened next week, when doubtless Mr. Merz's estimates will be subjected to severe criticism.

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In the Law Courts much interest centred around an action heard by Mr. Justice Lawrance and a special jury. A fault occurred on the distributing network of the Manchester Corporation Electricity Department one day in 1903 and resulted in a fire on a consumer's premises. The consumer brought an action against the Corporation to recover damages and, the amount of damage being agreed upon between the parties, the only questions to go to the jury were those of nuisance and negligence. It was contended by the plaintiff that the Corporation was negligent in employing a system of distribution which made it possible for such an accident to occur, thus constituting a nuisance; and further that the servants of the Corporation were negligent in not taking the proper steps to deal with the fault. Witnesses for the defendants maintained that the system employed in Manchester was, at the time of the accident, the best known, and that the accident could not possibly have been foreseen so as to be prevented. Moreover, they said that everything possible and reasonable was done as soon as the fault was discovered. Thus we have it from four eminent members of the electrical profession that, in 1903, it was not possible to put down a system of electrical distribution without the risk of burning down property situated in streets through which the system ran. It is a matter for the sincerest congratulation to the whole of the electrical industry that the jury did not accept this view, and it would seem that the witnesses have forgotten that there are such things as gas-tight cast-iron service boxes, in which it is quite safe to put a fuse.

Quite apart from the suitability of the system, however, it must be confessed that the practice of burning-out faults with many hundreds of horse-power is not to be encouraged; the cases in which this method of localisation is essential are in the minority, and Manchester has always been unfortunate with its distribution network. Many faults have occurred and it is not surprising. Some of the old rubber cables, at one time drawn into iron pipes, have been withdrawn and laid solid in bitumen, with, in many cases, disastrous results, which doubtless have been aggravated by the system of locating all the faults by the "column of smoke" method. The policy of employing for the "services" old rubber cable, unfit for use as mains, and laying it solid in wood troughs, has not been justified, and this is not the first fire due to the same cause. If the service had consisted of armoured cable laid directly in the ground, the fire caused by the fault could never have reached the consumer's premises. Probably the jury were influenced, not so much by technical details of this kind, as by the fact that previous fires had occurred on consumers' premises and compensation had been paid by the Corporation.

In the Appeal Court, the judges have affirmed the decision of Mr. Justice Farwell in the case of The Attorney-General (on relation of the Willesden Urban District Council) *v.* the Metropolitan Electric Supply Co. We pointed out in our leading article on the former occasion (*The Electrician* of November 4, 1904) how far-reaching the result of this decision will be, if affirmed, and the peculiar interpretation placed upon the Electric Lighting Acts. As the case is to be taken to the House of Lords, we are debarred from commenting on it at the present juncture, but we refer our readers to our previous article, pointing out what may be the limitations imposed on an industrial company by the acquisition of a Provisional Order, if Mr. Justice Farwell's reading of the Acts is affirmed by the Law Lords.

Mr. W. J. A. London's Paper on the mechanical construction of steam turbines and turbo-generators, an abstract of which appears in this issue, is a timely and valuable supplement to the articles on steam turbines which have appeared from time to time in these columns. The Westinghouse steam turbine, with which the author deals more particularly, is remarkably compact, owing to the fact that it is a combination of the action and reaction turbine. Being a double-flow turbine the dummy pistons are dispensed with, but it is open to doubt whether efficiency has not been sacrificed to obtain this feature. Nickel steel was considered at one time the material *par excellence* for turbine shafts, and it is significant that Messrs. Parsons have reverted to mild steel shafts, and that the Westinghouse Company also employs this material for the same purpose.

The portion of the Paper dealing with the electrical problems of turbo-generators is also interesting, and will repay close study. It seems to be generally agreed in this country that carbon brushes are out of place for turbo-generators, on account of the excessive friction losses which they involve, and the fact that they cannot effectively be kept from "dancing" when bearing on high-speed commutators. But carbon brushes have been and, as far as we know, are still used by one Continental firm of reputation, and in the generators attached to Curtis turbines. Carbon brushes are, of course, valuable from a commutation point of view, but with the advent of auxiliary poles and other compensating devices this quality loses its significance. It will be learnt with some surprise, from the remarks of Mr. F. H. Whysall in the discussion, that a 2lb. brass-wire brush of a 1,800kw. generator running at 1,050 revs. only lasts some 336 hours. After these generators have been equipped with compensating devices, the life of the brushes will doubtless be appreciably lengthened, since the short life was due to excessive sparking. The author's remarks concerning the shifting of armature conductors in the running machine are very much to the point and draw attention to the importance of securely embedding the winding. Much remains to be written on the construction of generators for turbine drive, and more Papers on the subject will be welcome.

There has been considerable comment in various quarters upon the terms of the wireless telegraph licences, published in our last issue, and in particular some doubt is expressed as to the scope of the clause in the "Commercial" licence prohibiting wireless telegraph companies from sending commercial messages to other countries. We believe that, should it happen that the Marconi Company succeeds in the near future in sending commercial messages across the Atlantic, it will be permitted to proceed with this business under certain conditions, in view of its pioneer work in this direction, but that the transmission of other foreign or colonial wireless telegrams is not likely to be allowed.

More important than this, however, is the announcement that we are enabled to make, that the projected second International Wireless Telegraph Conference is not to take place this year. The reason for this is evidently the war between Russia and Japan. It would have been necessary to invite both these Powers to send representatives to the Conference, but it is contrary to diplomatic precedent that representatives of two belligerent nations should meet at a convention of this nature. Consequently, the meeting, which was to have been the outcome of the Preliminary Conference in 1903, has had to be indefinitely postponed.

THE question has so frequently been raised whether large electricity works should also undertake house wiring, and it has so frequently been answered in the negative, that it is a matter for surprise that the municipal electricity works in London should persist in asking Parliament to grant them the power to carry on this business. In the case of "free wiring" or rented wiring schemes, in which the actual work is sub-let to a contractor, we have nothing to say against the practice; but we trust that all wiring contractors will strenuously oppose any attempt at establishing municipal competition with their business. It is a matter for regret that the "instruction" was not passed, which was moved by Sir F. BANBURY last week when the London County Council's Bill, seeking to confer wiring powers upon the London Borough Councils, came up for second reading in the House of Commons. Mr. JOHN BURNS, in support of the Bill, frankly confessed that its object was to deprive the "middleman" of his profit—the middleman in this case being the hard-working wiring contractor. The argument that the electricity supply companies in London have power to do wiring is not admissible, for they do not exercise it.

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Since the publication of our summary of Mr. E. H. RAYNER'S Institution Paper last week, we have received from the Engineering Standards Committee, on whose behalf the experiments were carried out, the full report (in book form) of the temperature experiments with field coils. The scope of these experiments was outlined in our last issue, and we need, therefore, only draw our readers' attention to one or two interesting points brought to light by the quantitative investigations. Of two field coils, wound with wire of 0·04in. and 0·072in., respectively, but otherwise exactly similar, the temperature rise in the coil with the thicker wire was appreciably lower than the temperature rise in the coil with the thinner wire, the C^2R losses being the same in both cases. This would indicate that coils with small percentages of cotton have lower temperature rises than coils with large percentages of cotton. Other experiments made indicate to what an unexpected extent the temperature of field coils depends on the thickness and nature of the final covering. These facts have, of course, long been known to dynamo designers in a general way, but exact figures have, so far, not been forthcoming. It is hoped that the experiments on insulating materials, to which we also referred last week, will be a guide in the direction of producing insulating substances retaining their good electrical and mechanical properties even at the highest temperatures, so that electrical engineers may look forward to a time when specifications will contain the temperature clause no more.

Personal.—Mr. J. C. Lamb, C.B., C.M.G., second secretary to the Post Office will retire on June 3rd next, by his own desire, after a full period of arduous and honourable service.

According to *Nature* Prof. Emil Warburg, of Berlin, has been appointed president of the National Physical Laboratory at Charlottenburg, and his place in the University is to be taken by Prof. Paul Drude, of Giessen.

Electrical Engineers (Royal Engineers) Volunteers.—Surgeon-Lieutenant C. H. Leaf, M.B., is gazetted Surgeon-Captain.

"A Short Introduction to the Theory of Electrolytic Dissociation."—The price of this book is 1s. 6d., and not 2s. 6d., as was incorrectly stated in the review which appeared in our issue of March 3rd.

Wireless Telegraph Notes.—Dr. Lee de Forest informs us that he has exchanged messages by wireless telegraphy between his station, erected at Key West for the U. S. Navy, and Chicago, a distance of 1,450 miles, most of which is overland.

Cable Interruptions.	Date of Interruption.
Cayenne—Pinheiros	**Aug. 13, 1902**
Belesi-Issa (Yemen)—Camaran	**Oct. 22, 1902**
Tarifa—Tangier	**Jan. 18, 1904**
Cayenne—Paramaribo	**July 13, 1904**
Jamaica—Colon	**Jan. 10, 1905**

Telephony in Canada.—*The Times* Ottawa correspondent announces that the Canadian House of Commons has, on the suggestion of the Government, appointed a special committee to investigate the telephone question. Sir William Mulock, the Postmaster-General, said that his personal view was that it was as much the duty of the State to take charge of telephones as to conduct the post-office.

McMillan Memorial Fund.—We are requested to say that Mrs. W. G. McMillan desires to thank in her own name and in the names of her children the numerous friends who so kindly contributed to this fund. It is impossible, on account of their great number, for her to thank them each individually, and she trusts, therefore, that they will accept this notice in acknowledgment of her gratitude for their generous kindness.

Interruption of Supply at Battersea.—An unfortunate breakdown occurred at the Battersea electricity works last Saturday night. The armature of a 750kw. generator went to "earth" at 8:50 p.m. causing a total extinction of the supply. Unluckily on the previous Thursday night a 350kw. machine had broken down in the same way. It was, therefore, impossible to cope with the demand at that hour in the evening, until the area had been split up into districts. By that time the demand was much lighter, and the whole supply was running again at 10:20 p.m.

Manchester Students' Inaugural Dinner.—Mr. C. D. Taite presided over a gathering of about 80 members of the Manchester students' section of the Institution of Electrical Engineers at the Grand Hotel, Manchester, on March 18th. He congratulated the hon. sec., Mr. A. E. Jepson, on the 200 per cent. increase in members since last year to the total of 300. Mr. E. W. Cowan said he envied the cotton mill owners who had experienced such an improvement in trade that they were having to refuse orders for cotton goods requiring delivery before July. Mr. F. O. Mills stated that the dinner was to be held annually, and suggested that active rivalry with the London students might be of general benefit.

Gilbert's "De Magnete."—An unusual circumstance has arisen in that two different London booksellers are offering for sale copies of the rare Latin first edition of Gilbert's famous book. This book is much rarer than the first folio Shakespeare, for while of that work no fewer than 156 copies are known to exist, there are only 68 copies of the first folio Gilbert known, and only two have been sold in the book auctions during the last 20 years. On the last occasion, nearly three years ago, an inferior copy fetched £15. 10s. A year ago a West End bookseller offered a copy at £24. Now Messrs. Maggs Bros. offer a copy at £19. 19s., and Messrs. H. Sotheran & Co. another copy, formerly in the library of the late Prof. Williamson, at £21. This latter is a remarkably fine clean copy with broad margins, the page measuring 11¼in. by 7¾in. It has the usual emendations in ink on pp. 11, 22 and 200; but as it lacks the usual emendation on p. 47, where "Non" is altered into "Aut," it is presumably an early copy from the press. The title page is clean and free from any inscriptions. It is to be hoped that this copy will be secured for some British library, and not pass, like many literary treasures, into foreign hands.

King's College (London) Engineering Society.—A lecture before the above society was delivered on Thursday last week by Prof. E. Wilson, the subject being "Magnetism." After a general introduction the lecturer showed the phenomenon of recalescence and the loss and recovery of magnetic quality in iron at about the same corresponding temperature. Iron can exist in a magnetisable and non-magnetisable condition at one and the same temperature according as it has been previously heated or cooled, and experiments were made to show that a nickel-iron alloy exhibits this property at about atmospheric temperature. In the two states the electrical conductivity, the tensile strength and density are respectively different. Experiments made to render a manganese-iron alloy magnetisable were unsuccessful. The lecturer suggested that such substances as copper, &c., were conceivably capable of being rendered magnetic if the means for varying temperature or varying magnetising force sufficiently were at our disposal. Experiments were then made with a large electro-magnet to illustrate the propagation of magnetism into the mass. The diffusion process, it was pointed out, depended in time upon the square of the linear dimensions when comparing similar magnets. Finally, the interesting effects of a rotating magnetic field (produced by polyphase current) upon pivoted copper discs and other shaped conductors were shown. The students asked a number of questions, and the meeting terminated with a hearty vote of thanks to the lecturer.

Electricity Supply Statistics.—The London County Council has just issued an analysis of the accounts of the various electric supply authorities in the county of London. In the case of the local authorities the period is for the year ended March 31, 1904, and of the companies December 31, 1903. So far as the latter are concerned, the particulars are somewhat belated therefore. The report runs into 22 foolscap pages of tables and information, a good proportion of which has already been given in a different form in our columns. The following figures are of interest, however. There are at present 15 local authorities and 13 companies supplying electricity in the London county area. During the periods above mentioned the local authorities sold 21,002,576 units for private supply and 6,960,561 units for public lighting, whilst the totals for the companies were 82,188,827 and 3,753,094. The total capacity of the plant of the various local authorities was 32,369kw., and that of the companies 107,386kw. The maximum load in each case was 19,031 and 70,987kw. The total connections expressed as the equivalent of 8 c.p. lamps was: local authorities, 1,211,983; companies, 4,553,965. The average prices received per unit by the local authorities for private supply were 3·59d. and by the companies 4·34d. per unit, and for public lighting 2·36d. and 2·01d. per unit respectively. The total sum raised by the local authorities was £2,995,051, whilst the capital raised by the companies was £11,815,101. The total revenue of the local authorities was £400,668 and of the companies £1,498,717.

Extension of Ilford Electricity Works.—The Ilford Urban District Council commenced its electric supply in April, 1901, with two 200kw. generating sets and one 100kw. set. Early in 1903 two 550kw. sets were added. But the demand for electric current increased so rapidly that a further extension became necessary. This latest addition, in the form of a 1,000kw. generating set for lighting and the corresponding extensions to the boiler plant, condensing plant, buildings, &c., was officially started yesterday afternoon after congratulatory and explanatory speeches by Mr. R. Stroud, J.P., Chairman of the Council, Councillor John Bodger, Chairman of the Lighting committee, Mr. A. H. Shaw, electrical engineer to the Council, and others. The new 1,000kw. set consists of a Belliss triple-expansion, vertical steam engine, running at 200 revs. per min., and coupled directly to a 1,000kw. Westinghouse generator, supplying current for lighting at 500 volts. The Allen condenser, used by the old plant, was formerly outside the building, but, as the building itself has been lengthened, it is now in the engine room. A new surface-condensing plant, also by Messrs. W. H. Allen, Son & Co., has been added to deal with the increase of generating plant. It is capable of condensing 27,000lb. of steam per hour. There is a grease separator, of Messrs. Holden and Brooke's make, and motor-driven air and circulating pumps. A new cooling tower has also been added. The extension panels on the switchboard were erected and fitted by Messrs. Kelvin & James White (Ltd.). The British Westinghouse Co. also supplied the new balancer set and reversible booster set, including the switchboards connected therewith. A water-purifying set has been erected in the yard by Messrs. Lassen & Hjort. Other additions are the coal bunkers, a weighbridge, steel tower and separating tank in the yard (into which the water from the well is lifted by compressed air) and an "Ados" CO_2 recorder in the boiler house.

Motor Car Exhibition.—Cordingley's tenth annual automobile exhibition was opened at the Agricultural Hall last Saturday and will close (to-morrow) Saturday at 10 p.m. Despite the several exhibitions of the same character that have already been held this year, the present exhibition has some interesting features of its own and is well worth visiting. The Krieger Electric Carriage Syndicate exhibit two of their well-known electric carriages. These are equipped with two compound motors, which are spring-suspended and drive the front wheels through single-reduction gearing. Starting resistances are not used, as all the variations in speed are obtained by grouping the battery halves and the motors in parallel or series, respectively. There are two positions of the controller handle for which electric energy is recuperated. The mechanical brake, when applied, automatically switches off the supply of current. The battery consists of 44 cells, the capacity of which, it is stated, will suffice to propel a four-seated car about 45 miles. A careful driver is said to be able to drive considerably further with the same initial charge. An electrically-driven carriage, exhibited by the Phœnix Carriage Co. of Birmingham, is noteworthy in that it is steered by an arrangement similar in action to those used on horse-drawn vehicles—that is to say, the front wheels and the front axle turn *en bloc* around one central pivot. It is claimed that this arrangement enables the carriage to describe sharper curves than is possible with the design usually adopted. There is one motor only, which drives through a differential gearing and by chains on to the back wheels. It is started and regulated by resistance control. An electric carriage is also exhibited by the Ekstrom Accumulator Co. Messrs. Geipel & Lange show an electric speed indicator, consisting of a small self-oiling waterproof magneto driven by a rubber band from an aluminium pulley fixed to the spokes on the inside of the off front wheel. The speed is read off on a hot-wire voltmeter graduated in miles per hour. The same firm have also high-speed trembling coils and hot-wire voltmeters on show. Messrs. S. Smith & Son show their speed indicators (fully described in a recent issue of *The Electrician*) and timepieces for motorists. The London Electrical Syndicate exhibit ignition batteries, portable electric lamps, coils, plugs and similar accessories.

Prof. J. J. Thomson on Radio-activity.—On Saturday afternoon Prof. J. J. Thomson delivered the second of his course of lectures on Radio-activity. The hour was devoted mainly to the analysis of the radiation from radio-active elements. Experiments on the penetrative powers, and on the deflection by magnetic and electric force, of the various rays were carried through successfully. The identity of the β and γ rays from radium with cathode rays and Röntgen rays respectively was also discussed. Incidentally, the lecturer gave a welcome explanation of the terms ion, corpuscle and electron. An ion is a charged atom or molecule, or group of atoms or molecules; in an ion the carrier of the electricity depends on the nature of the gas the ion is derived from. A corpuscle is exactly what is sometimes called an electron; it is always negatively charged, and has a mass which is the same whatever the substance it is obtained from—a mass about the one-thousandth part of that of the hydrogen atom. Prof. Thomson prefers the term corpuscle to the term electron, because the use of this second word seems to him to imply that positive electrons, of a nature analogous to the negative electron, should exist; and, so far, this is found not to be the case. The lecturer next described some very recent experiments he had made, which were commenced in an endeavour to find if smaller positive masses than those constituting the α-rays from radium could be detected escaping from a mass of radio-active substance. Some radium was placed very near to a small electroscope in an extremely high vacuum. It was then found, contrary to all expectation, that a copious stream of negative electricity was proceeding from the radium. This stream could, however, be diverted by a powerful magnetic field, and not till then could the ordinary α rays be detected by the electroscope. This fact showed that there proceeds from radium a plentiful flow of negative corpuscles travelling with low velocity. These corpuscles turn out to have the same mass and the same e/m as the β-rays. Their penetrative power is so extremely feeble that they have hitherto escaped discovery. Prof. Thomson proposes for this new radiation the name δ-rays.

Telephony.—In the second Cantor lecture, last Monday evening, Mr. H. Laws Webb dealt with the electrical, mechanical and commercial aspects of the telephone network, characterising this part as the most important and difficult to deal with. At the beginning of commercial telephony iron wires were used with earth return, and they are still employed for short lines in rural districts where cheapness of construction is essential. As the range of telephonic transmission increased, copper and bronze were substituted for iron. The speech over telephone circuits is attenuated by the losses due to the ohmic resistance in the telephone wires, to leakage of current and also to the losses in the dielectric where cables are used. In addition to this weakening of the current impulses received at the further end, the electric waves are also distorted by capacity and induction. Induction effects are got rid of by employing a complete metal loop and by revolving or transposing the conductors. Capacity plays a much more important part in cable lines than in overhead lines. It was much reduced in value by insulating the strands of the cable with cotton, silk or paper instead of rubber as was originally done. But the best means of eliminating capacity, the lecturer continued, consists in counteracting its effects by distributed self-induction, as proposed by Mr. Oliver Heaviside and first put into practice by Dr. Pupin, of America. This application of distributed self-induction represents, in Mr. Webb's opinion, one of the most splendid and important advances ever made in the telephonic art. Until a few years ago overhead wires were most extensively used for transmission, even in towns, and especially in America and on the Continent. But owing to the increase of the telephone business and to the interruptions and damage caused by storms, cables have been employed in recent years more and more extensively, especially in cities. Mr. Webb then proceeded to describe the various kinds of ducts for cables, the manner in which the cables are drawn in and jointed, illustrating his remarks by many instructive lantern slides. The difficulties which beset the telephone engineer in laying cables in cities were also dwelt upon, and some especially striking pictures illustrating these difficulties in London were thrown on the screen. The lecturer concluded by describing the two methods in use for splitting up a telephone main first into branches and then into single pairs ready to be brought into the telephone user's premises. Some specimens of telephone cable were exhibited, the largest specimen containing some 400 pairs of wires.

Students' Dinner.—On Thursday last week the students of the Institution of Electrical Engineers held their first annual dinner, Mr. H. D. Symons, Chairman of the Students' Section, presiding. Among the guests were Mr. Alexander Siemens (President of the Institution), Prof. J. Perry, F.R.S., and Mr. R. Kaye Gray (Past Presidents), Messrs. J. E. Kingsbury, W. M. Mordey and W. H. Patchell (Vice Presidents), Mr. H. E. Harrison and Prof. Ernest Wilson; and about 70 students were present. Mr. C. H. Lang (the Students' Vice-Chairman) proposed the toast of "The President and the Institution," to which Mr. Siemens and Mr. Patchell replied, the President reminding his hearers of the necessity of co-operation in addition to individual effort. Prof. Perry, in proposing "The Students' Section," said that it seemed a recognised thing when addressing students to give advice—advice similar in nature to copy-book maxims. He referred to a recent address to the students which, although "snappy and paradoxical," still on examination amounted to a repetition of the same old copy book maxims. Three-quarters of those who gave advice to students had never studied the question of education, and were nothing but amateurs. In fact, the whole of our educational system suffered from being too amateurish, and the reason was largely that the country did not offer decent pay to attract decent men to occupy the posts. Prof. Perry then went on to criticise, as in his presidential address of a few years ago, the tendency for engineers to work as if experimental science had done its most, and to desire everything standardised: this, he maintained, would ultimately result in the profession degenerating into a trade. Those who started only with the idea of earning salaries and becoming rich, he warned them, would not even get as far as the salaries. Mr. Symons, in responding to the toast, alluded to the recent improvement in the attendance at the students' meetings, the success of the students' papers, and of the Easter visits to works. He also referred appreciatively to Mr. A. G. Ellis's services as the students' honorary secretary. Mr. F. Creedy gave the toast "The Colleges," and incidentally pointed out that the English student was certainly welcomed by American electrical firms, in spite of the fact that such unfavourable comparisons were drawn in our own country between English and American electrical engineers. Prof. Ernest Wilson and Mr. H. E. Harrison replied, Prof. Wilson speaking of the changes which the technical educational system of London had recently undergone, and Mr. Harrison emphasising the necessity of good generals, since the majority of the rank and file were becoming neither skilled workmen nor electrical engineers. Mr. G. A. Freire-Marreco then proposed "The Guests," Mr. W. M. Mordey responding. Mr. Mordey's advice was "aim at being underpaid," otherwise there was no chance of getting a "rise."

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, March 24th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Pender Electrical Laboratory, University College, Gower-street, W.C., by the invitation of Prof. J. A. Fleming, F.R.S. Agenda. (1) "Note on the Voltage Ratios of an inverted Rotary Converter." By W. C. Clinton. (2) "On the Flux of Light from the Electric Arc with varying Power Supply." By G. B. Dyke. (3) "The Application of the Cymometer and the Determination of the Coefficient of Coupling of Oscillation Transformers." By Prof. J. A. Fleming, F.R.S. (5) Exhibition of Cymometers and other instruments.

RUGBY ENGINEERING SOCIETY.

8 p.m. Meeting in the Benn Buildings, High-street, Rugby, when Mr. J. T. Milton will deliver the third and last of his course of lectures on "The Minute Structure of Metals."

ELECTRO-HARMONIC SOCIETY.

8 p.m. Smoking Concert (the last of the season) in the King's Hall, Holborn Restaurant.

ROYAL INSTITUTION.

9 p.m. Evening Discourse by Sir Oliver Lodge, F.R.S., on "A Pertinacious Current."

SATURDAY, March 25th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture III:—"Electrical Properties of Radioactive Substances," by Prof. J. J. Thomson, F.R.S.

ASSOCIATION OF TEACHERS IN TECHNICAL INSTITUTE.

7 p.m. Meeting at the Regent-street Polytechnic, when an Address will be delivered by Mr. W. J. Lineham on "Technical Training: a Teacher's View."

MONDAY, March 27th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture III.: "Telephony," by H. Laws Webb.

TUESDAY, March 28th.

SOCIETY OF ARTS.

4.30 p.m. Meeting of the Colonial Section. Paper to be read: "The Manufacturers of Great Britain II. Australasia," by the Hon. Walter Hartwell James, K.C.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER LOCAL SECTION.

7.30 p.m. Meeting in the University. Paper to be read: "Use of Electrical Energy in Mines and Collieries," by M. B. Mountain.

WEDNESDAY, March 29th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7.30 p.m. Meeting at 92, Victoria-street, Westminster, S.W. Paper to be read: "A Modern Generating Station, with Special Reference to the Lot's-road, Chelsea, Station," by Mr. Chaffers.

FRIDAY, March 31st.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Extra Meeting, when the "First Report of the Steam Engine Research Committee" will be further discussed.

MECHANICAL CONSTRUCTION OF STEAM TURBINES AND TURBO-GENERATORS.*

BY W. J. A. LONDON.

The present Paper deals briefly with some of the difficulties met with in the successful design of steam turbine machinery, and it is hoped that advantage may be gained by the opening of a discussion on this important subject. The steam turbine has, during the last two or three years, come into such prominence, threatening, as it does, revolution in the steam engine world, that engineers and scientists have realised the importance of fathoming and understanding, as much as possible, the various laws governing its action.

The bedplates of large turbo-generators should be of some moderately inelastic body, such as concrete, or brick and cement, and should extend the whole length of the turbine bedplate. Steel or iron constructions in foundations are not to be recommended as they invite trouble, due to vibration.

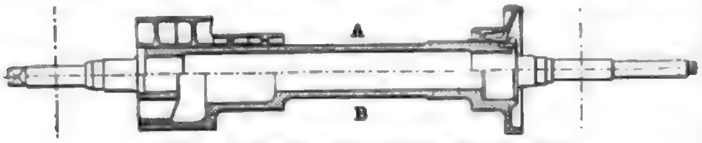

Fig. 1.—Construction of Turbine Shafts.

In the Parsons and Westinghouse turbines expansion takes place in the revolving blades as well as in the stationary blades. This calls for fine radial clearances. With a drum type of spindle the loss by radial clearance space is somewhat larger than is the case with a disc type of machine, but skin friction is reduced to a minimum, there being no big areas revolving in media of different densities.

Owing to the difference of pressure between the two sides of the rotating vanes in a Parsons turbine, the whole annulus must be filled with steam so that small diameters and low velocities have to be resorted to where its density is very high, in order that the percentage of clearance to blade height will not be excessive. As the steam expands, its volume increases, and as the number of rows or blades varies with the square of the velocity, it is advantageous to step up in the diameter of the spindle as soon as possible. Various designs have been tried for these spindles, one type being shown in Fig. 1A, which consists of a plain forged steel drum having ends pressed into it of high carbon, or nickel steel. The steps are taken care of by a series of cast-steel rings. This type of spindle has the advantage that the forged steel body in itself is more homogeneous than the casting, and consequently is less likely to cause balancing troubles. The cast-steel rings can each be separately balanced and shrunk on. The disadvantage to this type is the number of parts necessary to make the whole, and the amount of machining and fitting necessary, which makes this construction somewhat expensive. Messrs. Parsons now use the type of spindle shown in Fig. 1B for all their designs, using cast steel for the drum. With spindles of this design balancing troubles are often very serious, it being impossible to guarantee absolutely homogeneous material, and on account of the weakest section falling midway between the bearings whipping is likely to occur, due to unbalanced mass.

The design of the stationary part of a Parsons turbine is a very important item, especially with large machines. As the diameters increase the greater is the tendency for distortion. Further, the cylinder cannot readily be supported between the bearings, owing to the fact that the centre part of the cylinder is at a higher temperature than the two ends, and the consequence would be that the cylinder would lift in the centre; this is exactly what must not take place. Further, any support or irregularity cast on to the part of the cylinder that must remain concentric at once causes distortion, and makes the cylinder elliptical or otherwise out of truth. It is, therefore, clear then that no rigid supports can be placed in the cylinder between the bearings. If ribs are necessary for stiffening on the under half they should be duplicated on the top half.

The British Westinghouse Co., between two and three years ago, when entering the field of turbine manufacture, arrived at the conclusion that the most successful turbine should combine the principles of action and re-action. The objections to building turbines on the straight Parsons principles lay in the great overall length, mechanical difficulties in the construction of the spindle, and the adoption of dummy packing rings to eliminate end thrust. By making the turbine double flow—that is, by admitting steam in the centre and passing same through equal rows of blades on each side—end thrust and dummies were eliminated, although the overall length of the machine becomes much greater than that of a straight Parsons turbine; further, the initial blade height would only be half the length of a single flow. This limiting blade height again would necessitate the stepping of the spindle.

In expanding steam from 160lb. abs. to 27in. of vacuum, the available work in heat units is 325 per lb., in expanding from 160lb. down to 60lb. abs. the available work is 78·9 B.Th.U., or about 24 per cent. of the total work in the whole expansion. In view of this it was considered that a slight decrease in efficiency might be allowed in the high-pressure end of the turbine if considerable mechanical improvements could be effected thereby. By adopting a combined impulse wheel for the expansion from boiler pressure to about 60lb. abs., it was found that the velocity necessary for the wheel fixed such a diameter that Parsons blading could be successfully used on the one diameter already determined by the velocity of the impulse wheels. The specific volume of the steam at 60lb. pressure was so much increased from boiler pressure that the initial blade height on a large diameter was not prohibitive. The result of this combination is that a machine can be built which is very much shorter than the Parsons machine for given conditions, at the same time maintaining the high degree of efficiency. With this type of machine skin friction of the discs of the ordinary impulse type of machine is eliminated. The efficiency of the compound impulse section is comparatively high, but perhaps not so great as the remainder of the machine; this again is probably balanced by the losses due to skin friction in the long high-pressure end of the Parsons machine.

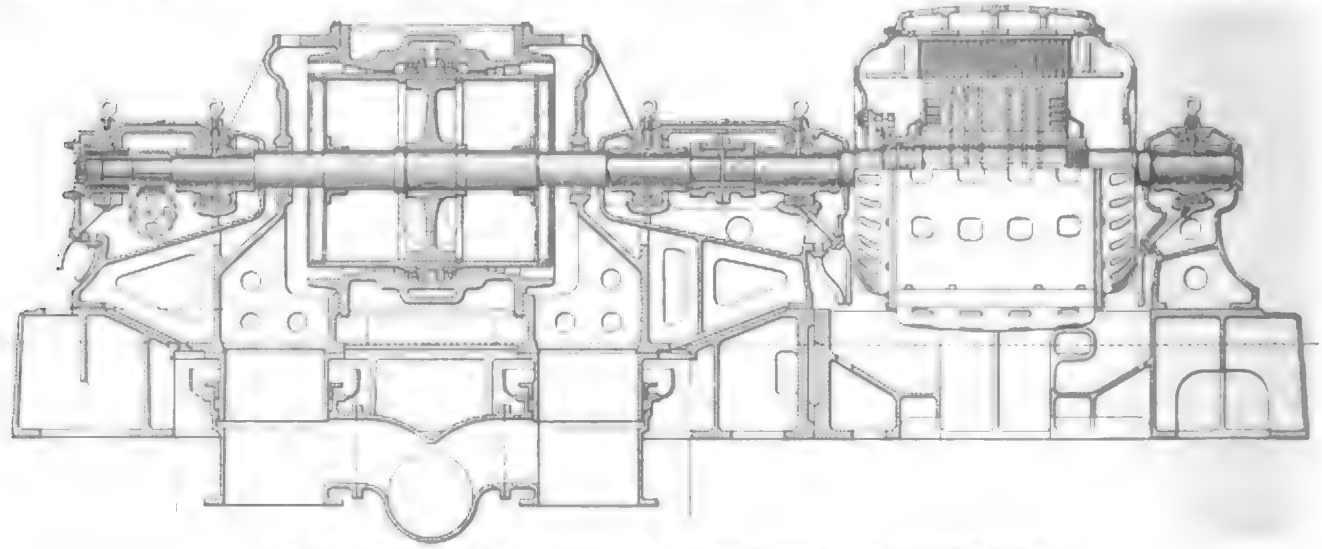

Fig. 2.—Longitudinal Section through a British-Westinghouse Turbo-Generator.

A longitudinal section of a British Westinghouse turbine is shown in Fig. 2 and the design allows of forged steel being used throughout in the construction of the rotating members. A centre shaft of high carbon steel extends from one bearing to the other, on which is shrunk the disc supporting the blade carrying drum. The centre disc is of forged steel and the outer drum is of weldless rolled steel. This outer drum carries the impulse blades in steel rings which are shrunk on. The Parsons blading is carried directly in grooves in the main drum. Stiffening discs of thin steel are also fitted into the ends of the drum. A spindle of this construction is extremely stiff, and having a through-going shaft there are no joints in the spindle likely to give way and cause trouble. The stresses due to centrifugal force in a reasonably thin drum can be reduced mathematically to the following simple equation :—$C = MV^2$, where C = centrifugal force, M = mass of material, V = mean velocity in feet per second.

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* Abstract of a Paper read before the Manchester Local Section of the Institution of Electrical Engineers on February 28th.

A further simplification of this formula, which, when considering steel or other material of similar density, is near enough for rough calculations only, is $C_1 = V^2/10$, C_1 in this case being the stress per square inch. The radius has no effect on the centrifugal stresses (other than loading by the blading), and the peripheral velocity is, therefore, the limiting feature.

Special construction of the generator is necessary to cope with the speeds demanded by this class of prime mover. The majority of continuous-current generators to-day are constructed with semi-enclosed slots, a keypiece being driven in on top of conductors. This construction is satisfactory for the core of the armature, but the end windings require some other method of support. Fig. 8A shows one method of end winding with binding wire. This construction, as will be seen, is so designed that where the heaviest load comes on the conductors the thickness of binding wire is greatest. The alternative to the above construction, now generally used, is shown in Fig. 8B, the end winding being kept in position by bronze end bells. This construction has the advantage that repairs can be readily attended to. The greatest difficulty so far that has been experienced with this class of end bell is the procuring of suitable material. With cast bronze it is difficult to ensure the material being homogeneous ; and, further, the physical properties are never so sure in this class of material as in the case of binding wire or forged material ; so that, in a construction of this kind for the end bells, it is advisable, where possible, to use rolled material.

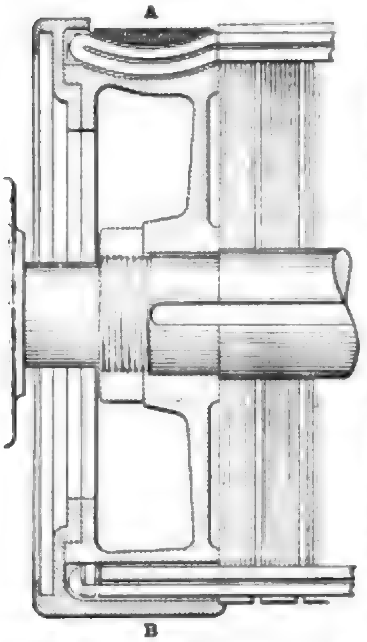


Fig. 3.—Methods of Securing the End-connections of Armature Windings.

The form of commutator now adopted in nearly all continuous-current turbo-generators follows the line shown in Fig. 4. The method of building up this commutator is as follows : The segments are built up with intervening layers of mica and clamped together. The mica is then tied round the outside at the place where the shrink rings are to be fitted, the steel rings then shrunk on and the whole machined inside and out. The commutator is then supported on cones at each end, which fit tightly on to the shaft. Owing to the wear that is bound to take place on such commutators, allowance must be made so that when the commutator is worn down to a certain extent, the segments do not become too weak to support themselves between the rings, and, in consequence, bulge out, causing high bars. To eliminate this a good scheme is to design the bars so that at, say, half the original depth, they are stiff enough to carry themselves rigidly, and have sufficient cross-section to carry the current without undue heating. In order that it may become apparent when it is time to stop truing up the commutator, a series of notches or grooves can be placed along the commutator segments indicating the limits for truing up. All overhanging mica, &c., should be turned off, as this has often been found to give trouble by collecting dirt. Everything throughout should be so designed that when running there is as little unbalanced mass as possible, and where keyways are cut in the shaft, two should be provided diametrically opposite, in order to keep the shaft itself as uniform as possible. Provision should be made in all armatures for the speedy application of balance weights.

It has been found that it is almost impossible to use carbon brushes on turbo-generators, owing to the fact that the armature floats when running, thus causing the brushes to dance. Metal brushes must, therefore, always be used, and, in consequence, unless commutating poles or compensating windings are adopted, the position of the brushes must be altered to suit small variations of the load. In all modern turbo-generators commutating poles or compensating windings are adopted, thus ensuring fixed lead.

During the last few years the demand for large turbo alternators for high voltages has necessitated the adoption of the rotating field type of alternator. The rotating field may be built up of (1) laminated plates ; (2) slabs of forged steel, say, about 2in. or 3in. thick ; (3) solid core with poles bolted on ; (4) one solid piece.

All the above constructions are now adopted by different makers. In large machines the peripheral velocity amounts to something like 300ft. per second. The British Westinghouse Co., in their design for the 5,500kw. turbo-alternators for the London Underground Railway Co., adopted the solid construction. These rotors run at 1,000 revs. per min. The outside diameter is 67$\frac{5}{8}$in., and the peripheral velocity of the pole faces 294ft. per second. The field itself is a solid forging of Whitworth fluid-compressed steel, the centre being bored out to admit the high carbon steel shaft. The sides of the poles are milled out to admit the windings, ventilating ducts being also milled out. The solid pole construction materially stiffens the shaft, and, as the whole length of the poles themselves can be taken as being absolutely rigid, the only deflection that takes place is between the ends of the poles and the bearings. To reduce as low as possible the loss by windage smooth cores should be adopted where possible. In order to obtain ample ventilation two totally different methods may be adopted : (1) As much exposed surface and free air way as possible ; (2) machine entirely enclosed with forced ventilation.

Both these systems are now extensively used, and it is hard to decide which is preferable. The first has the advantage of being more efficient, but has the objection of being noisy. This noise is almost entirely eliminated in the enclosed machine, but tests have shown that, with this type, to obtain sufficient ventilation, a considerable amount of power is absorbed by the blowers, resulting in a somewhat less efficient machine.

In turbine bearings we are confronted with the following conflicting conditions : On the one hand, the shaft should be sufficiently strong and rigid, necessitating large diameter journals, and the bearings must be sufficiently long to keep the pressure per square inch low, to allow of the oil being constantly renewed round the journal. On the other hand, the circumferential speed of the journal must be kept as low as possible to reduce friction. In order to make the whole length of the bearing effective, this length must not be excessive. For small turbines and generators with high speeds down to about 2,000 revs. per min. the bearing almost universally used consists of a series of concentric tubes fitting loosely over one another, the intervening cylindrical spaces being filled with oil. For large machines, however, with speeds below that mentioned, the rotating elements can be sufficiently well balanced to run smoothly in solid bearings. The small bearings referred to above are invariably of bronze, but with solid bearings, cast iron, white-metal lined, have shown themselves to give excellent results. Even with large bearings for the comparatively slower speeds the bearings must be allowed a certain amount of give ; this can be done either by easing off the bushes towards the end or fitting the whole bearing into a spherical seat. With white-metal bearings the danger, of course, lies in their running out should the oil supply at any time fail. With bronze bearings the effect would be very severe seizing of the shaft, doing possibly a considerable amount of damage to the whole spindle. With good white-metal bearings the writer has seen the oil supply fail, the only result being a slight wearing of the bush, causing no damage whatever to the shaft. As regards the metal for the journal itself, the experiments of Herr O. Lasche, of Berlin, go to prove that the metal employed, whether of nickel steel, Siemens-Martin steel or mild steel, has little influence on the degree of friction. With regard to the degree of smoothness and to the facility for taking a highly-polished surface, Herr Lasche points out that microscopic examinations of the outside faces, even with magnifications of 100 times, did not reveal any great difference in their structure. The coefficient of friction for mild steel was found to lie between those of the harder materials, Siemens-Martin and nickel steel. The experiments clearly show that there is no great gain by using nickel steel. Further, the nickel steel, after a somewhat prolonged service, showed larger pores than a mild steel journal of equal service. The effect of clearance has a marked influence on the efficient working of turbine bearings. It also has a large influence on the amount of total friction and also on the running and safe working conditions. In bearings with small clearances a relatively great amount of power is required to overcome the friction, even if the shaft is not very heavily loaded. Friction between the shaft and the oil, between the oil and the bushes, and between the oil particles themselves has to be overcome. In consequence it is better to ease the bearings considerably on the upper half ; this materially decreases the friction and allows much smoother running. If the shaft is well balanced the upper half of the bearing can be entirely dispensed with, and this is practically done in many instances, a clearance of $\frac{1}{32}$in. being allowed on the top half of the bearings. However, should the shaft have any tendency to whip, an uncovered bearing of this kind leads to trouble, as it offers no resistance to the shaft moving laterally. For this reason instead of cutting the whole of the top of the bearing away it is safer to allow a strip of the bearing to remain along the top, thus holding the whole shaft.

The peripheral velocity in turbine bearings is necessarily very considerably higher than in ordinary steam-engine practice, velocities of 50ft. per second being regular practice. The load per square inch, however, must be kept very low. In steam turbine practice to-day it is usual to allow a constant of 2,500 for the peripheral velocity in feet per second multiplied by the pressure per square inch on the bearings. This in some cases is raised as high as 3,000. Experimental bearings have been run, however, with a peripheral velocity of 70ft. per second and a pressure of 70lb. per square inch, thus giving a figure of 4,900. The crux of the whole question is the facility for dissipating the heat, and for this reason as much of the bearing as possible should be in contact with the outer walls, provided, of course, that the outer walls themselves are also free to dissipate heat. Water-cooled bearings are very often resorted to in very large machines, the principal advantage of these being that in a turbine of the Parsons type the heat from the high-pressure end of the turbine is transmitted to the bearing, the water-cooled bearing, therefore, isolates this heat from the bearing proper. In machines where there is no close contact with steam-heated surfaces, the bearings working within the limits mentioned—viz., from 2,500 to 3,000 for p.v. can run satisfactorily without water cooling. An ample oil supply, however, should be given; in fact, the supply of oil in turbine bearings should not be restricted. In steam turbines the oil leaves the bearings uncontaminated by water or other matter, and can be returned to the cistern and re-used, so that there is little loss by providing an ample oil supply. The usual European practice in turbine work is to allow about 0·05 gallons per square inch of bearing surface per minute. Ball bearings at moderate speeds give excellent results, but they do not stand the test of high speeds; they are noisy even with small balls. This is very pronounced when the peripheral velocity of the revolving body is about 30ft. per second, so that on the whole they are not suitable for high speed work, nor are they as safe as the plain bearing.

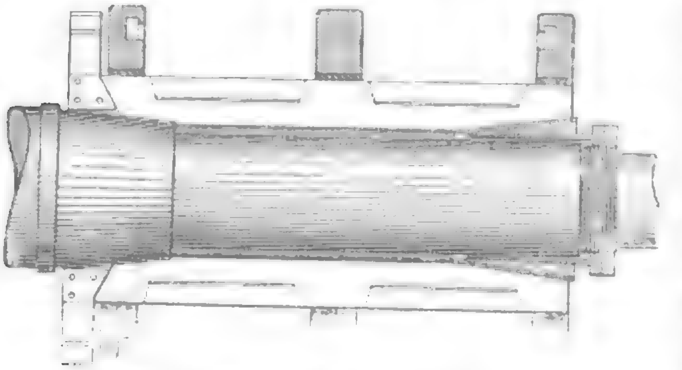


FIG. 4.—COMMUTATOR FOR TURBO-GENERATOR.

To reduce the troubles arising from imperfect balancing to a minimum, the following points must be taken into consideration in the design of the machine:—(1) The materials adopted should be as homogeneous as possible. (2) The design should be absolutely symmetrical. (3) Where possible all parts should be machined inside and out with the greatest accuracy. (4) The shaft must be sufficiently stiff to resist undue whipping. (5) Special care must be taken with the windings and insulations to ensure rigidity when running. (6) Where possible the normal running speed should be below the "critical speed." If this is not possible the normal speed should be reasonably higher, so that the critical speed, except when running up or shutting down, is never reached in ordinary operation.

Where possible forged steel should be used throughout in the construction of the rotor; if this is adhered to considerably less trouble is likely to present itself than would be the case were castings used. In connection with the design of a shaft of sufficient strength to resist whipping, the length between the bearings should be kept down to a minimum. This length, however, is determined by the maximum peripheral velocity allowable on the rotor. With turbine spindles of the Parsons type the ratio of the length between centres of bearings to the diameter at the centre of the shaft is often as high as 11, and in small generators 6 to 8. It is often necessary, therefore, to apply balance weights at, or about, the centre as well as at the ends before smooth running can be accomplished. In continuous-current machines provision is therefore often made for applying balance weights to the inside ring of the commutator (Fig. 4). With rotors for 1,000kw. generators and upwards, this ratio rarely exceeds three, and in the majority of cases in very big machines about 2·5. With this ratio balancing troubles, with the reasonably low speeds now adopted, are never very serious. One of the greatest troubles experienced in maintaining good balance of turbo-generators is due to the shifting of the conductors. This often happens after the machine has been running some time and as the insulation dries it gets compressed by the centrifugal force on the conductors. The slightest shifting of these conductors is likely to throw a big rotor considerably out of balance. Should the machine at one time or another run away and attain the speed of, say, 1½ times the normal running speed, the severe load resulting is often sufficient to throw the whole rotor out of balance. In all bodies revolving at high speeds there is a period at which excessive vibration will take place, and is called the "critical or whirling" speed. It coincides with a point at which the natural period of transverse vibration of the shaft loaded with the rotating element is equal to the impulses given to the shaft by the centrifugal force acting on a slightly bent shaft; at this speed steady operation of the shaft is impossible. Mathematical investigations of this phenomenon have been carried out and published by Prof. Dunkerley and others.

The critical speed for any shaft is given by Foster as:— $N=9{\cdot}55\sqrt{Fg/W}$, in which W = weight of rotating mass and a portion of the shaft, and F = force in pounds weight necessary to bend the shaft 1ft. at the point of attachment of the wheel.

The above formula is for a shaft of diameter D feet.

Then $F=3EI(a+b)/a^2b^2$, in which E = modulus of direct elasticity in pounds per square foot; I = moment of inertia of the cross-section $=0{\cdot}0482D^4$; and a and b = distances in feet of the wheel from the bearings.

The following formula is given by Behrend for turbo-generators:— $N_1=\sqrt{KEI/ML^3}$. In this case N_1 is the angular velocity at critical speed, E = modulus of elasticity, I = moment of inertia of the shaft in relation to bending, M = mass of rotating element, L = distance between bearings, K = constant whose value is about 75.

Where possible in the construction of the rotating parts for turbo-generators static balance of the respective parts should always be resorted to before assembling. Again, the whole body should be statically balanced before being run; although, of course, it does not necessarily follow that, if it shows perfect balance on the knife edges, it will be correctly balanced when running. In balancing, if the rotor is considerably out of balance, one is very often much tempted to apply considerably more weight than is necessary. If the weights are applied at the periphery of the body, which has a velocity of, say, 300ft. per second at a radius of 1ft., the actual weight applied is multiplied by the centrifugal force 3,000 times. Very small weights, therefore, have considerable effect in throwing the whole body back into balance.

The following is an abstract of the discussion which took place in connection with the Paper.

Mr. C. D. TAITE (chairman) asked the author for further information regarding the stripping of blades, clearance and the best metal for blades under different conditions.

Mr. J. F. NIELSON asked if it was not feasible and common practice to support turbines on foundations of a combination of steel joists with a space below for condensers.

Mr. T. L. MILLER thought gunmetal rings would be better than wire shrouding for turbine blades and admired the Curtis blade construction which he considered a better mechanical job. He recommended a hydraulic accumulator for the footstep bearing in a Curtis turbine and then it would not matter if the pump failed for a short time. The stuffing-box under the generator in a Curtis turbine was no detriment to this type as there were no more than 5lb. pressure of steam on it; and there was also a down draught from the armature. With regard to De Laval turbines it would perhaps be interesting to know that Messrs. Greenwood & Batley, the English agents, had just equipped a Swedish textile factory with direct driving turbines of this type. Dryness of steam was very important, as priming had a very bad effect, and there was no doubt about the advantages of superheat.

Mr. J. D. BAILIE (Leeds representative of Messrs. Parsons) pointed out that Curtis turbines really occupied considerable floor-space owing to the auxiliary plant required. He instanced a vertical turbine at Harrogate taking 142 sq. ft. floor-space as follows:—Turbine, 82 sq. ft.; air pump motor, 25 sq. ft.; circulating pump motor, 35 sq. ft. The information regarding vibration he had himself found to be correct, and recently tuned out vibrating floors adjoining turbine premises by adding two extra joists. He recommended girder foundations as satisfactory and objected to the bed-plate being bedded in—grouting was all that was required. With regard to turbine spindles going out of balance, Messrs. Parsons had not had to balance more than six in 11 years. Armature spindles were likely to give most trouble, owing to shifting of conductors, &c. Messrs. Parsons had given up nickel steel for mild steel spindles. With regard to cylinder distortion, he recommended thicker metal instead of ribs. Double-direction turbines had been given up by his firm, as it was reasonable to suppose that two small turbines were not as economical as one large one. He regretted the absence of test figures regarding Westinghouse turbines—one had no proof of their efficiency. Returning to the question of vibration. The critical speed was often found to be one-third of the normal speed. Binding was only used for continuous-current armatures. He considered the use of knife edges very satisfactory, and found often that spindles required no further balancing after leaving knife edges.

Mr. F. H. WHYSALL, referring to the two 1,800kw. turbines installed at the Dickinson-street works of the Manchester Corporation, mentioned that a 2lb. brass-wire brush only lasted 336 hours. Commutation was the weak point. Compensating devices were about to be adopted, and with a fixed brush position there was bound to be a great improvement. The speed of the commutators was 6,000ft. per minute, and carbon brushes seemed out of the question. He was glad to say that large turbines could be perfectly balanced, and had found the rings for balance weights absolutely necessary when changing armatures &c. Commutators required turning up once in two years. The bearings were water cooled and the temperature of oil used to be 130°F., but since using 100°F. superheat it had risen to 150°F. What was, he asked the author, a safe working limit for ordinary bearing oils with white metal bearings? He was glad to say that, with a turbine speed of 1,050 revs. per min., he had never had a breakage of the binding wire.

Mr. **LINDLEY** thought a footstep bearing very objectionable, and bound to put a turbine out of commission immediately should the oil pressure fail.

Mr. **MILES WALKER** mentioned that the Metropolitan turbo-generators were three in number and of 3,500kw. capacity, each designed for 11,000 volts. There had been experimental difficulties.

Messrs. Seaton, Dr. Bowman, Frith, Aitcheson and Cooper also spoke.

Mr. W. J. A. **LONDON**, in reply, said that the British Westinghouse Company used mild steel for their spindles. If the blades of the Curtis turbine were damaged, due to stripping, the whole ring had to be replaced. An accumulator was used in connection with a footstep bearing for the vertical type of Westinghouse turbine. Conduction of heat by the shaft to the armature was an objection to vertical type. Priming would pull up a turbine, but recovery was immediate. He preferred ribs to thicker metal in the turbine stator—they must have ribs for bolting flanges. Double flow turbines eliminated dummy ring losses. Alternators had binding wire round the armatures. No tests were given because no official tests had been made. In the shops with a 2,000kw. turbine with a 27in. vacuum and no superheat, the British Westinghouse Company had used 18·6lb. of steam per kilowatt hour. Spindles could be often caulked or strained into balance. 150°F. was a safe working temperature for oil in turbines, and the limit depended entirely on the quality of the oil. Blades were drawn and rolled, also buffed, laced in position and finished to the right diameter. Carbon brushes could not be used satisfactorily.

ELECTRICAL EQUIPMENT OF MESSRS. HARLAND & WOLFF'S SHIPBUILDING WORKS.

(Continued from p. 874.)

Fig. 12 is one of the punching machines in the platers' shed, already referred to, and in the case of a machine of this nature the importance of mounting the motor on springs is very great

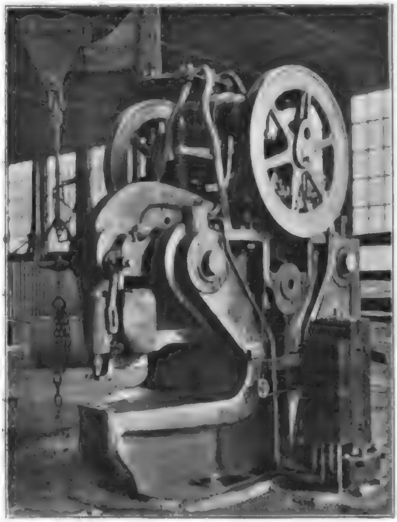


Fig. 12.—Punching Machine driven by 10 h.p. A.E.G. Motor.

The period between the strokes of the punch is about 3 seconds, while the whole energy of the stroke is expended in a small fraction of a second. The motor is rated at 10 b.h.p. It is an A.E.G. three-phase motor, with wound rotor, and the starting is done in the usual way with resistances in the rotor circuit. Connected mechanically to the controller is a wire rope which actuates the brush-lifting mechanism as soon as all the resistance is out of the rotor circuit. A photographic view of the motor and springs is given in Fig. 18.

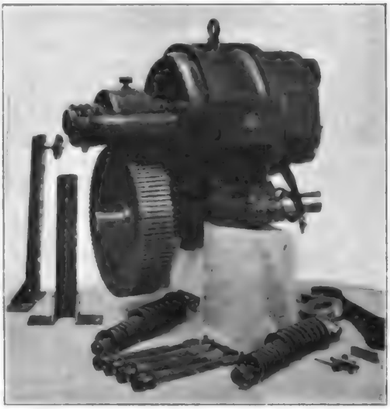


Fig. 13.—12·6 b.h.p. Enclosed Motor and Springs for Punching and Shearing Machine.

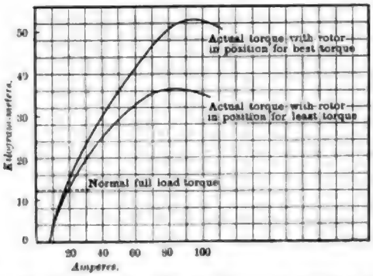


Fig. 14.—Curves showing Starting Torque of Enclosed 12·6 b.h.p. Motor driving 1½in. Punching and Shearing Machine (420 volts, three-phase, 57 ∼ per sec.). The mean value lies between the two curves.

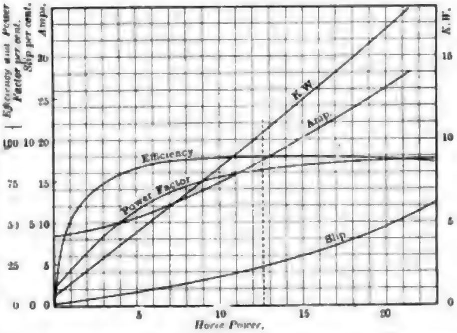
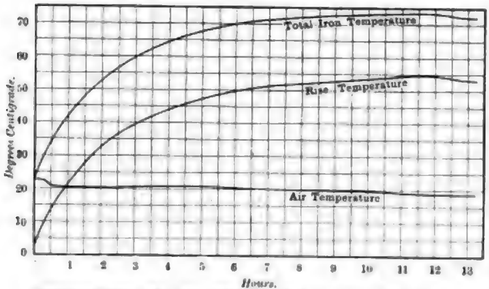


Fig. 15.—Curves showing Load, Slip, Power-factor and Efficiency of 12·6 h.p. Enclosed Motor.

The majority of the punch motors are, however, 12·6 b.h.p. totally enclosed on intermittent rating, but designed to give torque up to 35 B.H.P. without pulling out, which, as the punches are to deal with 1½in. diameter holes through 1¼in. steel plate, has rendered a special design of motor advisable.



Resistance { Stator, 0·244 cold 0·2965 hot 23·3° Increase = 55·7°C. } by resistance
per phase { Rotor, 0·070 cold 0·087 hot 24·3 Increase = 60·7°C. } method.
Rotor Temperature 18·8° cold 72·5° hot Increase = 53·7°C. by Therm't'r.

FIG. 16.—TEMPERATURE CURVES OF ENCLOSED 12·6 B.H.P. MOTOR.

Fig. 14 shows the starting torque of one of these motors Fig. 15 shows the current, kilowatts, slip, power-factor and efficiency at various speeds, and Fig. 16 the temperature rise.

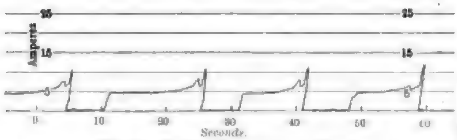


FIG. 17.—TEST ON STRAIGHTENING ROLLS.

Plate ½in. thick, 48in. wide, 10ft. long. A.E.G. Enclosed Motor tramway type, 440 volts, 14 amps., 7 B.H.P., 590 revs. per min.

These motors are totally enclosed owing to the large quantity of dust in the platers' shed. They have a larger clearance than is usual in the case of three-phase motors, as they have to withstand considerable shocks in spite of the springs on which they are mounted, while, on the other hand, it will be seen from Fig 14 that they are designed for large starting torque.

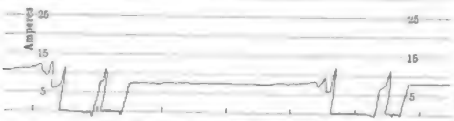


FIG. 18.—TEST ON STRAIGHTENING ROLLS.

Plate $\frac{3}{16}$in. thick, 48in. wide. 10ft. long.

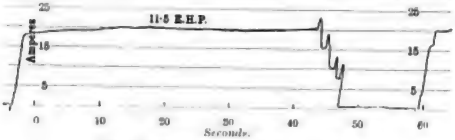


FIG. 19.—TEST ON STRAIGHTENING ROLLS.

Plate $\frac{5}{16}$in. thick, 52½in. wide, 10ft. long.

Fuses are employed in preference to cut-outs in nearly all the motor circuits, and these as a rule are rated high, so that there is no hesitation in getting the maximum possible work out of each machine. An exception had to be made in the case of the straightening rolls shown in Fig. 20. It was found that breakdowns constantly occurred, and a series of tests was made to investigate the matter. The tests with different thickness of plate are shown in Figs. 17 to 19. The increases of load are very rapid, and with electric drive through spur gearing, there was no slipping belt to relieve this as formerly. In this case, therefore, an electromagnetic cut out is inserted in the circuit. Fig. 21 is a general arrangement of the electric driving of plate-bending rolls of a similar pattern. An electromagnetic brake, seen in the figure is inserted in series with the armature, the brake being held off when current is flowing, but coming on at the moment of reversing.

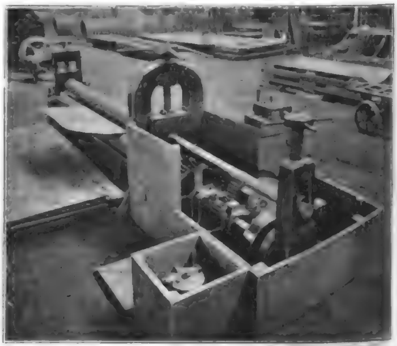


FIG. 20.—STRAIGHTENING ROLLS, DRIVEN BY 12 H.P. 440 VOLT CONTINUOUS CURRENT MOTOR (SPEED, 360 REVS. PER MIN.) WITH REVERSING CONTROLLER.

Fig. 22 is a vertical drilling machine, the motor being placed on a pivoted bracket supported by a helical spring. In this case, the necessary speed reduction is obtained by a combination of spur-gearing and belt cones, the arrangement—which has only been adopted for a few light tools—providing for the necessary belt tension. In the majority of instances, the difficulty which arises in the application of motors to tools is that the former run at essentially higher speeds than the latter. For example, in a representative group of engine works tools, comprising lathes, slotters, boring and milling machines, the speeds of the driven motion for the slowest-running machine range between 33 and 217 revolutions, and in the case of the quickest-running machine to between 143 and 402 revs. per min. Now the variable speed continuous-current motors with solely field regulation run in general at 300 to 900 revs. per min., whilst in some extreme cases the range is from 200 to 1,100 revs. per min., so that gearing in some shape has to be adopted. This, in nearly every case, takes the form of spur and pinion wheels, with cut involute teeth, having fairly fine pitch, and moderate pitch line velocities enclosed by dust-proof gear cases in exposed situations.

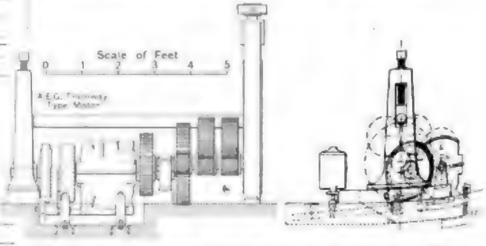


FIG. 21.—ARRANGEMENT FOR ELECTRIC DRIVING OF PLATE-BENDING ROLLS
356 revs. per min. on Motor when developing 10 H.P.

Dissimilar metals are selected for preference, thus where the pinions are phosphor bronze, the spur wheels are cast-iron, or, if the strains are high, cast-steel. Or with a train of three wheels the driving pinion is forged steel, the intermediate wheel of phospor bronze either solid, or if of large diameter taking the form of a cut-rim bolt to a cast-iron hub, and the driven spurwheel cast-iron or steel.

Lower speeds than are usual have in many cases been selected, with the view to eliminate double or treble gearing for speed reduction, with resultant wear and tear. That slow speeds are not incompatible with efficiency, even in the case of three-phase motors, the following figures will show:—

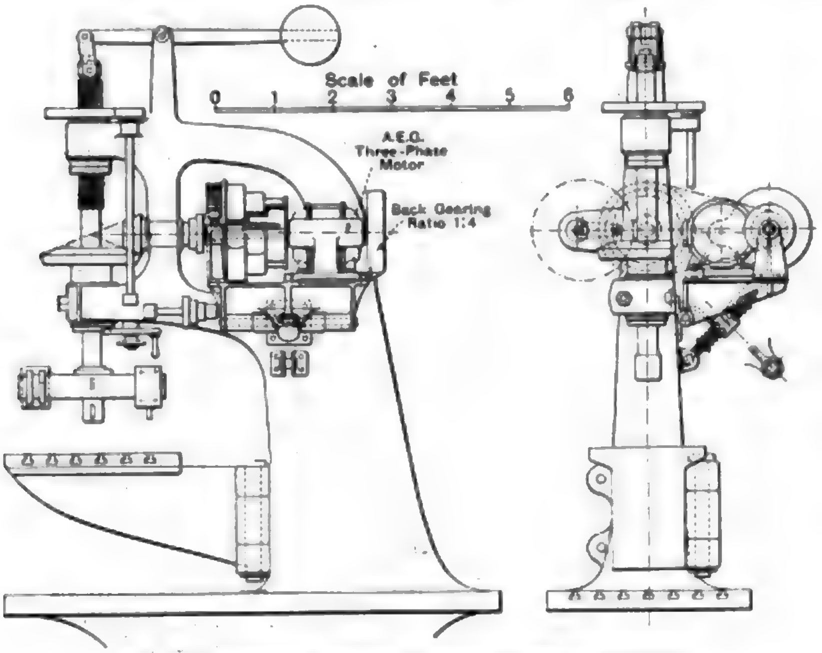


Fig. 23.—Electrically-driven Vertical Drilling Machine.

Three-phase line-shaft motors, 440 volts, 15 B.H.P., 655 revs. per min.

	Full-load.		¾-load.		½-load.
Efficiency	86%	....	85·5%	....	82%
Power-factor	0·85	....	0·8	....	0·7

These motors are designed in such a way that the four sizes selected, 5, 7½, 10, and 15 B.H.P., are interchangeable on the same supports to facilitate the selection of the right size of motor for each group of tools.

(*To be continued.*)

ELECTRICITY METERS.*

BY C. H. W. GERHARDI.

(*Continued from page 876.*)

Hookham Meter.—The Hookham meter for continuous-current supply consists of a motor in which the main current is lead into an armature by means of mercury, the armature being immersed and partially floated in this liquid. Fig. 50 is a sectional drawing showing the principal portions of the meter known as the 1897 type. A permanent magnet, AAA, which consists of a bent bar of tungsten steel, provides the magnetic field for the motor and also the brake. The ends of this magnet rest on two soft iron pieces, BB, which are separated from each other by a brass piece, C. The lines of force here divide, some flowing up through EE and the bridge piece G, forming the brake field in which the brake disc O rotates, and others down through the armature N to the bridge piece DD and up at the other side, thus passing through N twice, cutting it in the opposite sense.

The current is led to the mercury by the copper strips KK (the mercury being insulated from the sides of the chamber except at the ends of K). It then passes through the armature N, which is slit radially for about one-third of its diameter, being left solid at the centre. The object of the slits is to cause the current to flow diametrically across the disc in the magnetic field, the pole-pieces each embracing about one-third of the periphery of the disc.

If friction, other than the magnetic friction due to the brake, were negligible the speed would be exactly proportional to the current and the curve would be a straight line; but the meter possesses fluid friction, due to the mercury, in addition to the solid friction due to the wheel train and bearings of the armature spindle. The fluid friction is proportional to the square of the velocity at slow speeds, but, increasing more rapidly as the speed increases, a compensation has to be introduced to eliminate errors due to this. This compensation is effected by the two or three turns H placed round the bridge piece G which tend to reduce the brake field as the current increases. Should a meter be found to register low at high loads only, either the turns of H may be increased or the bridge piece G may be brought into closer magnetic contact with the cross bars on which it is fixed in cases where a slight gap has been left (filled with vulcanised fibre or other non-magnetic washers).

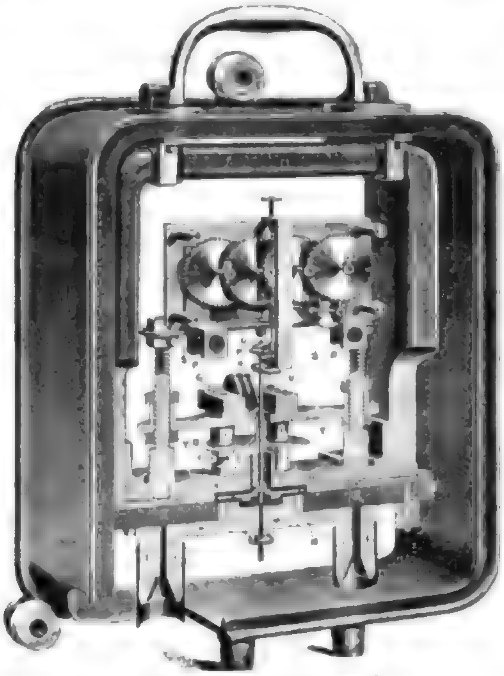


Fig. 50.—1897 Hookham Meter.

The curve can be raised or lowered slightly by raising or lowering the plate, thus increasing or reducing the brake air-gap. The iron bridge piece D can also be turned through a small angle by loosening the square lock-nut underneath W. The meters are, however, fitted with change wheels of various ratios instead of being calibrated to a fixed speed, and consequently all meters of a size do not run at the same speed for a given load, a point which renders testing (especially testing in situ) somewhat more complicated. Moreover, great care must be taken to ascertain that the given constant is correct, either by an accurate dial run or by counting the teeth on the change wheels.

A clamping gear is provided consisting of a rubber washer which, on being released by unscrewing the small milled nut in the front (not shown in Fig. 50), rises up underneath the disc and closes the mercury chamber. This arrangement has been found to be not altogether satisfactory. The rubber washer is liable to stick to the disc when unclamped, and also perishes after a time. This meter, in common with all other meters which contain a liquid in an open chamber, is liable to be entirely altered if any of the liquid be spilled in its journey from the test room to the consumer's premises. In sizes above 100 amperes they are provided with shunts for carrying the greater part of the current, only a definite fraction passing through the meter itself. In such sizes the meter is either placed on top of the shunt, as in Fig. 51, or for switchboard use it may be mechanically separated from its shunt.

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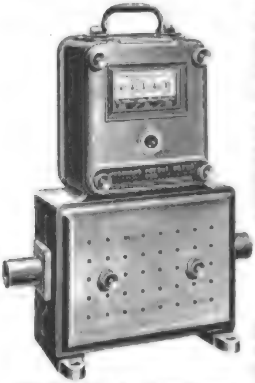

Fig. 51.—5,000 and 1,000 Ampere Hookham Meter.

The torque of motor meters containing mercury cannot be measured with accuracy owing to the impossibility of effectually preventing the mercury rotating. When the disc is held up the mercury will rotate, and the friction against the held-up disc will create a torque tending to drag the disc round with the mercury, so that results obtained will be in excess of the torque. This important factor will also be somewhat different in different samples. The following results were, however, obtained on meters of different sizes:

Size.		Full load torque in gramme centimetres.
10 amperes	....	2·4
25 ,,	....	4·9
50 ,,	....	9·45

The 1901 type of Hookham continuous-current meter is made in sizes up to 10 amperes capacity, and is the same in principle as the 1897 type meter, the arrangement being different with a view to reducing the price. In this type the armature and brake discs are replaced by a single cylindrical copper bell, A (Fig. 52), which is completely immersed in mercury in the annular chamber H. The permanent magnet MMM produces the field, and the current, led from the positive terminal, enters the mercury bath at G, passes down through A, and leaves the mercury bath by the screw F. Eddy currents are also produced in A, due to its rotation in the magnetic field; thus the bell serves the double purpose of driving armature and brake disc. In the larger sizes the current on leaving F passes through the coil on the soft iron bridge piece V, which compensates the error caused at high speed, due to the fluid friction of the mercury. As will be seen, it forms a magnetic shunt to the field through the armature—*i.e.*, that flowing between KL—weakening this field more and more as the current increases. This compensating device, therefore, reduces the Foucault brake force relatively to the driving force, but at the same time reduces the driving force and consequently the torque. Adjustment is made by altering the number of turns of the coil in circuit.

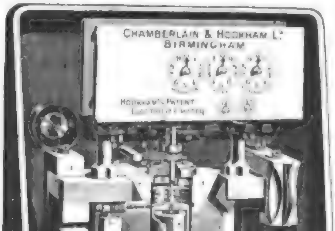

Fig. 52.—1901 Hookham Meter.

Two balance weights, Q and R, are fixed to the main spindle to prevent the bell A from floating off the supporting pivot E. The mercury bath is covered by the ebonite piece P, to the underneath of which is attached a soft rubber washer, W. When the meter is clamped for transport the balance weight Q is raised up against this washer and closes the mercury chamber. Only a portion of the clamping gear is shown in the figure—viz., the two prongs S fixed to the shaft. The prongs are raised by turning the shaft by means of a long crank on the front end of the latter, which comes down and terminates in a pointer just above the label on the base plate, indicating when the mercury bath is open or shut. The prongs engage with the balance weight R, thus raising the spindle and closing the mercury chamber. The torque of this meter is very low indeed; from tests made by the author it has been found to be as low as 0·35 gramme-cm. at full-load on 3-ampere meters. The mechanical friction of the main moving portion, being partially floated as it is, must be small, but it seems from numerous tests made that the wheel train friction is large and variable. This, owing to the small torque, seems the cause of results differing from each other being obtained. The curve also depends considerably on the compensation.

A plate screwed to the front of the meter enables the meter to be connected up to the circuit, and the unclamping to be performed without breaking the seal on the main cover or door.

The same remarks apply to measurements of the torque of this meter as to the 1897 type.

(*To be continued.*)

THE NATIONAL PHYSICAL LABORATORY.

The general board of the National Physical Laboratory held a reception at Bushy House, Teddington, last Friday afternoon, when a large number of distinguished men of science were present. On entering, visitors were received by Lord Rayleigh and Lord Kelvin, and a tour of the laboratory was commenced immediately. The following is an abstract of the director's report for the year ending December 31, 1904:—

Physics Department.—1. Electricity.

A.—*Fundamental Units* (*Mr. Smith.*)

(a) *Standards of Resistance.*—An inter-comparison has been made of the mercury standards of resistance constructed last year. The differences found were in agreement (within the limits of the errors of observation) with those previously observed. The methods of building up resistance coils, having values in ohms approximately equal to some power of 10, have been investigated. The evaluation of a 10-ohms coil by placing 10-unit coils in series, or by Lord Rayleigh's most convenient "build-up" of three 3-ohms coils capable of being placed in series or in parallel, is not sufficiently accurate for standards purposes. Build-up boxes have been designed consisting of coils having resistances in the ratio of the numbers 1.1.2.2.5.10, the arrangement of the coils being such that the lines of flow are of the same form when the separate coils are being evaluated, as when they are placed in series. No contacts form part of the resistance measured, and careful checking proves the build-up to be accurate to 0·0001 per cent.

(b) *Standard Cells.*—The investigation of certain anomalies of Clark and cadmium cells has been continued. Special four-limb cells were constructed, designed so as to contain three different samples of any one element of the cell. In this way the instability of the samples was determinable. Mercurous sulphate was the first substance to be investigated, the observations of previous years indicating its behaviour to be most unsatisfactory. The investigation proved the sulphate, as ordinarily prepared, to be quite unsuitable for standard cells, and a standard method of preparation was sought. Three methods proved to be successful. The first of these is a modification of one due to Divers and Shimidzu, the salt being prepared with fuming sulphuric acid and mercury. The second is a precipitation method, while the third is an electrolytic method, due to Prof. H. S. Carhart, Mr. G. A. Hulett, and Dr. F. Wolff. Very satisfactory results were obtained. Six cadmium cells, prepared with samples of mercurous sulphate so made, were taken to the United States by Dr. Glazebrook in September, the object being to compare the E.M.F.s with those of other cells constructed by Prof. Carhart. Unfortunately, the cells changed in transit; the reason for this is unknown, but will be investigated. There is little doubt, however, but that a depolariser can now be prepared, such that the E.M.F.s of cells prepared with samples manufactured at different times will not be different by more than a few hundredths of a millivolt. With purchased samples of mercurous sulphate, cells were prepared having E.M.F.s different by more than 2 millivolts. An investigation has also been made to determine the difference, if any, of E.M.F. between the H form of cell and the tube or Board of Trade form. Since 1892 the H form has been assumed to have a smaller E.M.F. by 0·0004 volts. Cells combining the two forms were constructed, and observations made on both Clark and cadmium cells. The results showed conclusively that no difference so great as $\frac{1}{10000}$ volt exist; the difference, if any, must be very small. In the coming year it is hoped that the investigation will be completed, and a satisfactory specification for both Clark and cadmium cells prepared. The various objections against both kinds of standards when subjected to a fluctuating temperature will also receive attention.

(c) *Ampere Balance of the British Association.*—The construction of the electrical portions of this has been the principal work of the year. The weighing mechanism was completed by Mr. L. Oertling in April, and was tested at Mr. Oertling's works, the results being entirely satisfactory. The four marble cylinders for use with the balance have been wound and successfully insulated. The turning and screw-cutting of these was performed by Mr. Taylerson, of the engineering department of the laboratory. The two large fixed cylinders have diameters of 18in., and are each 11in. long. The small suspended cylinders are 8in. in diameter, and approximately 6in. long. On each fixed cylinder are two double helices of No. 24 bare copper wire. The pitch of each helix is $\frac{1}{24}$in., so that the air space between consecutive turns is less than $\frac{1}{1000}$in. Double helices are also wound on the small cylinders. The object of the double helix is to enable the insulation resistance between the strands to be measured. Initially, this insulation resistance was surprisingly low, and great difficulty was at first experienced in raising it to more than a few hundred ohms. Finally, however, an insulation resistance greater than 30,000 megohms was secured for each pair of coils. To obtain the mean diameter of the coils measurements were made in nine or 10 approximately equidistant planes, and 14 observations made in each plane. A complete survey of the surface of the coils was thus ensured. The measuring apparatus was specially designed, and enabled the diameter of any turn to be determined. Readings could be repeated to 1 micron. The observed diameters have been plotted so as to illustrate the ellipticity and conicality of the cylinders. The average ellipticity is such that the diameters of the ellipse vary by about 10 micron, while the average difference between the maximum and minimum means of the readings in the various planes is about 12 micron. This latter is a rough measure of the conicality. The dimensions of the coils are probably known with greater accuracy than any coils hitherto constructed. Many accessories for the balance have also been constructed, and there still remains much delicate fitting to be done. The outlook for a speedy determination of the absolute unit of current is, however, very hopeful.

B.—*General Measurements.* (*Mr. Campbell and Mr. Melsom.*)

Tests.—A number of the leading British instrument makers who were exhibiting at the St. Louis Exhibition had a wide variety of their instruments verified by the laboratory before sending them to St. Louis. Most of these instruments were intended for measurements of the highest order of accuracy, and the list included many kinds of resistance boxes, several types of potentiometer, insulation and conductivity testing sets, and standard resistances from 0·001 ohm to 1 megohm. Some small self-inductances of the order of 0·2 to 5 millihenries were measured by Wien's method. In this method a high-frequency alternating-current is used, and this was furnished by a microphone buzzer giving 700 ∿ per second. Ultimately the buzzer was modified and improved so that an almost pure sine curve alternating current, with a frequency as high as 2,000 ∿ per second, was obtained. An increase of frequency of this amount is of great advantage, as it so increases the sensitiveness of any method used. The small inductances were also compared with larger standard ones already tested (at lower frequencies) against the standard air condensers by Anderson's method; the agreement was satisfactory. In order to find if any change, due to alternating currents at high voltages, could be detected in a copper conductor, measurements of electrical conductivity were made on samples of Ferranti concentric mains (*a*) which had been in use with high voltages for many years, and (*b*) which had stood idle for the same period. The results showed that no difference due to use could be detected. Early in the year a set of preliminary experiments were made on a number of samples of gutta-percha, and from these were arranged the methods for the actual tests of a large series of samples done later in the year, chiefly by Mr. White and Mr. Rayner. The apparatus used is described below. The gutta-percha samples were in the form of sheets and the coverings on wires (in ½-mile lengths). For each sample there were two thicknesses of material, both for sheets and on the wires. The material was tested for dielectric resistivity at a number of different temperatures, the effects of ageing being found by repeating the tests at intervals extending over six months. Most of these tests were made both with 200 and 1,000 volts, and with one and two minutes' electrification. In addition to the usual direct deflection method, in many cases the loss of charge method was also used. With both the wires and the sheets several series of tests of specific inductive capacity were made, and the effect of varying the temperature was tested. It may be of interest to mention that resistances of the order of 1,000,000 megohms were dealt with by the direct deflection method.

Tests on Laboratory Instruments, &c.—The standard B.A. air condensers were tested, and a higher degree of accuracy than in former determinations was obtained by using a chronograph in conjunction with the standard clock. Some tests of temperature co-efficient were made on several mica condensers. For the gutta-percha tests a large water tank was set up; the water in this could be maintained within 0·1°C. by means of an electrical thermometer relay which controlled a number of electric heaters at the bottom of the tank. For the calibration of the galvanometers used in the high resistance tests a subdivided resistance of 100,000 ohms was constructed, capable of bearing easily 1,000 volts. The voltage was measured by an electrostatic voltmeter across a suitable fraction of the resistance. Another resistance of 100,000 ohms was built to act as the standard in the galvanometer circuit. A set of five non-inductive resistance frames (each 50 ohms and to carry 2 amperes) was constructed. By means of these comparisons were made, both with direct and alternating current, of one of the standard Kelvin electrostatic voltmeters, and one of the Kelvin balances (to 100 amperes). The agreement was quite satisfactory, and this disproves (for ordinary frequencies) the allegation that when used with alternating currents the accuracy of the balance is affected by eddy currents in the metal parts near the coils. For testing resistance boxes, &c., at various temperatures, a large well-lagged cupboard was set up with electrical heating and regulation; uniformity of temperature is ensured by a motor-driven fan, which keeps the inside air in vigorous circulation. Some experiments were made with a view to setting up standard direct-reading moving-coil ammeters and voltmeters free from zero creep. The results of these are encouraging, and a satisfactory solution of the problem seems certain. For testing current capacities of secondary cells an adjustable resistance for 2 volts (1 to 100 amperes) was constructed. In connection with low-resistance measurements a resistance box of 10,000 ohms, reading to 0·1 ohm, was built. In magnetic testing a number of experiments were made on a modified form of the Isthmus method with a view to reaching flux densities of 22,000 to 23,000. For hysteresis and other magnetic tests a special stand was made by which a primary winding of 30 turns could be applied to a ring in a few minutes. On testing this arrangement the results obtained were in satisfactory agreement with those obtained from the same ring evenly wound in the usual manner. For hysteresis tests a Searle ballistic wattmeter was set up, and by its help a measurement of hysteresis can be got by observing four throws of the moving coil—a considerably quicker method than the standard one of drawing the hysteresis loop and measuring its area. As this wattmeter must be very sensitive, considerable difficulties arose with it in the earlier part of the work. Three sources of error were traced and almost completely eliminated. These were:—(*a*) Insufficient inductance in the choking coil used to delay the rise and fall of the magnetising current; (*b*) Electrostatic action of the series circuit on the moving coil and damper; (*c*) Air convection currents caused by the heating of the series coils, which are run at a high-current density. To get over (*a*) a large subdivided choking coil (with closed iron circuit) was built. The electrostatic action (*b*), which was largely due to the necessity of working from a portion of the 100-volt experimental battery, was almost eliminated by applying suitable strips of tinfoil to the surroundings of the moving coil. The convection currents (*c*) were much reduced by placing the series coils further apart and screening the moving coil from them by thick shields of ebonite. For calibrating the wattmeter a simple magnet inductor (a coil slipping over a permanent magnet) was constructed. It is used as a working standard of magnetic flux, being checked from time to time against a standard mutual inductance. The wattmeter method has been used to test a number of rings, and so far the results have been in good agreement with those given with the same rings by the ordinary ballistic galvanometer method. Some comparison tests were also made on a Ewing hysteresis tester.

C.—*Electro-technics.* (*Mr. Paterson.*)

Equipment.—Progress has been made during 1904 in the equipment of an electro-technical department to undertake the testing of electrical apparatus on a commercial scale, and it is hoped that early in 1905 the installation of the necessary apparatus will be complete. For direct-current work cells have been installed with a capacity of 1,000 amperes, and a plug board and resistance has been fitted up for the purpose of regulating this current. There are three Kelvin balances, with capacities up to 600 amperes, connected to a board which enables any one to be put in circuit as required. A water-cooled manganin tube resistance capable of carrying 1,000 amperes and dropping 2 volts, has been constructed at the Laboratory. It has been made specially non-inductive with a view to its employment for alternating currents. Overhead leads have been brought across from the 300-volt battery in the physics building, enabling steady currents to be obtained for voltmeter calibrations. The 480-volt supply of the Twickenham Electric Supply Co. has also been brought into the room, so that, if necessary, direct-current pressures up to 800 volts can be obtained for commercial testing purposes. For alternating-current measurements, three electrometers—voltmeter, wattmeter and ammeter—of the Addenbrooke type, have been bought, together with a switch box for the calibration of the instruments. A Kelvin multicellular voltmeter with a large circular scale at 2½ metres radius will form the standard for alternating-current voltage, all these instruments being so arranged that they can be observed at the same time. Three step-up transformers, giving from 1,000 to 10,000 volts, have been kindly presented by Messrs. Siemens Bros. & Co., who also gave the motor-generator installed last year. In addition to these, three step-down transformers have been ordered from the British Electric Transformer Co., giving currents up to 800 amperes. A low-resistance potentiometer has been designed and made at the Laboratory for use in this department. The following apparatus has been kindly presented to the Laboratory for use in this department:—Three step-up transformers, presented by Messrs. Siemens Bros. & Co. and one galvanometer, presented by Messrs. Crompton & Co.

D.—Special Research. (*Mr. E. H. Rayner.*)

During the past year electrical research work on behalf of the Engineering Standards Committee has been in progress.[*]

Thermometry. (*Dr. Harker and Mr. Hugo.*)

New Apparatus Installed.—By the kindness of the Cambridge Scientific Instrument Co., the old Callendar recorder used in the high temperature comparison of standard instruments has been exchanged for a fine instrument of the latest pattern, capable of being used either as Wheatstone bridge or potentiometer. The 240 and 480-volt direct-current mains of the Twickenham and Teddington Electric Supply Co. have been brought into the laboratory, and a specially designed switchboard and convenient regulating resistances, capable of dissipating safely a considerable power, have been installed. Arrangements have also been made by which large currents may be taken from the special thermometric accumulator battery, and the present large regulating resistances have been supplemented by addition of a set of water tubes, capable of easily carrying 500 amperes. Among the new apparatus made or fitted up in the department may be mentioned :—Five wire resistance furnaces ; several carbon tube furnaces ; one large arc furnace of the Moissan type ; three new thermometer comparison baths of various forms ; one bath for temperatures to −100°C.

Research Work.—The chief research in the department has been the commencement of a study of the resistance and thermo-electric properties of solid electrolytic conductors, such as are used in Nernst lamps, with a view to the design of a system of electrical high-temperature measurement based on some of the properties of these materials. Certain apparatus useful in the preparation of the materials in question (zirconia, yttria, &c.) was purchased from the British Nernst Light (Ltd.), and to Mr. Solomon, formerly with that company, we are indebted for much valuable information. Tubular electric furnaces have been constructed capable of continued use at temperatures well above 2,000°C. By means of these furnaces and a number of thermo-junctions of widely different properties, whose E.M.F. in terms of the standard temperature scale up to 1,300°C. had been previously determined by extended comparisons with the laboratory standards, a careful determination of the melting point of platinum was made, using six different junctions for temperature measurement and four different samples of platinum. The results of the different determinations, which were closely concordant, will be published shortly. The existence, at high temperatures, of large thermo-electric forces between rods of the various earths, made up and treated as ordinary thermo-junctions, has been securely established by direct electrometric methods, and the apparatus necessary for a detailed study of these phenomena is in course of construction.

Thermo-junctions.—A number of comparisons of thermo-junctions of platinum with various platinum alloys of accurately-known composition were made with the collaboration of Mr. George Matthey, F.R.S., the results of which are nearly ready for publication, and a considerable number of melting and boiling points of various substances have been determined for use as fixed points in high-range thermometry.

OPTICS.

A.—*Photometry.* (*Mr. Paterson.*)

Test Work.—Investigations on the 10 c.p. Harcourt-Pentane lamp, which were begun in the later part of 1903, have been completed during the past year. The following formula, showing the variation in candle-power with humidity and barometic pressure has been found experimentally, and enables the standard to be used in photometric comparisons in which the test lamp is unaffected by atmospheric conditions. Candle-power $= 10 + 0{\cdot}066(10 - e) - 0{\cdot}008(760 - b)$ where $e =$ litres of moisture per cubic metre of pure air. $b =$ barometic pressure in millimetres. Care has been taken in the setting up and regulation of the lamp as well as in a thorough ventilation of the photometer room, and a standard has yet to be found which combines exact reproducibility with simplicity and ease of manipulation.

Special attention has been paid to the comparison of seven Pentane lamps by different makers against the N.P.L. standard, in order to determine the extent of possible variations in the candle-power of lamps made to the specification of the Metropolitan Gas Referees. The variation in any two lamps has been under 1 per cent., and in most cases the difference is less then ½ per cent., a result which has justified the adoption of this lamp as a standard of illumination. A number of standard electric glow lamps—kindly presented to the Laboratory by the Ediswan Company have been carefully compared against the pentane lamp, and now form the working standards of candle-power. They have been re-compared from time to time in order to see that no variation has occurred in their illuminating power. Inter-comparisons have been made by means of glow lamps with the National Standards Bureau, Washington, and the Electrical Testing Laboratories, New York, as well as with the Reichsanstalt. Further investigations to determine the ratios between the standards of candle-power accepted in America, Germany, France and Great Britain are now being undertaken. In addition to the tests here mentioned, comparative tests were made on two systems of street lighting to determine the illumination in the street given by gas and electric lamps respectively. For this purpose a portable photometer was constructed, the standard being a previously calibrated electric glow lamp, run off a portable battery of accumulators, the voltage on the lamp being varied and the photometer head remaining fixed. Measurements were made at night on four separate occasions, in streets lighted by the two systems. Throughout the greater part of the year tests have been in progress on 60 electric glow lamps, to determine whether the over-running method of testing lamps is any guide to their performance when run under normal conditions. These measurements, which were completed in November, comprise upwards of 5,000 individual candle-power observations. The watts per mean spherical candle-power of each lamp were obtained, after which some were overrun and others subjected to the ordinary life test, a comparison being made between the two methods on the basis of watts consumed per candle at the beginning of the life of each lamp.

Equipment.—In June, the 480-volt supply from Teddington was installed, chiefly for the purpose of generating alternating current for life tests. The motor-generator was erected and in working order in July, and an automatic alternating-current voltage regulator, actuated by two relays, was devised for the purpose of keeping the pressure on lamps for life test adjusted to within ½ per cent. This has been working satisfactorily night and day during the remainder of the year. A Berry transformer, made by the British Electric Transformer Co., supplies current for life tests at any desired voltage.

A list of apparatus designed and constructed in the laboratory includes the following : Attachment to photometer bench for measuring candle-power distribution round glow-lamps ; lamp rotator with mercury contacts made for use with photometer bench ; automatic voltage regulator. The following apparatus has been kindly presented to the Laboratory for use in this department : Flicker photometer, presented by Messrs. Alex. Wright & Co. ; lamp rotator, presented by the British Thomson-Houston Co. ; three standard lamps, Fleming-Ediswan pattern, presented by the Ediswan United Electric Light Co. ; six standard lamps, presented by the Electrical Testing Laboratories, New York. Apparatus bought includes the following : Standard gas meter, gas governor, 2¼kw. adjustable transformer.

Steam Research. (*Mr. Jakeman.*)

The first piece of work undertaken in this research is the determination of the specific heat of superheated steam. The method adopted is the direct measurement of the heat necessary to raise a known weight of steam from and to any temperatures chosen. The steam is heated by an electric current flowing through a coil of wire, and the energy needed is measured by means of an accurate volt and ammeter. A temporary apparatus was constructed in order to test the method and obtain some approximate values for the specific heat. This was in the first instance provided with mercury in glass thermometers. These were found to give considerable trouble owing to the continuous changes of zero they underwent, in spite of a very thorough annealing before use. At the beginning of the year it was therefore decided to provide the outfit for measurement of the temperatures with platinum resistance thermometers, before continuing the experiments. These thermometers are constructed in the usual way with fine wire wound on mica frames, the resistance being about 2·6 ohms at 0°C. The thermometers are enclosed in steel tubes 1cm. in external diameter, and these tubes are placed directly in the steam. The bridge used for measuring the resistance is of the type used by Prof. Callendar, with some modifications in detail to suit the special circumstances. The slide wire is 50cm. long and about ½ ohm. resistance. The bridge unit is the change of resistance produced by a shift of ½cm. on the wire (= nearly 0·01 ohm.) The coils in series with one end of the wire are 350, 50, 50, 50, 50, 50, 50, 50, units respectively. Thus with the first coil only the two fixed points, 0°C. and 100°C., are both on the slide wire, the "fundamental interval" of the thermometers being adjusted to be 100 bridge units. The addition of each coil afterwards causes a shift in the position of the slider of one-half the length of the wire, so that there are always two positions where balance can be obtained. This gives a very convenient check of the accuracy of the bridge. For these experiments two temperatures are always required, that of the inlet steam and that of the outlet. These may differ by a large quantity, and in order to obtain them quickly it was necessary to duplicate some parts of the bridge. This was done by providing two copper bars, one connected to each of the compensating leads from the thermometers, and to each of which any number of the coils can be connected independently. Two sliders are also provided, one for each thermometer. A six-pole mercury cup switch is provided, making, with one shift, the circuit through either thermometer, the corresponding compensating lead with the coils arranged and the corresponding slider. Thus the coils and sliders are always set for each temperature and either can be read by shifting the switch into one position or the other. In the same box is placed a thermo-electric key, a series resistance in the galvanometer circuit with a turning head and a battery switch and reverse. The only detached parts of the apparatus besides the thermometers are the galvanometer and battery. The coils are all of manganin wire, so that temperature changes do not affect the reading, and the contacts are made by large mercury cups, so that trouble with contact resistances does not occur. The whole of the apparatus has been made in the laboratory workshops. As the thermometers are adjusted to the bridge unit the readings are direct in platinum degrees, conversion to centigrade degrees being made afterwards by means of tables. The bridge has proved very handy in use, and with a sensitive galvanometer of quick swing, it is possible to take an observation of each temperature within 10 seconds. During the preliminary tests it was found absolutely necessary to have perfect control over the heating current. To obtain this a large resistance frame has been constructed in the laboratory workshops. The main frame contains 29 coils regulating the current from 5 to 20 amperes and controlled by a 30-point turning head. A second turning head with 30 points is provided, one turn of which corresponds to the shift of one step on the first head. Thus nearly 900 steps are obtained between 5 and 20 amperes. The heads are of special design to prevent any alteration in contact resistance affecting the adjustment. By means of this resistance the watts in the circuits are kept constant during any experiment, to a fixed reading on a 3,000-watt wattmeter obtained from Messrs. Elliot & Co. During the year improvements have been made in the insulation of the heating coil from the case. The superheater is now lined with a glass tube, and the leads have been enclosed in glass tubes, a satisfactory steam joint having been devised.

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[*] [*The Electrician* for March 17, p. 884.—Ed. *E.*]

The financial position of the Laboratory during the earlier part of the year was a cause of some anxiety to the committee; the large additions made to the donation fund, which has risen from £1,124. 3s. to £2,318. 13s., and the increase in the work during the latter part of the year have, however, turned the loss which was feared into a balance. The expenditure during the year has been £12,257. 8s. 7d., and the receipts £12,758. 8s. 9d., showing a balance in favour of the committee on the year's working of £496. 0s. 2d. While this result is satisfactory, the committee realise it is due in great measure to the efforts made by the Special Fund committee to increase the donation list, and that such a source of income is necessarily a precarious one. In addition, a sum of £1,815. 18s. 2d. has been spent on equipment, mainly out of previous accumulations of income. The balance is now £4,142. 0s. 4d., as against £2,379. 9s. 11d. at the beginning of the year, but this includes a donation of £2,000 and £396, the balance of a donation of £500 respectively, made recently for new equipment.

The sources of income have been as under, and may be compared with the receipts in 1903.

	1903.			1904.		
Government grant	£4,000	0	0	£4,000	0	0
Gassiot fund	426	12	2	453	14	4
Donations and subscriptions	1,124	3	0	2,318	13	0
Charges for work done	4,347	9	5	5,625	16	0
Charge for commissions for foreign and colonial Governments	255	2	6	318	1	8
Miscellaneous receipts	46	17	2	41	18	9
	£10,200	4	3	£12,758	8	9

In estimating the receipts for work done it must be remembered that a large proportion of the donations and subscriptions come from technical and learned societies, which expect contributions in return in the form of research work of importance to their members. In some cases the actual research to be carried out is specified. Thus some large part of the subscriptions is really payment for work. In the report for 1903 some account was given of the preliminary steps taken to bring the needs of the Laboratory before the Government, in view of the fact that the five years for which the grant of £4,000 was made lapsed in September, 1904. In accordance with a request from the Treasury, the committee prepared for the Royal Society a detailed scheme for carrying on the work. This was submitted to the Government and discussed at a meeting in the Chancellor of the Exchequer's room in July last. A reply has been received from the Lords Commissioners of His Majesty's Treasury, in which their Lordships express their readiness to place on the Estimates an increased grant to provide for an augmentation in the number and salaries of the staff. The annual grant for 1905-6 is to be £5,500, an increase of £1,500, and their Lordships will, in addition, be willing to consider whether this sum of £5,500 should, in the Estimates for 1906-7, be further increased by a sum not exceeding £500 a year, making a total of £6,000. The memorandum of the committee also pointed out the need for capital expenditure on new buildings and equipment of a sum approaching £30,000. With regard to this their Lordships write:—

"With every desire to develop in the public interest the resources of the National Physical Laboratory, my Lords feel that this somewhat extensive programme is one which, having regard to the financial exigencies of the time, and the numerous other demands on the Exchequer, can only be carried out by being spread over a number of years. They will, however, be prepared to ask Parliament for an additional grant of £5,000 for 1905-6, and they hope that for four or five years to come it may be possible to provide an equal amount."

In reply to a request from the Royal Society for an expression of their opinion, the executive committee have asked the president and council to convey to their Lordships their thanks for the increased grants. They have felt, however, bound to observe that the sum of £6,000 per annum falls considerably short of the amount of £10,000 which, as they pointed out in their memorandum, will, in their opinion, be ultimately necessary to discharge the duties which have been laid upon the executive committee, while the long period over which the work of equipping the Laboratory is to be spread will make its full development slow. At the same time the committee gratefully realise that the additional resources thus placed at their disposal will enable them at once to extend their work, and they cannot doubt that the public utility of the operations of the Laboratory will in future establish a claim for further assistance from His Majesty's Government. Since the receipt of this reply the committee have had under consideration the question which of the extensions described in the memorandum is the most urgent, and have decided to obtain plans and tenders for two new buildings to house the departments of electrotechnics and metrology.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Proceedings of the Royal Society," Vol. LXXIV., No. 505. (London: Harrison & Sons.) 2s.

"British Standard Specification and Sections of Flat-bottomed Railway Rails." Report by the Engineering Standards Committee. (London: Crosby Lockwood & Son.) 10s. 6d.

"Harmsworth Encyclpædia." In 40 fortnightly parts. Part I. (London: The Amalgamated Press (Ltd.) and Thomas Nelson & Sons.) 7d.

RECENT DEVELOPMENTS IN ELECTRIC SMELTING IN CONNECTION WITH IRON AND STEEL.*

BY. F. W. HARBORD.

(Continued from page 878).

THE RESISTANCE FURNACE.

In this type of furnace the heat is generated by the resistance offered by the whole, or a portion, of the furnace charge to a very powerful electric current. It is best represented by the Héroult and Keller furnaces, which are both employed commercially in the manufacture of steel and alloys of iron.

The Héroult Process.—The Héroult furnace for the manufacture of steel has been in successful operation now for several years. One 4-ton furnace at Kortfors, in Sweden, and a somewhat smaller furnace at La Praz, in the South of France, are producing steel commercially on a considerable scale, and of the highest quality. The furnace shown in Figs. 2 and 3, taken from the Canadian commission report, is a tilting furnace, so far as the construction of the body of the furnace is concerned, very similar to that of the well-known Wellman and Campbell tilting furnace. The furnace hearth is basic lined, as in the ordinary basic open hearth process, and two large electrodes pass vertically through the roof, and can be raised or lowered either by hand or automatically by a specially constructed regulator. An alternating current of 4,000 amperes and 110 volts is used at La Praz, and the intensity of the current passing through the bath is regulated by increasing or decreasing the width of the air-gap between the electrodes and the slag line. The section of the roof between the electrodes is usually made of bronze, in order that no magnetic circuit may surround them. The electrodes may or may not be water-jacketed where they pass through the roof, but water-cooling not only increases the life of the furnace and electrodes, but enables a considerably larger output to be obtained. At the date of my visit the Kortfors furnace had water-jacketed electrodes, while the La Praz furnace had not, but the latter has since been provided with those. One very great advantage connected with this furnace is that common steel scrap of good average quality, such as bar ends, rail ends, &c., can be converted into steel of the highest quality, and it is not necessary to use an exceptionally pure or high-priced material, as in the induction furnace. The construction of the furnace is such that it enables the impurities in the scrap iron to be readily removed by the addition of suitable fluxes, and the slag can be poured off, and a new slag made at will to further remove any remaining impurities. The furnace is charged by throwing the scrap iron or steel on to the hearth of the furnace through the doors at the end, and the electrodes are then lowered sufficiently to establish the electric current, the current passing through the charge from one electrode to the other. In the early stages of the heat, when the charge is melting down, the electrodes are generally in contact with some parts of it, and the energy is largely absorbed by the numerous high-resistance contacts and small arcs between the pieces forming the charge. During this period there are great variations in the resistance of the hearth, and violent fluctuations of the current, due to the continual change in contacts and disruption of the circuits owing to the melting of the different pieces. Gradually, however, the entire charge melts, an arc is established between each electrode, and the molten iron and the two arcs absorb the greater part of the energy. The position of each electrode is controlled by an automatic regulator by means of a small motor at the back of the furnace geared to the mechanism supporting the electrode. An electric mechanism actuated by variations of the voltage below or above certain predetermined limits controls the motor, which, according to the direction of its rotation, raises or lowers the electrode. During the melting stage, or when pouring off the slag, the arc is liable to be short-circuited, and it is better then to switch out the regulator and regulate by hand.

The method of working is as follows: Miscellaneous scrap, with some lime, is charged on the furnace hearth, and as the charge melts further additions of scrap and lime are made, a little pure iron ore being added when the metal is entirely melted. After the bath has been molten for some time the furnace is tilted, the slag poured off, and finally raked off the surface, until practically nothing but metal remains in the furnace. A new slag is now formed by suitable additions of ore and lime; this is melted and kept in the furnace for some time, when it is removed in the same way as the first slag, and a third slag formed to remove the last traces of impurity. Ferromanganese in the case of low carbon steels is now added, and the metal is ready for pouring into the ladle, and teeming into the ingot mould. When high carbon steel is required at the end of the operation, "carburite," a mixture of pure iron and carbon, is added in the furnace in such a quantity as to give the percentage of carbon required in the finished steel. During my visit at La Praz, steel varying from 0·079 to 1·000 per cent. was made without the slightest difficulty, the former being a special low carbon steel used for transformers. The following, taken from the Canadian report, gives some particulars of the electrical plants at La Praz, with electrical measurements taken (the charges given are for a low carbon and a high carbon steel). The usual charge was about three tons, but the low carbon heat was a very small one, as only a small quantity of this steel was required for a special order. An alternating current is used, and is generated directly on the alternator at 110 volts. The alternator has 16 poles, and operates at 250 revolutions per minute, giving a periodicity of 33 cycles. It is a revolving field machine, with horizontal shaft, and is directly connected to its water-wheel. The water-wheel is operated with partial gate opening at the beginning of the charge to limit the output of the alternator during the period when the current fluctuates violently, but when conditions become more stable it is given full gate opening, and the alternator operates at full load through the remainder of the run. When the furnace is tilted to scrape off the slag the current is taken off, and again applied as soon as this operation is completed. The electrical readings were taken on the regular switchboard voltmeter and kilowatt-meter, for which no calibration could be obtained. There was no ammeter in circuit, hence no determination of the current input or of the power-actor could be made. The following readings were taken:—

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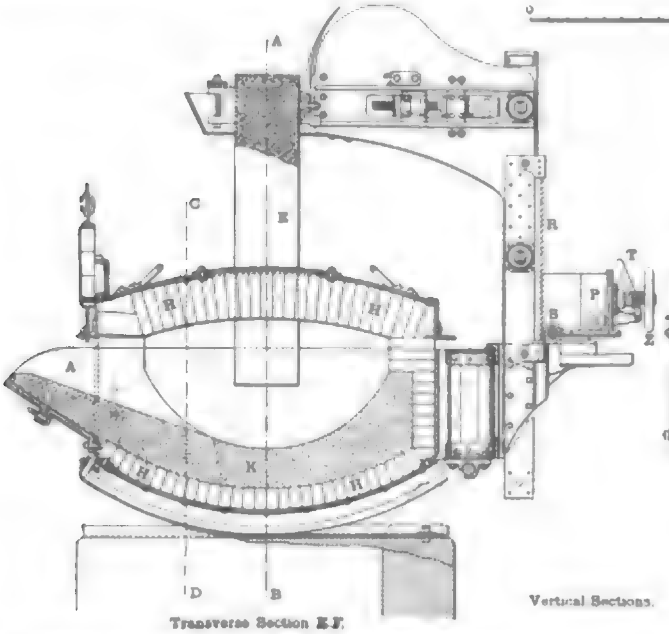
* Paper read before the Faraday Society on March 6.



Transverse Section E.F.

Fig. 2.—Vertical Section through the Pouring Spout of the Heroult Furnace at La Praz.

A, pouring spout; E, suspended electrode, of which there are two, passing through roof; H, basic or burnt Dolomite bricks; H', Silica bricks of roof; K, rammed basic material; P, motor for driving automatic regulator; T, lever for throwing motor, P, out of action; Z, hand-wheel operating pinion, S', for regulating electrodes by hand; R, rack gearing with S, by which electrode is raised or lowered. An alternating current of 4,000 amperes and 110 volts is used.

Charge No. 658, March 5th. To obtain dead soft steel:—

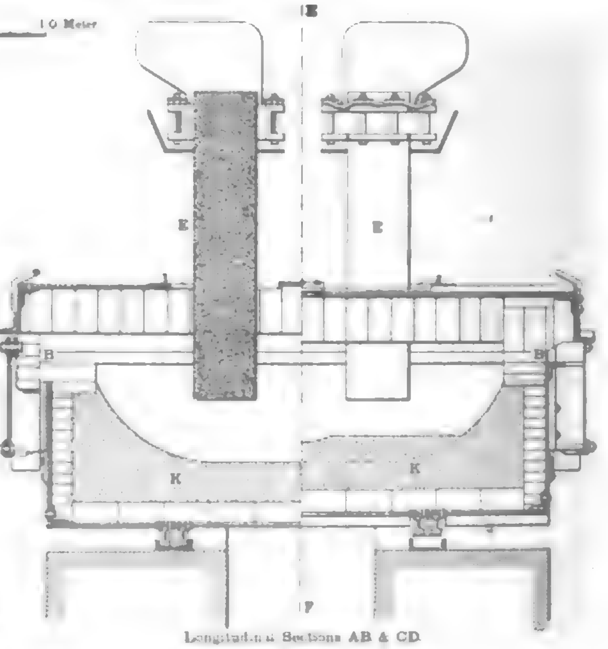
Time.	Volts.	Kilowatts.	Time.	Volts.	Kilowatts.
7:45 p.m.	110	200	10:30 p.m.	107	360
7:50 „	115	220	11:00 „	108	360
9:00 „	..	350	11:30 „	105	350
9:30 „	110	330	12:00 „	105	360
10:00 „	108	360			

Beginning of run, partial gate opening, p.m.	7:45
Full gate opening, p.m.	9.0
End of run, a.m.	12:15
Length of run, total hours	4½
Mean voltage	108
Mean kilowatts, partial gate opening	210
Mean kilowatts, full gate opening	353
Total kilowatt-hours	1,410
Mean horse-power, full gate opening	480
Total horse-power-hours	1,920
Total horse-power-years	0·219
Output of ingots, kilogrammes	1,283
Horse-power-years per ton of ingots (2,240lb.)	0·17
Cost of electric energy per ton of ingot, at 41s. 8d. per horse-power-year	7s. 1d.

Charge No. 660, March 6th. For tool steel:—

Time.	Volts.	Kilowatts.	Time.	Volts.	Kilowatts.
11:45 a.m	120	220	4:45 p.m.	107	340
12:0 „	120	200	5:15 „	105	340
12:15 p.m.	115	225	5:45 „	110	340
2:45 „	110	340	6:15 „	110	330
3:45 „	108	350	6:45 „	110	340
4:15 „	107	340			

Beginning of run, partial gate opening, a.m.	11:40
Full gate opening, p.m.	12:45
End of run, p.m.	7:40
Length of run, total hours	8
Mean voltage	110
Mean kilowatts, partial gate opening	215
Mean kilowatts, full gate opening	340
Total kilowatt-hours	2,580
Mean horse-power, full gate opening	462
Total horse-power-hours	3,500
Total horse-power-years	0·4
Output of ingots, kilogrammes	2,341
Horse-power-years per ton of ingots (2,240lb.)	0·17
Cost of electric energy per ton of ingot, at 41s. 8d. per horse-power-year	7s. 1d.



Longitudinal Sections AB & CD.

Fig. 3.

In the above figures of energy consumed the short periods have been neglected during which the current was taken off to remove the slag. The violent fluctuations of the current and the liability to short-circuit make it desirable to limit the possible current to a moderate overload by the use of a suitably designed alternator and transformer. It will be noted that the energy consumed per ton of ingot produced was the same in the low-carbon steel as in the high-carbon steel, but this is due largely to the smallness of the charge in the former case, and had it been a full heat, the energy consumed would have been considerably less. In the case of charge No. 660 the bath was completely melted and decarburised and sufficiently hot to tap, five hours after starting, and had ordinary structural steel been required it would have been tapped then; the remaining three hours were spent in purifying the metal by slagging and melting the carburising additions. The energy consumed up to five o'clock was only 0·111 E.H.P. years per ton of ingots, instead of 0·170 for the high-grade carbon steel.

The Keller Steel Process.—At Livet, at the works of Messrs. Keller, Leleux & Co., the process of steel making is not carried on commercially, the chief business of this firm being the manufacture of alloys. They have, however, an experimental furnace of about 35 cwt. capacity, in which they made an experimental heat. The furnace employed was identical, from a metallurgical and an electrical point of view, with the Héroult furnace, differing only in details as to tilting, &c. The electrodes passed through the roof, an alternating current was employed; common scrap was the raw material, and purification was effected by removing and renewing the slag several times. The charge made was of medium carbon, and the energy consumed was about 0·120 E.H.P. years per ton of ingots made. Before considering arc furnaces it may be desirable to compare the three processes of steel making above described.

Comparison of Kjellin, Héroult and Keller Processes of Steel Making.—The amount of electric energy consumed by the Kjellin or Héroult process, as determined experimentally and confirmed by figures supplied from the books of the two firms, was practically the same when all grades of steel are considered, and wages for furnaces of the same output would be about the same. The cost of repairs, refractories, &c., it is very difficult to estimate, but from figures taken from the respective works' books these are more costly in the Héroult than in the Kjellin, the respective figures being 5s. 10d. and 2s. 6d. per ton respectively. In addition to this we have to add, in the case of the Héroult process, the cost of electrodes, about 10d. per ton. Assuming that the cost of scrap pig, &c., in both cases was the same, the difference in the cost of production would not be more than a few shillings per ton one way or the other; unless one could compare two furnaces working under identical conditions over a considerable period of time it would be unfair to draw conclusions. Since my visit to La Praz, M. Héroult has written to say that he has increased his output from 4 to 7 tons in the 24 hours; and Mr. Kjellin has increased his from 4 to 5 tons, which makes it still more difficult to compare the cost of production. The chief point, however, when one process has an advantage over the other, is in the cost of raw material. The Kjellin process, to produce the highest-class tool steel, is limited to the best Swedish scrap and the best Swedish pig, or pig and ore, whereas common miscellaneous scrap is the raw material used in the Héroult process. In Sweden this high-class scrap can be obtained at a comparatively low figure, but in other countries Walloon scrap, if obtainable at all, which is not likely, would cost probably £12 per ton, and possibly more, and it would most likely be necessary to buy the Walloon bars at the same price as bars for cementation. On the other hand, ordinary steel scrap in England can be bought from 50s. to 60s. per ton, so that in countries outside Sweden the Héroult process has a great advantage. It is quite possible that Mr. Kjellin may be able to modify his furnace so that he can renew his slag and thus effect purification in the same way as in the Héroult process, but in its present form it is limited to the purest material either as scrap or scrap pig ore. His latest results with pure ore have no doubt reduced the costs, but the Héroult process still has a great advantage as regards the raw materials.

Quality.—So far as analytical, mechanical, microscopic and workshop tests show, steels can be made either by the Kjellin, Héroult or Keller process equal in every respect to best crucible steel. A large number of analyses taken from the centre, top, bottom and outside of different ingots showed the steel to be remarkably uniform and free from all liquation of the impurities. The steels were also tested for maximum stress, elastic limit, elongation, &c. The most important tests from the tool steel point of view, however, were those made at Woolwich under the supervision of Mr. H F. Donaldson, chief superintendent of the ordnance factories. A number of different steels varying in carbon from 0·8 to 1·80 per cent. were sent to Woolwich and forged into turning tools, comparative trials being made against turning tools of high-class Sheffield steel known as grade "A" containing 1·38 per cent. of carbon, and also against Mushet's steels. Steels lower in carbon than the standard steel were purposely sent, to determine, as far as possible, the point in carbon content when the steels ceased to be equal to the Sheffield steels. Mr. Donaldson reported that the material was not as good as Mushet's steel, and at a cutting speed of 19ft. per minute was useless, whereas the Mushet steel was working well within its capacity. As compared with grade "A," the results showed that, *speaking generally*, there was little difference between this and most of the steels experimented with. One peculiarity noticed in using the electric furnace steels as against Mushet's steel was an exceptional tendency to build up a false edge from the material operated upon. A reference to the tables on pages 86, 87 and 88 in the Canadian report will show that this tendency became more noticeable as the carbon decreased. Although the steels examined gave practically the same results as grade "A," when the actual detailed results are examined as to length of run and material removed in a given time, they divide themselves into two classes, those quite equal, and those not quite equal to grade "A." With one exception in every trial with steel above 1·20, the results were equal to those obtained with grade "A," those marked as not equal being lower carbon steel. This was to be anticipated; but the fact that in Mr. Donaldson's opinion the general behaviour of the steels was equal to grade "A," shows that even in the lower carbon steels the material was exceptionally good. It is important to remember that these steels cannot be compared with the special high-speed tool steels which are so largely replacing carbon steels for turning tools, and the comparison with Mushet's steel was only made to see if the steels under experiment were in any way superior to the ordinary carbon steels. The quality of the steel, whether made in the induction furnace of Kjellin or a furnace of the resistance type, like the Héroult or the Keller, seems to be equal in all respects, and the selection of one type of furnace or another would depend almost entirely upon local conditions. In each case steel equal to high-class crucible can be made, although the Kjellin process undoubtedly approaches most nearly to the conditions of crucible steel manufacture; the absence, however, of any very appreciable amount of oxygen in the Héroult furnace is shown by calcium carbide having been found in the slag, according to some recent analyses of M. Héroult. The cost of production in either process will thus vary with the raw material available, but under the same conditions as to the cost of materials, and taking fuel at the present price in this country, and electric energy at £10 per E.H.P. year, which is a price at which, under favourable conditions, it might be generated, either process could produce steel at a price lower than the cost of crucible steel; in other words, the electric furnace, even under English conditions, is a cheaper melter than the crucible furnace.

(To be continued.)

MANCHESTER TRAMWAYS—POWER SUPPLY*.

BY H. C. GUNTON AND S. L. PEARCE.

(Continued from page 889.)

SECTION II.

In this section of the Paper the authors wish to put on record some figures which have been obtained in connection with the power supplied to the Manchester trams, with special reference to the maximum and average output during the busy periods of the day. To avoid confusion, it will be well at the outset to explain the nomenclature which has been adopted for each of the various outputs or loads which occur.

The full traction output from a generating station or sub station is the highest output which is at all continuous as given by the readings of the integrating wattmeters taken over the busiest hours of the day.

The Maximum traction output from a generating station or substation is the momentary maximum output which is liable to occur at any time during the period of full traction output, with a certain number of cars being supplied. This output can, of course, only be noted by means of indicating instruments The term "full lighting output" will be applied, for the sake of uniformity, to what is generally known as the peak of the lighting load. There is, of course, no momentary maximum lighting output corresponding in degree to the maximum traction output.

Cars.—From the full details of the routes and services of cars which were available, it was possible to determine closely, not only the total number of large and small cars running, but also the approximate number on different portions of the system. At the time the observations were made the total number of cars was about 300 in the proportion of about 4·4 small to one large car. The small cars are double-decked single-truck cars with a normal carrying capacity of 45 passengers, and equipped with two 25 H.P. motors. The weight of one of these small cars empty is 8 tons 2 cwts. The large cars are double-decked maximum traction bogey cars, with a total normal carrying capacity of 73 passengers, and equipped with two 35 H.P. motors. The weight of one of these large cars empty is about 10 tons 12 cwt. It appears that in Manchester a safe figure to take for the average passenger load on the cars during the busy periods of the day, taken over a complete double journey, is half the total normal carrying capacity; hence the weight of one of the small cars, including this average passenger load and driver and conductor (allowing 10 stone per passenger), would be about 9·6 tons, and the weight of one of the large cars under the same conditions would be 18·0 tons. By taking careful observations of the full traction output and the maximum traction output from the Bloom-street station, from the Stuart-street station and from the sub stations, it is possible to construct curves showing approximately the relation between these quantities and the number of cars supplied.

Table II. gives readings of the full traction output and maximum traction output taken during the busy periods—8 a.m. to 9 a.m., and 5 p.m. to 7 p.m., at the Polygon, Moss Side and Rusholme sub-stations on five consecutive business days, Jan. 5 to Jan. 9, 1903, inclusive. It also gives the combined full traction output for all the sub-stations which were then running for the same period. It is not, of course, possible to obtain the simultaneous maximum traction output for all sub-stations together, from readings taken at the sub-stations, owing to the rapid fluctuations of the load, but this figure can be obtained from readings taken at the Stuart-street station in the manner shown in Table III. This table gives the readings taken at Bloom-street, Stuart-street, and the sub-stations between 5 p.m. and 7 p.m. on Wednesday, December 31, 1902, and on Monday, January 5, 1903. It is probable that the apparent difference in the results obtained for the outputs per car

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* Abstract of a Paper read before the Manchester Local Section of the Institution of Electrical Engineers on February 21st.

Table II.

—	Maximum traction Output kilowatt.		Full traction Output kilowatt.	
	8 to 9 a.m.	5 to 7 p.m.	8 to 9 a.m.	5 to 7 p.m.
All sub-stations, 1903 (127 cars):				
Jan. 5	..	..	983	977
„ 6	..	..	971	906
„ 7	..	..	991	1,032
„ 8	..	..	925	995
„ 9	..	..	951	976
			Average = 970	
Polygon (39 cars):				
Jan. 5	636	609	321	293
„ 6	583	583	287	270
„ 7	636	689	291	297
„ 8	636	636	275	291
„ 9	583	636	287	290
	Average = 623		Average = 290	
Moss Side (85 cars):				
Jan. 5	530	503	244	281
„ 6	530	450	292	252
„ 7	530	556	305	303
„ 8	477	503	287	298
„ 9	503	556	296	276
	Average = 514		Average = 283	
Rusholme (12 cars):				
Jan. 5	212	281	88	88
„ 6	265	238	83	81
„ 7	238	244	87	93
„ 8	222	265	82	87
„ 9	238	281	83	84
	Average = 249		Average = 86	

Table III.—*Extracts and Calculations from Special Observations taken over the Whole System.*

	Wednesday, Dec. 31, 1902. 5 to 7 p.m.	Monday, Jan. 5, 1903. 5 to 7 p.m.
Total number of cars running	298	300
Approx. number of cars within Bloom-street area	171	173
Approx. number of cars within sub-stations' area	127	127
Full traction output L.T. from Bloom-street from integrating wattmeter	kw. 1,550	kw. 1,550
Combined full traction and lighting output H.T. from Stuart-street: E_1 from integrating wattmeters	..	1,760
E_2 average of indicating wattmeters	1,773	..
E_3 calculated from integrating wattmeters at sub-stations	1,783	..
Full lighting input H.T. at sub-stations, from integrating wattmeters	444	432
Full traction input H.T. at sub-stations, from integrating wattmeters	1,220	1,214
Combined full traction and lighting input H.T. at sub-stations. (F + G)	1,664	1,616
*Efficiency of Transmission: I_1 observed (H/E)	..	93·5%
I_2 assumed	93·5%	..
Full traction output H.T. from Stuart-street G/I or E – (F/I)	kw. 1,300†	kw 1,300†
Full traction output L.T. from sub-stations from integrating wattmeters	972	977
Maximum traction output L.T. from Bloom-street	1,716	1,768
Combined maximum traction and lighting output H.T. from Stuart-street	2,100	2,020
Approximate lighting input H.T. at sub-stations at same time (calculated from log sheets)	506	450
Approximate lighting output H.T. from Stuart-street at same time N/I	540	480
Approximate maximum traction output H.T. from Stuart-street (M – O)	1,560	1,540
Approximate maximum traction output L.T. from sub-stations calculated as follows:—		
q_1 = Maximum traction input H.T. to sub-stations (I × P)	1,460	1,440
q_2 = Number of motor generators running	11	11
q_3 = Maximum input H.T. per motor generator q_1/q_2	kw. 133	kw. 133
q_4 = Efficiency at this maximum input. (See Fig. IV.)	83·7%	83·3%
Hence maximum traction output L.T. from sub-stations—$(q_4 \times q_1)$	kw. 1,222	kw. 1,199
Full traction output L.T. per car supplied from Bloom-street D/B	9·1	9·0
Full traction output H.T. per car supplied from Stuart-street J/C	10·2	10·2
Full traction output L.T. per car supplied from sub-stations K/C	7·7	7·7
Full traction output L.T. per car supplied from Bloom-street and sub-stations (D + K)/C	8·5	8·4
Maximum traction output per car supplied from Bloom-street L/B	10·0	10·2
Maximum traction output H.T. per car supplied from Stuart-street P/C	12·3	12·1
Maximum traction output L.T. per car supplied from sub-stations Q/C	9·6	9·4

* At this time traction and lighting loads were supplied by one H.T. feeder.

† Approximate.

for the areas supplied by Bloom-street and by the sub-stations is at least partly due to the number of cars within the Bloom-street area and sub-station area being greater and less respectively than the numbers calculated from the service tables. It is difficult to make an accurate allowance for the "bunching" of cars in the central area.

Fig. 11 shows in dotted lines the results from Tables II. and III. plotted in the form of curves, giving the full traction output (low-tension) and the maximum traction output (low-tension) and also the full traction output (low-tension) per car and the maximum traction output (low-tension) per car for different numbers of cars. From this diagram it will be seen that a safe value to take for the full traction output (low-tension) per car is 8·5kw. The effect which an increase in the number of cars supplied has in reducing the maximum traction output, as compared to the full traction output is shown by the curves in Fig. 11. It should be remembered that the difference between the maximum traction output and full traction output shown on Fig. 11 is by no means entirely due to the starting up of the cars, but is also due to irregularities in the distribution of the cars between the various areas—that is, by the bunching of the cars at different points. It is the importance of this ratio: Maximum traction output/full traction output, which it is desired to emphasise by these curves, and not so much the actual amount of power taken by the cars, which must, of course, necessarily depend on local conditions, and on the sizes, proportions, equipment and driving of the cars of different types.[‡] In order, however, to determine the approximate components of the figure—8·5kw. per car—and put the results in a form in which they will be likely to be more generally useful, tests were made on one large car and one small car over much the same route between the City and Fallowfield, and between the City and Palatine-road respectively, and on very similar days, having regard to the state of the track. Observations were made, not only of the power consumed over the whole double journey, measured by an integrating wattmeter, but also of the speed, voltage, and passenger load at different parts of the routes. In each case the car lamps were switched on. The following figures give the principal results obtained:—

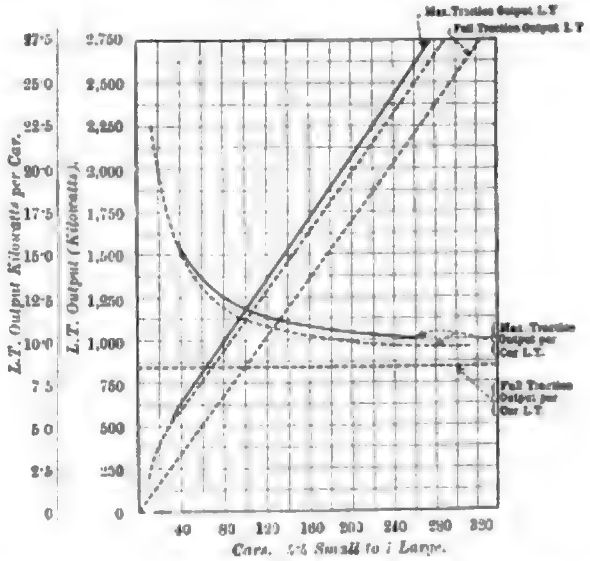


FIG. 11.

—	Double deck. Double truck car.	Double deck. Single truck car
Average passengers, including driver & conductor, carried over whole double journey	20	20
Hence average total weight of car plus load over whole double journey ....tons	11·85	9·35
Speed—double journey, incldg. stops..m.p.h.	7·4	8·0
Average kilowatts for whole double journey.	12·7	7·1
Average kilowatt-hours per car-mile	1·71	0·89
Average watt-hours per ton-mile	144·0	95·0
Correcting above on account of car not being loaded to its average load:		
Average kilowatt	13·0*	7·3†
Average kilowatt-hours per car-mile	1·87	0·91
Average watt-hours per ton-mile	144·0	95·0

$$^{*}12{\cdot}7 \times \frac{13{\cdot}0}{11{\cdot}85} = 13{\cdot}9. \qquad ^{\dagger}7{\cdot}1 \times \frac{9{\cdot}6}{9{\cdot}35} = 7{\cdot}3.$$

[‡] It will scarcely be necessary to remind members of the valuable investigation made in this connection by Mr. M. B. Field, the results of which were included in his Paper read before the Glasgow Section of the Institution in April, 1902.

If the above results for the single-truck car and the double-truck car are combined it will be seen that the full traction output per car for 4·4 small cars and one large car agrees with the figure 8·5kw. per car obtained in quite a different manner from measurements at the stations.

$$\frac{(4{\cdot}4 \times 7{\cdot}3) + 13{\cdot}9}{5{\cdot}4} = 8{\cdot}5\text{kw.}$$

It would be expected that the power as measured on the cars would be rather less than the power as measured at the switchboards, as in the latter case the loss in the low-tension feeders is included. The feeders are short, however, and this loss is therefore small. Knowing the approximate components of the figure—8·5kw. per car—curves can be constructed for any combination of small and large cars. Such curves have proved very useful in forecasting the loads which have had to be dealt with as the total service and the proportion of large cars increased.

In November, 1903, when the number of sub-stations being worked and the number of cars supplied had been considerably increased, an opportunity was taken to check the figures given above. Between 5 p.m. and 7 p.m. on November 17, 1903, when the full traction output from the sub-stations was about 2,340kw., the traction output at Bloom-street was continuously about 1,325kw. As the total traction output from Bloom-street and the Stuart-street sub-stations together between 5 p.m. and 7 p.m.—3,665kw.—is the greatest total which was obtained on that day by combining for the same two hours the sub-stations and Bloom-street continuous loads, this output is the full traction output for the whole system. The number of cars running between 5 p.m. and 7 p.m. on this day was 392, in the following proportions:—

Double-deck double-truck cars	102
Single-deck double-truck cars	18
Double-deck single-truck cars	272—392

The single-deck double-truck cars are approximately of the same weight when loaded with an average load as the double-deck double-truck cars, and therefore the proportion of small to large cars may be taken as 272 to 120 or 2·3 to 1. Combining the results of the tests of the single cars in these new proportions, we obtain the figure 9·3kw. per car.

$$\left\{ \frac{(2{\cdot}3 \times 7{\cdot}3) + 13{\cdot}9}{3{\cdot}3} = 9{\cdot}3\text{kw.} \right\}$$

392 cars at 9·3kw. per car = 3,645kw. (approximately), which agrees closely with the 3,665 kw. actually observed.

With regard to the maximum traction output, the distribution of cars on this date, between the areas supplied by Bloom-street and by the sub-stations, was not calculated from the service tables, but from the distribution of the full traction outputs it is evident that the number of cars in the area supplied by the sub-stations was about 250 to 270, say 260 cars. From the dotted curves in Fig. 11 it will be seen that with 260 cars the maximum traction output would be 13 per cent. greater than the full traction output. The observed full traction output from the sub-stations was 2,340kw., and we should therefore expect 2,640kw. for the corresponding maximum traction output (2,340 × 1·13 = 2,640 approximately). The actual maximum traction output (low tension) as calculated from the observed combined maximum traction and lighting output at Stuart-street was 2,775kw., or 5 per cent. more than would have been expected from the dotted curves in Fig. 11. While the dotted curves in Fig. 11 have proved sufficiently reliable for all practical purposes, it has been considered desirable, in view of these later results, to modify slightly the slope of the curve of maximum traction output, and also, of course, the dependent curve of maximum traction output per car. These modified curves are shown in full lines in Fig. 11. The authors wish to emphasise that the particulars given in this section of the Paper refer to the outputs occurring during the busiest periods of the day, which govern the amount of plant which has to be provided at the sub-stations, and they hope that these particulars may be of some use in this connection. On exceptional occasions, such as after a heavy fall of snow, or after a general shut down, loads may occur which exceed those which have been indicated, but it is considered right to rely on the stand-by plant for such exceptional cases.

Fig. 12 gives the load curves for January 5, 1903, for traction and lighting outputs from all the sub-stations together. It also shows the combined full traction and lighting output from all the sub-stations, the combined full traction and lighting output from Stuart-street, the combined maximum traction and lighting output from Stuart-street and the maximum traction output from the sub-stations, the last-named output being calculated as shown in Table III.

Having indicated the relation which exists between the maximum traction output and the full traction output, it will be well, without going into detail, to refer to the way in which these relations affect the arrangement and equipment of stations for supplying power for tramway purposes. Fig. 11 shows that even in the case of a station supplying 80 cars, the maximum traction output would be as much as 50 per cent. more than the full traction output, and except in the case of a station supplying a large number of cars it is clearly the momentary maximum traction output which decides the number of machines which must be run. On the other hand, in the case of a station supplying 220 cars, it is the full traction output which decides the number of machines to be run, as the corresponding maximum traction output would not be more than about 20 per cent. greater, and would, therefore, be within the overload capacity of the plant. In the case of a station supplying less than about 220 cars, the overload capacity of the plant should clearly be made as great as possible. Generally, the following considerations should be kept in view in order to reduce the disadvantages of the variations of the traction load, although these considerations are not, of course, equally applicable to the different cases which present themselves.

1. The possibility of running stations in parallel on to the lines. It is quite possible by carefully adjusting the compounding of the generators in the various stations to supply the different areas in parallel, and this method does, on the whole, tend to reduce the fluctuations of the load. On the other hand, it is more difficult to keep the drop of pressure in the rails within bounds, and it is also difficult to guard against excessive loads being taken by any one station, especially on starting up after a general shut down.

2. The use of machines capable of dealing with momentary loads greatly in excess of their normal most efficient loads. In the case of synchronous motor generators the shape of the "V" excitation curve of the synchronous motor is, of course, of great importance in this connection. With regard to generators, compound-wound machines, such as are used for traction work, meet the required conditions well, since an increase in the load is accompanied by an increase in the strength of the field, which is just what is required for sparkless commutation. The Manchester sub-station synchronous sets have been found capable of successfully taking momentary loads up to 50 per cent. in excess of their normal full-load capacity, though the nominal overload capacity is 25 per cent.

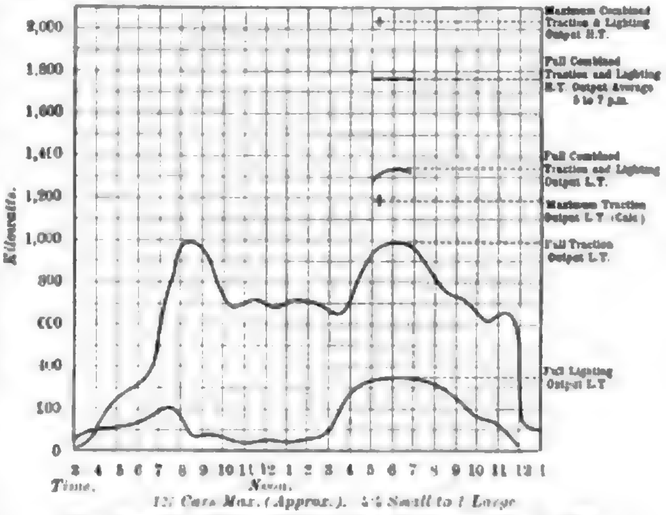


FIG. 12.—Stuart Street Station Load Curves. Jan. 5, 1903.

3. The number of stations for supplying a given number of cars should be kept as few as possible. Where there are a number of cross routes it is, of course, much easier to supply a large number of cars from one station without excessive drop in the rails or excessive outlay in mains than in the case of a single long route. Even in the case of a single long route, however, the area of supply can be extended by means of additional positive and negative feeders and boosters, and in some cases these will be preferable to installing a separate sub-station towards the end of the line. This, of course, is considering the matter entirely from a traction point of view. The Manchester sub-stations had to be arranged to suit lighting requirements as well as traction.

4. The use of batteries, preferably with reversible boosters. (A) At the power house in the case of a direct-current station supplying a small number of cars. (B) At the sub-stations in the case of an extensive system supplying a large number of cars. As a rule, however, it is only in cases where reliability is the governing condition that the cost of providing batteries of the necessary sizes at the sub-stations is justified.

The authors wish to express their thanks to Messrs. Kennedy and Jenkin for permitting them to publish results of tests and particulars in connection with the Stuart street plant, and also to Mr. J. M. McElroy, the general manager of the Corporation tramways department, for the information which he has given in connection with the cars and the car services.

APPENDIX.

"A."—DICKINSON-STREET STATION.

Eighteen Lancashire boilers, each 30ft. by 8ft., with Galloway superheaters. Four Babcock & Wilcox, of 10,000lb. capacity, with superheaters. In practice 90deg. of superheat obtained at engine. Six sets of Green economisers. Working pressure, 135lb. to the square inch. Duplicate steam ranges throughout. The coal is delivered by canal, discharged by means of travelling jib crane into the bunkers, whence it falls into the stoker magazines. Vicars' stokers throughout. The coal used is washed slack. Lowest weekly consumption, 3·98lb. per Board of Trade unit generated.

Two Ferranti vertical cross-compound engines coupled directly to direct-current multipolar dynamos by the British Westinghouse Co. of 750kw. capacity. The generators are arranged to over-compound up to 10 per cent., and the speed of the sets is 160 revs. per min. Two Parsons-Siemens sets of 750kw. capacity, each running at 1,500 revs. per min., have just been put down.

Two Korting's ejector and two Parsons surface condensers with vacuum augmentors. Separate motor-driven circulating pumps. Condensing water obtained from Rochdale canal. The British Thomson-Houston Co.'s standard switchboards.

"B."—Bloom-street Station.

Eleven Babcock & Wilcox boilers, with superheaters, each capable of evaporating 18,000lb. per hour. Eleven sets of Green economisers. Working pressure 160lb. per square inch. Duplicate steam ranges throughout. The same coal-handling plant as at Dickinson-street. Chain-grate stokers. Coal used, washed slack. Lowest weekly consumption, 3·2lb. per Board of Trade unit generated.

Four Musgrave vertical cross-compound engines, coupled directly to direct-current compound-wound multipolar dynamos by the British Westinghouse Co. of 1,800kw. capacity each, and working up to 25 per cent. overload. Speed 75 revs. per min. Each engine has two Musgrave surface condensers in parallel. Air pumps driven directly off crossheads of engine. Independent motor-driven circulating pumps. Condensing water obtained from the Rochdale canal.

Ediswan switchboards throughout. Reverse-current circuit-breakers on main generators; maximum circuit-breakers on feeders. Equaliser bars not brought to switchboard, but run down the centre of the engine room. Equaliser pillars and switches fixed close up to main generators.

"C."—Stuart-street. No. 1 Station.

Twenty-four Babcock & Wilcox boilers, each capable of evaporating 12,000lb. of water per hour. Working pressure, 160lb. per square inch. Berryman feed heaters. The coal is hauled by rail from the Lancashire & Yorkshire Railway Co.'s sidings right into the depot, bunkers being placed directly under the respective sidings. The coal and ash elevators are of the gravity bucket type suspended from an endless chain. Chain-grate stokers used throughout. Washed peas and washed slack coal used. Lowest weekly consumption, 3·2lb. per Board of Trade unit generated.

Six Yates & Thom vertical cross-compound engines directly coupled to high-tension three-phase alternators of 1,500kw. capacity each, by the Electrical Co., running at 94 revs. per min. Overload capacty 20 per cent. Six Willans & Robinson's barometric condensers, with motor-driven circulating water pumps and no air pumps. Condensing water for 5,000 H.P. of steam plant drawn from the Ashton canal, the remainder from Corporation mains, with four forced-draught cooling towers. Three Willans Electrical Co.'s high-speed sets, giving 220kw. each, at 200 to 220 volts. Induction-motor exciter sets. Excitation from Willans sets as alternative to induction-motor sets.

Electrical Co.'s switchboards, controlling six 1,500kw. generators and 18 high-tension feeders, together with feeder-testing, feeder-charging, bar-coupling, and interboard-connecting panels. Each high-tension feeder protected by high-tension fuses.

No. 2 Station (Extensions).

Twelve Babcock & Wilcox boilers, each capable of evaporating 20,000lb. of water. 12 sets of Green economisers. Working pressure 200lb. per square inch. Babcock & Wilcox superheaters. Holder & Brooke feed heaters. Coal-handling plant same as No. 1 station.

Two "Wallsend Slipway" triple expansion, four-crank vertical engines, coupled directly and externally to high-tension three-phase alternators of 3,750kw. capacity, each by the Electrical Co. Two sets of surface condensers, by Messrs. Mather & Platt, each provided with 11,000 sq. ft. of cooling surface. Air pumps (wet and dry) and circulating pumps driven direct off the crosshead of the high-pressure and low-pressure engines. Condensing water obtained from Corporation mains, involving the use of six forced-draught cooling towers. Auxiliary plant provided by the Stuart-street sub-station.

Ferranti type switchboards, controlling two 3,750kw. generators, 14 high-tension feeders, together with feeder-charging and board-coupling panels. Each high-tension feeder protected by oil circuit-breakers of the excess-current type. Automatic oil-break switches inserted between the two main switchboard 'bus bars

DISCUSSION.

Mr. TAITE thought the sub-station efficiency low, and asked if it was due to the size of motor-generators; how did these compare with rotary converters? The low total works costs of 0·27d. for Stuart-street, 0·28d. for Bloom-street and 0·432d. for Dickinson-street were very encouraging. The evidence before them proved that small stations were—owing to capital cost—not to be considered, and that large stations were a necessity.

Mr. L. ANDREWS emphasised the advantages of a combined station. He considered 78·5 per cent., as representing the average monthly conversion efficiency for all traction sub-stations, very satisfactory, for it must be remembered that it was an all-day efficiency. He had not known of single-phase alternating supply giving more than 50 to 60 per cent. all-day efficiency, and it compared very favourably with such. From the figures given he had deduced the cost of current generated at sub-stations, and found it to work out at about 0·4d. per unit. It was impossible to obtain so low a figure at small separate generating stations. He would like to ask Mr. Pearce if 0·103d. per unit represented the total distribution cost or only to the sub-station terminals? It was interesting to compare the Stuart-street coal consumption of 0·17d. per unit when working condensing with 0·26d. when the station was working non-condensing. The saving in coal when condensing was substantial and genuine. He drew attention to the tests of one of the 1,800kw. Musgrave-Westinghouse sets at the Bloom-street works with saturated steam. This set took 19·8lb. of steam per unit generated, and with steam superheated 90°F. only 17·2lb. per unit generated. These figures showed a remarkable saving by the use of superheated steam, but he would like to ask what extra fuel was burned to obtain the superheat?

Mr. R. ORSETTICH wanted to know if any trouble had been experienced with the switching in and out of the motor-generators with reference to static effects. He had designed 250kw. motor-generators having 89 per cent. efficiency, and thought any more increase in the size of unit would not effect much further economy.

Mr. FRITH thought capital charges should have been included in figures given.

Mr. SHEFFIELD thought the question as to the use of small or large cars was one of traffic considerations rather than cost per car-mile.

Mr. FIELD considered the heating effect the main factor in determining the overload capacity of generators. He noticed that with 80 cars the maximum demand was 50 per cent. more than the full traction load, and he considered that 50 per cent. overload had really a small heating effect and could be easily taken up. There was no danger of motor-generators getting out of phase with even 80 to 100 per cent. overload of short duration. Batteries would reduce the heating effect by taking up variations in demand, but calculations showed only about 8 per cent. saving in the heating effect. He drew attention to the heavy demand after a total shut down, and did not know why it lasted so long; in Glasgow it was about half an hour. He considered the question of rail drop very important, and in Glasgow, with negative boosters, they did much better than the Board of Trade demanded, the greatest difference of potential between any two points not being more than 1 volt.

Mr. AITCHESON (Rochdale) said that with the number of cars and the type necessary 25kw. per car was about the Rochdale figure. He instanced Coventry as a station that made use of its traction extensions to extend its lighting area, and asked if that was the case in Manchester. He also asked whether the Manchester negative traction feeders were in parallel with the rails or taken straight back. Also whether motor-driven three-phase generators had been tried in parallel with engine-driven sets, as motor-driven sets were installed at Dickinson-street.

In his reply, Mr. PEARCE said that 0·103d. per unit generated represented the total distribution cost. With regard to coal used for superheat boiler tests were not conducted, and he was unable to give any figures comparing the test of December 21st with that of the 22nd, which was an unofficial test. Coal figures for non-condensing and condensing were 4·1lb. and 3·2lb. respectively. Parallel running had been quite satisfactory, and there was a difference of opinion about the relative merits of former-wound coils and hand-wound. He agreed that there was little to be gained by increasing the size of motor-generators. The rails were not connected at the station, and feeders went straight back.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

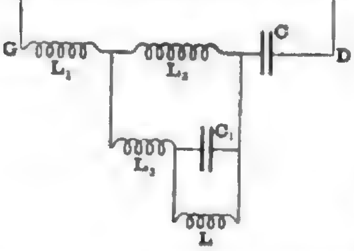
Recorder of Atmospheric Ionisation.—C. Nordmann describes another apparatus for registering the ionisation of the atmosphere, which has over his own previous method the advantage of not requiring a high resistance or a thermostat, and over that recently described by Langevin the advantage of giving an absolutely continuous record. The apparatus consists essentially of a cylindrical condenser filled with the air whose ionisation is to be determined. The outer cylinder is kept at a fixed potential by means of a battery. The inner one is connected with the earth, so that there is a constant current from the condenser to the earth, whose intensity depends simply upon the ionisation of the air. To measure this current, the author makes the connection with the earth not by a wire, but through a jet of water connected with the inner cylinder. The number of drops per second can be accurately regulated, and, as their size is constant, they will take away a charge proportional to the potential of the inner cylinder. This, again, depends upon the ionisation, and thus if the potential of the inner cylinder is measured it will at any instant indicate the degree of ionisation. The inner cylinder is therefore connected with one pair of quadrants of an electrometer whose other pair is earthed and whose needle is charged. The deflection of the needle is then proportional to the ionisation, and is continuously registered by a photographic cylinder. The best arrangement is to have an outflow of four or five drops of 2mm. radius per second. The temperature is without sensible influence as long as it does not vary by more than about 10deg.

[C. Nordmann, *Comptes Rendus*, February 13, 1905.]

Action of Radium Rays on Conductivity.—B. Sabat has made a large number of determinations of the effect of radium rays on the conductivity of various metals. The experiments were made with a very strong radium preparation, consisting of 0·2 grammes of pure radium bromide enclosed in a glass vessel with thin walls. Wires of the various metals were rolled on thin paper tubes, in the interior of which the radium preparation was placed. In the case of bismuth, the wire was wound in a flat spiral. In every case the thickness of the wire was less than 1mm. The uniform result obtained in the case of bismuth, iron, steel, copper, platinum, brass and German silver was an increase in the resistance. This increase begins immediately on exposing the wire to the action of the radium rays, and before any heat from the spontaneous heating of the radium could have time to produce the effect. If the radium is kept near the wires for a length of time, the resistance increases to a certain maximum value. On removing the radium, the metals slowly return to their original resistance. The author adopts the view that the energy of the impinging β-rays is converted into heat, which increases the resistance of the wires in the usual way.

[B. Sabat, *Comptes Rendus*, March 6, 1905.]

Dielectric Viscosity.—The quantity of electricity on the armatures of a condenser subjected to a potential oscillating in a sinusoidal manner is retarded with respect to the electric field. This phenomenon, known as dielectric viscosity, has been investigated by O. M. Corbino with sine currents of frequencies ranging from 2,000 to 4,000 per second. For this purpose he attached to the two poles of an arc the somewhat complicated combination of condensers and inductances shown in the diagram. On increasing the intensity of the feeding current and shortening the arc, the Duddell currents circulating in the shunts gradually approached the perfect sine shape. With a paraffined-paper condenser he obtained a lag of more than 2deg. This lag is not due to a fault in the insulation, since the resistance was 10 million ohms instead of 1,400 ohms, as it would have to be to explain the lag. The author supports the theory of Hess, but extends it by supposing that dielectrics contain two kinds of conducting particles, one kind possessing a greater mobility than the other. The different kinds would be brought into vigorous action at very different frequencies.



[O. M. Corbino, *Physikalische Zeitschrift*, March 1, 1905.]

Point Discharges.—Röntgen found that for positive discharges in different gases the product of the mean free path and the minimum discharge potential is nearly constant. Warburg found that the discharge from a negative point was improved by cooling the gas, and that helium conveys the discharge much more readily than nitrogen or hydrogen. P. Ewers has since carried out 300 series of measurements, comprising 2,000 readings, with various gases at different temperatures and pressures. To ensure purity he made lavish use of the liquefying machine. Two of the gases examined were monatomic—viz., helium and argon, and two diatomic—viz., hydrogen and nitrogen. He found the following law: the product of minimum potential and square root of mean free path, divided by the number of atoms in the molecule, is constant for all the four gases at the same temperature and pressure. Combining this with a law governing the relation between current and E.M.F., he deduces the more general law that for a given E.M.F. the current is simply proportional to the mean free path of the molecules. This corresponds to the fact that in metals the conductivity is proportional to the mean free path of the electrons.

[P. Ewers, *Physikalische Zeitschrift*, March 1, 1905.]

Ionisation in Flames.—P. Massoulier has studied the ionisation in flames by means of vertical electrodes placed symmetrically with regard to the flame, so as to avoid the distortion produced by the upward current and by differences of temperature. He found the current sensibly independent of the distance between the electrodes. This tends to show that the ionisation takes place, not so much at the surface of the electrodes as throughout the volume of the flame. If the ionisation is really a volume phenomenon, the quantity of ions liberated per second is proportional to the distance between the electrodes. If saturation currents could be obtained, these ought to be proportional to that distance. Experiment shows that this proportionality does not hold, but it is known that true saturation currents cannot be obtained in flames. The field is really localised in the immediate neighbourhood of the electrodes, in layers not thicker than 0·5mm. The field in the middle space is insignificant. The ionisation in flames is very intense. The author calculates that every cubic centimetre of the central region contains at least 10^{10} ions of each sign. The ionisation depends, however, not only upon the temperature of the flame, but also upon the chemical reactions within it.

[P. Massoulier, *Comptes Rendus*, March 6, 1905.]

Solution of Platinum in Sulphuric Acid.—A. Brochet and J. Petit have carefully examined the action whereby an alternating current is empowered to dissolve platinum in sulphuric acid. It is well known that platinum does not dissolve in sulphuric acid when simply immersed in it, nor when serving as an electrode for a continuous current through it. The authors found that an alternating current is not essential to this action; it suffices if the current is variable. Platinum is dissolved at the anode, the solution is coloured by the formation of sulphate, and the metal is deposited at the cathode. The addition of an oxidiser does not favour the solution of the metal at the anode, but rather the contrary. It hinders the deposition of the metal at the cathode, since the reducer acts upon the oxidiser instead. The metal remains in solution. Naturally, the concentration of the solution has a limit, so that a state of equilibrium is soon attained. Without an oxidiser, the metal dissolved is entirely restored in the shape of platinum black. If a continuous current is superimposed upon an alternating current, the platinum is dissolved at the anode of the continuous current. The alternating current has no effect except in so far as it converts the continuous current into a current of variable intensity.

[Brochet and Petit, *Comptes Rendus*, March 6, 1905.]

Petrol-Electric Motor Car.—At the end of a Paper on electric traction, recently read before the New York Railroad Club, Mr. W. B. Potter referred to a petrol-electric car, now being built by the General Electric Co. of America. This car is provided with passenger, smoking, toilet and baggage compartments, and is 65ft. long over all. The engine room is at one end, and a motorman's compartment is provided at each end of the car to permit its being operated in both directions. The car complete will weigh approximately 55 tons. The engine will have a full-load output of 200 B.H.P. and will run at 600 revs. per min. It will be direct connected to a 600-volt generator, the fields of which will be separately excited from an exciter driven by the engine. The controller for the motors will be provided with a series parallel switch, but no starting resistance in the usual sense will be required, as the speed of the motors will be regulated by controlling the voltage of the generator through field-resistance points in the controller. The water-cooling system for the engine will be carried through radiators on the top of the car during the summer and in the winter through the ordinary heater pipes for the purpose of warming the car. An engine of the size proposed will provide for an acceleration sufficient to maintain a schedule speed of 20 to 25 miles where stops are 3 to 4 miles apart, and the car can be easily maintained at a running speed of 40 miles. It is estimated that, including all expenses—of the motorman, conductor, fuel and maintenance—the cost will be between 15 and 20 cents per car-mile. Several different types of engines are under consideration, as is also the use of kerosene as a fuel.

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UNIVERSITY COLLEGES.

A year ago, a deputation of representatives of the University Colleges waited upon the Chancellor of the Exchequer, the object being to ask for an increased grant from the Treasury. Up to that time the amount set aside each year was not more than £27,000, and this was unequally divided among some 14 University Colleges situated in different parts of the United Kingdom. In reply, the Chancellor said he would recommend Parliament to vote £54,000 for 1904-5 and £100,000 in the following year. A Committee was appointed to consider the allocation of the additional money, and at the same time to report on how State aid to University teaching could be most effectively organised and applied. This Committee submitted their first report on December 19, 1904, but fuller reports were presented subsequently.

In their first report, the Committee recommended the distribution of £9,000 of the additional grant on the same basis as the old, with the exception of the proportion originally allocated to Dundee College, this college being now provided for by Scottish University funds. For the present year only they also recommended that a second £9,000 be distributed on the same basis as the first, and they reserved their proposals with regard to the remaining £9,000. The second report was dated February 23, 1905, and dealt solely with the question of the balance then undistributed. It appears that the Committee inquired of each college as to how a sum not exceeding £700 could be most usefully spent on books, apparatus, &c.; as a result of these inquiries, the Committee have recommended that £700 be given to each of the 11 largest colleges and £650 to each of the remaining two. It is interesting to observe that, with the exception of Southampton, every one of the University Colleges stood in need of a library or of an addition to that already in existence. Several of the colleges were sadly deficient with regard to apparatus, and many were anxious either to start or enlarge their museum.

The third report, bearing the same date as the second, is the most important of all. It is pointed out that since elementary education has been progressively modified, so the standards in secondary and technical education are rising, and in every department of life, whether practical or otherwise, the tendency in civilised countries is towards raising the standard of knowledge. Now this raising of the standard is partly the result of the introduction of fresh subjects of study, such as engineering, architecture, &c., whence it follows that certain branches of learning which were hitherto excluded will now have to become recognised as "University teaching." This is, however, a minor point as compared with what follows in the report. The Committee state that they were particularly impressed by the absence of provision for post-graduate scholarships and fellowships, the lack of equipment in books and scientific apparatus, and the insufficiency of remuneration of many of the teachers. It is not suggested that the State should grant scholarships as a reward for past work or as remuneration for work to be done by teachers; but emphasis is laid on the necessity of providing students, of marked ability, who have already obtained their degree, with means to continue their student life by engaging in special inquiry or research. Unfortunately, this difficulty is no new one, and it does not appear that the amount which the Treasury proposes to allocate will altogether remove it. However, the Committee are of the opinion that the distribution of money for this purpose should not be in accordance with the principle upon which the original grant is made—viz., in proportion to the income and importance of the college, but that it should depend entirely on the work done by individual students. It is therefore proposed that some impartial authority be appointed, this authority having power to consult teachers as to the merits of their students and to distribute the grant directly to the students as may seem best. Such an authority would necessarily have to consist of men who, from their experience and position, can speak with authority on questions affecting university and scientific work.

With regard to books, the opinion is expressed that general libraries should be provided locally, and that only works of reference on specialised work should be subscribed for by the State. Similar observations also apply to instruments and apparatus.

It has long been notorious that the salaries of the teaching staffs of university and technical colleges are inadequate, and, if the Committee do nothing more, they will have justified their existence by calling the attention of Parliament to the state of affairs now prevailing. This subject is of far greater importance than that of post-graduate work, for the reason that students cannot be properly prepared for post graduate work unless they are taught by competent men. The result of under-paying teachers is to drive them to extend their work either inside or outside the college until there is left to them neither time nor energy to do full justice to their students or to keep themselves abreast of the latest developments in the branches of learning which they represent. For this reason the Committee recommend that some apportionment of the new fund might usefully be made available for increasing salaries. We think, however, that no impediment should be placed in the way of the principal teachers carrying on outside professional work, for, in the case of men of marked ability and high standing, the college will benefit by this extension of their experience; but, by keeping the salaries too low, there is more than a risk that few men at the top of their science or profession will be attracted to the University at all.

While these reports are a matter for congratulation, it must not be forgotten that the extra grant made by the Treasury is not a very large one, although it will doubtless be welcome to the recipients. Much depends on the constitution of the authority which it is proposed to form in order to distribute the additional money. If the members of this are properly chosen, then its potentialities for good will be very great. Unfortunately, its deliberations will concern University Colleges only, and will have nothing whatever to do with technical colleges, although, of course, a large amount of technical instruction is given in University Colleges. Perhaps, some day, Parliament may be induced to set aside an annual sum specially for technical colleges, if these latter do not disappear entirely by becoming absorbed by universities.

THE HOLBORN AND FINSBURY ELECTRICAL EXHIBITION.

This exhibition, which opened last Monday at 118-122, Holborn, and will close on April 5th, has been organised by the County of London Electric Supply Co. for providing consumers and residents in the company's areas of supply with an opportunity of inspecting the latest developments in electric lighting, heating and power appliances.

The Mayor of Holborn in declaring the exhibition open referred to the cordial relations which had always existed between the County of London Company and the Borough of Holborn. He subsequently explained the objects of the exhibition and wished it every success. The Mayor of Wandsworth then referred to the excellent work being carried on by the company in Wandsworth. He believed that power supply was given to large manufacturers there at a rate lower than any other in London. In reply to these remarks, Mr. Braithwaite, jun., Chairman of the County of London Company, said that they were promoting a Bill to connect together their stations on the north and south sides of the river. If this bill passed, the result would be that they would get a better load-factor and the tariff would be reduced. Altogether they had about 20,000 H.P. in motors connected to their mains, and in Wandsworth alone there were 2,000 penny-in-the-slot meters.

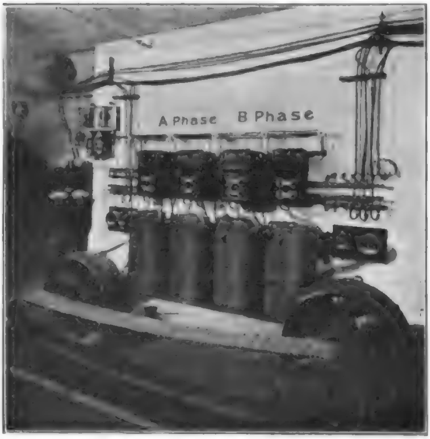


FIG. 1.—TEMPORARY SUB-STATION.

The exhibition itself is representative in character and the stands and model rooms show the various applications of electricity to good advantage. Exhibitors have the choice of an alternating or continuous-current supply. Alternating current at 2,000 volts is brought into the building from the company's mains and is transformed in the basement to 104 volts by the temporary transformer station shown in Fig. 1. Continuous current at 580 volts is also supplied by the company, and, for those exhibitors who require a lower voltage than this, there has been installed a continuous-current motor-generator which supplies current at 200 volts. The wiring of the entire building was carried out partly by the exhibitors themselves and partly by sub-contractors under the supervision of the company. We understand that the insulation resistance of the wiring, at test, came to 8½ megohms.

One of the features of the exhibition is the large number of electrical heating apparatus, such as electric stoves, cooking utensils, electrically-heated irons for ironing, foot-warmers, cigar lighters, and so on. It appears that electric stoves especially are steadily gaining in favour. A stove suitable for a room of medium size is stated to consume about ¼th of a unit per hour, the price charged per unit by the company for this purpose varying from 2½d. to 1¾d. Stoves are let by the company, a medium-sized stove costing 7s. 6d. per annum. The fittings, appliances and machinery on exhibition are of sound and practical design, most of them being on approved standard lines. A list of the exhibitors would serve almost as well as a more extended description to show the intending visitor the comprehensive character of the exhibits, and as nearly the whole of the stands are occupied either with machinery in motion or with working demonstrations of the exhibits shown, the Holborn and Finsbury Exhibition ranks with those instructive displays which have helped to familiarise the public with the possibilities and the advantages to be derived from the electrical equipment either of their private residences, their offices or their works for electric lighting or for driving domestic and industrial machinery by electricity. We may, however, devote a small space to a description of a few of the exhibits which promise to attract visitors to the exhibition.

Messrs. Maple & Co. (Stand No. 1) show artistic fittings and radiators, and have a novelty on view in the shape of Cooper's electrical illuminating table cloth. This cloth is interwoven with parallel metallic braids, alternate braids being connected together and with one of the electric light supply terminals by means of a flexible cord brought under the table along the floor. The cloth is used as an undercloth, being covered with any ordinary table cloth. The portable electric lamps used are fitted at the base with two metallic points, which penetrate the ordinary table cloth and the "electric" cloth, and make contact with any two alternate braids, thus completing the electric circuit.

There is, at Stand 18, a good assortment of the Western Electric Co.'s special makes of electrical accessories. At another stand furnished by this company (No. 46) a quantity of small machinery in motion is shown employed in driving a pump and a sewing machine. Encased and open type motors, alternating and continuous-current arc lamps, desk lights, electric laundry tools, supply station accessories, and other examples of the company's well-known manufactures are exhibited at this stand.

The County of London Electric Supply Co. show rooms fitted up with slot meter installations similar to the workmen's cottages on the L.C.C. Totterdown estate at Tooting.

At Stand No. 11 the Simplex Steel Conduit Co. show their well-known specialities. Amongst the novelties is the "Simplex" iron-clad house service cut-out shown in Fig. 2. The lower part contains a porcelain body with a clip terminal and set screws for attaching the incoming cable. The cover of the box carries the fuse terminals and can be entirely removed for replacing the fuse. A glass window is provided as shown. It is scarcely necessary to mention the Simplex Co.'s other specialities, as they are well known wherever electrical installation work is carried on, and can be found in a very large number of principal installations in all parts of the country.

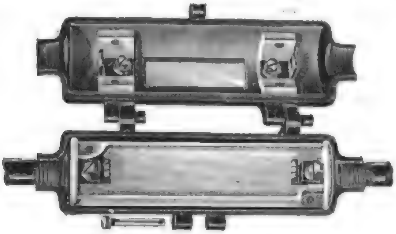


Fig. 2.—"Simplex" Iron-clad Cut-out.

At Stand 19 the Dowsing Radiant Heat Co. have an attractive exhibit and show their latest form of Solarium or electric sun bath. These baths have become exceedingly popular, and we are aware of a number of orders recently placed with the company for them by members of the aristocracy. Special electric heaters are fixed, as shown in Fig. 3, in corner positions in the cabinet, and patent reflectors are employed to direct the light and heat rays upon the person seated in the bath, who in this way enjoys the full advantage of a hot-air bath without any of the sometimes unpleasant consequences of hot air baths that are not worked electrically. The bather has complete control of the bath, from which he can emerge by the slightest effort. These baths are intended to be used in ordinary rooms wherever connection is made to the public supply mains, and the price at which they are supplied and their extreme portability will undoubtedly ensure for them a large demand.

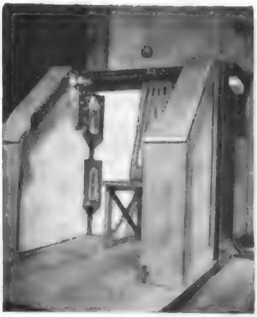


Fig. 3.—Dowsing Solarium Bath.

The Reason Mfg. Co. (Stand No. 20) show specimens of their arc lamps, street light fittings, meters, demand indicators, slot meters, time switches and similar apparatus.

A well-arranged exhibit is that of the General Electric Co. (Stand 21), who show electric lamps and fittings of all descriptions, electric radiators, heaters, laundry irons, shaving pots, glue pots, as well as motors, fans, &c. At the adjoining stand the process of manufacture of the Robertson incandescent lamps is shown. This interesting exhibit is always the centre of attraction at these exhibitions, and has become familiar to all who make it their business to attend such displays.

At Stand No. 30 the Brockie-Pell Arc Lamp Co. exhibit their well-known manufactures, including single enclosed lamps for 5 to 7½ amperes and twin-carbon enclosed lamps, for 2½ to 3½ amperes. Many of these lamps must be very familiar to the public by this time, as there are thousands of Brockie-Pell lamps in use, both for interior and exterior lighting of shops and business premises, street lighting, &c.

At the Callender's Cable & Construction Co. Stand (No. 31) there is an excellent display of all kinds of electrical distribution appliances and cables.

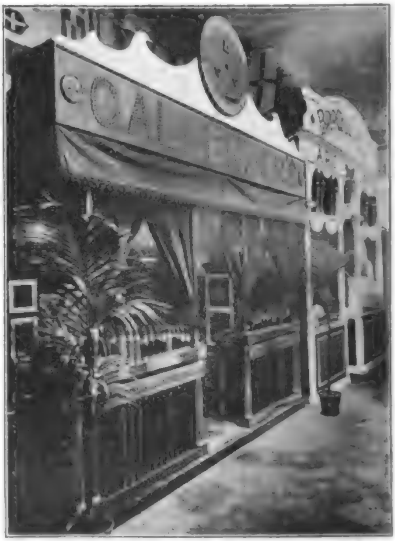


Fig. 4.—The Callender Company's and the Brockie-Pell Company's Stands.

The Electrical Co. have two fine stands (Nos. 32 and 52), where the latest type of Luna flame lamps, open and inverted, large and small, Nernst lamps of all the latest types, Rignon lamps, radiators, fittings of special design, meters, advertising devices, &c., are shown. Stand 52 is devoted to heavier machinery, comprising continuous-current motors, motor generators, motor-driven drills and other tools and machinery, and several examples of special types of Rignon miniature arcs for factory and inside lighting.

Messrs. Geipel & Lange exhibit devices for starting and controlling motors, time switches, "turn-down" lamps, &c. Speed indicators and motor car accessories, for which this firm have secured a large trade, are here shown to advantage.

J. & P. arc lamps, measuring instruments, switches, &c., are shown by Messrs. Johnson & Phillips, at stand 36.

The British Westinghouse Co. (Stand 40) show two-phase motors of standard design and a number of accessories, including a single-phasesynchroscope. They also exhibit some powerful Cooper-Hewitt lamps.

The Morris-Hawkins Electrical Co. show electric motors and accessories, an electrically-driven dough-mixer and a "Handyman" boot machine, suitable for trimming and finishing boots. This is an interesting exhibit, and will not be missed by printers and other traders who will be attracted to the exhibition, and will look for examples of machinery in motion in which they are interested and will find these at work at this stand. Nodon electric valves, supplying continuous current for a number of small appliances and for charging accumulators, are shown by the Nodon Valve Co. A description of these valves, together with some test results, will be found in *The Electrician*, Vol. L., p. 551, and Vol. LI., p. 765. The valves are made for 50 to 140 volts, alternating, and for currents from 1 to 100 amperes. They are made to order, however, for other voltages and currents.

The British Insulated & Helsby Cables (Ltd.) (Stand 50) have specimens of their paper and V.I.R. cables, junction boxes, telephone and telegraph cables and accessories of a most varied description. Among the telephone cables there is one which contains no less than 690 pairs.

Messrs. Crompton & Co. (Stand 51) have many small motors, accessories, arc lamps and instruments on view; also two Punkah fans, driven by vertical motors hung from the ceiling.

A fine display of electrical instruments is that made by Messrs. Elliott Bros. at Stand 58. This is one of the most prominent stands at the exhibition, and engineers interested in switchboard instruments will find much to occupy their time at this stand, where is also shown a working model of the "motor meter," a speed indicator and a cyclometer combined in one instrument. The indicator is constructed with a specially designed governor mechanism. The whole weight of the governor is carried on ball bearings which require no lubrication. The cyclometer has two sets of figures which show at two small windows, the lower counting up whenever the car is run, and in this way shows the total number of miles which the car travels. The upper set can be set at zero when desired. In this way the mileage of any particular trip can be seen at a glance.

The Electromotor & Dynamo Co. exhibit a number of motors, singly and applied to a printing machine, pumps and hoists. Verity's Limited have a fine display of motors, electrically-driven fans, arc lamps, cooking utensils and a number of accessories of all kinds. The Brush Electrical Engineering Co. exhibit alternating and continuous-current motors, transformers, lamps, meters and so on. Interesting, too, is the show of J. G. Childs & Co., which includes a number of automatic lifts for domestic and business purposes. Electric hoists and tackle are also on view on Messrs. G. Hopkins & Sons' stand. An up-to-date central-station photometer is exhibited by Messrs. A. Wright & Co. Messrs. Babcock & Wilcox display models and photographs of water-tube boilers, chain-grate stokers, water-softening and purifying plant and a water-tube cleaner, consisting of a small water turbine which drives a number of short arms carrying some toothed steel discs. The water to drive the turbine is obtained from a boiler, and as the turbine rotates the arms, which are hinged, are pressed outwards and against the interior of the water tubes by centrifugal force, thus cleansing them thoroughly.

Practical woodworkers will be interested in the display of Messrs. F. W. Reynolds & Co., who exhibit an electrically-driven band saw, a 12in. overhand planer, a spindle machine and a "Hercules" and mortising machine. The Union Electric Co., at Stand 64, show motors, arc lamps, indicating meters, switch gear for high and low tension and so on. The flame lamps supplied by this company, which are becoming so well known in many of the principal London thoroughfares, will be found installed here. Monté-Callow & Co. exhibit standard motors, starters, regulators, controllers, measuring instruments, "Atkinson's" maximum demand indicators, &c.

Messrs. G. Candler & Sons have furnished a dining room which is electrically heated and fitted

Some beautiful "kupronised" busts, figures, plates and so on are shown by Messrs. Dellagana & Co., also a collection of electric light accessories, bells and similar work.

The Electrical Co. show "Luna" flame lamps, Nernst lamps, Rignon lamps and have also a fine display of electric fittings.

The India Rubber, Gutta Percha & Telegraph Works Co. have on view their Silvertown specialities, such as "Association" wires and cables, submarine cables, motors, jointing material, instruments and other accessories.

Messrs. G. Worsman & Sons show a refrigerating machine in action driven by an electric motor.

The National Telephone Co. display a fine series of telephones and accessories.

Some very powerful Cooper-Hewitt and Bastian lamps are shown by Messrs. A. W. Penrose & Co., who also exhibit, at another stand, electric lift equipments, electrically-driven machine tools, motors and arc lamps.

Messrs. Nye & Sons have on view knife-cleaning machines, coffee mills and roasters and other labour-saving machines, which may be driven by one and the same electric motor by means of a flexible shaft, the ends of which are readily attached to the electric motor shaft and to the shaft of any one machine, respectively.

Messrs. H. Dakin & Co. show some very artistic fittings and globes of cut glass. A feature of this stand is the fancy glass globes with designs in green. Green light is not desirable, but the globes referred to, although green in parts, do not give off green light.

Electrical fittings of every description are also shown by the Adnil Electric Co., Durtnall & Pries, C. J. Ferguson & Co., Henderson, Blanchet & Co., Hunt & Hess, Ernest F. Moy (Ltd.), W. G. Murrin, W. Newton, R. Russell & Co., B. Weaver & Co., Westminster Engineering Co., J. Wilson and A. H. Wood & Co. and Messrs. A. Boyd & Son. Electric lamps and their accessories form the greater part of the exhibits of the Linolite Co.; and Messrs. J. Richmond & Co. and Waygood & Co., show lifts, hoists and corresponding accessories. Electrically-operated pianos are shown by Messrs. Elman Bros. and D. Harper & Co, while glass wares for accumulators, &c., are to be found on the stand of the Jeumont Plate Glass Works.

We have not space more than to refer to the excellent exhibits made by a large number of installation fims who have taken stalls at this exhibition. These stalls are numerous, and every one of them well worth a visit. Some of them are conspicuous for a number of useful domestic appliances, electrically driven or heated, and many others display some excellent examples of the metal workers' art in electroliers, standards, pendants, brackets and other fittings. Downstairs in the power section of the exhibition there are a number of stands which will well repay a visit, not only from local residents, but from others. There are numerous attractions to visitors, not the least of these being several electrically-operated pianos and other instruments. An excellent band helps to make an hour's visit to the Holborn and Finsbury Exhibition pass pleasantly.

CORRESPONDENCE.

A PECULIAR LIGHTNING EFFECT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following rather unusual thing occurred at Burnley during a recent thunderstorm. The outburst was very brief although the atmosphere was very threatening for the greater portion of the day. Only one "clap" was heard. At the same time the earth fuse at the station was blown and the negative voltmeter dropped off the scale which reads down to 190 volts, so there was as much as 30 volt drop. This only lasted a few seconds and the fault disappeared.

Afterwards we found the electricity supply was cut off from a consumer's premises. On investigating the matter we found that the negative service cable had been destroyed. The service crosses underneath the paved street in a 3in. iron pipe. The cable is armoured and ends in the consumer's fuse box. The lights were extinguished at the moment of the electric discharge. The fuses in the premises remained intact, but the armouring of the cable was burnt through in several places, the insulation being charred and the 7/16 cable burnt through near the point of connection with the main. At this point the armouring was broken when putting in the service. No damage to the roadway was visible. The next building is a church with a steeple. The consumer says the flash and report were simultaneous, and that he never experienced anything so severe before.—Yours, &c. R. BIRKETT.

Electricity Supply Works, Burnley, March 21st.

THE LIFE OF NERNST BURNERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to Mr. Walton's letter, re new "U" type Nernsts, our experience in Tynemouth may be of interest. We have about 1,000 Nernsts on our mains, a large proportion being of the new type. Most of them are looked after by the station. Occasionally we have a run of bad luck with a few, but I much prefer the later "U" type of burner. For street-lighting work the average life seems likely to work out at over 500 hours per lamp, and I think that as time goes on we may improve on this. I think that for houses the life will be about the same amount.

Lamps hanging at an angle give some trouble. The weight of the lamp causes it to sag downwards, so that very often one of the studs is not in proper contact with the lamp-holder plunger. This difficulty could be got over by a better design of the contact studs.

Our most interesting result has been obtained in the works, where the polarity is frequently reversed in the course of the evening, when we change the load over from one side to the other to bring it against the outside out of balance. Under these circumstances, the lamps last very well indeed, although run right up to their voltage, apparently longer than when run with constant polarity. I intend to put a reversing switch on some street lamps to see the effect on them. The switch will reverse the polarity each time the lamp is switched on.

This effect, of course, is quite different from what happens when a lamp is permanently put on the wrong way; it is also different from an alternating current. If further experiment confirms the result obtained with a few lamps in the station, then it may be worth while to use the method on a large scale.—Yours, &c., C. TURNBULL.

Electricity Works, North Shields, March 21.

PARLIAMENTARY INTELLIGENCE.

LONDON ELECTRIC POWER BILLS.

Earl Camperdown's Committee of the House of Lords resumed consideration of the nine electric power bills proposing to supply electricity throughout London on Friday last week. The Committee and list of the bills were given in our last issue. The previous sitting was held to determine the procedure. The first bill dealt with was that of the

ADMINISTRATIVE COUNTY OF LONDON & DISTRICT ELECTRIC POWER CO.

Friday, March 17.

The Hon. J. D. Fitzgerald, K.C., Mr. H. Lloyd, K.C., Hon. Evan Charteris, Mr. Arthur Paget and Mr. Lynden Macassey are the counsel for the promoters.

The Hon. J. D. **FITZGERALD**, who opened the case for the bill, said it was a proposal to incorporate a company and to confer upon that company powers for the supply of electrical energy in the County of London and certain adjacent districts in the counties of Middlesex, Surrey and Kent. The idea of the promoters was to establish three generating stations on the banks of the Thames in suitable positions for the purpose of obtaining a cheap supply of coal, and practically an unlimited supply of water for condensing purposes. From these stations a supply of electrical energy would be given at a very cheap rate to all the existing electric supply companies and local authorities, if they desired it, and also to any person requiring supply for power purposes. The area scheduled in the bill was divided into two portions, described as the "non-industrial" and the "industrial" areas, the powers in respect of which differed somewhat. The bill was a power bill for London framed on the lines of the power bills which had been passed in considerable numbers over large industrial areas throughout the United Kingdom within the last five years. He thought he was correct in saying that London now was the only industrial area in respect of which a power bill had not been passed. Referring briefly to the history of legislation on this subject, Mr. Fitzgerald said that when the two Electric Lighting Acts of 1882 and 1888 were passed, they were framed principally for the electric lighting business, although, as a matter of fact, the supply of energy for power purposes was not prohibited. But lighting was regarded as the main object, because the prices that were supposed to be the ordinary prices in those days were prices that made the use of electricity for power purposes on a large scale absolutely prohibitive. In 1889 an enquiry was held by Sir Francis Marindin, on behalf of the Board of Trade, with the result that numerous Provisional Orders were granted to various local authorities and companies for the supply of electricity in certain areas and further orders had been granted from time to time since. Under none of these orders was a monopoly granted, for competition was allowed in some cases. The result was that at the present time there were, within the area of the Administrative County of London Co., 30 local authorities and 21 companies supplying electrical energy. These owned 62 generating stations. The price which was ten years ago regarded as an average one was 6d. per unit, but this would be absolutely out of the question at the present time. The reason for this, as he had already mentioned, was that it was not then foreseen what an enormous demand would arise for electric traction purposes, nor was it then known that by concentrating the plant for the generation of electricity in large stations placed on suitable sites, the price of energy could be so reduced as to make it not a luxury, but far away more economical than steam for large manufacturers to make use of it. When all these conditions were realised years afterwards, the first power bill was introduced in 1898, and, as a consequence, a joint committee was appointed, presided over by Lord Cross, to consider the questions that arose in connection with this matter. One of the questions which Lord Cross's committee had before it was the desirability of the establishment of large central generating stations for the purpose of supplying over a large area. This committee answered the question as follows:—"Where sufficient public advantage is shown, powers may be given for the supply of electrical energy over an area including the districts of numerous local authorities and involving plant of exceptional dimensions and high voltage. The committee further think that undertakings of this character may properly be authorised on conditions differing in some respects from those imposed by and under the existing acts." As a result of that report several power bills were introduced in the next session of Parliament, and were referred to a select committee presided over by Sir James Kitson. By this committee the whole matter of the framing of these power bills was most carefully considered, and the committee, in fixing the form of the bills, had the assistance of the Board of Trade, and this form had been adhered to practically ever since.

The **CHAIRMAN**: Can you tell us whether there were any companies working provisional orders in the areas of these power companies?

Mr. **FITZGERALD** said he could not recollect whether there were any companies in the areas in question, but there were certainly local authorities, some of which owned provisional orders, and others had applications for orders pending.

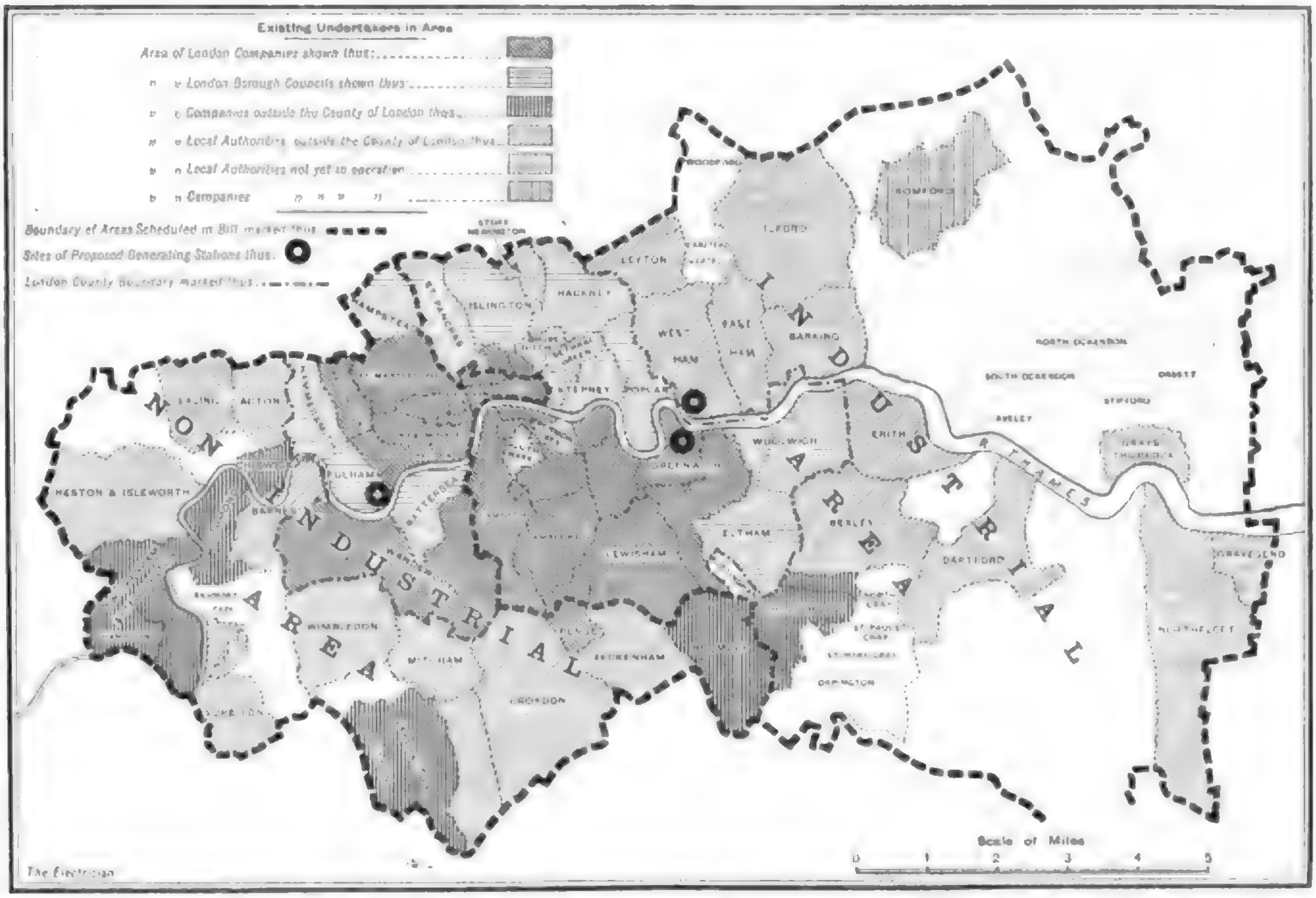
Continuing: Some 20 power bills had now been passed, including such areas as Yorkshire, South Wales, Tyneside, Cleveland and Durham, &c. Most of the existing power companies had not been established a sufficiently long period to enable one to speak of what they had performed with the exception of the Tyneside Co., and he would bring very strong evidence, indeed, to show how enormously successful this company had been. London undoubtedly required a power company, for at present there were something like 600,000 hands employed in the industrial centre, and the horse-power of manufacturing machinery there already amounted to 450,000 H.P. Of that only about 4 per cent. was at present supplied by the existing companies and local authorities. This alone showed that the present means of supply was quite inadequate for the demand, for the reason that the stations were much too small and badly placed. Many of them were cramped, and from their surroundings incapable of extension except at an enormous cost, and most of them were not equipped with the machinery for economical production on a large scale. Taking the most modern and largest of the London stations they were all open to one or other of these objections. The stations had all been designed and constructed for the purpose of carrying on a lighting business, and, in fact, the lighting business of the present authorities was 90 per cent. of the total. The non-industrial area of the bill included all the principal residential parts of the West of London, as well as the whole of the City of London and the Strand. The industrial area took in all the East, North-East and South-East of London, as well as a stretch of rural country, the reason for this being that it was now the policy of manufacturers to remove their works out into the country where the conditions were favourable. The difficulty of obtaining cheap power which had hitherto existed in this connection would be done away with under this scheme. It was proposed to erect three generating stations, one on the south of the Thames at Greenwich, another nearly opposite on the north at West Ham and a third at Fulham. The first two would be the main generating stations. The capital proposed was £5,000,000 and the usual one-third borrowing powers. This capital would be raised by instalments as the business progressed, but if the hopes of the promoters were realised the whole of the capital would be required in a very moderate time.

Perhaps the most important part of the bill was the price, and this was given in the second schedule as follows: "(1) The charge to be made by the company to any consumer shall not, in respect of the total units supplied, exceed the rate of 1½d. per unit. (2) The company shall, if required by the consumer, make such charge by way of a fixed sum per quarter annum not exceeding £1 per quarter per kilowatt of the maximum power required to be supplied, and in addition a sum not exceeding ½d. per unit for all units supplied to such consumer." Under No. 2, therefore, a moderate consumer of current for power purposes for 8 hours out of the 24 hours, the price would work out at about 0·865d. per unit. These were record prices, because in not one of the other power bills were such low charges included as the maximum. The promoters of this bill numbered 63, including Sir Andrew Noble, Mr. Eric Hambro, Lord Armstrong, Mr. Yarrow and Sir George Gibb. These were gentlemen who knew what they were about, and who had considerable financial strength. In fact, it was an offer of those gentlemen to provide a supply of electricity throughout London at a rate which no company had ever offered in an industrial area before.

With regard to the business to be done by the company, he would deal first with the non-industrial area. The promoters' opinion was that they could supply nearly all the existing authorities at a much lower price than they themselves were generating at to-day. There was no compulsion to take power from the promoters of this bill, and in fact, it was not anticipated that all the existing generating stations would be scrapped at at once. But where the supply was increasing and the present generating plant was not sufficient to deal with it, it would be found to be much more economical to take this additional supply from the new company. It was also proposed, in the non-industrial area, to supply railway companies, tramway companies, canals, docks and Government departments. When the existing railway and tramway companies in London adopted electricity as the motive power, they had in all cases been compelled to set up generating stations of their own, there being no company in existence to supply the necessary power economically. In this manner the Central London Railway, the Metropolitan & District Railways and the London United Tramways Co. had all to build separate generating stations. These companies now, of course, could not be expected to be customers of the new company, but there were numerous other underground railway schemes coming before Parliament, as well as the numerous suburban railway lines, carrying a large traffic. In this respect a large demand might be looked for. That these estimates were not merely the sanguine hopes of the promoters, but were based upon fact, was proved by what had taken place around Newcastle, where the North-Eastern Railway Co. and the Tyneside Tramways Co. both took energy from the power company there.

The CHAIRMAN: Do you take powers for lighting in the non-industrial area?

Mr. FITZGERALD: Not in the ordinary sense. The proposal was that any power consumer might use the energy for lighting his premises to the extent of 20 per cent. of his total supply. In the industrial area there were a very large number of manufacturers, which created a magnificent field for carrying on a business such as was proposed in the bill, and 250 firms, employing 80,000 hands, had petitioned in favour of the bill. All that was being proposed here had already been done on the north bank of the River Tyne, where steam driving in factories had been almost entirely displaced. Up there, it was true, the coal was much cheaper than it would be in London, but this would be more than compensated for in London by the larger size of the stations and the greater demand. There would be an enormous saving in capital cost in proportion to the output. The average capital cost of the existing London generating stations was £51 per kilowatt, whereas the capital cost of one of the proposed generating stations under the bill would be less than £9 per kilowatt. The generating stations would have a capacity of 90,000kw. The most modern of the London stations cost £30 per kilowatt. Steam turbines would be employed, and their general advantages over steam engines would be explained by his witnesses. In working costs, however, the saving in coal consumption in using 1,000 H.P. turbines, as against 500 H.P. turbines was 25 per cent. per kilowatt hour, and 33 per cent. if 10,000 H.P. turbines were used, as was the intention of the promoters. The largest steam turbine at present in use in London was 750 H.P. Another source of economy anticipated by the promoters was as a result of the position of the generating stations, which gave ample water for condensing purposes and cheap water-borne coal. It might be stated by the opponents to the bill that they were already supplying power at a cheap rate, but with the existing stations chiefly supplying lighting during certain hours, it was possible to supply power during the day time at a cheap rate, but it was not possible to carry on a business of the magnitude proposed by this bill. A still further economy by the use of large generating stations was in coal consumption. The recent report of the Royal Commission on Coal Supplies had put the average consumption of coal in the production of steam at 5lb. per horse-power. By the erection of stations such as were proposed this would be reduced to about 2lb., with a consequent saving of hundreds of thousands of tons of coal per year in London, as a result of the reduction in the number of small plants. Dealing briefly with the opponents to the scheme, counsel remarked that the electric light companies and the local authorities alleged competition. But if any competition did take place it would be of the smallest possible character. In the non-industrial area no competition at all would take place with regard to lighting, which was the principal business there. With regard to power supply not one of the existing electric supply authorities in that area supplied the consumers which it was anticipated the new company would supply—viz., railways, canals, tramways, Government departments, &c. Concerning the industrial area power consumers could only be supplied with the consent of the authorised distributor, and failing consent the Board of Trade would be asked to determine whether such consent was reasonably withheld. The promoters asked for no monopoly. The London County Council, and the City Corporation's petitions raised the question of purchase. But this had always been regarded as inapplicable to power companies as a general rule. Nearly all the petitioners alleged the breaking up of streets, but it was not the intention of the promoters to do anything against the wishes of the local authorities.


Existing Undertakers in Area
Area of London Companies shown thus:
" " London Borough Councils shown thus
" " Companies outside the County of London thus
" " Local Authorities outside the County of London thus
" " Local Authorities not yet in operation
" " Companies " " " "
Boundary of Areas Scheduled in Bill marked thus
Sites of Proposed Generating Stations thus.
London County Boundary marked thus
NON INDUSTRIAL AREA
INDUSTRIAL AREA
THAMES
HACKNEY
ISLINGTON
LEYTON
ILFORD
ROMFORD
WEST HAM
EAST HAM
BARKING
STEPNEY
POPLAR
WOOLWICH
ERITH
NORTH OCKENDON
SOUTH OCKENDON
ORSETT
AVELEY
STIFFORD
GRAYS THURROCK
FULHAM
BATTERSEA
HESTON & ISLEWORTH
EALING
ACTON
WIMBLEDON
MITCHAM
CROYDON
BECKENHAM
LEWISHAM
ELTHAM
BEXLEY
DARTFORD
GRAVESEND
NORTHFLEET
ORPINGTON
Scale of Miles
0
1
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5
The Electrician

MAP SHOWING THE INDUSTRIAL AND NON-INDUSTRIAL AREAS SCHEDULED IN THE ADMINISTRATIVE COUNTY OF LONDON AND DISTRICT ELECTRIC POWER BILL.

[We dealt with the contents of the bill at some length in our issues for Nov. 15 and Dec. 30, 1904, and March 10, 1905, and give a map of the area above.]

Mr. C. H. MERZ, consulting engineer to the promoters, after dealing at length with the general advantages of a cheap supply of electric power, in the course of which he stated that the use of electricity brought about a saving of 40 per cent. in power compared with steam driving, went into the prospects of the new company. In the industrial area there were factories employing 600,000 persons, and these factories were almost all entirely driven by steam. The only explanation that he could offer of the present small use of electrical power was the high price that was charged by the existing undertakers, a disability which would be removed if this bill were passed. The main object was to supply energy to authorised distributors, and also generally to persons who carried on their businesses over large areas, such as railway and tramway companies, &c., who could not obtain their energy from one small local generating station. Two of the proposed generating stations were situated on the River Thames below all the bridges, and great reliance was placed upon the situation of these stations. Having gone into the requirements of London and the position of electrical supply, he had compiled a table showing the amount of electrical power supplied from public generating stations per 1,000 head of population in various large cities of the world. First of all came Boston (U.S.A.) with 41 H.P. per 1,000 head of population; the Newcastle-on-Tyne Electric Supply Co. came second with 30 H.P., whilst London was last with only 5 H.P. At present in the industrial area the amount of current for power purposes supplied by the existing undertakers was only 18,316 H.P. and in the whole area of the Bill 34,236 H.P., and he knew of no electricity supply station in London whose costs were so low that it would not pay them to come to an agreement with the promoters on the terms given in the second schedule to the bill. If all the manufacturers in London could be induced to take power from the promoters it was estimated that by 1911 the demand would be 380,000,000 Board of Trade units per annum: and, in addition, assuming the present curve of increase was maintained, the lighting demand would be 298,000,000 units. Then as regards traction, assuming that all the existing suburban lines were worked electrically with the present speeds and present traffics, the demand in 1911 would be 552,000,000 units, making a total demand of 1,200,000,000 units per annum six years hence. These were, of course, maximum possible figures. The existing stations could not possibly deal with such a load. No one in London hitherto had set to work seriously to encourage the use of electric power in the manner proposed by the promoters. To make such a business a success every possible customer must be secured and considerable help given in the reorganisation of the various work for electric driving. This latter often included the hiring out of the machinery, and the Tyneside Co. had £100,000 invested in this manner. The average total cost in London at present was 1·92d. per unit, whereas something under 1d. would be the average price charged by the promoters. It was not proposed to interfere in any way with the present undertakings, and all his estimates had been based on the demand that would arise in the future, in excess of what at present existed. His opinion was that London offered unique opportunities for the generation of electricity on a maximum scale, and therefore should be supplied at a cheaper rate than any city in the world, even those on the Continent where the current was generated by water power. The design of the existing stations was all against the supply of power as he deemed it was necessary, and even the most up-to-date works—the Willesden works of the Metropolitan Co., and the Bow station of the Charing Cross Co.—were primarily designed for lighting loads. In the stations proposed by the promoters, the kilowatt capacity for the same output of the smaller stations put together would be 30 per cent. less. The average capital cost of the generating station in London now was £51 per kilowatt, against about £10 of the promoters. After laying great stress on the advantage which would be gained by the use of large turbo-generator sets, Mr. Merz handed in the following table of estimated capital expenditure of the new company:—

I.—*Capital Expenditure of Proposed Undertaking.*

	1910. Works completed.	1916. Works completed.
Generating stations	£717,200	£2,615,000
Transmission system	583,000	1,872,000
Sub-stations and distribution system.	401,000	1,503,000
Plant on loan	200,000	400,000
	£1,901,200	£6,390,000
Land and preliminary expenses	180,000	350,000
Total	£2,081,200	£6,740,000
Less..Reserve, &c.	..	500,000
Net capital required	£2,081,200	£6,240,000

Capital authorised by the bill	£5,000,000	
Borrowing powers	1,667,000	
		£6 667,000

The figures represented the capital expenditure which was estimated at 1910 and 1916 respectively, the 1916 figures being calculated on supplying two-thirds of the 1,200,000,000 units above referred to, so that his estimates were well on the right side. The actual demand calculated for in the 1910 figures was:—Lighting, 64,000,000 units; traction, 23,500,000 units; and "bulk," 50,000,000 units. The estimated capital cost of the proposed generating stations was as follows:—

II.—*Cost of Proposed Generating Station.*

Capacity of station, 90,000kw.

Capital Expenditure—		
1. Land	£40,000	£40,000
2. Condensing conduits, sidings, quays and main foundations	77,000	
3. Iron buildings, chimneys, boilers, piping, auxiliaries and coal-handling plant	330,000	
4. Generating plant	195,000	
5. Switch gear and sundries	50,000	
	652,000	
6. Engineering, supervision and contingencies, 10 per cent. on all expenditure except land	65,200	717,200
Total		£757,200

Expenditure per kilowatt, £8·4,

The estimates for the transmission and distribution system are given in the following table:—

III.—*Transmission and Distribution Systems, Proposed Undertaking.*

	For dealing with supply assumed for 1910.	For dealing with supply to whole area.
Transmission system—		
Main system—Conduits	£232,000	£524,000
Cables	136,000	689,000
Tributary system—Network	162,000	489,000
	530,000	1,703,000
Engineering and contingencies, 10 per cent.	53,000	170,300
Total	£583,000	£1,872,300
Sub-stations and distribution system—		
Main high-tension distributing centres	19,000	85,000
Transformer sub-stations	90,000	180,000
Low-tension network	210,000	801,000
Connections to consumers	45,000	300,000
	364,000	1,366,000
Engineering and contingencies, 10 per cent.	36,400	136,600
	£400,400	£1,502,600
Land for sub-stations	£40,000	£100,000

Continuing, Mr. MERZ said it was proposed, as regards main cables, to lay a ring main round London in streets which would be agreed upon with the local authorities. The mains would be laid with sufficient spare conduits so that the streets would never have to be broken up again. The route of these mains would be arranged so as to tap as nearly as possible all the existing supply stations, railways, &c. It was proposed to adopt a pressure of 12,000 volts alternating, the periodicity being 25. This was unsuitable for lighting purposes, so that it was an additional safeguard against direct competition for the present lighting supply. The promoters were willing to meet all the reasonable requirements of local authorities as regards the routes of mains. His estimates of works costs and revenue were as follows:—

IV.—*Works Costs at Proposed Generating Station.*

Works Costs per Board of Trade Unit Generated—		
Wages	0·0225d.	
Coal	0·11d.	
Water, oil, &c.	0·0045d.	
Repairs	0·017d.	
		0.154d.

V.—*Estimated Revenue.*

Cost of generating 183,300,000 units at 0·1541d. per unit	£117,617	By sale of 137,500,000 units at 0·7d	£401,042
Distribution	23,680	Sundry receipts	20,000
General expenses, management, rent, rates, taxes, insurance, sundries	58,500		421,042
Selling department	15,000	Deduct expenses as stated	290,387
	214,797	Balance	£130,704
Depreciati'n, renewals, &c.	75,540		
Total	£290,387		

This balance would be sufficient to pay a dividend of 6 per cent. on a capital expenditure of £2,000,000, as set out in the first column of Table I. Not one of the units estimated was at present supplied by the existing companies; it was all new business. With regard to the £15,000 for the "selling department" in Table V., he said this was necessary, as it would be impossible to secure this amount of business without some expense in the way of a special department to give advice to intending consumers. The item "Sundry receipts" £20,000, was the rental on the apparatus which it was proposed to hire out, and the interest on the capital which it would be necessary sometimes to lend to manufacturers. He regarded his estimates as fair ones for the needs of the districts by 1910. So far as the opposition was concerned, he could not see what the companies had to complain about, especially in the non-industrial area. In the "industrial" area they could only supply direct to a power consumer with the consent of an authorised distributor, or, failing such consent, with the consent of the Board of Trade. There would be no competition for lighting, and, he maintained, no competition for power, because the existing authorities were practically not supplying any at all. If the local authorities throughout the area purchased current on the terms of the bill they could reduce their present charges, and by the year 1931 would have saved millions of money.

Monday, March 20.

The CHAIRMAN said he had been reading the other bills which were before the Committee, and was in a little doubt as to what would happen with respect to them after the Administrative County of London Bill had been heard. Supposing it was thought that it was not expedient that the latter bill should not proceed, he apprehended that the other bills would come up for consideration one by one and be dealt with on their merits; but supposing that the Committee decided against the present bill, he was not quite clear as to whether that decision would have necessarily any effect upon the other bills. He was anxious that no injustice should be done to the remaining bills.

Mr. BALFOUR BROWNE, K.C., thought the Committee would find that the best course was, that after hearing the case for the present bill, to postpone any decision until all the other bills had been heard.

The CHAIRMAN said he thought there was a difference between the proposals of the other bills and the present one, which was merely asking for powers to supply in bulk.

Mr. BALFOUR BROWNE: That is what they say.

The CHAIRMAN: The other bills seem to be for extensions of existing areas.

Mr BALFOUR BROWNE: And also for supplying in bulk.

The CHAIRMAN: I understand then that you think it expedient that we should hear all the bills separately.

Mr. BALFOUR BROWNE: Yes.

Other counsel agreed with this view.

Mr. C. H. MERZ was then cross-examined by Mr. Balfour Browne on behalf of the existing companies and the promoters of the competing bills. At the commencement a little discussion took place as to the origination of the Newcastle Power Co., from which it was made clear that the Newcastle-upon-Tyne Electric Supply Co. was started as a lighting company with Provisional Orders, and that in 1899 the Walker and Wallsend Gas Co. obtained an Act for the supply of electricity, which the Newcastle Company acquired. Continuing, Mr. Merz said that he had taken his figures for horse power of electric motors installed in London from *The Electrician* Tables, which were the most complete that he knew of.* On the question of the average cost per kilowatt capacity of the existing London stations which he had put in—viz., £51—this was comparable with his own estimate of £8·4 per kilowatt, neither including anything for sub-stations. He knew that several London stations averaged less than £51, but even the Metropolitan Electric Supply Co.'s figure of £32 for their Willesden station was comparable with his £8·4, because they both included something for future extensions. He did not know how the demand for power in London was increasing, but whatever it was it was not being met on the right lines, because by the nature of the existing stations there was no question that they would have to be scrapped eventually. It was only a question of time. Of course, the London companies could do what was proposed by the bill if they had the money, the land and the same bill. The position of the ring main was such that it would touch the existing company's generating stations at Bow-road, Deptford, Wandsworth and Wood-lane, among others. The energy would be transformed for power consumers, but supplied in bulk at high pressure to authorised distributors. An authorised distributor would have to take energy for seven years, and guarantee for that period 20 per cent. of the cost of the mains. The bill also differed from the Provisional Orders of the existing companies in that the company was not bound to supply in any district or lay mains in any particular streets.

Mr. BALFOUR BROWNE: You are not really bound to supply any one, whereas the London companies are bound to supply all who ask for electricity.

The CHAIRMAN: Under clause 52 the promotors are bound to supply.

Mr BALFOUR BROWNE: Yes, but only upon arbitration terms. The maximum prices are not binding on anyone.

Under further cross-examination by Mr. Balfour Browne,

Mr. MERZ said that the prices in the bill did not include transformation of the three phase current, or reduction in pressure. The average price paid by the North-Eastern Railway Co. at Newcastle was 0·55d. per unit, high tension. The transformation was the subject of another agreement, and the total average price for the last year was 0·63d. per unit. The railway company guaranteed a minimum consumption of 5,000,000 units per annum, which was about one-quarter or one-third the total supply of the Newcastle Company. Witness was next questioned with regard to details of the estimates which had been put in. Each station, he said, would contain six generating sets which would have a total economical output of 120,000kw. for short periods, the over-load capacity of each being 20,000kw. The evaporative capacity of each boiler would be 80,000lb. per hour. Messrs. Babcock & Wilcox had undertaken to carry out the buildings, boilers, piping, &c., at the prices given in his estimates, and the prices were calculated on the work being done in London. The arrangement of the plant would be on the same lines as at Carville. He did not know whether any boilers of this size had ever been constructed, but both Messrs. Babcock & Wilcox and Messrs. Stirling were willing to construct water-tube boilers of the size estimated for. With regard to the use of iron buildings, he knew of the existence of the London Buildings Act, and that was why these had been excluded from being binding upon the company, under the bill. The estimates for the generating plant were also based upon an actual tender. The switch-gear figures were estimated upon the cost of the gear at Carville. The main cables would have a length of 528 miles, and they would be 0·25 sq. in. three-core copper-sheathed and lead-covered, the estimates being based upon the present prices of copper. Duplication of the mains had been provided for, and every sub-station would be fed by two loops. The duplication of the supply mains to large consumers was provided for in the estimates under the head of "Tributary System," and the length of this would be 276 miles by the year 1910. In the sub-stations, which numbered about 80, there would be 200,000kw. of transformers.

Mr. BALFOUR BROWNE next put several general questions. Mr. Merz, in reply, said that competition in the electricity supply business was dependent on whether the bodies supplying already were doing their duty. If they were supplying at the lowest possible price, the introduction of competition would not be to the benefit of the consumer.

Mr. BALFOUR BROWNE pointed out to the Committee that this had been the decision in the case of the London gas companies, between whom now there was no competition.

In the course of further cross-examination, Mr. Balfour Browne referred to the opposition of the Newcastle Company to the power bill of the Tyneside Power Co. of 1900, which was rejected on account of this opposition. This power bill, he said, was on all fours with the present bill, and the opposition of the Newcastle Company was in all respects similar to that of the London companies, for at that period the Newcastle company was practically only supplying under a Provisional Order.

On the question of the estimates Mr. Merz admitted that his figures for what he expected to do in 1910, and these had been compared with what was being done to-day by the existing authorities. It might be that by 1910 the existing authorities could do the same, but his case was "concentration," and with the existing stations it would be impossible to achieve the results he anticipated. With regard to the largest steam turbine yet constructed, he said he always took the maximum capacity, and the 5,000kw. machines at Carville were the largest. The normal capacity was 3,500kw. On the position of the present undertakers in London, he admitted that, assuming there would be competition, the promoters had an advantage by reason of the many restrictions placed upon the existing authorities under their Provisional Orders, such as the compulsory purchase, &c. But he did not admit that there was going to be competition.

Mr. BALFOUR BROWNE: If a local authority, for instance, cannot supply as cheaply as you can, cannot you ask the Board of Trade to allow you to come in?—Yes.

That would be competition?—For power, yes.

Continuing: The capital cost per kilowatt at Carville was between £11 and £12.

A long discussion then ensued between counsel and witness, comparing the results at Carville and the results at certain of the London stations with the estimates for the new stations; but Mr. Merz stated that his estimates for the new company's works were not altogether based on what had been done at Newcastle. There could be no comparison with the published analysis of the Newcastle Co.'s costs (*The Electrician*, March 10, 1905, p. 826) and the estimates of what he maintained was possible in London. As a matter of fact, his estimates in many respects were too conservative, compared with Newcastle. The cost of coal at Newcastle was 5s. 6d. per ton; for the Greenwich station of the new company he had taken 8s. 6d., which would have to be increased for the Fulham station. The following Tables were handed in, giving the capital expenditure and works costs at the Carville station:—

VI.—*Capital Cost of Carville Power Station. (Erected 1903-4 for the Newcastle-upon-Tyne Electric Supply Co.)*

Main buildings and foundations	£13,346
Generating plant	43,030
Steel work and boiler-house construction	61,854
Switchboards	18,143
Auxiliary apparatus	6,040
Proportion of general expenses	8,200
Total	£150,613
Add engineering and sundries, 5 per cent.	7,580
	£158,143

Plant installed, Peak capacity, 15,000kw. Cost per kilowatt, £10·5.

VII.—*Works Costs at Carville Generating Station,* **Per Unit Generated.**

	Works costs per unit generated. d.	d.
Wages—Engine Room	0·00572	
Switchboard	0·00473	
General cleaning	0·00118	
Boiler houses	0·00875	
Coal handling	0·00103	
Ash handling	0·00085	0·02223
Material—Coal	0·07841	0·07841
Water	0·00217	
Oil	0·00119	
Stores	0·00109	0·00415
Battery Maintenance, Repairs	0·00057	
Wages	..	
Material	..	
Repairs by Construction Department—		
Cleaning Boilers—Wages	0·0038[illegible]	
Material	..	
General—Wages	0·00305	
Material	0·00660	0·01611
Total	0·12123	0·12123

Mr. BALFOUR BROWNE: I see that for a supply of a very small number of units in comparison, your mains cost you £319,000 at Newcastle. That seems rather an extraordinary figure to compare with

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* There is always a difficulty of obtaining the connections of large electricity supply undertakings detailed under the various items, and Mr. Merz's total is therefore obtained by omitting the motors supplied by the City of London Co., the County of London Co., the Chelsea and the St. James's and Pall Mall Cos. From information subsequently obtained we are able to state that the City Company has about 10,000 H.P. of motors connected to its mains, and the County of London Co. about 20,000 H.P., so that Mr. Merz's total of 34,236 is about half what it should be.—Ed. E.

£530,000 for London?—I cannot understand what is the object of comparing Newcastle with London; it is an entirely different district under entirely different conditions.

I should have thought it would require a good deal more to lay mains in London?—But they are entirely different loads, and entirely different circumstances.

Continuing, witness said that this estimate was on the basis of 137,000,000 units per annum?—Yes.

Mr. **BALFOUR BROWNE**: And I am comparing that 137,000,000 with your 17,000,000 in Newcastle, and your expenditure on mains there?—First of all, as I have said, this is a different district, and, secondly, the capital expenditure of the company over a period of 15 years is different, consequently the Newcastle figure entails hundreds of miles of cable in individual streets, whereas here we expect to sell a large part of our energy wholesale or in bulk, or to large users like railway companies.

Mr **FREEMAN**, K.C., for the London Borough Councils, on the question of cheap power, pointed out that at St. Pancras, for instance, as well as at Fulham and elsewhere, electrical energy was being supplied for power purposes at 1d. per unit, at a profit. The details of cost were: Works costs 0·45d., and distribution cost 0·38d., leaving a profit of 0·17d. per unit.

WITNESS asked as to the capital charges. None appeared to have been included.

Mr. **FREEMAN** replied that the published accounts showed a profit.

The **CHAIRMAN**: Perhaps it is a good thing that this witness does not audit the accounts.

Further cross-examined, Witness said he had not had any experience of laying mains in London, but all the estimates had been checked against actual tenders, and the estimates were highest. So far as the already crowded condition of the streets was concerned, one of the leading cable makers had given him advice to the effect that from their own knowledge of the district, it was quite possible to lay mains in the streets shown on the map which he handed in.

Sir **RALPH LITTLER**, K.C., for the City Corporation, asked for an undertaking from the promoters that they would not lay any mains in the City.

WITNESS replied that they would certainly avoid laying mains in the City if they possibly could.

Continuing: He was not aware that the City Corporation, if it cared to in 1914, could buy out one of the two companies now supplying in the City by paying 4 per cent. upon the ascertained capital expenditure. Neither was he aware that the City Corporation could buy up the undertaking of the company outside the City if they chose. But although these were special circumstances, he did not think that the entrance of the new company into the City, supplying in bulk to the two existing companies, would affect the position of the City Corporation.

By Mr. **BLENNERHASSETT**, K.C., for the Westminster City Council: He refused to limit the powers of the company in the non-industrial area to supply in bulk, because this would have the effect of increasing the price to the consumer generally. He failed to see that, supposing all the present distributors were to take current eventually from the promoters and scrap their generating stations, the new company would secure a monopoly. On the question of the laying of mains, he could not agree to leave it entirely in the hands of the local authorities to prescribe the routes. Similarly, he would not agree to insert a clause to buy land upon which to place their street boxes to avoid adding to the present congestion of the streets.

By Mr. **BEADER HARRIS**, K.C.: He refused to cut Barnes and Ealing out of the area, despite the fact that there were no railways or Government departments to supply and that the local authority did not wish to take a supply from the promoters. He thought a supply in bulk would be required eventually.

By Mr. **MOON**, K.C., for the Westminster Electric Supply Corpn.: He admitted that there would be direct and unrestricted competition with the electricity supply companies for the supply to local authorities, and that, owing to the restrictions as to purchase under which the existing supply companies were placed, they would be unable, probably, to quote on equal terms. The figure of 0·7d. per unit, which was given in his estimates as the average selling price, was based upon a 35 per cent. load-factor. He anticipated that the average size of the power installation in the industrial area would be between 50 H.P. and 100 H.P.

Tuesday, March 21.

The **CHAIRMAN** said that in view of the enormous size of the promoters' area, he thought any decision would create a precedent for the future. Therefore, to assist the Committee, he would ask all the counsel engaged in the bill to agree to have a return prepared giving particulars with regard to those companies authorised to supply electric power in districts in which companies or local authorities were already supplying electricity under Act of Parliament or Provisional Order.

Counsel agreed to confer and send in a statement which would be accepted by everyone.

Mr. E. **MOON**, K.C., for the Westminster Electric Supply Corpn., continued his cross-examination of Mr. Merz, and dealt with the cost of generation in his estimates. Witness admitted that to pay the anticipated profit of 6 per cent. they would have to make a profit of 0·193d. per unit, and that if this profit were not obtained, the dividend would drop 1 per cent. for every 0·03d. per unit that the costs exceeded the estimates. This might not appear a large margin in pennies, but it was in percentages. But he could reduce the number of units generated to one quarter, and yet not increase the generating costs. In calculating the probable demand for power in factories, &c., he had taken two ninths of the total at present installed, and then had assumed 600 units per annum per horse power. He did not claim to have made any special discovery that enabled him to generate cheaper than had ever been done before, and although it might be possible for the existing companies to do precisely the same as was proposed in the bill, they had made no effort to do so.

Mr. **VESEY KNOX** (for the Southwark Borough Council, for Ilford, Gravesend, Dartford, Bexley and other local authorities): What reason (I want to test the care with which this scheme was prepared) had you when you were drawing the boundary line for putting the industrial line in such a way as to include Chislehurst, a district of suburban residences of well-to-do people. You see it is just on the boundary. You were deciding where to put your boundary, and you might have drawn it, if you considered the district at all, just as well on one side as on the other side. Why did you do it?—I will look up my notes. I have no reason in my head at the moment why we included it.

And you cannot suggest any reason at all?—No; I must look up my notes; I cannot recollect the exact areas and boundaries of Chislehurst.

Mr. **MERZ**, in answer to further questions, said the ring main did not go to the east of the Greenwich power station on the south side of the river. If Dartford or Greenwich wished for a supply they would have to guarantee 20 per cent. of the cost of the main, which would be £3,000, the main costing, say, £15,000. He did not think this was a big guarantee. He was aware that there were four authorities now supplying in various parts of Southwark, and all over the borough there was competition.

Mr. **VESEY KNOX**: I suggest to you that it is a curious thing that in all those parts of London where there is competition the price is highest.

By Mr. C. E. **HUTCHINSON**, for the City of London Co. and the promoters of the East London and Lower Thames Bill: He expected that the Greenwich station would be completed in about two years, and that at the end of another year the demand would be 18,000,000 units.

In answer to the Chairman, Mr. **HUTCHINSON** said that this at present was the output of the City Co. The City Co. had now amalgamated with the promoters of the East London & Lower Thames Electric Power Co., and the two bills which would come before the Committee would cover the whole of the industrial area of the present promoters.

Mr. **MERZ**, in reply to further questions, admitted that the position of the City Co.'s generating station offered all the advantages that he could offer, but much of the City Co.'s plant was antiquated. This plant would have to be replaced in order to secure a great extension of business. He also admitted that he gave evidence in favour of the East London and Lower Thames Bill last year. He had not been responsible for the engineering details of that bill, but he had desired that no power bill for London should be thrown out on engineering grounds.

Mr. **CLEASE**, for the Barking Urban District Council, also cross-examined Mr. Merz in order to show that unfair competition would be set up, because the promoters would be enabled to lend money or apparatus to the manufacturers for converting their works to electric driving, whereas the local authorities were not legally empowered to do this. In answer to further questions, Mr. Merz explained that, unless the local authorities arranged to take power "in bulk" from the company and to distribute it under a satisfactory arrangement, the company would compete with them for power supply.

Wednesday, March 22.

Under further cross-examination, Mr. **MERZ** said he was willing to treat with Hackney for a supply on the terms of his estimates. This would be transformer current and not at high-pressure supply. This offer he would keep open for a month. The promoters had offered to open negotiations with the Hackney Borough Council, but had not received any reply.

Re-examined by the Hon. J. D. **FITZGERALD**: It would be impossible to erect the generating stations proposed if the London Building Act and other building bye laws had to be complied with.

By the **CHAIRMAN**: He did not know of any other power company which had been given this power. If they could not come to an agreement with the local authority, of course the buildings could be erected if the bill was passed, with the exemption of the Building Acts included in it.

The Hon. J. D. **FITZGERALD** said that the railway companies were exempt at any rate from some of the building bye-laws, and he believed that some of the gas companies' buildings were also exempt.

Under further re-examination, Mr. **MERZ** said his calculation of the cost of the current for power supply at St. Pancras was 1·65d. per unit, and seeing that it was sold at 1d. per unit, he failed to see where the profit came in. To the items given by Mr Freeman had to be added capital charges. With regard to the suggestion that the London companies could offer a very cheap supply of electricity for power purposes, he mentioned as an instance the offer of the Metropolitan Electric Supply Co. to the Marylebone Borough Council to supply at 3d. per unit for the first two hours of the maximum demand and ¾d. per unit afterwards, the average price being 1·7d. per unit. Even the maximum prices under the bill were about one-half this, and no doubt for the large quantity required the new company, had it been in existence, would have quoted better terms. As to hiring out motors, the terms of the Metropolitan Electric Supply Co. for supplying a 25 H.P. direct-current motor were £2. 10s. per quarter. The Tyneside Power Co. hired out a similar motor for considerably less than half that sum. For alternating-current motors the Metropolitan Co.'s price was higher, whereas on the Tyne the price was about one third. Further, the London companies had no limitation as to dividend and no sliding scale. Some of them were paying as much as 14 per cent. dividend. His estimates were all based upon actual tenders.

In answer to Lord **ZOUCHE**,

Mr. **MERZ** said that the clause as to purchase of undertakings was put in because so many of the London undertakings were in such an unsatisfactory position that it would probably pay them to sell their undertakings to the new company.

The Hon. C. A. **PARSONS**, F.R.S., was the next witness. He dealt first with the question of the advantages of the steam turbine. The price decreased as the size increased; for instance, a 1,000kw. turbine cost twice as much per kilowatt as would a 10,000kw. machine, and the latter would consume 50 per cent. less coal per kilowatt. [Models were exhibited to demonstrate that the floor space that would be taken up by the larger sizes was not materially increased over that of the smaller sizes.] The object of the early part of the evidence was to show that with generation on a large scale, the price could be reduced to a very low figure. The 10,000kw. turbo-generators which it was proposed to use had a maximum capacity of 20,000kw. No new conditions would be involved in the construction of these large units, and, in fact, the governing factors became more favourable with the increase in size. Their steam consumption would be 13lb. per kilowatt. On the Tyneside the steam consumption was 15·4lb. per kilowatt, and this difference would largely equalise the difference in the cost of coal in London. Many of the London stations, by being so far from a river, were compelled to put up cooling towers, which, besides discharging large volumes of steam into the atmosphere, necessitated a large expenditure.

Under cross examination Witness said he was quite willing to supply anyone with the 10,000-H.P. turbines. No turbine of this size had yet been built, the largest being 3,500-H.P. turbines, with an overload capacity of 6,000 or 7,000kw. Two of this size had been built. The difference in efficiency between a 3,500kw. and a 10,000kw. turbine in steam efficiency was 18 per cent. in favour of the latter, and the difference in capital cost about the same. Turbines could be run at an overload capacity of 100 per cent. for periods ranging from half an hour to 24 hours. It all depended on the generator. He admitted that in his evidence before the Royal Commission on Coal Supplies, about a year ago, he had stated that it might be cheaper for factories to generate their own power if they used, say, 500 H.P., and were four or five miles distant from a large generating station. But he would not now stand by that evidence, owing to the great advance that had been made. The same held good with regard to the portion of his evidence before the Coal Commission relating to underground high-pressure mains, to the effect that their stability was doubtful. One of the 10,000kw. turbo-generators could be manufactured in nine months.

Mr. COURTHOPE MUNROE, of the St. Pancras Borough Council, stated that the 1,000kw. turbine supplied to that body had been very unsatisfactory. The following particulars showed this:—

	Guaranteed steam required.	Actual under test.
Quarter load	6,000lb.	6,800lb.
Half load	9,700lb.	10,800lb.
Three-quarter load	13,400lb.	14,600lb.
Full load	17,000lb.	18,000lb.

Mr. PARSONS, in re-examination, said as a matter of fact the test referred to did not make use of the proper condensing plant, and that actually the plant was not yet out of the makers' hands.

Mr. C. E. L. BROWN, of Messrs. Brown, Boveri & Co., agreed with the general principles of the scheme. His estimate of the cost of erecting a station of 90,000kw. on the Continent was that it would be between £7 and £7·5 per kilowatt, excluding land. The use of cooling towers in connection with such large stations would be most unpractical. He entirely agreed with the general principles of the scheme.

Cross-examined: He confirmed Mr. Parsons' evidence that the turbines would be constructed to give 100 per cent. overload and that the alternators would also stand this overload for long periods; it was only a question of proper design.

Mr. S. Z. DE FERRANTI agreed with the evidence and estimates of Mr Merz, both in their details and their conclusions. He had advocated, from the commencement, the concentration of large generating stations, and this scheme was merely a reversion to what was originally advocated. He had gone into the estimates in great detail and entirely agreed with them. He had been over more than 100 miles of the streets in which it was proposed to lay mains. He was acquainted with a large number of the existing power stations in London, and he went in detail into the disadvantages of many of them. All suffered from the want of plentiful supply of river condensing water, and several had to use evaporative condensers. Coal in several instances could not be delivered by barges on the river, and in those cases where the stations were on the river, the operations were not on a sufficiently large scale to warrant the coal being brought by steamer. All were very cramped, and only a few could be extended. The Metropolitan Electric Supply Co.'s station at Willesden was practically covered with fog in the shape of steam from the cooling towers. [Photographs were handed in to show this.] The amount of steam given off into the London atmosphere from electrical generating stations, being mostly at night, was not so noticeable as it might be. If all the present stations had a large power load all day, the London atmosphere would be fearful. Individually, the London stations could not give the supply intended by this bill, and so far as trying to unite the stations altogether, this was impossible owing to the various systems of supply, voltages, periodicities, &c.

Cross-examined by Mr. BALFOUR BROWNE: It was true that he had chosen the site for the works of the London Electric Supply Corpn. at Deptford, but the scheme as he had drafted it was much larger than the one which the directors could find the money to carry out. To have carried out the condensing arrangements would have cost £30,000. The Lancashire Power Bill and the Yorkshire Power Bill were not power bills in the true sense of the term, because they could only supply authorised distributors. He could not give a precedent for the present bill because there was only one London, and, consequently, only one set of such conditions. Competition between two power companies would be fatal, and this had been recognised by Parliament, but no competition between small lighting companies was possible owing to the greater number of consumers.

THE CHAIRMAN: The only result of your bill, therefore, would be that the existing companies would, in many cases, have to take their supply in bulk from you?—Yes, and in many cases we would take business, such as railway companies and large power consumers, which the present authorities could not hope to do unless they were on as large a scale as we propose to be. But this cannot injuriously affect the existing undertakings in London.

But it would prevent the erection of further generating stations?—Yes, and thus prevent the spending of ratepayers' money.

The CHAIRMAN: That is a very attractive argument if it would only come off.

Mr. BALFOUR BROWNE: I am afraid nothing will prevent spending the ratepayer's money.

Mr. FERRANTI: By extending their present works the existing undertakings would increase the capital costs and also increase the charge to the consumer.

Mr. BALFOUR BROWNE: But increasing the plant would mean increasing the size, and size according to you is economy?—No, only when size is known from the commencement.

Is it your idea that the present stations should supply up to their present capacity and then take from you?—Possibly.

Then the local authorities and companies will simply become the distributors of your electricity?—I should not like to say that at the commencement.

But it will be at the end, and then you will have one gigantic monopoly?—Only the monopoly of cheapness.

In the course of a short re-examination, Mr. FERRANTI said that it might possibly be that the restrictions placed upon the Lancashire Power Co. and the Yorkshire Power Co. by the exclusion of so many authorised distributors had been the cause of the state of those undertakings.

[*Thursday, March 23.*

Mr. VINCENT RAVEN, chief assistant mechanical engineer to the North-Eastern Railway Co., gave evidence as to the working of the Newcastle lines of that company by electric traction, and the satisfactory results obtained therefrom. The directors of the company had very carefully considered the question of erecting a separate generating station, but owing to the large amount of capital which would have been necessary they had decided to accept the offer of the Newcastle-upon-Tyne Electric Supply Co. No inconvenience had been experienced through taking the supply from an outside company. They now were taking current for power in their workshops, and arrangements were also being made to take the current to the railway company's docks. It was his opinion that none of the London railway companies would be justified in converting their lines to electrical working unless they could get their energy at less than 0·75d. per unit.

Cross-examined: He believed that the North-Eastern Railway Co. was the only railway company in England, America, or the Continent which bought electrical energy for working their lines. The price charged to the Newcastle Railway Co. was a special one and lower than that charged to the ordinary power consumer. The total cost to the railway company was 0·63d. per unit, without cost of mains or distribution.

Mr. J. F. S. GOODAY, General Manager of the Great Eastern Railway, and Mr. BERRY, General Manager of the Great Northern Railway, spoke of the advantages of being able to take a supply from a large power company, and that probably the existence of such a company would expedite the adoption of electric traction upon their suburban lines.

Mr. G. C. CUNINGHAM, General Manager of the Central London Railway Co., also supported the bill, and thought that if a supply as was proposed had been available at the inception of the Central London Railway, there was a reasonable doubt as to whether they would have put up a separate generating station.

Mr. E. F. GRIPPER, of Messrs. Edmundsons' Electricity Corporation, also gave evidence in favour of the scheme.

Representatives of various manufacturing and engineering firms were then called in support of the scheme.

The CHAIRMAN asked that this evidence should be curtailed.

Mr. WATSON gave particulars of various offers of current for power purposes by some of the existing companies. The offers by the County of London Electric Supply Co. to a number of firms whom he had advised as to electric driving, was 2½d. per unit, with discounts. In some cases the firms put down their own plant, in others they abandoned the idea of altering their mode of driving. He also gave a number of other cases in the areas of other companies with the same result.

Cross-examined: He admitted that in one case the offer was an advertisement on the bill for ordinary lighting.

Other evidence of a similar character was then called.

Financial evidence was next taken.

Mr. JAMES FALCONER, one of the promoters and chairman of the Mersey Railway Co., said the main object of the Bill was to supplement the existing means of supply in London as far as possible by co-operation with the present authorities. A very large proportion of the capital, and if necessary the whole of it, could be obtained by the promoters, practically every one of whom had subscribed £500 towards the preliminary expenses. All were willing to bind themselves to find a considerable portion of the necessary capital. The idea of the scheme came from Mr. Merz.

Cross-examined: The reason for making the company a limited liability company was that this was thought to be the only way of safeguarding the interests of the shareholders in such a vast scheme.

The CHAIRMAN said the important part was, Would the money be found.

Mr. ROGER WALLACE, K.C., for the Westminster Company, said he did not dispute that the subscribers could find all the capital required.

Mr GASPARD FARRER, director of Messrs. Baring Bros., also supported the bill.

The Committee adjourned until Monday.

LONDON COUNTY COUNCIL (GENERAL POWERS) BILL.

In the House of Commons on Thursday last week, the London County County Council (General Powers) Bill came up for second reading. On part XV.,

Sir F. BANBURY moved that it be an instruction to the Committee to omit this section. The effect of it was to empower the London borough councils to supply electrical fittings and apparatus to their consumers and to borrow money for this purpose. The result would be to introduce municipal trading of an unfair character and to interfere with the legitimate work of electrical contractors.

Mr. JOHN BURNS said the County Council was acting on behalf of the borough councils, 16 of which had been granted authority by Parliament to supply electrical energy. There were also 13 electric light companies who had the powers which the County Council were now asking for in respect of the borough councils. It was found that a supply of electricity could not be given so cheaply when the consumer had to buy his fittings from the middleman, who frequently made large profits. He asked for a little consistency in these matters and pointed out that the South Metropolitan Gas Co. was allowed to supply fittings and cooking stoves under the same conditions which it was now sought to refuse to give to the borough councils.

Sir H. KIMBER supported the motion.

Mr. J. W. BENN pointed out that both the Woolwich and the Marylebone Councils already had these powers.

Major EVANS-GORDON supported Mr. Burns.

On a division, the motion was rejected by a majority of six.

POSTPONEMENT OF TUBE RAILWAY BILLS.

The tube railway bills that have been deposited this session have, not unexpectedly, been postponed. It will be remembered that the Hammersmith, City & North-East London Railway Bill was rejected on Standing Orders a few weeks ago. The dates of postponement of the second reading, by order, of the remaining bills proposing new lines are as follows:—

Central London Railway until May 3, Great Northern, Piccadilly & Brompton Railway until May 3, North-East London Railway until April 11.

OTHER ELECTRICAL BILLS.

The *Tyneside Tramways and Tramroads Bill* came before the Unopposed Committee of the House of Commons on Tuesday. The main object of the bill is to authorise the company to issue capital as preference capital. The Committee allowed the bill to proceed.

The *Metropolitan District Railway Bill* also came before the Unopposed Committee of the House of Commons on Tuesday. This empowers the company to apply to the general purposes of their undertaking, among other things, to the cost of adopting electric traction, a portion of the capital authorised by their act of 1897. It also seeks to amend the powers under that act as to borrowing. The bill was ordered to be reported for third reading.

The *Shepton Mallet (Gas Electric Lighting) Bill* was read a second time in the House of Lords on Monday.

When the *Dublin United Tramways Bill* came on for second reading in the House of Commons on Monday, an instruction was moved and carried to the effect that the promoters should include a clause binding them to give a supply of electrical energy for lighting purposes to the Blackrock Urban District Council.

Sir Edward Strachey had notified his intention of moving, on the second reading of the *Light Railways Bill* in the House of Commons, that it be deferred for six months.

The *Birmingham Corporation Bill* and the *Edgware & Hampstead Railway Bill* are now proceeding unopposed.

Charing Cross, Euston & Hampstead Railway Bill came before a Committee of the House of Commons, presided over by Mr. Compton Rickett, on Tuesday. The line is under construction, and the main object of the bill is to construct a station underneath the forecourt of the Charing Cross station of the South-Eastern Railway Co. The latter company had agreed with the promoters, but the Westminster City Council, as the street authority, objected on the ground that the opening of such a large volume of traffic into the Strand was all against the interest of the public. The point between the parties was such a small one that the chairman ordered an adjournment until Monday to see if an agreement could be arrived at.

ACCIDENTS ON THE NORTH-EASTERN RAILWAY.

In the House of Commons on Monday.

Mr WEIR asked the Secretary to the Board of Trade if he would state the names of the persons who had met with fatal injuries since the opening of the electrified portion of the North Eastern Railway a year ago through coming into contact with the live rail; and what compensation had been awarded to the relatives in each instance.

Mr. BONAR LAW, in a printed reply, said the names reported to the Board of Trade were as follows:—John Frederick Irving, Joseph Innes, Jonas Whitehead, James Harris and Elizabeth Chapman. The accident to the last named appeared to be that which the hon. member has referred to in previous questions as an accident to Alice Maughan. He was not aware what compensation has been paid to the relatives in any of these cases.

STREET BOX EXPLOSIONS.

In the House of Commons on Monday.

Sir THOMAS DEWAR asked the Postmaster-General whether his attention had been called to accidents reported by the Metropolitan Police as being due to explosions caused through gas escaping into telegraph inspection chambers and coming into contact with leakage from an electric wire; and would he state what compensation had been paid for any personal injuries which such accidents might have caused, and what action had been taken to prevent their recurrence.

Lord STANLEY, in a printed reply, said his attention had been called to this matter frequently, but, as he told the hon. member last session, he had not seen any reason to suppose that explosions had been due to leakage from a telegraph or telephone wire. No compensation had been paid by the Post Office, which had not been in any way in fault. The engineers of the Post Office were considering whether there was anything the department could do to diminish the danger arising from the escape of gas.

RAILWAY COMPANIES & MOTOR OMNIBUSES.

In the House of Commons on Tuesday, on the motion for second reading of the North-Eastern Railway Bill,

Mr WHITLEY moved that it be an instruction to the Committee to whom the bill was referred to limit clause 38 to the running of omnibuses to and from the company's railway stations.

Sir E. GREY, while holding the view that municipalities ought not to be unduly competed with in connection with their electric tramways, thought the company would be prepared to say before the Committee that they were not taking powers to run omnibuses in any borough or urban district except to and from their railway stations. He opposed the instruction.

Mr. ATHERLEY JONES having supported the instruction,

Mr. WHITLEY said he was satisfied with the assurance of Sir E. Grey and withdrew his amendment.

LEGAL INTELLIGENCE.

Attorney-General (on Relation of Willesden Council) and Willesden Council v. Metropolitan Electric Supply Co. (Ltd.)

This case came before the Court of Appeal (the Lord Chief Justice and Lords Justices Vaughan Williams and Stirling) on Wednesday on the appeal of defendant company from a judgment of Mr. Justice Farwell. The facts of the case and Mr. Justice Farwell's judgment were given in our issue of Oct. 4 last. Plaintiffs claimed a declaration that defendants were not entitled to supply to any person, company or corporation electrical energy within the Urban District of Willesden otherwise than under the authority of Parliament or under a licence granted by the Board of Trade. Plaintiffs also claimed a declaration that defendant company were not entitled to use any of their cables or wires or any mains or cables connected therewith for the transmission of electrical energy from their works at Willesden and Acton otherwise than to the several distributing stations of the company in their Paddington, Marylebone and Mid-London areas defined by the several provisional orders scheduled in the Metropolitan Electric Supply Co.'s Act, 1898, and the area in St. Martin-in-the-Fields and the neighbourhood defined by the Metropolitan Electric Lighting Order, 1889, or to use the said generating station otherwise than for the purpose of supplying areas or districts over which the company had, on August 12, 1898, powers of supply, or over which they might thereafter have such powers. Plaintiffs also claimed an injunction.

It appeared that defendant company under its memorandum of association had unrestricted powers of acquiring land, erecting electricity works and producing and supplying electric energy, but sec. 5 of the Metropolitan Electric Lighting Act, 1889, restricted electricity undertakers from supplying energy or (except for the purposes of the act) erecting or laying down any electric lines or works beyond the area of supply otherwise than under the authority of Parliament, or under a licence granted by the Board of Trade, provided that where the undertakers were on May 25, 1889, supplying, or under any binding agreement to supply, any premises beyond the area of supply, they might continue to supply until Sept. 29, 1890. All electric lines or works used by the undertakers for supply of energy beyond the area of supply and situate in or across any public street, &c., might and should (unless sold to other authorised undertakers) be removed, and for failure to remove same within six months they were liable to a penalty not exceeding £20 for each offence. Plaintiffs alleged that the areas of supply described in the first schedule to the 1889 act did not, in fact, comprise Willesden District Council. By three subsequent provisional orders the company obtained like powers in three other districts, all situate in the County of London, and each order contained a prohibition similar to that contained in sec. 5 of the act of 1889. In 1898 the company secured the passing of a private act, the preamble of which, after reciting the act of 1889 and the subsequent orders, recited that "whereas the demand for the supply of electric current within the areas supplied and authorised to be supplied by the company has increased and is increasing very rapidly, and in order to enable the company to meet this demand, the company had found it practically impossible to provide adequate station accommodation within their said areas; and whereas the company, in order to provide for the demand upon them, has acquired a piece of land in the parishes of Willesden and Acton, and are engaged in constructing a large electrical generating station and works thereon on which they have expended and are in course of expending large sums of money; and whereas it will conduce to the convenience of those who use the electric current in the said several areas of supply of the company, that the company should be empowered to supply from the said electrical generating station and works electric current to their distributing stations within the several areas of supply hereinbefore mentioned, and for that purpose to lay down electric cables or wires from the said lands to connections with their several distributing stations, and mains and cables within their several authorised areas of supply." The act provided that it should be lawful for the company to hold and use as a station for generating electric current the said lands in Willesden and Acton, and to establish and work on those lands plant for generating electrical energy and for other purposes incidental to and connected with their undertaking or business. It also enacted that it should be lawful for the company to use any of their cables or wires, and any mains or cables connected therewith for the transmission of electric current from their works on such lands to the several distributing stations of the company within Paddington, Marylebone, Mid-London and other areas defined in the company's acts and orders, and in such areas or districts over which they might hereafter have powers. The land at Willesden was not situate within the limits of any of the statutory districts which they were empowered to supply with electricity. In December, 1903, the defendant company commenced to supply the L. & N.W. Railway Co., which has sidings adjoining their generating station at Willesden, with electrical energy from the adjoining station, and plaintiffs contended that such a supply was a violation of the statutory prohibition in the Act of 1889 and the subsequent orders.

The company pleaded that under its memorandum of association it had full and unrestricted powers to acquire lands, erect electric works and to produce and supply electric energy, and that such powers were aided in particular districts by auxiliary statutory facilities conferred by various acts and provisional orders, but were not dependent thereon. Defendants further submitted that the Act of 1889 and the other Acts of Parliament and provisional orders passed in or about 1889, were intended to give in specified districts within the metropolis statutory facilities for supplying electric energy to various undertakers within such districts, and to prevent such undertakers from using the special statutory facilities in their own districts to enable them to compete with similar undertakings in adjoining districts under similar statutory facilities, but were not to limit the general powers of the defendants in the carrying on of their general business. Defendants further said that the prohibition contained in the Act of 1889 was not a general prohibition, but only applied to the company as undertakers under the particular act. Mr. Justice Farwell agreed that the prohibition was not meant to extend to the company for all time, but he said he could not interpret it so as to limit it as defendants wished. He decided that the undertakers, so long as they were undertakers working that particular undertaking, must not supply electricity outside the statutory area. His lordship granted an injunction, but suspended its operation pending the present appeal.

At the conclusion of the arguments of counsel for the appellants, and without calling upon counsel for respondents, the LORD CHIEF JUSTICE, in giving judgment, said he was unable to see any fault in the reasoning of Mr. Justice Farwell. He did not think that these electrical supply acts could be considered independently of the general legislation on the subject. The main argument on behalf of defendants was that what they were doing was not done in the exercise of any authority given to them by statute or Board of Trade orders. It was said that they were a company incorporated under the Companies Act of 1862, and that the exercise of their powers under that incorporation was not prohibited by anything contained in the Acts of 1889 and 1898. His Lordship was unable to take that view or to give to sec. 6 of the act of 1889 any other construction than that which had been given to it by Mr. Justice Farwell. He agreed that the main object of the act of 1889 was to provide for the metropolis – to carry out what was recognised as the best scheme for the administrative County of London. But he was unable to follow the argument that you were entitled to disregard the outlying areas. The words of sec. 5 must be taken in their natural sense. He thought that prima facie the section meant that when the right to supply electricity was given to the company one of the terms of the bargain was that they were not to supply electricity beyond the specified area otherwise than under the authority of Parliament or under a licence from the Board of Trade. He thought the company had bargained for limited rights upon the condition that they should not supply electricity outside their area. He could not find in the Act of 1898 anything which by implication negatived the prohibition in sec. 5 of the Act of 1889.

The Lords Justices concurred, and the appeal was accordingly dismissed.

Mr. CRIPPS asked that the injunction might be suspended in view of the defendants appealing to the House of Lords.

Their Lordships granted a suspension, except in Willesden.

A. H Midwood & Co. v. Corporation of Manchester.

This case came before Mr. Justice Lawrance and a special jury on Monday. It was an action to recover the estimated loss of the plaintiffs' stock in trade, which was destroyed by fire, caused by the fusing of one of the Corporation's electrical cables. The plaintiffs alleged that the Corporation had laid their mains in such a way as to constitute a nuisance, and that the fire was caused by their negligence.

The Corporation denied the allegations.

Sir Edw. Clarke, K.C., Mr. Bousfield, K.C., and Mr. Wood Hill appeared for the plaintiffs, and Mr. Fletcher Moulton, K.C., and Mr. J. W. Gordon for the defendants.

Sir EDW. CLARK, in opening the case, said that it involved very serious questions, both of law and of fact, the answers to which would probably lead to considerable discussions. The jury would not be troubled with any questions as to the amount of damages, as they had been agreed at £677. 4s. 6d., which was the amount the plaintiffs would receive if they were entitled to recover. The mains were laid by the Corporation, and the plaintiffs contended that the system employed by defendants constituted a danger to the premises of persons adjacent, and the Corporation had, therefore, been guilty of a nuisance and were responsible for the loss incurred. The explosion occurred at 3:30 a.m. on May 24, 1903, part of the pavement was lifted up, a large stone broke in the door of a house opposite, and the fire which ensued destroyed nearly £700 worth of property belonging to the plaintiffs. It was clear that the explosion and subsequent mischief were caused by a defect in the cable. The learned counsel said that at Manchester the network was divided into districts which were connected together. If time permitted these could be isolated, but a fault could not be effectively localised until there was some indication of actual mischief having been done. There was practically no means of indicating the exact spot where the mischief was until smoke was seen, and then it was impossible to prevent serious consequences. Another system was one in which fuses were used and in which the fault indicated itself and the light was cut off. It was rightly said in the course of correspondence between the Corporation with the Board of Trade that under their system it was impossible to foresee an accident of this kind The plaintiffs' case was that the defendants were responsible under the act quite apart from the question of negligence, but they further said that defendants when they established a system of this kind, which involved this danger and was known to involve it, they were setting up a nuisance and endangering the neighbouring property in a way they were not entitled to do. He and his learned friend, Mr. Moulton, had agreed to the following questions being left to the jury :—

1. Was the fire caused by the fusing of the Corporation's cable?
2. Does the system adopted by the defendants constitute a danger to persons having property adjacent to the mains?
3. Is the method of localising faults by the burning out or smoke tests a reasonable and proper method having regard to risk of fire?
4. When the defendants became aware of the fault, did they deal with it for the purpose of preventing fire in a reasonable and proper manner?

Mr. THOS. JOSEPH GOUGH, electrical engineer, in the employ of the Corporation from June, 1902, until February, 1904, said it was reported to him on the afternoon of May 23 that there was something wrong with the electric light at the Crown Hotel, Fountain-street. He found that there was a considerable consumption of current somewhere, and ordered further pressure to be applied. The fault developed about midnight, and at 3:30 there was a serious explosion and fire.

Cross-examined: There was nothing in the log book to indicate trouble before 1:30 a.m. What happened up to that time did not indicate anything serious – merely the light going in and out.

Re-examined: The Manchester newspapers made a very heavy demand on the electric light, but this being a Saturday night the demand was much less than usual prior to 1:30, the indications of trouble were capable of satisfactory explanation, but after that hour it was quite clear that there was mischief. The load was kept up, the natural consequence being that the fault would be burnt out. The smoke seen by the constable indicated where the mischief was.

Mr. A. L. TAYLOR, electrical engineer to the Royal and the Liverpool, London and Globe Insurance Companies, said he had had considerable experience with reference to the designs of street mains, service connections, &c., and had been engaged in inspecting that kind of work. He had examined the scene of the Fountain-street explosion, and found that the fire had travelled inwards from the Corporation's main. It was probably spread by the melting of the gas pipes in the basement. At that time the Manchester system was a single one, all the districts being linked up together. He believed that Manchester had since adopted the system of dividing up into a number of networks. The system of linking up was neither usual nor right for a place the size of Manchester. He had never known it used in a place of such a size. If the fault had occurred at Liverpool it would only have been necessary to turn out an area of 1,000 lamps. The burning out process had been frequently used at Manchester.

Replying to further questions, Witness stated that the detection of faults in Manchester was frequently being made through the appearance of smoke. It was obvious that the Manchester system of dealing with faults involved risk to property, and the risk of fire was considerably increased by the practice of putting on additional machines to keep the pressure up.

Is it reasonably practicable to carry out the Manchester system of electric lighting without this danger?—Yes, it is possible. Liverpool has been running a system 10 years longer than Manchester, and their mains have been on fire, but there has not been a single case of the fire spreading inside premises.

Cross-examined: In his opinion Liverpool and Manchester were the two extremes. He did not know another case in which the areas were divided up as they were in Liverpool. He did not think that the Manchester system was in accordance with the Board of Trade regulations either in respect of the wholesale joining up or the taking of precautions to prevent fire spreading to buildings. No action was taken by the insurance company in the other Manchester cases he had referred to.

In reply to further questions the witness admitted that up to 1 o'clock on the morning of the accident the Corporation were working well under the figure as to leakage which the Board of Trade stipulated as to the danger limit. In his view, when the leak was discovered the works ought to have been stopped. Assuming it was necessary to go on, what was done was right and proper. He did not find fault with the device used for linking up, but with the wholesale system of linking. In the two other cases he had mentioned the Corporation admitted that the fires arose in their mains.

Re-examined: If the defect could be localised and isolated, as in Liverpool, there would be no necessity to put on additional machines to maintain the pressure.

Mr. W. W. REYNOLDS, a hosier of Manchester, said that on November, 20, 1902, there was an electric light explosion in his celler, and the Corporation paid the damage.

Mr. EVAN ROBERTS, a tailor, of 10, Cross-street, Manchester, said that two electrical meters exploded in his cellar on April 17, 1902, and the Corporation paid £101 damage.

The hearing was adjourned.

On the resumption of the proceedings on Tuesday, Sir EDWARD CLARKE stated that the evidence given on Monday constituted the case for the plaintiffs.

Mr. MOULTON, in opening the case for the defence, submitted that the plaintiffs had not shown that the Corporation had failed in any one particular in abiding by the directions of the general acts or the special acts of the Board of Trade. Everything that the Board of Trade required was attended to without negligence and completely. Those were the points of law with which his Lordship would have to deal, but he would have gone a long way towards proving his case if he showed that everything prudent men would do had been carefully and thoroughly done by the Corporation. An electric supply without accident under any circumstances was just as impossible as a supply of gas under all circumstances without accident. It was wholly impossible to supply such an immense area as Manchester without the possibility of accident, and he would submit that an inevitable accident which could not be foreseen or guarded against did not make the Corporation liable. They were not insurers in that respect. The Corporation had done all that could be done to ensure a safe and certain supply of electricity according to their duties. They were bound to supply the entire area. To have a part of the town in darkness would be a breach of duty and a danger far greater than the remote danger of an accident such as had occurred in the present case. The pressure in the mains must be maintained during the whole time the supply was going on, otherwise the supplying agency failed in its first duty, which was to continue the supply and lay down mains which would enable them to do so. The Corporation in this case did their duty in keeping up the pressure. As a rule, it was perfectly safe, and under their system of working and construction any risk there might be in supplying electricity was utterly minimised. The system adopted by the Corporation was not only the one adopted by the Board of Trade, but it was the best one. He could not help thinking that the description given of the Liverpool system was a great exaggeration. If it were true, then Liverpool must have gone back to the dark ages. The alternative system suggested would be wholly useless for any large town. Manchester had 500,000 lights on its system, and its record was an extraordinary good one, if the trifling accidents with respect to which evidence was given the previous day were the only ones that could be put forward. With regard to the fire on the plaintiffs' premises, he would show that the Corporation did everything that could be done immediately the leakage was detected.

Mr. STANLEY PEARCE, chief electrical engineer to the Manchester Corporation, said that in the case of a defect it was possible to subdivide the area down to the length of one street supplied by one feeder only. In his opinion the system was a good one. It was approved for Manchester by the Board of Trade, who had inspected it from time to time. It was put down by Mr. Wordingham, who was now with the Admiralty. A fault was usually detected by irregularity in the lighting on a consumer's premises or by smoke or smell percolating through the pavement flags. He had known it take three days to localise a fault by the process of division.

Cross-examined: In order to remedy a defect the central, north and south-eastern districts would have to be separated. It would take a considerable time to effect the severance. When any mischief was discovered the mains engineer would be called in to disconnect the districts. The mains engineer would not be in attendance at the generating station between the middle of the day on Saturday and Monday morning, but he could be summoned by telephone. The south-eastern district was cut off after the accident, and then the central was isolated from the northern at about 3:30. These operations were not recorded.

Mr. H. L. HOWARD, assistant mains engineer to the Corporation, related the steps taken by him to localise the fault in Fountain-street when he was called up on the telephone.

Cross-examined: There was nobody at the Dickinson-street station with authority to commence the work of disconnecting the districts in his absence. If there had been it might have been possible to localise the fault in time to prevent mischief. It was not customary to give notice to the police when a fault was discovered.

Mr. W. H. PATCHELL, chief engineer to the Charing Cross, West End and City Electricity Supply Co., said that in his opinion the Liverpool system, as described on the previous day, was an impossible one. You could not supply a large town in that way and comply with the Board of Trade regulations with regard to steady pressure. The difficulty of using fuses was to know what sized fuse to put in. The use of the five-wire system was almost confined to Manchester.

In cross-examination: Witness said that what occurred in Fountain-street was a necessary incident of the Manchester system in those days. Early in 1903 no engineer in the country knew of a fuse he dared put in a street box. Witness knew of explosions caused by fuses in street boxes which made people think that the remedy was worse than the disease. Since then his company had spent further money on experiments and had got an enclosed type of fuse which they were now using. Asked if he considered the Board of Trade regulations for localising defects satisfactory witness said they could be improved, but, like Acts of Parliament, one had to work under them.

In re-examination, Mr. FLETCHER MOULTON read the Board of Trade regulations, and Witness declared that none of them had been contravened by the Manchester Corporation. The Manchester system could be divided into blocks of 80 consumers. In fact, there was no length of main with more than that number of consumers on it.

Mr. C. P. SPARKS, chief engineer to the County of London Electric Supply Co., said the Manchester system was properly laid in accordance with the Board of Trade regulations and modern electrical knowledge. He could not see what more the Corporation could have done in the case of the Fountain-street explosion.

The hearing was adjourned.

On the resumption of the proceedings on Wednesday, Mr. ALFRED CLOUGH, the engineer in charge of the electrical distributing system of the Liverpool Corporation was called to give evidence with respect to the statement made by Mr. Taylor that the system in Liverpool was to divide the area into districts of 1,000 lamps, each district being connected with the generating station by a separate feeder and disconnected from all other disticts. Witness stated that this was only correct so far as the outer area was concerned. The reason they had small circuits in the outlying area was because they were connected with small generating stations. They had five generating stations connected with refuse destructors. Under the Liverpool system it might take several days to localise a small defect, and three or four hours if it was a very large one.

Cross-examined: Instead of being linked up like Manchester, they had 100 different circuits with separate feeders. They had not been free from accidents, but had not had many serious ones.

Mr. J. A. COOKSON, mains surveyor to the Manchester Corporation, stated that the mains were so composed that blocks of 80 consumers could be cut out.

Mr J. SWINBURNE said he had inspected the Manchester system, and it was in accordance with the Board of Trade regulations, and in accordance with modern electrical knowledge. It was quite a representative system. The only thing in the least peculiar about the Manchester system was the use of the five wires instead of three. Everything else was standard. With respect to the Fountain-street trouble, the recorder did not indicate any really serious disturbance until well after 1:30 a.m. The steps taken by Mr. Howard were the proper steps in the circumstances. He knew of no better system of localising a fault than the one adopted.

Cross-examined: In Manchester they did what they could to localise a fault, and if they were unsuccessful they relied upon the appearance of fire or smoke to show where the defect was.

Re-examined: The link system was practically universally adopted because it was the best. The important point was not the localising of faults, but the maintenance of uniform pressure.

On the resumption of the proceedings on Thursday, Counsel having addressed the jury on behalf of their respective clients,

His LORDSHIP, in summing up, pointed out to the jury that the questions of negligence and nuisance must be kept distinct. It was no answer to the charge of creating a nuisance to say that you had not been negligent. On the question of negligence the jury would have to say whether the defendants took reasonable steps to avert the risk of fire.

In the result, the jury found that the system adopted by the defendants constituted a nuisance by causing danger to persons having premises adjacent to the mains, that they were guilty of negligence in adopting their method of localising and dealing with the fault, and that when they became aware of the fault they did not deal with it for the purpose of preventing fire in a reasonable and proper manner.

On these findings his Lordship entered judgment for the plaintiffs for the agreed sum of £677. 7s. 4d., with costs.

Puxon v. Brooker & Goss (Ltd.)

This case again came before Mr. Justice Farwell on Friday on a motion by plaintiff to appoint a receiver and manager in a debenture holder's action.

Mr WILKINSON said the company was a small one; it was incorporated in January, 1903, and £900 of debentures were issued. Plaintiff held a debenture for £300. The principal was not payable till October, 1910, but interest was in arrear. The company was unable to pay wages, the gas had been cut off, and three quarters' rent were due.

Mr. COZENS-HARDY, for the company, asked that the matter be referred to chambers. Rightly or wrongly, the suggestion was that the plaintiff was bringing on this motion on behalf of his son, who had been employed by defendants as a draughtsman.

His LORDSHIP appointed plaintiff's nominee as receiver.

Galbraith v. Hadfield's Steel Foundry Co. (Ltd.)

At the West Riding Assizes at Leeds on Monday, plaintiff sued defendants to recover damages for wrongful dismissal and for salary due and commission earned. Defendants denied that any salary or commission was due.

Mr. TINDAL ATKINSON, K C., for plaintiff, stated that in January, 1889, his client became secretary to defendant company, and he remained in the service of the company until August last year. In 1893 defendants opened a London branch and plaintiff was asked to take charge of it. He was disinclined to do so, but ultimately consented. He was then receiving a salary of £425, and it was agreed that he should start at £475 as London manager. He had entire control of the London branch, and was so successful that the turnover had grown from £15,000 to £160,000. His employers increased his salary until it reached £1,000 a year. In the latter part of the time Mr. Galbraith had to complain of men from the Sheffield office interfering with his customers, and eventually this led to a disagreement. A clerk named Pickering was instructed to see an important client for whom work had been done for Lisbon Tramway Co., and plaintiff was requested to accompany him. He objected to do so, and in consequence was dismissed without notice. He brought this action to recover three months' salary in lieu of notice, certain commissions earned and damages for wrongful dismissal.

Plaintiff gave evidence in support of his case.

For the defence, Mr. W. B. PICKERING said he was traveller for all tramway track specialities of the company, a department that had been originated and developed since 1893, when Mr. Galbraith left for London. He had particular knowledge of those specialities, and on that account was chosen to go to London to join Mr. Galbraith in a certain interview as to the Lisbon wheels and axles. Mr. Galbraith declined to go with witness on that errand.

Mr. R. A. HADFIELD, managing director of defendant company, said Mr. Galbraith had no technical knowledge of the manufactures of the company. He did not blame Mr. Galbraith on that account, but it was necessary that he should be assisted technically. He never engaged with plaintiff not to send people to London without his approval or consent. The only arrangement was that the firm should not send anyone up to London behind Mr. Galbraith's back. He detailed the circumstances under which Mr. Pickering, who was going to London on other business, was directed to see Mr. Galbraith on the Lisbon matter and go with him to the interviews. He did not give Mr. Pickering any instructions to undertake the interviews alone. He was exceedingly sorry that that matter had occurred, but he thought Mr. Galbraith had treated him badly. He had still a great regard for Mr. Galbraith, who was a good business man, and had enormously increased the turnover of the London business.

His LORDSHIP: Don't you think it was a very small matter to turn him off for?—Not after the way he treated me.

Other evidence having been given, the jury found for plaintiff, with damages to the amount of three months' salary (£250), plus £21 previously due, and £30 commission—£301 in all.

Mr. SCOTT FOX, K.C., raised the question of the breach of agreement, under which, he contended, Mr. Galbraith was debarred for two years from being concerned in the manufacture or sale of steel castings, or from divulging the firm's trade secrets.

His LORDSHIP said the old agreement could hardly apply to the new facts. He saw a great change in Mr. Galbraith having gone to London from being secretary at Sheffield, and if the firm had wished to continue the disability, they should have drawn up a new agreement.

Judgment was accordingly given for plaintiff on the counter-claim as well as on the claim.

Tramcar Passengers' Risks.

At Newcastle-on-Tyne County Court on Friday, Judge Greenwell gave judgment in an action brought against the Corporation by a passenger for damages for injuries received through being jerked off a tramcar. At the time plaintiff was standing on the footboard after it had passed the stopping place, where, he alleged, he had told the conductor he desired to alight. The defence was that he gave no order, and tried to alight as the car was moving.

The JUDGE said he accepted plaintiff's statement, but did not see how that gave him a claim. If he had given an order with which the conductor did not comply that did not justify him in remaining on the footboard after the car increased its speed on passing the stopping place. The footboard was a place where a passenger had no right to travel, having due regard to his own safety and the liability of the Corporation. It was common for people to travel on it, but he thought they must occupy the same position as people who tried to get off while the car was moving. They were on the footboard at their own risk. He found for defendants, with costs.

Acetylene Gas and Electric Smelting Co. (Ltd.)

Mr. Justice Buckley on Tuesday dismissed the petition of J. W. Hopwood for winding-up on the ground of the smallness of creditor's debt (£26). It was not (his Lordship said) the practice of the court to make winding-up orders for such trivial sums, although there was jurisdiction to wind up for smaller sums.

Airdrie Town Council v. Airdrie & Coatbridge Tramways Co.

Sheriff Mackenzie has given judgment in this action which was brought in the Airdrie Small Debt Court by the Council to recover £8. 0s. 7d. from the Airdrie & Coatbridge Co., expenses incurred in clearing away accumulations of snow in the street caused by defenders' use of a snow-plough during a heavy fall of snow on Dec. 10 last.

The Sheriff decided in favour of the Council.

Trolley Wire Accident.

James Brough, collier, sued the Potteries Electric Traction Co. at Staffordshire Assizes last week for damages for injuries received from a live trolley wire, which had fallen, and with which plaintiff came in contact, on April 30 last.

Defendants pleaded that every reasonable precaution had been taken for the safety of the public, but the jury found for plaintiff for £300 damages.

Customs Decisions.—The Customs authorities of New Zealand have fixed the rate of duty leviable on lay-outs and cables for electric tramways (classified as tramway plant and material) at 20 per cent. ad val.

The Japanese authorities have increased the duties upon electric lighting apparatus and instruments or parts thereof by 5 per cent. ad val., thereby increasing the duty to 15 per cent. The duty on telephones and parts thereof has been similarly increased. The duty on imported telegraph poles has been increased by 10 per cent., making the duty 30 per cent. ad val. These increases are made under authority of the law of Dec. 28 last.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

London County Council require two divisional inspectors (at £600 per annum, rising by annual increments of £25 to £800), one possessing special qualifications in mathematics and science and the second in technology, including electrical and mechanical engineering; also an inspector in wood and metal work at £400, rising to £500. Applications by 10 a.m. April 1.

Pudsey Corporation require an electrician to take charge of distributing mains, meters, &c. Applications by 5 p.m. 31st inst.

Salford Tramways committee have appointed Mr. Geo. W. Holford, manager of the Corporation tramways in succession to Mr. E. Hatton who is leaving for Newcastle-on-Tyne. When the question of the municipalisation of the Salford tramways arose a special committee was appointed to consider the subject, and Mr. Holford was appointed their secretary. The committee afterwards made him chief assistant in the new tramways department. The committee recommend that the commencing salary shall be £300 per annum, increasing annually by £50 to £500.

EDUCATIONAL NOTICES.

Apprentices' Technical Education.—Messrs. Vickers, Son & Maxim have over 700 apprentices, half of whom attend Barrow Technical School. The directors have decided that in future all apprentices in the engineering and ordnance departments will be required to pass examinations in algebra, geometry, &c., and will be advised to attend the technical school. Successes gained at the school will entitle an apprentice to an increased wage and a reduction of working hours.

East Ham Technical College was opened by H.R.H. the Prince of Wales on Saturday.

Acton.—In the estimates for the year ending 31st inst. provision is made for an anticipated deficiency of £550 on the electricity undertaking.

Argentina.—The "Review of the River Plate" states that:

$2,000,000 m.n. (nearly all subscribed privately) is the authorised capital of a company recently formed to construct and work electric tramways between South Barracas and Androgue.

The Navy Department has decided to erect an electricity generating station at the Military Port (Buenos Ayres) to supply current to vessels in port in order to obviate the consumption of fuel on board for running engines and dynamos whilst in port.

The United River Plate Telephone Co. have received a concession for joining up their Buenos Ayres and Rosario lines, the work to be completed in two years.

The Civil Appeal Court has confirmed the decision of the lower court ordering the payment of $25,362·57 gold by the Compañia Alemana Transatlantica de Electricidad to Buenos Ayres Municipality. The amount was claimed as arrears of a tax of 5 per cent. upon the charge for current supplied by the company to the city tramway companies. The defence was non-liability as the current in dispute was delivered in the company's power house and transmitted thence by cables owned by the tramway companies.

Messrs. Sawyer & Lacroze, who have a concession for tramways to connect Buenos Ayres with the western suburbs, are opposing the application of the Buenos Ayres & Belgrano and Rural Tramway Companies for authority for extensions. If, however, the companies' application is granted, compulsory running powers over these lines will be sought by Messrs. Sawyer & Lacroze.

There are 10 tramway companies at work in Buenos Ayres, and the passengers carried during 1904 numbered 82,746,352 on the electric lines (against 61,670,749 in 1903) and 65,532,746 on the horse lines (against 71,048,519). The receipts on the electric lines were $865,166·59 m.n., in 1904, against $585,979·07 in 1903.

Asylum Lighting.—Clonmel (Ireland) Asylum committee have decided to light the asylum electrically, and have accepted a scheme prepared by Mr. L. J. Lawless, of Dublin.

Australasia.—As the Government of South Australia has failed to come to an agreement with the tramway companies as to the price to be paid for their undertakings under the Tramways Act, 1904, the companies have been invited to appoint an arbitrator to act for them collectively.

Kalgoorlie Electric Power & Lighting Corpn. have entered into an agreement with the Roads Board for an extension of the public lighting, and have secured powers to supply current to private consumers. The charges for current for private lighting will be 7d. per unit up to 500 units per month, 6d. up to 800, and 5d. over 800. For motors up to 1 H.P. 7d. per unit, over 2 H.P. 4d. per unit, for less than 300 hours per month, 3½d. up to 600 hours, and 3d. over 600; minimum 15s. per H.P. per month. Discounts of 5 per cent. off motive power accounts, and 10 per cent. off lighting accounts are provided for.

At Subiaco (W.A.), a seven-year-old municipality, the supply of electricity was started with 50 consumers eighteen months ago. There are now 250 consumers, and the undertaking is paying all expenses, including interest and sinking fund charges.

Baildon.—The Council have decided to apply for a provisional electric lighting order.

Barnsley.—The council on Friday decided to apply for a loan of £4,403 for extensions of the electricity undertaking.

Barnsley & District Electric Traction Co. recently applied for supply of current at 4 a.m. instead of 5, and it was agreed to comply with the request on condition that the company recouped the Corporation for any additional cost thereby occasioned.

Bermondsey (London).—With respect to the proposed expenditure of £6,159 on mains extensions, the Finance committee reported on Tuesday that they had only passed an estimate for £1,213 for distributors.

A discussion took place on a recommendation by the same committee that the charge for street lighting be at the same rate as that recently adopted for all large consumers (3½d. per unit up to 300,000 units), any excess to be charged at 2d. per unit, instead of 3d as now.

Ultimately the committee's recommendation was rejected.

The electrical engineer submitted a report on the excess of expenditure over the estimate on mains in connection with the Rotherhithe extension. The total cost of extension was £18,024. 11s 6d. compared with the estimate of £11,078., excess £ 6,946. 11s. 6d. Of that amount £2,652. 12s. 9d. had been passed by the Council for work involved in taking the mains across the Surrey and Lavender docks, leaving £4,293. 18s. 9d., which was accounted for by (1) the congested conditions of the footway by mains of different authorities, necessitating placing the work under the roadway at greater expense in opening up and reinstating, (2) to extra depth of trenching required to clear mains of other authorities, (3) to extra labour and tackle entailed in supporting the large number of pipes exposed in the excavations, (4) owing to deviation in the run of conduits to clear the excessive number of pipes and other obstructions found when excavating, a large number of extra brick chambers had had to be provided so as to avoid as far as possible the use of sharp bends, (5) to extra labour entailed in pulling in the cables wholly by manual power instead of by winch, so as to decrease the risk of abrasion of the insulation in drawing them through the bends in the conduits which were unavoidable. During the carrying out of the work excessively wet weather was experienced, which seriously interfered with the progress of operations.

Burnley.—The present financial year comes to a close at the end of March, and the Electricity committee report that on the prices obtained (1·75d. per unit.) for traction supply, 4d for lighting, 3d. and 1d. for motors and 3d. for public lighting, the net profits will exceed £10,000. The committee recommend that the tramways be allowed a rebate for the year, making the price 1½d.

For the coming year the charges will be as follows:—Tramways 1·45d. per unit, private lighting flat rate of 3½d., public lighting 1½d. and motors 1½d. for first hour and 1d. after. This will bring the average price per unit sold to 1·7d. and the net profit to £4,000, after allowing £2,500 for depreciation. The above changes are subject to the approval of the Council, and a lively attack is expected from the Tramways committee, whose contention is that the reductions should all have gone in their favour. The committee has decided to purchase further plant, including a 500kw. generator, boiler and condensing plant.

Colwyn Bay.—The Council have rescinded a resolution to light the promenade by gas. Electric lighting is to be adopted.

Corporation Officials and Consulting Work.—Aberdeen City Council on Monday passed by 20 votes to 10 a resolution proposed by Bailie Booth "that no Corporation official be allowed to engage professionally in any work other than that connected with the Corporation unless with the consent of the Council."

Coventry.—The official inspection of the extensions of the Coventry Electric Tramways Co.'s system took place on Tuesday.

Dalkeith.—Application is to be made for a provisional order to incorporate a company to construct electric tramways between Liberton and Dalkeith and in Bonnyrigg and Lasswade.

Dublin.—It was reported to the City Council last week that the income of the Electricity department for the past year had considerably exceeded the estimate, and as a further increase was expected during the coming year, it would be unnecessary to make any call on the rates.

Mr. Irwin (chairman of the Electric Lighting committee) said they had provided in the estimates for interest and sinking-fund charges upon £20,000 which would be spent later on the extension of the electric lighting in the old city area. The income of last December quarter was £4,000 in excess of the corresponding quarter of 1903. It was intended to reduce the price of current, notably for motive power.

Dundee-Broughty Ferry Tramways.—The *Dundee Advertiser* understands that arrangements have been definitely completed for the formation of a company to construct the Dundee-Broughty Ferry and district tramways, and that contracts have been entered into with an electrical engineering firm amounting to nearly £90,000.

Exeter.—In a report just presented to the Electric Lighting Committee by the city electrical engineer (Mr. H. D. Munro) it is stated that the cost of generation for the past year would come within the estimated figures, representing a saving of £1,000 per annum, with an increased output of 10 per cent. Interest and sinking fund would be met without aid from the rates, and the extra supply for tramways, motors and lighting already secured would enable the undertaking to meet all its liabilities in the coming year.

The committee do not advise the Council to incur the expense of an independent test of the new machinery, but have resolved that the electrical engineer be required to report as to the efficiency of the whole equipment as soon as the work is completed.

Electric Lighting of Miners' Dwellings.—Messrs. Pease & Partners have prepared a scheme for the electric lighting of the miners' houses at Waterhouses and Esh Colliery. The firm will wire each dwelling provided the necessary guarantee is forthcoming. A committee has been appointed to canvass the district, and at the same time the company's representative (Mr. T. Pearson) is collecting information as to cost, &c.

Electrical Exhibition at Holborn (London).—Particulars of the exhibits at this well-organised display of electrical accessories will be found on a previous page.

Electrical Exhibition at Paddington.—Recent advances in the applications of electricity to machine driving and other power purposes, the introduction of a very extensive range of high-class fittings for electric lighting, the development of interior and exterior lighting by arc lamps, the introduction of new types of Nernst and other special forms of electric incandescence lamps, and the generally utilitarian nature of many new applications of electricity to domestic and industrial purposes, have amply justified the promoters of the various exhibitions, local and otherwise, which have taken place of late with the object of displaying the advantages claimed for the latest advances in electrical plant, apparatus, instruments, accessories and sundries. With a view to making these advantages known in the important areas covered by the operations of the Metropolitan Electric Supply Co. in the West of London, the company recently decided to organise an exhibition of a very interesting character at Queen's-road Baths, Bayswater, London, W. These premises are centrally situated, and the exhibition, which opens to-morrow (Saturday) and remains open until April 8, promises to be of considerable interest. It is very satisfactory to record the undoubted success of the electrical exhibitions which have be held in the London districts during the past few months.

Exhibitions.—Willesden Council are ascertaining if the Local Government Board will sanction expenditure in connection with the proposed exhibition at Olympia in the autumn promoted by the National Electrical Manufacturers' Association.

An electrical exhibition, organised by the Salisbury Electric Light and Supply Co., is to be held at the County Hall, Salisbury, for six days, commencing April 3.

An exhibition of electrical appliances and fittings, promoted by the Urban Electric Supply Co., was opened at Stamford last week. The profits go to a local infirmary.

A six-days' electrical exhibition was opened at the Market Hall, Frome, on Monday. The show was organised by the resident electrical engineer (Mr. F. M. Nichols) for the Urban Electric Supply Co. A good variety of electric light fittings, motors, lamps, domestic appliances, X-ray apparatus, &c., is on view.

In connection with the Liège International Exhibition to be held during the summer, a committee has been formed to aid in securing the representation of this country. Firms and persons who desire to participate should make immediate application to the Hon. Commissioner-General for the United Kingdom, Mr. Imre Kiralfy, 19, Buckingham-street, London, W.C. The list of applications will close in a few days.

An international exhibition will be held at Christchurch, New Zealand, towards the end of 1906. Mr. T. E. Donne, who is connected with the exhibition, can be communicated with at 13, Victoria-street, London, S.W.

There is to be a Swiss National Exhibition of automobiles and similar vehicles to be held at Geneva from April 29 to May 7. Only Swiss manufacturers and traders in Switzerland selling foreign productions will be allowed to participate. The idea is to hold a similar show annually.

Hackney (London).—In framing the estimates for the ensuing year, the Finance committee have decided that to the expenditure of the electricity undertaking there should be added, for depreciation, an amount equal to 1½ per cent. upon capital outlay.

Hanley.—Mr. W. Adams, chief assistant electrical engineer, has been granted an honorarium of 20 guineas in respect of extra work recently thrown upon him while in temporary charge of the electricity undertaking, and has also been appointed deputy Corporation electrical engineer.

Hanwell.—Ealing Council have offered to give a supply of electricity in bulk to Hanwell in about six months at 2¾d. per unit. Ealing Council is not prepared to take over the whole of Hanwell Council's electric lighting responsibilities.

Harrogate.—The Lighting committee recommend that the charge for current for lighting be reduced from 5½d. to 5d. per unit on the flat rate, the first hour's maximum demand charge remaining at 6d.

and 2d. (instead of 2½d.) per unit after. In discussing these suggestions,

Ald. Fortune suggested the maximum demand system be discontinued and discounts be allowed

Councillor Hindell, secretary to the Home for Incurables, commented upon what he termed the perplexing nature of the maximum demand system, and said the charge paid by the Home for current for the first quarter was surprisingly high, whereas in the second quarter the Corporation owed the Home £2. 10s.

It was decided to ask the committee to consider the discontinuance of the maximum demand system and the adoption of a scale of discounts.

Hastings.—The chairman of the Electricity committee (Councillor Bones) has announced that for the first time there was a net profit of £117 on the year's working of the electricity undertaking. This compares with a deficit of £950 in 1903-4, notwithstanding that £1,670 extra has had to be met for interest and sinking fund charges. 98 new consumers were added, representing the equivalent of 4,666 8 c.p. lamps. Credit for the altered state of affairs was due to the borough electrical engineer (Mr. R. F. Ferguson).

Ilkley.—Mr. W. Antrobus, 124, Earl-street, Longsight, Manchester, informs us that he has just prepared a scheme for lighting Ilkley electrically by means of a water power installation. The water of the river Wharfe at Beanlands Island will be used for the purpose. The working head will be about 6ft. and about 200 H.P. is available. A small beck at the other end of the town will also be utilised, and the two plants will be kept running night and day, the surplus current over that required for lighting the town being utilised for electro-chemical work (thermic and electrolytic). Mr. Antrobus considers that by this arrangement the District Council will obtain their current for lighting at a very small cost.

Italy.—The Italian Minister of Posts and Telegraphs has been authorised to establish telephonic communication between a number of provincial towns.

The Rome provincial authorities propose to construct an electric railway between Rome and Civita Castellano.

The Adriatic Railway Co. propose to construct an electric line between Chiasso, Comé and Chiavenna.

Kidderminster.—The Kidderminster & District Electric Traction Co. has abandoned the Bewdley light railway scheme.

Light Railway.—The application for an order authorising the construction of a light railway from Ackworth to Immingham, near Great Grimsby, was heard by the Light Railway Commissioners on Tuesday.

Mr. Danckwerts, K.C., for the promoters, said the railway was intended to carry passengers and farm produce, and to provide facilities for the carriage of coal from mines situated to the east of Swinton and Knottingley Railway. The line would be 53 miles long, would pass through a tunnel under the Trent, and would cost (apart from the electrical installation) £580,000, or £11,000 per mile.

The engineer for the scheme (Mr. Shilton) gave technical details, and said an income of £70,000 per annum was expected, while working expenses would be about half that amount. There would be two generating stations. He did not think the proposed line would compete with the Great Central Railway or the Humber Railway and Dock, but would rather bring traffic to the Dock. Messrs. Ganz & Co. were prepared to carry out the electrical work at the figures which had been put in.

The Chairman, after consultation with the other Commissioners, said the magnitude of the scheme must be apparent to all, and asked Mr Danckwerts to state why the case should not be one for Parliament.

Mr. Danckwerts said the Commissioners had never rejected an application on the sole ground of magnitude, and there had been many cases of competition in which Orders had been granted and the Board of Trade had not objected. The present application was for a railway such as the Light Railways Act intended. Every public authority along the line was pressing for the scheme to be sanctioned, and the line would not compete with other lines, but would rather act as a feeder and distributor to them.

The Chairman replied that the Commissioners believed they were coerced by statute to let the case go to Parliament.

Lisbon.—The Lisbon Tramways Co., an English undertaking, has obtained a concession to construct and work an electric tramway in Lisbon, between Rua do Auro and the Largo de Santo André.

London County Council.—Mr. Allen Baker has been elected chairman, and Capt. Hemphill vice-chairman, of the Highways committee.

Metropolitan District Railway.—It is expected that the new electric service will be inaugurated before the end of April.

Mirfield.—The Council have accepted tenders for cables, &c., in connection with a scheme for the distribution of electricity taken in bulk from the Yorkshire Electric Power Co. The following charges have been adopted: Lighting 5d. per unit, power 2d. per unit for first two hours, and 1d. after, provided the motor is run at three-quarters full load.

Modern Management of Industrial Works.—Mr. G. K. B. Elphinstone (member of the well-known firm of Elliott Bros.) delivered a most instructive lecture before a crowded audience of visitors and workpeople at Ladywell Parish Hall, Lewisham, on Friday evening last, the subject being "The Factory of the National Cash Register Co.: Its lessons and how they may apply to us."

The lecturer had been over these American works some time ago, and had been so impressed with the good all-round results accruing from scientific and truly social management of that model factory, that his firm had decided to follow similar methods at Century Works. Mr. Elphinstone proceeded to describe in detail the American works as a harmonious whole, and the various departments in particular, the description being completed by a series of beautiful lantern slides. Attention was drawn to the means and methods adopted for saving time in all directions, for ensuring tidiness, for diminishing waste and so forth. Reference was made to the welcome extended by the American firm to the army of visitors which flock to see the establishment and to the careful practical training and teaching of salesmen. Special attention was given to the social management of the works, entrusted to various committees, which has for its object the promotion of mutual respect and sympathy between employers and employed. The object lesson, so eloquently taught by the American concern is (continued Mr. Elphinstone) now being gradually introduced into the Century Works, as it has already been introduced in this country by several firms whose names were mentioned. Most interesting of all, perhaps, as showing the spirit of the men in meeting the endeavours of the management, were the suggestions put into boxes provided for this purpose. These suggestions (which relate to improvements in manufacture, design and similar matters) were increasing in number since the scheme was first started, and during the last three months some 300 suggestions had been made.

Col. Holden, after the lecture, expressed the hope that the Americans would soon have to come to this country to find the best governed works. He also alluded to the difficulty of applying the schemes outlined in the lecture to factories making not one but a number of articles.

Certificates and prizes were distributed to the men whose suggestions were judged to be the best by the Suggestion Committee.

Municipal Telephony.—Brighton Telephone committee recently considered a report by the town clerk on the purchase by the Government of the National Telephone Co.'s undertaking:—

The minutes of the committee presented at the Corporation meeting on Thursday last stated that at the recent Conference of Municipalities owning and working telephones it was unanimously agreed that each of the competing municipalities should apply to be heard before the Select Committee, to which it is intended the agreement between the Postmaster-General and the National Telephone Co. shall be referred, for the purpose of giving such evidence as they may think necessary. Brighton committee had resolved to lay before the committee such evidence as they deemed desirable for the protection of the interests of the Corporation telephone undertaking.

Councillor Lintott (chairman of the committee) thought the proposed sale of the National Telephone Co.'s undertaking to the Government would preclude the possibility of cheap telephones in this country. If representations were made to the Postmaster-General in a fair and impartial manner he believed that concessions which had been or might be granted to the company would similarly be granted to the Corporations.

Ald. Carden said the purchase meant that they would have no more municipal telephones and no more cheap telephones in this country. Brighton Corporation had a licence until 1926, and if they wanted cheap telephones in Brighton up to then they must support the Corporation. They could give an object lesson to the whole of England as to the cheap price at which an efficient telephone service could be maintained. At a moderate estimate the Corporation were saving some 2,000 users £4 a year, and in 20 years that would amount to £160,000.

Natal Imports.—The imports of electrical fittings from the United Kingdom into Natal in 1904 were of the value of £24,200, compared with £47,300 in 1903. The United States figures were £2,800, compared with £6,000, and European countries £6,900, against £6,700. Electrical machinery imports from the United Kingdom stand for £107,000 in 1904, against £95,800 in 1903; U.S., £21,250, compared with £24,000; European countries, £20,700, compared with £19,800.

Newcastle-on-Tyne.—The estimated expenditure of the Tramways committee for the year ended March 31, 1906, is £188,744, against £205,239 last year. Capital expenditure on new plant, &c., is estimated at £30,000. Working expenses are put down at £115,265, interest and redemption of loans at £55,128 and construction and equipment of tramways at £11,330. The estimated income is £194,737, against £209,100.

Obituary.—We regret to record the death of Mr. Thos. Topham Hardaker, chief engineer of Transvaal Telegraphs, which took place suddenly on Tuesday.

Mr. Hardaker, who was a native of Durham, commenced his telegraphic career in Newcastle as a learner with the Electric & International Telegraph Co. Subsequently he was in charge of the office at Alnwick, and when the Government took over the telegraphs in 1870 he was transferred to Newcastle. In 1879, when volunteers for the Cape service were asked for, Mr. Hardaker was selected, and he was appointed to the charge of several offices in that country. Afterwards he became superintendent of telegraphs in Natal, and then chief engineer of Natal telegraphs. He took a leading part in improving existing and constructing new lines in South Africa, and he rendered valuable service in reconstructing the telegraphic systems after the late war.

The death is announced of Mr. John Morris, senior partner of Ashurst Morris, Crisp & Co., solicitors. Mr. Morris, who was in his 82nd year, was connected with numerous companies either professionally or as a director. He was a director of the Buenos Ayres & Belgrano Electric Tramway Co.

On March 17, at Accra, West Coast of Africa, Mr. James Moon, for many years with the African Direct Telegraph Co., passed away, at the early age of 42.

Paddington (London).—An agreement has been come to between the Borough Council and the Metropolitan Electric Supply Co. with respect to the transfer of Amberley-road generating station to Willesden.

The Council will give the necessary consent provided the charges for current for private lighting are reduced from 5½d. per unit to 5d. for the first two years and 4¾d. for the next three years; that current for trade lighting (including churches and schools) be reduced to 4¾d. per unit for the first two years, and 4½d. for the next three years, consumers to have the option of the maximum-demand system. Where a five years' agreement is not entered upon, the charge will be 5½d. for private and 5d. for trade lighting. The agreement comprises clauses providing that the station at Willesden for the supply of Paddington is to be capable of complete severance from other generating stations and plant of the company, and protecting the Council's right of purchase.

Penrith.—As the Local Government Board are not satisfied with the financial prospects of the proposed electricity works they have declined to sanction a loan of £6,850 recently applied for by the Council.

Poplar (London).—The Controller's department of London County Council points out in a letter to the Council the desirability of the creation of a reserve or renewal fund in connection with the electricity undertaking.

In reporting upon this the Electricity committee state that under the Electric Lighting Acts, 1882 and 1888, a depreciation reserve fund should be formed not exceeding 10 per cent. of the aggregate capital expenditure and they propose that a fund, to reach at least £11,000 (the approximate cost of one of the large generating sets) be formed by the transfer of £2,500 from present profit balance of £6,892. 13s. 5d. and by the transfer to the fund of 3½ per cent. of net annual revenue. This amount, calculated upon present revenue, is approximately £400 per annum.

The Electricity committee has reported that 22 ½-ampere Nernst lamps installed experimentally in the public library gave an increase of 200 per cent. in light while there was a reduction of 44 per cent. in cost for current. For the extension of the generating station at an early date it is proposed to purchase from the L.C.C. for £4,200 a site (3,050 sq. yds.) in Glaucus-street.

On the recommendation of the electrical engineer (Mr. J. H. Bowden) customers are to have the option of taking current at a flat rate of 4d. per unit as an alternative to the maximum demand system under which the cost is 5d. and 3d.

Radcliffe (Lancs.).—The Council recently applied for sanction to a loan of £10,000 for wiring consumers' premises. The Local Government Board now require detailed estimates, a copy of rules and regulations for carrying out the scheme, &c.

Richmond (Surrey).—Owing to the Council's opposition to the London United Tramways' bill for extension of time for carrying out road widenings and construction of tramways authorised by the company's 1902 Act, the Richmond portion of the bill is withdrawn.

Salford.—The Tramways committee are about to adopt on their tramway system a new single-deck car which has been designed by the general manager (Mr. E. Hatton). The makers (Messrs. Dick, Kerr & Co.) have already delivered a sample car.

This is a combination of English and American car styles, with an open centre and a closed compartment, each with accommodation for 12 passengers at both ends. The closed portions of the vehicle are so arranged that in the summer months the windows may be lowered and the car converted into an open one throughout. The car is approached by two steps placed in the middle of the body. It has a centre gangway running from end to end, which enables the guard to collect the fares without the danger of having to go out on to the footplate. In the open part or centre of the car there are blinds which may be used to keep out the wind or rain. The ventilators are in the roof. The new car will provide dry seats for 48 people and is lighted from the roof, the lamps being placed in elaborate bronze fittings.

Shrewsbury.—Expenditure of £5,295 for an additional engine, boiler and dynamo for the electricity works has been sanctioned by the Council.

Stoke Newington (London).—The Finance Committee informed the Council on Tuesday that the receipts from electricity consumers during the ensuing half-year were expected to cover the estimated expenditure of £800.

At a special meeting this week the Council decided to erect a refuse destructor on a site between Milton-road and Church-street at an estimated cost of £18,500. The consulting engineers have advised the Council that, if desired, electrical energy can be generated at the destructor works on remunerative terms.

South Shields.—After consideration of the report of the deputation recently appointed by the Corporation to collect information as to motor omnibuses, the Tramways committee report:—

That in our opinion the motor 'bus service is unreliable, the smell of petrol highly objectionable, the vibration excessive and discomforting to passengers, the shocks at periods of stopping, starting and changing of speeds, severe and objectionable; and, further, as no reliable data are obtainable as to the working costs of the motor 'buses, owing to the very short period they have been in use, but that everything tends to show that such working costs are high, and in excess of an electric tramcar service, the deputation cannot recommend the adoption of a motor 'bus service for the borough.

The report was adopted by the Council on Wednesday.

Telegraphic Communication with the Continent.—An agreement has been entered into between the United Kingdom and Norway respecting telegraphic communication between the two countries. The agreement, which was signed at Stockholm on Feb. 2, provides that on the expiry of the existing arrangement between the Great Northern Telegraph Co. and the two Governments the question of the renewal of the concessions shall be discussed, and that no new concession shall be granted to any company or private individual for the establishment of submarine telegraph cables between the two countries without previous consultation between the respective Governments. It is further agreed that no concession shall be granted to any company or private individual for the establishment of communication between the two countries by means of wireless telegraphy without similar previous consultation.

Telephone Purchase.—Mr. A. R. Bennett, who is consulting engineer to a number of municipal telephone undertakings, gives his views upon the proposed agreement between the Postmaster-General and the National Telephone Company in the "Manchester Guardian" for March 23.

Torquay.—The electricity department received for current sold last year £7,339 (against £6,395 in 1903). Working expenses were £3,923 (against £3,479), interest and sinking fund charges £2,319. £100 was placed to reserve, the net profit being £1,338 (against £577).

West Auckland.—The Parish Council have decided to open negotiations with the Urban Electric Supply Co. (which possesses a privisional order for Bishop Auckland) for a supply of electricity for West Auckland.

West Fife Tramways.—Dunfermline & West of Fife Tramway Co. have published notice of intention to apply for an order to construct these tramways.

West Ham.—Messrs. A. Boake, Roberts & Co. contemplate the adoption of electric driving throughout their large chemical works. 250,000 units of electrical energy will be required per annum. The Corporation have authorised an extension of their mains to the works.

Dinners.—The third annual dinner of the Liverpool branch of the Electrical Contractors' Association (Incorporated) was held on Friday last, when a party of 40 sat down. Mr. W. Sutton, chairman of the branch, presided. The guests included Mr. W. Rawlings (president of the Association), Mr. E. L. Berry (London), Mr. J. McDermott (chairman, Northern Section), Mr. Shaw (Stockport), Mr. A. Clough (Liverpool Corporation electrical engineer), and Mr. T. D. Clothier (Bootle Corporation electrical engineer).

Mr. J. McDermott proposed "The Electrical Contractors' Association Incorporated," and spoke as to the progress of the association and to the advantages of membership.

Mr. Rawlings in reply, referred to the unfairness of Liverpool Corporation in carrying on electrical fitting and wiring in competition with contractors who are ratepayers.

Mr. A. Clough in replying for "The Visitors," referred to his 21 years' service at Liverpool, first with the company before it was taken over by the Corporation, and now with the Corporation as their resident electrical engineer. He was pleased to acknowledge the high standard of work done by the contractors of Liverpool who were members of the association. The Corporation carried on their contracting and fitting department under Parliamentary powers, but he found that times had changed since the early days when the company fixed over 90 per cent. of the lamps connected. Now the contractors carried out between 80 and 90 per cent of the total of the installations.

Mr. T. D. Clothier said Bootle Corporation also had powers to carry on wiring and contracting, but they did not exercise them as he thought there were plenty of contractors able and willing to carry out all the installations satisfactorily. Mr. E. L. Berry maintained that the electrical contractors were the Corporation's best canvassers, as each installation connected meant an additional customer for the current which the Corporation supplied.

During the evening a presentation of a chiming clock was made to the hon. sec. of the branch (Mr. Geo. J. Harford).

The annual dinner of the staff at the Witton Works of the General Electric Co. was held at Birmingham on Saturday. Mr. M. Railing, a director, presided. Among the party was Dr. W. E. Sumpner, Principal of the Municipal Technical School.

Electro-Harmonic Society.—The address of the Electro-Harmonic Society is now at Finsbury-pavement House, E.C., where all future communications should be addressed to the Hon. Sec., Mr. W. E. Lane.

The next smoking concert (the last of the season) will be held this (Friday) evening at Holborn Restaurant, London, W.C., under the chairmanship of Mr. James Swinburne.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1905 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date (to Feb. 22), and the Directorial Division of the new volume has been corrected up to February 11th, 1905. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. The number of large sheet Tables, &c., has been increased, and the 1905 Edition of this indispensable work is offered as the most complete book of the kind ever published.

Among the chief features of the Handbook Division are Notes of the Year on Electric Traction and Electric Power, Turbine Notes, Electric Lamp Notes, Wireless Telegraph Notes (very full), Parliamentary Summary, Legal Decisions, and a complete set of all the chief documents used by Government Departments affecting the Electrical Industry (including the new "Special Mining Rules," issued Feb. 22).

TENDERS INVITED.

The magistrates of the City of *Utrecht*, Holland, invite tenders for supply of 20 complete electric motors for the city tramways. Tenders to the Magistrates before April 8. Specifications, &c., from the Town Clerk. See also an advertisement.

Stockport Gas and Electricity committee invite tenders for supply and laying of electrical feeder cables. Specifications, &c., from the borough electrical engineer (Mr. A. J. H. Carter), Mill Gate, Stockport. Tenders (adressed to chairman of the committee) to the town clerk's office by first post 30th inst. See also an advertisement.

Batley Corporation invite tenders for permanent-way construction and paving of Bradford road tramway route, overhead equipment, steel poles, &c., feeder cables, conduits and accessories. Specifications, &c., from the consulting engineers (Messrs Lacey, Sillar & Leigh), 2, Queen Anne's-gate, Westminster, after 29th inst. Tenders to the town clerk (Mr. Jos. Hanson Craik) by April 17. See advertisement for further particulars.

Aberdeen Corporation invite tenders for one surface condenser with air pump, oil separator, &c. Specifications, &c., from the city electrical engineer (Mr. J. Alex. Bell) after 29th inst. Tenders to Mr. Bell before noon April 19. See also an advertisement.

Hammersmith (London) Borough Council invite tenders for supply of boiler flues and economisers, high-pressure steam pipes, steam and feed-water pipes, exhaust steam water heater and circulating water pics, steam valves and feed water heaters and coal elevator. Tenders to Town Hall, Hammersmith, by 4 p.m. April 5.

Bradford Corporation invite tenders for supply, erection and setting to work of 2,500kw. of motor generators, or rotary transformers for transforming l.t. c.c. to c.h.t. a.c., and vice versa, together with the necessary controlling gear. Tenders to town clerk (Mr. Frederick Stevens) by first post March 30.

Manchester Electricity committee invite tenders for supply, delivery and erection at Dickinson street generating station of high and low-tension switchboards. Tenders to chairman of Electricity committee, Town Hall, Manchester, by April 4.

London County Council require tenders by 10 a.m. April 4 for eight 500kw. induction motor-generators for electric tramway substations, and also for wiring material, low-tension cables, cable boxes, &c. Specifications from County Hall, S.W.

The Lancashire & Yorkshire Railway Co. (*Manchester*) require tenders by 10 a.m. April 3 for 12 months' supply of stores, including signal and telegraph fittings, signal, telegraph and electric light wires, &c.

Great Yarmouth Corporation invite tenders for delivery of surface condenser, with steam-driven air and circulation pumps. Tenders to the Town Hall by noon March 29.

Hornsey Town Council invite tenders for the supply of cables, junction boxes, fuse boxes and meters. Tenders to the town clerk (Mr. F. D. Askey), 90, Southwood-lane, Highgate, N., by 27th inst.

The Clyde Navigation Trustees require tenders by April 10 for electric power generating and lighting plant for *Clydebank Dock*. Particulars from Mr. G. H. Baxter, 16, Robertson-street, Glasgow.

Colchester Electric Light and Power committee invite tenders by April 5 for independent surface-condensing plant and electrically-driven pump.

St. Marylebone (London) Council invite tenders for supply, delivery and maintenance for two years of house meters. Tenders before 4 p.m. April 4 to the town clerk.

Glasgow Corporation also invite tenders by 10 a.m. April 5 for tramway stores for one year from June 1.

Bolton Corporation invite tenders by March 30 for cooling tower and condensing apparatus.

Aston Manor Corporation require tenders by noon 24th inst. for reconstruction of existing tramways and construction of other works.

Salford Corporation require tenders by 31st inst. for wiring their new school at Seedley.

Rathmines and Rathgar (co. Dublin) District Council require tenders by 27th inst. for condensing plant.

Johannesburg Municipal Council invite tenders for (*a*) Tramway poles and brackets, (*b*) feeder pillars, controllers, insulators and all overhead material, (*c*) glow lamp fittings, ornamental lamp-posts, automatic switches, &c., (*d*) erection of material included in sections (*a*), (*b*) and (*c*), (*e*) motor tower waggon. Copies of specification at the Council's offices, Johannesburg, and from the consulting engineers (Messrs. Mordey & Dawbarn), 82, Victoria-street, London, S.W. Tenders to Messrs. Mordey & Dawbarn by noon May 7.

The Director-General of Spanish Telegraphs, 10, Calle de Carretas, *Madrid*, will open tenders on April 11 for 20,000 pine telegraph posts impregnated with sulphate of copper by the Boucherie system. The posts will be of the following sizes :—100 12 metres high, 600 10 metres, 18,000 8 metres, 6,800 6½ to 7 metres. The maximum price at which tenders will be received is 35 pesetas, 24 pesetas, 16.50 pesetas, and 12.10 pesetas per post respectively. A deposit of 5 per cent. of the value of the goods at the upset price is necessary to qualify any tender, and local representation is necessary.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been accepted by Hammersmith (London) Council :—

Cross & Cross, constructional steel work for generating boiler-house extension, £2,218 ; Steel Core Conduit Co., conduits in connection with main extension to Ducane-road, £246. 10s. ; Universal Electrical Mfg. Co., converting arc lamps from rectified to alternating current, £1s. 9d. per lamp (18 to be done as an experiment and remainder if experiment is successful) ; Sloan Electrical Co., carbons, £227. 5s. 1d.

Bedwellty Guardians have accepted the tender of Edwards & Armstrong for steam dynamo, booster, battery, switchboard and motors, and that of Vaughan & Co. for cables and wiring in connection with the electric lighting of Tredegar Workhouse, the total cost being £2,289.

Bermondsey (London) Council have accepted the following tenders for annual supplies :—

Veritys Ltd., arc lamp carbons ; Doulton & Co., conduits ; Johnson & Phillips, meter boards, indiarubber and jointing material, lead-covered cables, &c. ; A. Duckham & Co., engine oils ; Reason Mfg. Co., meters up to 15 amps., demand indicators and cut-outs ; Chamberlain & Hookham, meters above 15 amps ; Simplified Underground Conductor Co., for compounds and insulating oil ; British Insulated & Helsby Cables, 200yds. of 0·5 cable.

Messrs. Owen Lucas & Pyke have received the following tenders for carrying out an electric light and power installation at Shernfold Park, Frant, Tunbridge Wells.

Belshaw & Co. (*accepted*)	**£2,050**	**0**	**0**	Leo Sunderland & Co.	£2,391	15	0
Alliance Electrical Co.	2,698	8	1	E. Powell	2,333	7	0
Nat. Elec. Construction Co.	2,434	15	0	H. M. Leaf	2,285	9	1
				Strode & Co.	2,187	15	0
				H. J. Cash & Co.....	2,092	15	0

Mirfield District Council have decided, on the recommendation of their consulting engineer (Mr. A. B. Mountain), to accept the following tenders in connection with their electricity supply scheme :—

Callender's Co., cables, troughing, &c., £832. 4s. 2d. ; British Thomson-Houston Co., meters ; British Westinghouse Co., transformers, £204. 17s.

A contract has been let to Linton Bros. for the extension of the temporary power station at Cwmbran for the South Wales Electrical Power Distribution Co.

Lowestoft Corporation have received the following tenders for supply and erection of a water-tube boiler, with superheater, brickwork settings, and accessories and pipework :—

Babcock & Wilcox (*ac'td.*)	**£1,337**	**0**	B. P. Rowland & Co...	1,415	0
Clarke, Chapman & Co...	1,464	0	E. Le Bas & Co.	1,391	0
Edwin Danks & Co.	1,423	10	Sterling Boiler Co.	1,391	0

Battersea (London) Council have accepted the following tenders for annual supplies :—

Charrington, Sells, Dale & Co., coal ; Sloan Electrical Co., carbons ; W. H. Willcox & Co., oils and engine-room stores : Electrical Co., meters ; Callender's Co., service joint boxes, &c., and cables, street boxes, &c.

An order at £1,810 has been placed by Battersea (London) Council with Babcock & Wilcox for pipe work in connection with the extension of the generating plant.

Poplar Electricity committee have provisionally accepted the tender of the Stirling Boiler Co. at £1,950 for an additional boiler. There was only one other tender (Messrs. Babcock & Wilcox, at £2,112).

Hull Electric Lighting committee have accepted the tender of Siemens Bros. & Co. for the supply of cables.

Grimsby Corporation have accepted the tender of Crompton & Co. for supply of electric motors for the next two years, and that of Lassen & Hjort for a water purifier at £315.

Salford Corporation have accepted the tender of W. T. Glover & Co. for cables.

Aberdeen Town Council have accepted the tender of Bruce Peebles & Co. for a 420kw. generator.

Hastings Council have placed an order with Bumstead & Chandler for a 25 H.P. steam engine at £166.

BUSINESS NOTICES.

Mr. W. Arthur Ker announces that he has made arrangements to devote at an early date the whole of his time to his practice as a consulting engineer (electrical and mechanical) at Edinburgh Life-buildings, 122-128, St. Vincent-street, Glasgow. Mr Ker has for the last few years been general manager for Paterson, Cooper & Co., and has had 25 years' experience in mechanical and electrical engineering, with the Fairfield Shipbuilding & Engineering Co., Easton, Anderson & Goolden, and W. H. Allen & Co., and in factories, waterworks, &c. Until May 28 Mr. Ker's address will be Patella Works, Paisley.

Mr. H. M. Salmony informs us that he is about to leave for Egypt on a business tour of several months' duration. Communications from the trade will be sent on to him if addressed to 70, Canfield-gardens, London, N.W.

Mr. Chas. Wm. Günther is retiring from the firm of W. Günther & Sons, mechanical engineers and turbine builders, Havelock-street, Oldham. Messrs. Jas. Adolph Günther and Emilius John Günther continue.

The British Electrical Trade Supply & Bitumen Co. are removing their offices to the works at Canal Bank, Deptford, S.E.

BANKRUPTCIES, &c.

The discharge of Robt. Foster, trading with Walter Baker as Nelson Electrical Engineering Co., Stott-street, Nelson, has been suspended for three years.

The trustee in the bankruptcy of Fredk. W. Parkes and Edwd. Sadleir, electrical fitters and engineers, the Dingle, Colwyn Bay, has been released.

Plant for Sale.—Messrs. White Bros. & Co., High-street, Stratford, have for sale an electric lighting generating set. See an advertisement.

The Sherwood Colliery Co., Mansfield, have for sale a Robey horizontal coupled compound engine belted to a 50kw. Westinghouse three-phase generator. See an advertisement.

Electric Lamps for Sale.—Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., have been instructed to sell by tender upwards of half a million incandescent electric lamps, fittings, &c. See an advertisement.

Factory Sites to Let.—Messrs. Woodhouse & Davidson, 10 and 11, Lime-street, London, E.C., have some conveniently-situated freehold factory sites for sale within 11 miles of London. See an advertisement.

Arc Lamp Tests.—Particulars of an interesting series of tests recently made by the Westminster Electrical Testing Laboratories with the "Excello" arc lamp, supplied by the Union Electric Co., 151, Queen Victoria-street, London, E.C., has been issued. Various claims have been made by the Union Co on behalf of these lamps, and it is urged that these claims are substantiated by the particulars now published. The company are preparing a polar curve outlined by the measured figures of the candle power, and other particulars of the tests are available.

Large Alternator Armature.—In the prominent announcement made in our advertisement pages by the Electric Construction Co., Dashwood House, New Broad-street, London, E.C., and Bushbury, Wolverhampton, there is shown an illustration of a very large alternator armature, which is being supplied by the company to the London County Council. It is common complaint that numerous orders for electrical machinery out of the ordinary run have been placed either in America or on the Continent, and it is, therefore, gratifying to find that the London County Council have experienced no difficulty, now that they have permitted a British firm to prove their capacity for the work, in finding an establishment which turns out such a machine as is here illustrated. The plant which is being manufactured at Bushbury for the Council is amongst the largest, if not actually the largest, that has yet been called for. There are four of these three-phase generators on order, each designed to give a continuous output of 3,200 kilovolt-amperes at 94 revs. per min., and a frequency of 25 ∿ per second per phase. The output of 3,200 kilovolt-amperes is to be rated with a power-factor of 94 per cent.; the working pressure is 6,600 volts, and the current per phase 280 amperes. The machines will be called upon to give an overload for two hours continuously of 20 per cent. additional current—that is, 350 amperes per phase. The field magnet system is constructed directly upon the rim of the engine flywheel, in which the amount of stored energy, when the flywheel is revolving at normal speed, is 11,000 foot-tons. The E.C.C. are constructing the complete flywheel.

"Pluto" Electric Heaters.—We have recently described briefly the "Pluto" type of electric heater. A novel arrangement is employed in this system, which was exhibited on Wednesday and Thursday by the Electrical Corpn. (Ltd.), at a press view to which we were invited. The arrangement has the effect of distributing heat in a room by currents of warm air rather than by radiation only, as is mostly the case with the older types of electric stoves. To this end the resistance coils—consisting of non-corrosive resistance wire wound on porcelain cores—are arranged in an asbestos-lined, closed-iron box. In this box is a number of vertical metal tubes, whose ends protrude at the top and bottom of the resistance box. In order to increase the radiating surface of these tubes, a spiral of metal wire is inserted in each of them. The heat given off by the electric resistances is communicated to the vertical tubes by radiation and conduction. Consequently the air in the tubes becomes hot and rises, and a stronger draught than that produced by these simple means may be obtained by placing a fan in the path of the air, the fan being driven by the hot air itself. The current is regulated by two small switches. We are informed that a stove for heating a 15 sq. ft. room consumes about 1¼ units per hour, and that the room is fairly heated half an hour after current has been switched on and thoroughly so after one hour. These stoves lend themselves to artistic design, as was evidenced by the specimens shown. In addition to the stoves the Electrical Corpn. (Ltd.), exhibited a number of electric cooking utensils, &c.

Catalogues, &c.—A serviceable pocket list of "Simplex" steel conduit fittings is now ready, and copies can be obtained on application.

In the "Electrical Progress" Sheet (No. 1,080) issued by the General Electric Co., a number of new items are given. Fig. 1 shows the "Osmi" portable lamp and accumulator supplied with a 4-volt battery to maintain a reflected light of about 6 c.p. for 7½ hours.

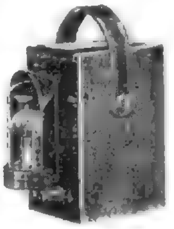

FIG. 1.

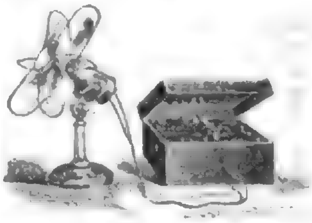

FIG. 2.

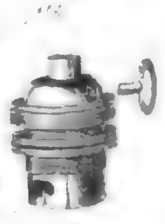

FIG. 3.

It is claimed that this is a great advance on any previous lamp of the kind both as to size and weight of battery. The time for thinking about cooling fans is coming along, and the G.E. Co. are introducing a new design of "Magnet" battery fan, as shown in Fig. 2. The commutator is of disc type, and the brushes are of pencil form fed by small spiral springs. The fan can be taken apart when not in use and folded into very small compass. The illustration shows the complete equipment ready for use. Fig. 3 shows a new lampholder with locking device designed to prevent the withdrawal of lamps by unauthorised persons. The method of inserting and releasing the key is simple and effectual.

An illustrated sheet list of engine and boiler fittings is issued by Birkett and Robinson, of Cleckheaton. Copies can be obtained by the trade on application.

Lehmann Bros., Station-road, Walthamstow, London, E., have ready a new list of British Association screw threads. A copy of the list will be forwarded post free to any member of the industry interested in taps, screw plates, dies, &c, of "B. A." or any other type.

Liverpool Electric Cable Co. have ready a new price list of electric wires and cables. It is notified that owing to the high price of raw materials an advance in prices has necessarily occurred. This company make a cheaper class of cable to meet certain requirements, to which attention is directed.

A new list of D-type dynamos for small outputs is issued by Mather and Platt.

An automatic feed pump and receiver is described in a pamphlet issued by the Geo. F. Blake Mfg. Co., Liberty-street, New York City. This apparatus is arranged to automatically pump water of co densation directly back to the boilers and is used for draining steam coils, radiators, heaters, drying cylinders, steam jackets, &c.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from March 15 to 21, with the ports of destination :—

Aden, £7. *Africa*—Alexandria, £287 ; Cape Town, £100 (including £79 telegraph material) ; Durban, £1,330 (including £513 telegraph material); Mombasa, £176 ; Port Said, £259 ; Suez, £166 (including £41 telegraph material) ; Tangier, £19 (telegraph material). *Argentina*—Buenos Ayres, £691 (including £100 telegraph material) ; Rosario, £106. *Australasia*—Adelaide, £16 ; Auckland, £71 ; Brisbane, £30 ; Fremantle, £25 ; Lyttelton, £254 ; Melbourne, £26 ; Otago, £220 ; Perth, £61 ; Sydney, £840 (including £143 telegraph material). *Belgium*—Antwerp, £75 ; Ostend, £22. *British Guiana*—Demerara, £43. *Brazil*—Pernambuco, £35 ; Rio Janeiro, £25 (including £18 telegraph material). *Canada*—Toronto, £25. *Ceylon*—Colombo, £378. *Channel Islands*—£20. *Chili*—Antofagasta, £413 (telegraph material) ; Iquique, £50. *China*—Shanghai, £825. *Denmark*—Copenhagen, £18. *France*—Paris, £20. *Greece*—Zante, £65. *Holland*—Amsterdam, £344 (including £86 telegraph material) ; Rotterdam, £118. *Hong Kong*, £809. *India*—Bombay, £1,339 (including £202 telegraph material) ; Calcutta, £4,466 ; Madras, £80. *Japan*—Kobe, £18 ; Tokyo, £289. *Malta*, £68. *Russia*—St. Petersburg, £150 (telegraph material). *Sweden*—Gothenburg, £30. *West Indies*—Barbados, £64. Total £14,393 against £17,992 in the corresponding week last year (March 16 to 22).

COMPANIES' MEETINGS AND REPORTS.

County of London Electric Supply Co. (Ltd.)

The eleventh ordinary general meeting was held on Thursday last under the presidency of Mr. J. B. Braithwaite, jun.

The SECRETARY (Mr. H. B. Renwick) read the notice convening the meeting and the report of the auditors.

The CHAIRMAN, in moving the adoption of the report and accounts, said : In the balance-sheet the only changes to which reference need be made is the issue of the balance of our second debenture stock of £150,000. On the other side we have expended on capital account during the past year £83,000, or £50,000 less than last year, which shows that we are beginning to overtake the heavy capital expenditure which has had to be made in our southern areas. The bulk of this capital expenditure has been on mains, transformers and meters, rendered necessary owing to the rapid building developments taking place south of the Thames. This provides for new houses being fitted for the electric light at the time of building, and secures the adoption of this method of illumination by the tenants. I think this money is well spent. On generating plant at the stations and sub-stations we have spent £10,905, and on other items £12,725. On the other side of the account the chief change has been in the increased reserve for depreciation, repairs and renewal, which now stands at £47,340. With regard to revenue, I think the story we have to tell you is a very satisfactory one. Revenue from sales of current realised £126,232, against £109,017, an increase of 15·8 per cent. on the year. The gross revenue was £135,790, against £119,748, an increase of 13·4 per cent. Station costs show a further substantial reduction. We have sold nearly 1½ million units more than last year, equal to an increase of 25 per cent., but although we have sold this large increased number of units, owing to the exertions of our engineering staff—to Mr. Sparks and his subordinates—there has been a decrease in the cost of £340. As to efficiency of distribution, we actually got paid for 71 per cent. of the units generated. Owing to reductions we have made from time to time, we are receiving less by rather more than a farthing per unit than last year, or about 7 per cent. decrease. The increased profit from our London stations this year is the largest we have ever had, amounting to £19,300, or £7,600 more than the increase in 1903 over 1902. With regard to lamp connections, we have achieved another record. The additional applications amount to the equivalent of 118,855 8 c.p. lamps, and this increase continues. A considerable proportion of this demand is for power. The total equivalent of 8 c.p. applied for at Dec. 31 last was 647,711, of which, as I have said, 118,855 were applied for during the year, against 112,564 in 1903, which is a 6,000 increase. We have 7,459 customers, of whom 1,956 were added last year. The outlook for the present year is good, as we have received up to the present applications for the equivalent of 17,000 8 c.p. lamps, including power, and the reduction in working costs has been more than maintained. In spite of our record for last year, we are not resting, but are using every means to increase the business and thicken our mains. We are putting in at the City-road station turbine plant, which we believe to be the most economical generating plant, and we hope this will further economise the cost of production. Against our increased profits there is to set increased interest charges owing to further capital issue, but the net result is that we are able to double our appropriation to depreciation by placing £20,000 to that fund instead of £10,000. Of this £20,000, £19,150 comes direct out of revenue and £85 is from the contingency fund established two or three years ago to meet the cost of certain changes in our plant. We shall give you an increased dividend amounting to £2,000, so I think that you will consider this a satisfactory arrangement. I do not consider the amount placed to depreciation is yet fully adequate and hope this year we shall be able to make another large addition, and that in two or three years' time we shall put into depreciation the right amount, which I estimate should be £35,000 to £40,000.

It will be seen from what I have said that the prospects of the company are satisfactory, but we are face to face with a certain amount of trouble and anxiety owing to an attempt that is being made by a £5,000,000 power scheme to invade our territory. This new company proposes to supply power to the whole of the County of London, including areas occupied by 22 companies and 32 local authorities owning in all 72 generating stations, but they propose only to supply the consumer whom it is profitable to supply—that is, the long-hour consumer—and ask to be relieved of any obligation to supply current to the small consumer. We have great hopes that Parliament will not grant such a cool demand. On our own part, we are seeking Parliamentary powers this session to enable us to supply electric power within our own and adjoining areas, and we are also seeking to interconnect our northern and southern areas, which will enable us to more economically employ our spare plant. We have already 7,000 H.P. or 8,000 H.P. in motors connected to our mains, and this power-load forms an important part of our income, especially north of the Thames. We are, therefore, interested in joining with other companies and with local authorities, including the London County Council, in defeating the efforts of the Administrative County of London Co. We are ourselves also promoting a bill for a provisional order for the rural district of Croydon. This application has the support of the District Council. The area adjoins the company's present southern area, and is one that is rapidly developing. The Coatbridge Co., in which we are interested, is getting to be in a satisfactory condition, and instead of being a dead weight round our necks it is now producing revenue for us. We are promoting an electrical exhibition in Holborn, and invite our shareholders to visit the show, where we are trying to demonstrate the advantages of electricity in many practical forms for lighting, for heating and for power. The latter section in particular the company are making a special feature of, the company's northern area being largely engaged in manufacturing operations. I now move the adoption of the report and accounts.

Mr. F. W. REYNOLDS seconded the resolution.

The CHAIRMAN having replied to several questions, the resolution was put to the meeting and carried unanimously.

Resolutions approving the payment of the dividends recommended by the directors having been carried, and the retiring directors (Mr. F. W. Reynolds and Mr. R. Percy Sellon) and the retiring auditor having been re-elected, a hearty vote of thanks to the chairman and directors, the chief engineer, secretary and the rest of the staff was carried unanimously, and the proceedings terminated.

Direct Spanish Telegraph Co. (Ltd.)

The fifty-third ordinary general meeting was held on Tuesday, under the presidency of the Most Hon. the Marquis of Tweeddale, K.T.

The SECRETARY (Mr. F. T. Preddle) having read the notice calling the meeting,

The CHAIRMAN, in moving the adoption of the report, said : The traffic receipts show a decrease of £266 as compared with those for the year 1903. This is owing to the reduction of the rate to Spain from 3½d. to 3d. per word, which came into operation on July 1, 1904, and the decrease would have been far heavier but for the fact that the first six months of 1904 showed an increase in receipts, as compared with those for the corresponding period of 1903, of some £1,300. To put us on the same revenue-earning basis as before the reduction took place, we naturally require to deal with a large increase of traffic, which, unfortunately, has not been experienced during the second six months of the year under review—an expectation which was foreseen when I spoke to you this time last year. The ordinary working expenses show an increase of £365 compared with those of the previous year. This increase is due to the normal increases of salaries in London and at the stations abroad, the new system of working the Bilbao cable from the landing place at Arrigunaga being accountable for £116 of that sum. Income tax shows a decrease of £179, but this is not due, I regret to say, to any decrease in the tax, but because the auditors require the full amounts of dividends and debenture interest to appear in the accounts instead of less the tax, as hitherto. The amount charged to revenue has, therefore, been reduced and the dividends and debenture interest accounts have been increased. Owing to the constant interruptions of the Marseilles-Barcelona cable which have occurred during recent years, your Directors decided to put the cable into a thorough state of efficiency, and this has been successfully accomplished, although at considerable cost, the amount of which will appear in the current year's accounts. The necessity of this step will be appreciated when I mention that the repairs of the Marseilles cable have cost on an average over £5,000 a year for the last four years, while the loss of traffic has, of course, been considerable. The Bilbao cable was also interrupted, but, happily, for only 7½ days, having been repaired with that promptitude which characterises their operations by the Eastern Telegraph Co., one of whose ships happened to be available at the time. When I met you last year I stated that the landing licence on the shores of this country expired on Oct. 31, 1903, and that negotiations were in progress for its renewal. I am happy to be able to report that an extension has been granted on terms which we consider to be satisfactory. Our operations in the year under review enable us to recommend the usual dividend of 10 per cent. on the preference shares and 4 per cent. on the ordinary shares, leaving our reserve fund on Jan. 1 at £17,421. Our cables are now in excellent order, and as trade is improving, and we may expect freedom from the costly repairs to which I have referred, and, perhaps, a real reduction under the head of income tax, we are, I think, entitled to look with confidence to the future of the Company. With these observations, I move the adoption of the report and accounts.

Sir J. DENISON-PENDER, K.C.M.G., seconded the motion, which was carried.

Resolutions approving the dividends and re-electing the retiring director (Sir John Denison-Pender) and the auditors (Messrs. Deloitte, Dever, Griffiths & Co.) having been passed, a vote of thanks to the chairman and directors terminated the proceedings.

AIRDRIE & COATBRIDGE TRAMWAYS CO. (LTD.).—The capital expended during 1904 was £24,000. 18s. 2d., making total expenditure for construction and electrical equipment of tramways £55,698. 16s. 4d. The revenue from Feb. 8 to Dec. 31 amounted to £9,673. 10s. 10d. and the expenditure to £7,742. 4s. 9d., leaving a profit of £1,931. 6s. 1d., of which £1,250 is to be placed to depreciation and renewal. A dividend at the rate of 4 per cent. per annum has been declared.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.).—After providing for debenture interest, preference dividend, and the ordinary interim dividend for 1904, also the redemption of debenture stock and preference and ordinary share capital, and after transferring £10,000 to reserve and £25,000 to renewals, the directors recommend a final dividend on the ordinary shares of 5s. per share (making 8s. per share or 8 per cent. for the year), carrying forward £5,922.

BRITISH INSULATED & HELSBY CABLES (LTD.).—The profit for 1903 amounted to £129,817. 6s. 11d., making, with £6,164. 8s. 5d. from 1903, a total of £135,981 15s. 4d. After deducting £108,867. 13s. 11d. for interest, depreciation (£21,000), preference dividend (£30,000), interim ordinary dividend (£20,000), directors' remuneration, special reserve (£[illegible]), &c., the balance is £27,114. 1s. 5d. The directors recommend a further dividend of 4 per cent. on ordinary shares (making 8 per cent. for the year), carrying forward £7,114. 1s. 5d. During the year the volume of trade has been large, but competition still continued very keen. Under these circumstances, the directors consider the result of the year's working satisfactory. Additions to new plant and machinery, &c., during the year at the Prescot, Helsby and Liverpool works had been necessitated in order to facilitate the company's business, and widen the scope of its operations.

GATESHEAD AND DISTRICT TRAMWAYS CO.—The revenue for 1904 was £48,318. 1s. 9d., against £47,600. 9s. 9d. for 1903. After deducting all expenses the profit was £13,238. 19s. 10d., to which is added £228. 1s. 6d. from 1903, making the available balance £13,467. 1s. 4d. £2,500 is put to depreciation and reserve, preference dividend absorbs £6,756. 12s. and a dividend of 3 per cent. on ordinary shares £4,050. The capital expenditure during 1904 was £3,725. 1s. 7d., making the total capital expenditure £311,379. 0s. 2d.

HARROW ELECTRIC LIGHT & POWER CO. (LTD).—The directors' report for 1904 states that, notwithstanding a reduction in charge, the surplus was £3,089. 13s. 8d. The amount to credit of net revenue account was £2,600. 17s. 4d. after payment of interest and interim preference dividend. £944 was put to depreciation, and after payment of the balance preference dividend and 4 per cent. on the ordinary shares £239. 0s. 4d. is carried forward. The number of 8 c.p. lamps connected was 3,381, against 1,769 in 1903, and the number of units consumed increased by 30,371 to 259,833. Works costs were 1·66d. per unit, against 1·87d. in 1903 and 2·24d. in 1902. Total costs were 2·61d. per unit, against 2·87d. in 1903 and 3·43d. in 1902.

HOVE ELECTRIC LIGHTING CO. (LTD.).—At the meeting last week Col. A. J. Filgate said that although the progress made during the past year had not been so large as in recent years, he did not think there was reason to be dissatisfied. The outlay during the year had been £5,018, compared with £20,610 in 1903. The new generating station was now well equipped, and the company would be able to meet a considerable expansion of business. The directors were contemplating a system of advancing the money needed for wiring small premises, the cost being repayable by instalments, and hoped to attract customers who were now prevented from taking current owing to the initial outlay. The number of units sold during the year was 820,781, against 779,985 in 1903.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY (LTD.).—Mr. E. Garcke, at the meeting last week, said that traffic for 1904 had not been so good as could be wished, almost entirely due to the severe depression in the cotton trade. They had carried 126,000 passengers less than in the previous year, and the receipts were less by £907. There had been a reduction of working expenses, but not in proportion, because it was not possible to reduce the service in any way temporarily, so that the falling off meant an entire loss to the company. The reduction of the net profit was only £412. There was an increase in the general expenses of £200, principally due to increase in local rates and insurance.

POOLE & DISTRICT ELECTRIC TRACTION CO. (LTD.).—For 1904 receipts were £15,673, and expenses, including interest, £10,791, leaving £4,881. £5,509 is available for distribution. The directors recommend paying a dividend at the rate of 10 per cent. for the year. Referring to the arbitration between Bournemouth Corporation and the company the report states that the directors estimate the distribution which the purchase price will allow will be not less than £17 per share.

ROBEY & CO. (LTD.).—The report for 1904 states that the accounts show a profit of £32,898. 1s. 10d., or over £13,000 more than the profit of either of the two previous years. £8,283. 3s. 10d. is put to depreciation of buildings, machinery and plant, £6,312. 10s. for debenture interest, and the directors recommend a dividend of 5s. per share (tax free) on the ordinary shares, carrying £9,000 to suspense account and £508. 18s. forward.

SALISBURY ELECTRIC LIGHT & SUPPLY CO. (LTD.).—The directors report that the number of consumers advanced during the year from 662, with 23,833 8 c.p. lamps connected to 820, with 26,674 lamps. The profit on the year's working (including amount from last account) was £4,916. 8s. 7d., and after paying interim dividend at rate of 4 per cent. (£600) and £1,452. 1s. 6d. interest, &c., the balance was £2,864. 2s. 1d. The directors recommend a further dividend at rate of 7 per cent. (making 5½ per cent. for the year), and £1,000 is placed to reserve.

SLOUGH & DATCHET ELECTRIC SUPPLY CO. (LTD.).—The directors' report for 1904 states that the capacity of the generating station is now 870 H.P., compared with 510 H.P. last year, and an additional boiler of 500 H.P. is on order. The supply mains have been extended in many directions. The capital expended during last year was £7,729. 18s. 7d., bringing the total to £38,982. 7s. 7d. The number of equivalent 8 c.p. lamps connected during the year was 2,482, bringing the total to 5,608, of which 198 represent motor power. The total revenue was £3,011 7s. 1d., including sale of current in bulk to Windsor Co. The net profit available for distribution was £1,628 8s. 1d., and a dividend of 3 per cent. per annum (less tax) is recommended.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—The report for 1904 states that the four stations (Bridgend, Cwmbran, Neath and Pontypridd) are supplying current. Arrangements have been made for supply of energy to a large number of collieries and works, the aggregate horse-power at present amounting to upwards of 10,000. Extensions of the Pontypridd and Cwmbran stations are in hand, these stations already needing additional plant.

SOUTHPORT TRAMWAYS CO. (LTD.).—The report for 1904 states that the loss on the working was less than in 1903, amounting, after paying rental of lines and interest charges (£7,196. 15s. 8d.), to £577. 8s. 1d.

UNITED ALKALI CO. (LTD.).—The accounts for 1904 show an available balance of £209,066. After payment of the final dividend on the preference shares and transferring to reserve and depreciation £52,219, £43,763 is carried forward.

WINCHESTER ELECTRIC LIGHT & POWER CO. (LTD.).—At the meeting on Tuesday the directors reported that the equivalent of 6,135 8 c.p. lamps had been added during the year, making the total 41,692 8 c.p. lamps. Including £156. 4s. 8d. from last year, the net profit was £5,706. 18s. 1d. An interim dividend at the rate of 4 per cent. was paid in October and a dividend at the rate of 7 per cent. was now declared (making 5½ per cent. for the year).

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

FORSTER & SONS (LTD.) (83,907.)—Reg. March 15, capital £16,000 in £1 shares, to acquire business carried on as Forster & Sons, and to carry on the business of glass manufacturers, makers of glass jars, tubes, &c., manufacturers of electric goods, &c. First directors, J. Forster, W. Forster and W. A. Forster. Reg. office, Barber-street, St. Helens.

HEXHAM & DISTRICT ELECTRIC SUPPLY CO. (LTD.) (83,869.)—Reg. March 10, capital £30,000 in £5 shares, to supply electricity for light, heat, power, traction and other purposes in urban district of Hexham and parishes of Acomb, Sandhoe, Hexham West Quarter and Warden (Northumberland), to acquire rights and powers granted to E. P. Harvey by the Hexham lighting order, 1904, &c. First directors, J. E. Tully, J. O. Scott, J. Gibson and W. Hall. Reg. office, Bank Chambers, Hexham.

KUETTNER, MACDONELL & COOKSON (LTD.) (83,946.)—Reg. March 18, capital £10,000 in £1 shares, to carry on business of railway and tramway constructors, owners and workers, lift and motor manufacturers, electricians, electrical, mechanical, civil, consulting, constructional, designing and general engineers, machinists, founders, wire drawers, &c., and to adopt an agreement with B. Kuettner, S. G. MacDonell and B. Cookson. First directors, B. Kuettner, S. G. MacDonell and B. Cookson. Reg. office, 3, Adam-street, Adelphi, London, W.C.

PEEBLES STEAM CAR CO. (LTD.) (83,805.)—Reg. March 4, capital £30,000 in £1 shares (15,000 preference), to adopt agreement with Bruce Peebles & Co. (Ltd.) and Electric Conversion Synd. (Ltd.), to acquire and turn to account any patents, inventions, processes or rights, and to carry on the business of manufacturers of steam, electric, petrol or other engines, railway carriages and waggons, cars, trucks, locomotives, rolling stock, &c. Reg. office, 25, Victoria-street, Westminster, S.W.

MORTGAGES AND CHARGES.

KRAMOS (LTD.).—Issue on Feb. 22 of £1,000 debentures, part of series created same date, to secure £4,000, charged on company's undertaking and property, present and future, including uncalled capital. Holders, M. Simons, H. J. Walford and M. J. Garcia. No trustees.

PREMIER ELECTRIC LAMP CO. (LTD.).—An agreement dated Jan. 27, 1905, extending time for payment of debentures for £12,500 and varying rate of interest thereon, has been registered. Property charged, company's undertaking and property, present and future. No trustees.

WEBSTER ELECTRICAL ENGINEERING CO. (LTD.).—Issue on March 13 of £625 first mortgage A debentures, part of series created Feb. 28, 1905, to secure £1,000, charged on company's undertaking and property, present and future, including uncalled capital and unpaid calls. Holder, F. W. T. Newbould. No trustees. No previous issue of same series.

SOCIETE ANONYME METALLURGIQUE PROCEDE DE LAVAL.—This company has been formed in Belgium to exploit Dr. G. De Laval's patent for the electric smelting of zinc. The promoters are German and Swedish financiers.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Mar. 19	1,076	− 6	42	56,297	+ 5,719
Airdrie	,, 10	200	− 19	10	1,932	− 12
Ayr Corporation	,, 18	188	+ 24	44	19,795	+ 640
Barnsley	,, 10	163	+ 17	10	1,485	+ 84
Barrow	,, 10	199	+ 64	10	1,784	+ 217
Bath Electric Trams, Ltd.	,, 15	551	− 57	11	5,650	+ 460
Birkenhead	,, 19	963	+ 2	...	...	...
Birmingham Corporation	,, 18	892	...	11	19,756	...
*Birmingham & Mid.	,, 10	1,758	+ 314	10	16,894	+ 2,065
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 16	881	+ 47	50	46,862	+ 6,218
‡Blackpool and Fleetwood	,, 18	197	+ 16	11	2,035	− 85
Blackp'l, St. Anne's & Lytham	,, 16	154	...	20	2,558	...
Bolton Corporation	,, 19	1,515	+ 201	51	91,997	+ 799
Bournemouth Corporation	,, 15	984	+ 90	§50	52,912	+ 2,886
Bradford Corporation	,, 18	3,975	+ 465	49	218,509	+ 11,045
Brighton Corporation	,, 19	831	+ 112	50	48,682	+ 3,796
Brisbane Tramways	Jan. 25	2,457	+ 319	8	4,564	+ 236
Bristol Trams & Carriage	Mar. 17	4,427	− 176	6	26,612	+ 263
Buenos Ayres & Belgrano	Feb. 12	3,118	+ 108	17	6,171	− 656
Buenos Ayres Elec. Trams	,, 18	1,036	...	7	7,446	...
Burnley Corporation	Mar. 18	1,028	− 186	21	11,109	+ 3,711
Burton Corporation	,, 19	312	+ 26	¶50	16,910	...
Calcutta Tramways Co.	,, 18	a28,907	+ a2,566	11	a160,606	...
Camborne-Redruth	,, 10	99	+ 6	20	2,100	− 106
Cardiff Corporation	,, 18	1,898	+ 108	50	100,878	+ 2,170
Carlisle Tramways Co.	,, 18	135	− 26	11	1,565	− 263
Central London Railway	,, 18	7,070	+ 9	11	79,128	+ 1,173
Chatham & Dist. Lt. Rys.	,, 16	600	+ 104	11	6,171	+ 734
*City of Birm'gh'm Tram Co.	,, 10	5,617	+ 623	10	52,074	+ 2,411
City & South London Rly.	,, 19	2,884	− 60	12	36,068	− 2,160
Colchester Corporation	,, 16	100	...	7	1,078	...
Cork Electric Trams Co.	,, 18	[illegible]	− 6	11	4,962	+ 199
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 10	415	− 85	10	4,194	− 175
Dover Corporation	,, 18	169	+ 4	51	10,871	− 106
Dublin & Lucan Railway	,, 17	109	+ 15	11	1,080	+ 30
Dublin Southern District	,, 17	834	+ 105	11	47,991	+ 788
Dublin United	,, 17	3,905	+ 203			
Dudley—Stourbridge	,, 10	799	+ 73	10	7,224	+ 188
Dundee Corporation	,, 15	772	+ 7	¶23	35,951	+ 350
East Ham Council	,, 18	781	+ 107	50	35,257	+ 2,088
Gateshead & Dist. Trams	,, 10	699	+ 51	10	8,534	+ 260
Glasgow Corporation	,, 18	14,544	+ 1,222	†38	596,113	+ 30,456
Glossop	...	...	...	...	...	...
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 10	196	− 20	10	1,914	− 187
Gt. Northern & City Rly.	,, 18	1,601	+ 637	11	17,035	...
Greenock & Port Glasgow	,, 10	494	+ 76	10	5,029	+ 668
**Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 10	267	+ 27	10	2,858	− 24
Huddersfield	,, 18	1,719	+ 116	50	67,072	+ 4,406
Hull Corporation	,, 18	2,218	+ 191	50	109,101	+ 11,672
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	,, 15	109	− 18	24	2,679	− 423
Ipswich Corporation	,, 18	344	− 2	50	21,669	...
Isle of Thanet Co.	,, 18	256	− 3	24	6,920	67
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	,, 10	92	− 7	10	861	− 21
Kilmarnock	,, 18	148	...	8	425	...
Kirkcaldy Corporation	,, 15	197	+ 5	2	390	+ 5
Lanarkshire Trams Co.	,, 16	606	+ 45	11	6,283	+ 609
Leeds Corporation	,, 18	6,368	+ 379	51	297,671	+ 17,580
Leicester Corporation	,, 18	1,910	...	11	19,532	...
Liverpool Corporation	,, 11	9,851	+ 534	10	97,794	+ 8,756
Liverpool Overhead Rly.	,, 19	1,497	− 15	12	17,569	− 622
*London County Council	,, 11	12,528	+ 2,496	†49	626,251	+ 139,744
Lowestoft	,, 15	116	− 8	11	1,323	...
Maidstone Corporation	,, 16	9,176	...	36	4,521	...
Manchester Corporation	,, 18	11,277	+ 1,129	50	605,780	+ 29,138
Mersey Railway	,, 18	1,620	+ 170	11	17,563	+ 1,258
Merthyr	,, 10	185	+ 1	10	1,702	− 114
*Metropolitan Elec. Trams	,, 10	1,852	+ 716	10	18,534	+ 8,032
Middleton	,, 10	263	+ 26	10	2,521	+ 224
Musselburgh	,, 9	158	...	12	2,150	...
Nelson Corporation	...	...	...	...	...	...
Newcastle-on-Tyne Corp.	,, 18	3,549	+ 102	11	35,946	+ 812
Newport (Mon.)	,, 18	520	+ 108	24	12,016	+ 1,657
Oldham, Ashton & Hyde	,, 10	500	+ 52	10	4,787	+ 83
Oldham Corporation	,, 19	1,534	+ 492	51	4,580	+ 5,961
Northampton Corporation	,, 17	871	+ 226	25	18,129	+ 6,662
Perth (W. A.) Elec. Trams.	,, 17	1,407	+ 74	11	16,176	+ 1,362
Peterborough	,, 10	101	− 6	10	960	− 68
Poole and District	,, 10	225	− 17	10	2,106	− 48
Portsmouth Corporation	,, 18	1,490	+ 48	§50	92,709	+ 6,544
Potteries	,, 10	1,662	+ 55	10	15,887	+ 438
Reading Corporation	,, 16	681	+ 53	...	...	...
Rochdale Corporation	,, 18	441	+ 239	51	10,878	+ 7,170
Rotherham Corporation	,, 16	892	− 17	50	[illegible]	+ 2,108
Rothesay	,, 10	45	+ 5	10	485	+ 35
Salford Corporation	,, 20	4,100	+ 431	50	[illegible]	+ 10,317
Sheerness	,, 8	60	+ 14	10	517	+ 88
Sheffield Corporation	,, 17	4,741	+ 416	†51	236,429	+ 7,611
Southampton Corporation	,, 16	838	+ 11	50	47,383	− 2,065
Southend Corporation	,, 15	214	+ 10	50	16,574	+ 1,010
Southport Tramways	,, 10	224	+ 1	10	2,207	− 54
S. Staffordshire Trams.	,, 10	662	− 29	10	6,273	− 281
Stockport Corporation	,, 17	427	+ 25	50	16,756	+ 8,604
Sunderland Corporation	,, 10	1,144	+ 80	51	62,416	+ 1,676
Swansea Trams	,, 10	670	+ 45	10	4,186	+ 43
Swindon	...	...	...	...	...	...
Taunton Trams	,, 10	41	− 5	10	393	− 61
Tynemouth and District	,, 10	173	− 19	10	1,649	− 281
Tyneside Trams Co.	,, 13	350	+ 40	11	3,512	+ 503
Wallasey District Council	,, 20	101	+ 81	§50	36,754	+ 2,633
Walsall	,, 18	435	...	11	4,833	...
Warrington Corporation	,, 16	301	+ 26	50	15,925	+ 680
West Ham Corporation	,, 16	1,080	...	...	53,782	...
Weston-super-Mare	,, 8	28	+ 6	10	236	+ 41
Wigan Corporation	...	...	...	...	...	...
Wolverhampton Corpn.	,, 18	647	+ 193	50	35,076	...
Wolverhampton District	,, 10	352	+ 20	10	3,330	+ 174
Worcester	,, 19	265	+ 28	10	2,583	+ 691
Wrexham	,, 10	104	− 12	10	914	− 23
Yorkshire Woollen District	,, 10	582	+ 108	10	5,859	+ 635

(a) These comparisons are with the corresponding period last year. † Minus 6 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 5 days. ** Fortnight. * Partly electrical.

CITY NOTES.

MEMORANDA (March 23).—Bank rate 2½ per cent. (since March 9, 1905). Price of silver 26$\frac{9}{16}$d. per oz. Consols 91$\frac{3}{16}$—91$\frac{5}{16}$ for money, 91¼—91⅜ for account; 2½ per cent. annuities 90—90½. Consols Pay Day, April 5. Stocks and Shares Continuation Days, March 28 and April 11; Ticket Days, March 29 and April 12; Pay Days, March 30 and April 13; Mining Share Carry-over Days, March 27 and April 10.

AMALGAMATION OF ELECTRICAL ENGINEERING FIRMS. — The "Financial Times" on Tuesday reported that an amalgamation was on the point of being effected between the British Westinghouse Electric & Mfg. Co. (Ltd.) and Sir W. G. Armstrong, Whitworth & Co. (Ltd.). The report is, however, denied.

AMERICAN TELEPHONE & TELEGRAPH CO.—During the week this company made an issue of $25,000,000 4 per cent. collateral trust bonds of $1,000 each.

ARMSTRONG, WHITWORTH & CO. (LTD.)—The directors have declared an ordinary interim divided of 1s. per share (at the rate of 10 per cent. per annum).

COMMERCIAL CABLE CO.—The regular quarterly dividend of 1 per cent. on the preferred shares in the Mackay companies will be paid April 10, the transfer books being closed from April 1 to 8 inclusive.

COMPAGNIE FRANCAISE POUR L'EXPLOITATION DES PROCEDES THOMSON-HOUSTON (PARIS).—A 5 per cent. dividend has been declared for 1904.

EASTERN TELEGRAPH CO. (LTD.)—This company announce payment on April 15 of dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock for the quarter ending 31st inst., and an interim dividend of 1¼ per cent. on the ordinary stock (tax free), in respect of profits for quarter ended Dec. 31. The transfer books of the ordinary stock will be closed from April 7 to 14 inclusive.

KRAFTUBERTRAGUNGSWERKE RHEINFELDEN.—A dividend of 6½ per cent. has been declared for 1904, compared with 6 per cent. in the previous year.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to grant quotations to a further issue of 5,000 £10 fully paid 6 per cent. cumulative preference shares of the *British Electric Traction Co. (Ltd.)*, a further issue of 2,000 £5 fully paid ordinary shares of the *Oxford Electric Co. (Ltd.)*, 10,000 £10 fully paid 6 per cent. cumulative preference shares of *J. G. White & Co. (Ltd.)*, and £537,351 assented extension preference (5 per cent.) stock and £962,649 unassented extension preference (5 per cent.) stock of the *Metropolitan District Railway Co.*, in lieu of the £1,500,000 extension preference (5 per cent.) stock now quoted.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., Mar. 22.	Rate per cent. yielded.	Dividend Due.	Business, Week to Mar. 21. High est.	Business, Week to Mar. 21. Low est.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
[illegible]	2/0	Anglo-Argentine Ord. Shares	[illegible]	3 8 6	Ap, Oc	[illegible]	[illegible]
1	2 6	Do. 5% Cum. Pref.	[illegible]	4 5 1	—	[illegible]	[illegible]
St.	6%	Do. Permanent 6% Deb. Stock	140 –143	4 3 11	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	106 –107	4 14 4	—	106	105½
10	6%	Barcelona Tramways Ord.	12 –12½	2 6 2	—	12⅛	12⅛
10	5/0	Do. 5% Cum. Pref.	9½–10	5 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	98 –100	4 10 0	—	..	..
100	5%	Do. 5 per Cent. Debs.	99 –102	4 18 1	..	..	..
1	..	Brisbane Electric Trams. Invest Ord.	1 – 1¼	..	..	1	..
5	5/6	Do. 6 per Cent. Cum. Pref.	[illegible]	5 17 3	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	94 –98	4 11 10	..	..	..
St.	6%	British Columbia Elec. Rlwy Def. Ord.	104 –107	5 12 2	—	103	[illegible]
St.	4%	Do. Pref. Ord. Stock	100 –103	4 17 2	—	102½	102
10	5/0	Do. 5% Cum. Perp. Pref.	10 –10½	4 10 11	—	[illegible]	..
[illegible]	4½%	Do. 4½ per Cent. 1st Mort. Dbs	[illegible]–117	4 5 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	99 –102	4 8 3	..	..	..
1	1/6	Buenos Ayres and Belgrano Ord.	[illegible]	5 12 0	—	[illegible]	[illegible]
1	2/0	Do. 6 per Cent. "A" Cm Pref	[illegible]	6 2 2	—	..	..
1	2/0	Do. "B"	[illegible]	5 6 5	—	..	..
St.	5%	Do. 5 per Cent. Debs.	107 –109	4 11 8	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov Certs.	103 –106	4 16 8	—	..	..
St.	6%	Buenos Ayres Elec. Trams (1901) Ltd.	97 –99	6 1 0	..	..	..
5	5 0	Calcutta Tramways ......ex rights	[illegible]	3 16 6	—	[illegible]	[illegible]
100	4½%	Do 4½% 1st Deb. Stock (red.)	106 –108	4 5 4	—	106½	..
1	0/6	Cape Electric Tram Shares	1½ –1¾	4 11 4	—	[illegible]	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt Deb. (red)	103 –105	4 17 2	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	101 –103	4 17 3	Ja, Jul	..	..
100	5%	Montreal St. Ry. St'g 5% Mort Debs. (1908)	102 –104	4 16 8	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 –105	4 5 9	..	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	105 –109	4 12 6	..	..	..
		ELECTRICITY SUPPLY.					
5	2/0	Calcutta Electric Supply Ord.	9 –9½	3 13 5	—	9⅜	[illegible]
1	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	[illegible]	..	..	..	..
St.	5%	Do. 5% Debs.	86 –91	5 9 11	—	..	..
10	..	Havana Electricity Co. Shares	9½–10½	—	—	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	[illegible]	..	—	..	..
1	..	Rand Electric	1 –1¼	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	100 –102	4 8 9	Ap, Oc	..	...

* In calculating the yield, allowance has been made for accrued interest but not for redemption.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., Mar. 22.	Rate per Cent. Yield. £ s. d.	Dividend Due.	Business, Week to Mar. 22. High est.	Low est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
1	..	Bath Elec. Trams Pref. Ord.	1½—1¾	..	..	..	..
1	11½d.	Do. 5% Cum. Pref.	1⅛—1¼	4 14 1	..	1⅛	..
St.	..	Do. 4½ 1st Mort. Deb. Stock (red.)	103—106	..	..	104½	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	99—101	..	..	100	99½
10	9%	Bristol Tramways and Carriage Ord.	18—18½	4 17 4	Feb, Aug	..	..
10	6%	Do. Cum. Pref. (fully paid)	10—10½	5 18 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	105—107	3 14 10	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	9½—9¾	6 2 11	..	9⅝	9⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅛—10⅜	5 7 10	Feb, Aug	10⅜	10¼
St.	5%	Do. 5 per Cent. Perpetual Debs	122—124	4 1 4	..	123½	122½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	98—100	4 10 0	..	98½	98
St.	4%	Central London Ordinary Stock	93—95	4 4 2	June, Dec	94½	93½
St.	4%	Do. 4 per Cent. Pref. Stock	101—103	3 17 8	..	..	..
St.	4%	Do. Deferred Stock	88—90	4 18 1	..	88	..
100	4%	Do. 4 per Cent. Debs.	110—112	3 11 5	..	..	..
5	2/6	City of Birmingham Trams 5% Cm. Prf.	4½—4¾	4 17 8	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	101—104	3 17 8	..	..	..
St.	1¼%	City and South London Rly. Con. Ord.	44½—45½	4 18 11	Feb, Aug	45½	44½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120—123	4 1 4	Feb, Aug	..	..
St.	5%	Do. (1896)	118—121	4 2 8	..	121½	120
St.	5%	Do. (1901)	116—118	4 4 9	..	117½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109—111	3 12 1	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13¾—14¼	4 2 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	16½—16¾	3 12 9	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	6—6½	3 12 0	..	6⅛	6¼
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9—10	..	..	9½	9¼
10	9%	‡†Imperial Tramways Ord	18—18½	4 17 4	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14¼—14¾	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109—111	4 1 1	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3—3½	7 2 11	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	60—62	6 7 0	..	..	..
10	1½%	Liverpool Overhead Railway Ord	3½—3¾	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10—10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10—10½	4 15 3	..	10⅜	10⅛
St.	4%	Do. 4% 1st Mort. Deb. Stock	98—101	4 0 0	..	100½	100½
St.	..	Mersey Con. Ord. Stock	4—7	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10—13	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅝—⅞	..	..	⅞	..
1	0/6	Do. 5% Cum. Pref.	1⅛—1¼	4 11 4	..	..	..
St.	4½%	Do. 4½% Deb. Stock	105—107	4 5 6	..	106½	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—1½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	9½—10	5 0 0	..	10	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9¼—9½	5 2 6	Feb, Aug	9½	9½
St.	4½%	Do. 4½ per Cent. Deb. Stock	103—105	4 5 9	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	—	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
	6%	Underground Elec. Rys. Co. of London	[illegible]	6 0 6	..	[illegible]	[illegible]
St.	3½%	Waterloo and City Ord.	92—94	3 6 5	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99—102	4 0 0	Jan, July	..	..
10	..	Amazon Telegraph	7½—7¾	..	Jn, Dec ..	..	..
100	..	Do. 5% Debs. (red.)	70—75	..	..	..	..
St.	17/6	Anglo-American	62—64	4 5 11	F,My,Ag,N	..	..
St.	35/0	Do. Preferred	108—109	5 0 11	F,My,Ag,N	109½	108½
St.	2/0	Do. Deferred	16½—17½	..	F,My,Ag,N	17½	16½
100	8%	Commercial Cable Capital Stock	230—240	3 6 8	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	98—100	4 0 10	Jn,Ap,Jy,O	99½	99
10	5/0	Cuba Submarine Ord.	8¼—8¾	5 8 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	17—18	5 11 1	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3½—3¾	5 11 9	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8½—9	5 11 2	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	101%—103%	4 7 10	Jan, July	101½	..
20	3/0	Direct United States Cable	11½—12½	5 8 5	Ja,Ap,Jy,O	11¾	11½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100—102	4 7 7	Jn, Dec ..	..	..
St.	35/0	Eastern Ordinary	146—148	4 14 7	Ja,Ap,Jy,O	147½	146½
St.	17/6	Do. 3½ per Cent. Pref. Stock	93—95	3 14 5	Ja,Ap,Jy,O	93½	92½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107—109	3 13 5	May, Nov	108½	108
10	2/6	Eastern Extension	14½—15	5 0 0	Ja,Ap,Jy,O	14¾	14½
St.	4%	Do. 4 per Cent. Deb. Stock	106—107	3 14 9	Feb, Aug	106	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1900	103—105	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%—103%	3 17 8	May, Nov	..	..
10	6/0	Great Northern (of Copenhagen)	31½—32½	4 8 3	Jan, July	33	31½
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100—102	4 8 3	June, Dec	100	..
25	12/0	Indo-European	47—49	5 2 0	May, Nov	48½	48
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99—102	3 18 5	June, Dec	..	—
10	4/0	West African Telegraph Shares	8—8½	5 17 8	—	..	..
2½	..	West Coast of America	⅛—¼	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	100—102	3 18 5	Jan, July	..	..
10	..	West India and Panama	½—1	..	May, Nov	¾	..
10	7/0	Do. 6% 1st Pref.	8½—9	7 4 5	May, Nov	..	..
10	—	Do. 6 per Cent. 2nd Pref.	6¼—6¾	..	May, Nov	6½	..
100	5%	* Do. 5 per Cent. Debs.	103—105	4 15 3	Jan, July	..	..
10	3/0	Western Telegraph	14—14½	4 16 6	Mr,Jn,O,D	14⅛	14⅛
100	5%	* Do. 5% Debs. (2nd Series, 1900)	101—104	4 17 1	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	103—105	3 16 11	—	..	..
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	6½—6¾	5 1 9	August ..	6½	..
1	0/7½	Monte Video Telephone Ord.	1⅛—1¼	2 11 9	..	..	..
St.	6%	†National Co. Pref. Stock	110—112	5 8 1	—	111½	110½
St.	6%	† Do. Def. Stock	101½—102½	4 14 10	..	101½	100
10	6/0	† Do. 6 per Cent. Cum. 1st Pref.	11¾—12¼	4 8 11	Feb, Aug	..	..
10	6/0	† Do. 6 per Cent. Cum. 2nd Pref.	13—13½	4 12 4	Feb, Aug	..	..
5	2/6	† Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—6½	4 5 11	Feb, Aug	6⅛	6⅛
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	100—102	3 8 7	June, Dec	101½	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104—106	3 11 6	..	106	104½
1	0/7½	Oriental	1¼—1½	4 4 2	April, Oct	1⅜	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 11 5	..	..	..
St.	90/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101—104	..	..	..	—
5	3/0	United River Plate	7¼—7¾	5 3 3	July	7½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4 17 9	June, Dec	..	—
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	107—109	4 11 9	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	1/3	Elec. & Gen. Investment 5% Cum. Pref.	4½—4¾	5 14 4	—	..	..
10	2/0	Globe Telegraph and Trust	10⅛—10⅝	5 0 0	Ja,Ap,Jy,O	10⅜	10⅜
10	3/0	Do. 6 per Cent. Pref.	14½—14¾	4 8 8	Ja,Ap,Jy,O	14½	14¾
100	6%	Submarine Cables Trust (Cert.)	126—128	4 13 9	April, Oct	..	..

Share.	Last Dividend.	Name.	Price Wed., Mar. 22.	Rate per Cent. Yield. £ s. d.	Dividend Due.	Business, Week to Mar. 22. High est.
		ELECTRICITY SUPPLY.				
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½—13	6 3 2	..	
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 7 10	..	10⅛
10	6/0	Do. 6% Cum. Second Pref.	11—12	5 0 0	—	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	105—107	4 4 2	—	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5½—5¾	3 9 7	..	5½
St.	4½%	Do. Do. 1st Debs	103—106	4 4 10	—	
5	4/6	Brompton & Kensington Elec. Sup. Ord.	16½—17½	4 13 0	..	17
5	3/6	Do. 7 per Cent. Pref.	10—10½	3 6 8	Mar, Sept	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105—108	3 14 1	..	
5	4/0	Charing Cross (W. End & City) El. Sup. Co.	8—8½	4 16 2	Feb, Aug	8½
5	2/3	Do. 4½ per Cent. Pref.	4½—4¾	3 17 0	Feb, Aug	4¾
St.	4%	Do. 4% Deb. Stock (red.)	105—107	3 14 9	..	106
5	2/3	Do. City Undertaking 4½% Cm. Pref.	5—5½	4 4 9	—	..
5	2/3	Do. Do. (1903)	5—5½	4 7 10	..	5⅛
5	3/9	Chelsea Electric Supply Ord.	7½—7¾	4 2 3	March ..	7½
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109—111	4 1 1	Jn, Dec ..	..
10	7/0	†City of London Electric Lighting Ord.	14¾—15¼	4 15 0	Feb, Aug	15
10	6/0	† Do. 6 per Cent. Cum. Pref.	13¾—14	4 5 9	Jan, July	13¾
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	125—127	3 18 5	Jn, Dec ..	
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	103—106	4 5 9	..	104
10	4/0	County of London Elec. Supply Ord.	9½—10	4 0 0	..	9⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	12¾—13¼	4 14 1½	Mar, Sept	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	110—113	4 0 2	—	
St.	4½%	Do. Second Deb. Stock Prov. Certs.	104—106	4 6 7	—	105½
5	2/0	Folkestone Electricity Supply Co. Ord.	4½—5	4 11 9	—	—
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101—104	4 6 7	—	..
5	3/6	Hove Electric Lighting Ord.	7¾—8¼	5 3 0	—	
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St (red.)	101—103	4 9 1	..	..
5	7/0	Kensingtn. & Kngtsbdg. Ord.	11½—12½	6 10 7	..	..
5	6%	Do. 6 per Cent. 1st Pref	6½—7	4 5 9	Jan, July	—
St	4%	Kensingtn. & Kngtbg. Co & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102—106	3 17 8	—	103½
5	1/5	London Electric Supply Ord.	2⅛—2⅜	3 4 6	—	
5	3/0	Do. 6 per Cent. Pref.	5½—6	5 0 0	..	
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	99—101	3 19 2	Mr,Jn,S,D	100
10	11/0	†Metropolitan Electric Sup. Ord.	11¾—12¼	4 18 8	April, Oct	12
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅛—5⅜	3 16 8	Jan. July	
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110—115	3 18 3	Jn, Dec ..	112½
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97—99	3 10 8	..	
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	99—101	4 9 1	..	100
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	15½—16	5 5 8	Feb, Aug	..
5	5%	†Newcastle Elec. Supply Ord.	7½—7¾	3 3 7	Feb, Aug	7½
5	6%	†Do. 5 per Cent. Non-Cum. Pref.	6—6½	4 2 8	Feb, Aug	6
1	3%	†Northern Counties Elec. Sup. 17/- paid	16/2—16/9	3 2 2	Mar, Sep	16/6
10	5/0	†Notting Hill Electric Ord.	14½—15½	4 0 0	March	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	102—106	3 17 0	..	
5	4/6	†Oxford Electric Ord.	6½—6¾	3 14 2	March ..	..
St.	4%	Do. 4% Deb. Stock	98—100	4 0 0	..	
5	6/6	St. James' & Pall Mall Elec. Ord.	14—14½	5 0 0	Feb, Aug	14¼
5	3/6	Do. 7 per Cent. Pref.	8½—8¾	4 0 0	Feb, Aug	8½
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98—100	3 10 0	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3½—3¾	5 10 7	—	..
St.	4%	Do. 4 per Cent. Deb. Stock	78—82	4 16 5	..	..
5	4/0	†South London Electric Supply Ord.	4—4½	4 14 3	—	4⅛
1	..	South Metrop'n Elec. Lt. & Power Ord.	½—1	..	—	..
1	0/8½	† Do. 7% Cum. Pref.	1⅜—1⅝	4 17 0	—	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	107—110	4 2 3	—	108
5	2/6	Urban Electric Supply Ord.	5⅛—5⅜	4 17 0	—	5⅛
5	2/6	Do. 5% Cum. Pref.	5½—5¾	4 10 3	..	5½
St.	..	Do. 4½% 1st Mort. Deb.	106—108	—	..	
5	7/6	Westminster Electric Supply Ord.	11¾—12¼	5 5 8	Mar, Sept	
5	2/6	Do. 5 per Cent. Cum. Pref.	6½—6¾	3 14 9	—	
		ELECTRIC MANUFACTURING, &c.				
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	½—¾	5 5 6	..	..
1	6d.	Aron Elec. Meter 6% Cum. Pref.	1⅛—1¼	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6½—6¾	6 3 8	July, Feb	..
5	3/0	Do. 6 per Cent. Pref.	6½—6¾	5 4 4	Jan, July	
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101—104	4 6 6	—	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	99—101	4 9 1	—	..
5	3/0	British Westinghouse 6% Pref.	7½—7¾	3 17 5	—	
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	91—95	4 6 0	..	..
2	..	Brush Electrical Engineering	½—1	..	March ..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½—2	6 0 0	Mar, Sept	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	92—96	4 14 9	Mar, Sept	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	79—82	5 9 9	Jan, July	81
5	6/0	Callender's Cable Con. Ord.	11—11½	5 5 8	Jan, July	..
5	2/6	Do. 5 per Cent. Cum. Pref.	6½—6¾	4 7 0	Jan, July	6
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	106—108	4 3 3	Nov, May	107
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	3½—3¾	4 0 6	—	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	91—96	4 13 9	..	..
1	0/6½	Chadburn's (Ship) Telegraph Ord.	1—1⅛	5 17 8	..	..
1	7½d.	Do. 6% Cum. Pref.	1—1⅛	6 6 8	..	..
2	1/6	Crompton and Co. (Nos. 1 to 64,000)	1½—1¾	3 8 4	Jan, July	
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96—98	5 2 0	Jan, July	..
5	10/0	Dick, Kerr & Co. Ord.	8—8½	5 17 5	Sept ...	
5	3/0	Do. 6% Cum. Pref.	6½—6¾	4 18 0	Sept ...	
St.	4½%	Do. 4½% Deb. Stock	106—108	4 3 4	..	
5	..	Ediron & Swan United ("A" Sh.) (£3 pd.)	1—1¼	..	Feb, Aug	
5	..	Do. (£5 paid)	1½—2	..	Feb, Aug	
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	80—86	4 14 2	June, Dec	
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	86—91	5 9 11	..	
5	2/6	Edmundson's Elec. Corp. Ord.	[illegible]	6 9 10	H'lf-yearly	
5	3/0	Do. 6 per Cent. Cum. Pref.	4½—4¾	6 13 8	—	
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106—108	4 3 3	..	106
2	1/7½	Electric Construction Co.	1½—1¾	6 8 9	July	
2	[illegible]	Do. 7 per Cent. Cum. Pref.	2½—2¾	5 12 9	July	
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	91—96	4 0 10	Jan, July	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	80—86	5 5 5	—	
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10	5 0 0	—	10
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	81—86	4 5 6	..	
5	10/0	†Henley's Telegraph Works Ord.	15½—16	6 10 8	Feb, Aug	15¾
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4 8 11	Feb, Aug	
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	109—111	4 1 1	Feb, Aug	
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	16—17	2 18 10	Feb, Aug	
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	103—105	3 17 5	Mar, Sept	104
10	3/0	Mather & Platt 6 per Cent. Cum. Pref.	11—11½	4 7 0	Mar, Sept	
12	24/0	†Telegraph Construction & Mainten'ce.	36—38	4 14 8	Mar, July	36
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	103—106	3 16 7	Jan, July	..
5	—	Willans and Robinson Ord.	1½—1¾	..	Apr, Oct	..
5	—	Do. 6 per Cent. Cum. Pref.	3½—3¾	—	Apr, Oct	
	4%	Do. 4 per Cent. 1st Mort. Debs.	76—80	5 0 0	May Nov	79

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these

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NOTES.

SIR OLIVER LODGE'S Royal Institution address, of which we give an account on another page, affords still another instance where steady pushing towards a definite practical end has enabled light to be cast into a dark place in pure science. In return, a fuller scientific understanding of the physical processes involved in the problem has brought, as usual, assistance towards the solution. Sir OLIVER has long been working to bring the task of fog-dispelling within the scope of engineering. The advent of the mercury rectifier went a long way towards a practical consummation of his desires. His efforts to improve the rectifier have now led him to the framing of a reasonable working hypothesis of its functions; a hypothesis which touches on other moot points in the theory of the vacuum tube, and so useful in connection with rectification as immediately to have suggested a new form of rectifier with increased efficiency. The hypothesis in question—that the *bulk* of the current is carried through a vacuum tube by positive ions, and that the flight of the cathode rays usually renders conduction difficult—may prove somewhat startling to the learned in these matters, and will not be at once accepted by them. But its helpfulness where it has been applied is its best recommendation. Sir OLIVER referred only slightly to the main problem of fog dispelling, and offered no quantitative information of the general efficiency of the process on the large scale at this present stage of the development of the apparatus. So we may at present chronicle only an improvement in detail.

◆

CONSIDERABLE interest attaches to certain portions of the annual report of the general manager to the Liverpool Corporation tramways. The question of steel-tyred *v.* chilled-iron wheels crops up once more, and it would appear that, as far as Liverpool is concerned, it has now been settled once for all. In 1898 the city had its first experience with steel-tyred wheels, and that experience was an unfortunate one, for the tyres "spread," and American chilled-iron wheels were substituted. The discarded steel tyres had been "made in Germany," and since that time British manufacturers have taken the subject up with no little success. The Liverpool tramways department has therefore returned to steel tyres once more. Top-cover cars are still in favour, and statistics show that if they are adopted the system may be worked, and more passengers carried, with fewer cars in service. But at the same time, the energy consumed per car-mile has increased during the last three years at the rate of 14, 20 and 31 per cent. respectively, as compared with that consumed in 1900. It would not, of course, be reasonable to assume that top covers are entirely responsible for this increase, as the number of passengers has also gone up, and there may be other causes. However, increase of passengers does not account for the greater cost for energy per car-mile during the last year, as there were actually 0·08 fewer passengers carried per car-mile than in 1903.

◆

TWO important patents have expired during the last few days. One, No. 5,074 of 1891, was granted to the Hon. C. A. PARSONS for improvements in steam turbines. In it the inventor draws attention to the fact that the steam in flowing from the inlet end to the exhaust end of the turbine gradually cools and passes into a supersaturated condition. In this state the steam contains considerable quantities of condensed water, which greatly impedes its flow, liquid friction being substituted for gaseous friction. The inventor then proposes to keep the steam in a dry condition either by superheating it before admission or by re-heating it during expansion by means of a steam-jacketed cylinder. With regard to the first solution, it is of historical interest to note that the specification says, "but this method would involve a temperature so high as to be detrimental to the surface of the engine, or it might cause distortion or damage. . . . ." Nowadays superheating is, needless to say, the only means adopted in turbines for keeping the steam dry, and steam jackets, especially favoured 14 years ago by the Hon. C. A. PARSONS, have since fallen into disuse. The superheater described and sketched in the patent specification consists of a coiled tube around which hot gases play, the steam being conducted through this coil before entering the turbine. The most important claim appears to be claim 2, which covers the combination of a superheater and steam turbine.

◆

THE second of the two expiring patents referred to is of more actual importance to electrical engineers. It is Mr. ALFRED DICKINSON'S patent No. 5,461 of 1891, protecting his well-known swivelling trolley and trolley pole. In years gone by central trolley wires were strenuously opposed on all sides because they necessitated either span wires, centre poles or side poles with long and ugly brackets. Mr. DICKINSON'S invention appeared at this juncture and jumped almost at once into universal favour. Now, however, there is a distinct reversion to the centre-running trolley, and even the fixed head is preferred by a large number of tramway engineers whenever it can possibly be employed satisfactorily.

◆

THE dispute between the Weybridge Urban District Council and the Urban Electric Supply Co., as to the supply of electricity in the neighbouring district of Walton-on-Thames from the company's Weybridge generating station, has been ended—at any rate for the present—by the passage through the House of Commons committee stage of a Bill authorising the company to do this. Similar questions of boundary have occasioned trouble to many electricity undertakers, but the circumstances in this case are somewhat different to the majority. The Urban Electric Supply Co. owned separate Provisional Orders for Weybridge and Walton, and in attempting to supply in both districts from the one station the company was held by the law courts to have come under the clause in the Electric Lighting Acts which prevents the holder of one Order from associating with the holder of another Order. In this case, of course, the holders of both Orders were one and the same company, but inasmuch as the Orders were separate, it was necessary to erect a generating station in each district unless a private wayleave could be obtained for the purpose of laying cables. This being impossible, it was necessary to promote a Bill, which was passed as above stated. Cases of this kind were dealt with in the Electricity Supply Bill which was passed by the House of Lords last session and then dropped.

◆

WE again devote considerable space to the Bill of the Administrative County of London and District Electric Power Co. in our Parliamentary columns this week. A good portion of the case for the opposition has now been heard, but the end is yet too far off to attempt any prophecy as to the decision. That the commercial abilities of the existing electric supply authorities is not of such a low standard as that stated by Mr. MERZ is proved by a perusal of our report this week, and it will be noted that the Chairman himself was particularly impressed by the evidence on this point, for in almost every case it appears that there is a staff of canvassers whose special duty it is to push the power part of the business. It is quite clear that great difficulties have been experienced in inducing London manufacturers to adopt electric driving, but the considerable development which has taken place during the past two or three years, as shown by the figures produced by the opposition to the scheme, indicates the reward of the persistent endeavours of the companies and local authorities to bring the advantages of this mode of driving before manufacturers. In Mr. NEVILLE'S address on behalf of the company, the conditions under which the present companies work and the effect of the purchase clause in their Provisional Orders were made clear to the Committee, and Mr. CONACHER'S evidence was sufficient to show that the more modern stations of the companies will be able to meet the increasing demand for power users in a far shorter time than the stations described in the promoters' scheme. The whole matter has now really come down to a question of cheapness of tariff.

◆

THE Marconi Company is still unsuccessful in the realisation of its schemes for telegraphing across the Atlantic. The day-by-day service for *The Times* has got no further than its inauguration two years ago, and the regular commercial service for the general public, promised from time to time, is constantly delayed for the erection of new stations or the modification of old ones. Last of all comes the service to ships at sea, which with the help of the Poldhu station was extended to ships in any part of the Atlantic a month ago. The Post Office has now ceased to accept telegrams for transmission by wireless telegraphy from Poldhu to ships at sea, this being probably owing to the uncertainty and delays which have occurred in the receipt of these messages.

◆

Lord Kelvin.—It was announced yesterday that Lord Kelvin had undergone a serious operation earlier in the week, but was progressing as satisfactorily as could be expected.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne—Pinheiros	Aug. 18, 1902 ..	—
Belasi-Issa (Yemen)—Camaran	Oct. 22, 1903 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—
Cayenne—Paramaribo	July 13, 1904 ..	Mar. 23, 1905
Jamaica—Colon	Jan. 10, 1905 ..	—

Large Frequency-changer for Shawinigan Falls.—According to the *Western Electrician*, the largest electric motor-generator ever built is now being installed at the plant of the Shawinigan Water and Power Co., Shawinigan Falls, Quebec. This machine was recently constructed by the Allis-Chalmers Co. of Cincinnati, and the synchronous motor is of 8,000 H.P. The rating of the generator is 5,750kw. at 300 revs. per min.

Manchester Local Section of the Institution of Electrical Engineers.—The annual general meeting of the Manchester Local Section will be held at the University (Physical Laboratory) on Tuesday, April 11th, at 7:30 p.m., for the election of chairman, vice-chairman, honorary secretary and 12 members of committee for next session. Dr. Hopkinson retires by rotation as ex-officio member of the committee, but is eligible for re-election. Nominations will be received up to April 2nd, At the above meeting, Mr. J. Frith will read a Paper on "Labour-saving Formulæ in the Design of Direct-current Dynamos."

The Society of Arts and the London Institution.—A scheme for the amalgamation of these two bodies is under consideration. A special meeting of the proprietors of the Institution has been called by the board of managers for next Wednesday, when the following resolution will be submitted :—

> That the proprietors of the London Institution approve of the amalgamation of the London Institution with the Society of Arts upon the lines, as far as possible, of the report of the joint committee, a copy of which has been furnished to each proprietor, and authorise the board of management to promote or to combine with the Society of Arts in promoting and obtaining an Act of Parliament for the purpose, and to take such other steps as may be necessary to carry the proposed amalgamation into effect.

Manchester Students' Section of the Institution of Electrical Engineers.—The annual general meeting of the students' section will be held at the Salford Royal Technical Institute on Friday, April 7, 1905, at 7 p.m., for the reading of the report, and the names of the new vice-chairman, hon. secretary and six members of committee for next session. The vice-chairman and hon. secretary are not open to re-election for the next session, but the following members remain on the committee :—

> H. N. Dutton (The British Westinghouse Co.), E. G. L. Mosley (Messrs. Mather & Platt), W. Winstanley (Lancashire Dynamo & Motor Co.), J. W. Campbell (other works), J. G. Potts (Central Station), R. W. Willis (Municipal School of Technology), C. F. Hewitt (Salford Royal Technical Institute).

After the above meeting, which will probably last till 8 p.m., a meeting will be held in the same room, when Mr. Jennison will read a paper on "Electric Cranes."

The Junior Institution of Engineers.—This Institution recently paid a visit to the Brockie-Pell Arc Lamp Works, Worship-street, London, where they were received by Mr. James Brockie, the inventor of the Brockie-Pell lamp, who gave a very interesting account of its development and construction, and described generally the necessary characteristics of an efficient arc lamp. In the workshops a number of lamps of different types were shown in course of manufacture and in the testing room demonstrations were carried out to illustrate the effect on the arc of two methods of regulation—namely, differential (main coil and shunt coil working in opposition) and shunt coil only, the result shown being that with the shunt coil alone the current might be varied very considerably without affecting the length of the arc, whereas with the differential method the variation in length of the arc was very considerable with the same change in the current strength. The two lamps were run in series so that each had the same current passing through it.

International Competitions.—Amongst the prizes to be awarded during the Milan Exhibition of 1906, by the Association of Italian Manufacturers for the Prevention of Accidents in Factories, are the following : (1) A gold medal and 8,000 lire for a new appliance for preventing accidents arising from contacts between primary and secondary windings in alternate-current transformers. The appliance must fulfil the condition that no disturbance in the action of the transformer must arise in case of atmospheric discharges or abnormal increase of potential. (2) A gold medal and 1,000 lire for a novel system of hand crane or winch fitted with a simple and practical contrivance to prevent the possibility of the handles revolving during the descent of the load. (3) A gold medal and 500 lire for a safety appliance, to be simple, strong and reliable, to stop trucks automatically on an inclined plane on the hauling rope snapping. The appliance must be adaptable to existing plant. All appliances entered for competition must be exhibited at the competitor's expense, in such dimensions and conditions as to allow of their being practically tested at the Milan Exhibition of 1906, in such time as may be determined by the Exhibition committee. No charge will be made for space. The appliances presented for competition are the property of competitors. Applications to compete must be sent in not later than July 31, 1905, addressed to the Presidency of the Association of Italian Manufacturers for the Prevention of Accidents in Factories, Foro Bonoparte, 61, Milan, from whom further information may be obtained.

Wireless Telegraph Notes.—It is stated by the Melbourne correspondent of the *Daily Chronicle* that the Australian Postmaster-General proposes to connect Tasmania and the mainland by wireless telegraphy.

According to a report by Capt. Gye, British Consul at Brest, a wireless station has been established near Stiff Bay, north-east of Ushant, and is opened to the public in connection with the French postal telegraph system. It is stated that the radius of communication with vessels at sea or other wireless stations is 140 miles. The charge for wireless telegrams is 7½d. per word to or from Ushant to a ship at sea or other wireless station, in addition to the local charge per word. Thus the total charge to or from any station in France is 8d. per word.

Lord Strathcona, the High Commissioner for Canada, has been notified by the Minister of Marine and Fisheries at Ottawa that the Canadian Government has decided to place a Marconi wireless telegraph station on Sable Island, and the station will come into operation by August 1st next. Sable Island is practically a rock and sandbank, 20 miles long, varying in width between one and two miles, lying off Nova Scotia ; it is sometimes almost entirely under water. Often it is enveloped by dense fogs, and the number of mishaps to shipping for which the island is responsible is very great.

University Intelligence.—According to *Nature*, by a statute passed in 1904, the University of Oxford established a "diploma in scientific engineering and mining subjects," and the committee appointed to arrange the details of the scheme has now issued the regulations concerning the diploma. Members of the University will be eligible for the diploma who have passed at the examinations required for the degree of B.A., and have satisfied the examiners in certain special subjects mentioned in the following list, after an approved course of study in those subjects extending over two years, and have also gone through an approved course of practical training lasting four months, either at a mine or in engineering works. The subjects that may be offered are : (*a*) Mathematics for applied science ; (*b*) physics and chemistry ; (*c*) French and German translation ; (*d*) engineering principles and machine drawing ; (*e*) surveying ; (*f*) geology ; (*g*) mineralogy ; (*h*) mining and engineering, hygiene and mine ventilation ; (*i*) electricity ; (*j*) assaying. For the ordinary diploma candidates will be required to pass in (*a*), (*b*) and (*c*), and in not less than three of the remaining subjects, provided that (*f*), (*g*) and (*i*) are not taken together without one or more of the others. Candidates who propose to become colliery managers and desire to obtain exemption from two of the five years' underground work required by the Home Office as a qualification for a certificate as colliery manager, must obtain a special diploma by passing in the subjects (*a*), (*b*), (*c*), (*h*), and three (not being *f*, *g*, *i*) of the remainder, and by taking their four months' course of practical training at a mine.

Telephony.—In his third Cantor lecture on "Telephony" last Monday evening, Mr. H. Laws Webb dealt with the equipment of telephone exchanges, illustrating his remarks with a number of lantern slides and the projection on the screen of some working models of spring-jacks. The lecturer commenced by describing the oldest switchboards and then traced step by step the development of the switchboard and its principal parts up to the modern multiple switchboard for central battery working. Three miniature switchboards of different periods, including one of recent design, had been lent by the Western Electric Co. and were connected up to a number of telephones in the room. The manipulations of telephone users and telephone operators at the telephone exchange were then actually gone through for the three sets of instruments referred to. Mr. Webb next dwelt briefly on the power plant of a modern exchange and referred to the general construction and subdivision of telephone buildings. He humorously remarked that the telephone exchange in Brussels was one of the rare instances in which the buildings were too large for the requirements, and the lantern slide illustrating the interior of the operating room at this exchange certainly bore out the lecturer's contention. Another slide showed the St. Petersburg exchange, in which the divided multiple switchboard system is being installed. "America," said Mr. Webb, "has discarded divided switchboards and St. Petersburg is just taking them up." There was a surprise in store for the audience in the form of a number ofbiograph pictures, showing the telephone exchange at London Wall in full swing. These pictures were taken, it appears, by the Biograph Co. only a few days ago with the permission of the National Telephone Co.

The Optical Convention.—The programme of arrangements for this Convention is now beginning to assume a definite shape. The Convention will be formally opened with an address from the President (Dr. R. T. Glazebrook, F.R.S., Director of the National Physical Laboratory) on the evening of May 30th, and the gathering will extend over the four following days up to and including Saturday, June 3rd. In the mornings Papers will be read and discussed, and there is no doubt that this most important section of the proceedings will result in valuable contributions to optical science, and will fulfil the aims which those who have been active in promoting the Convention have set before them. In addition to the Papers, demonstrations of apparatus of special interest will be given in the afternoons in the laboratories of the department of technical optics of the Northampton Institute. The exhibition of optical and scientific instruments will be held in the large hall of the Northampton Institute, and will be open daily to the public from 12 to 10 p.m. between May 31st and June 3rd inclusive. The charge for admission will be 1s. during the day and 6d. after 7 p.m. By an arrangemement made by the "exhibition and catalogue" sub-committee each section will be dealt with by an expert in the construction of the instruments represented in the section, together with an independent scientific member of the committee, so that all classes of instruments will be adequately dealt with and described. Arrangements for promoting the social interest of the gathering, and for providing for the comfort and convenience of members attending from outside London, are now being considered by a "hospitality and entertainments" sub-committee. In addition to the presidential address to be given on the Tuesday evening, which has already been mentioned, there will be an evening lecture by Prof. Silvanus P. Thompson, F.R.S., on "The Polarisation of Light by Nicol Prisms and their Modern Varieties." On the third evening it is proposed to hold a conversazione; and for the Saturday afternoon a visit to the National Physical Laboratory at Teddington is proposed, at the kind invitation of Dr. Glazebrook. Further particulars will be announced later, when the programme is more definitely settled. It will greatly help towards ensuring the social success of the Convention if intending members will send in their applications at once to the hon. secretary, Mr. F. J. Selby, Elm Lodge, Teddington, Middlesex, the subscription for membership being 5s. The "local societies and representatives" sub-committee is dealing with the question of facilities for the attendance of visitors from a distance, and the secretary of this committee is Mr. W. Rosenhain, 443, Gillott-road, Edgbaston, Birmingham, who will be glad to give information in answer to inquiries, and will also be ready to receive applications for membership of the Convention.

Prof. J. J. Thomson on Radio-activity.—The last of this short course of three lectures at the Royal Institution was delivered by Prof. Thomson on Saturday. The lecturer adverted to the new δ-rays whose discovery he described in the second lecture. The corpuscles in the δ radiation, though the same in every respect as those in the β-rays, move with speeds only one-fiftieth those common in the β-rays. Thus the energy per corpuscle is much smaller in the δ-rays than in the β-rays. It is, therefore, probable that δ-rays rather than β are given out by ordinary matter, if such matter gives out any rays at all. There is evidence that this actually happens in certain common metals, and especially when ultra-violet light is thrown upon the metallic surface. For example, the curious liquid alloy of sodium and potassium possesses the power of discharging a positively charged electroscope, very rapidly when illuminated by ultra-violet light and slowly even in the dark. Rubidium is still more active. If some of the metal, usually slightly oxidised, be heated in a vacuous tube, the blue deposit of the metal formed in the cold parts of the tube gives off while fresh a considerable amount of δ radiation in the most perfect darkness. Probably many bodies not usually styled radio-active possess to some extent similar properties. Prof. Thomson, after describing the changes the radium atom goes through in the course of its disintegration, emphasised the fact that radio-activity and transmutation always go hand-in-hand. The phenomena are, no doubt, due to instability in the atom. He did not think, however, that the questions of the stability of an atom and of a planetary system were on a par, for in the latter, instability would arise from an exceptional grouping of the planets and thus in a time which has a direct connection with the periodic times of those planets; while in the case of the atom, instability would seem to arise rather from such causes as bring about the inevitable fall of a spinning top. The frictional resistance which reduces the spin of the top till at last it can no longer maintain its erect position, has as its analogue in the atom, the radiation of energy in the electromagnetic form. Thus the average life of the radium atom—800 years—has no direct relation to the period of the corpuscles in the orbital motion, about 10^{-15} second. Finally, in answer to the question as to whether all elements are undergoing transmutation, affirmative evidence has been gathered in spite of the difficulty of freeing ordinary substances from that most universal element radium. Two methods are open. The first method consists in examining electrically a large number of samples of a pure substance. If the discharge rate of each sample is the same the probability is against its being due to radium, whose proportion is almost sure to vary among the samples. The second method is to consider the penetrating power of its radiation as a specific property of each substance, as it certainly is among the radio-active elements; that is, to measure the penetrating power of the radiation from a substance, and note if it differs from that of radium and other substances. Both methods point to the possession of radio-active powers by the ordinary metals.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY March 31st.

Institution of Mechanical Engineers.

8 p.m. Extra Meeting, when the "First Report of the Steam Engine Research Committee" will be further discussed.

MONDAY, April 3rd.

Society of Arts.

8 p.m. Cantor Lecture IV.: "Telephony," by H. Laws Webb.

TUESDAY, April 4th.

Faraday Society.

8 p.m. Meeting at the Institution of Electrical Engineers, 92, Victoria-street, London, when the following papers will be read:—(1) "Alloys of Copper and Antimony and Copper and Bismuth," by A. H. Hiorns. (2) "Refractory Metals for Furnace Linings" (Discussion), by E. Kilburn Scott. (3) "Electrically Heated Carbon Tube Furnaces," Part I., by R. S. Hutton and W. H. Patterson.

THURSDAY, April 6th.

Junior Institution of Engineers.

7 p.m. Visit to the Taylor's-lane Generating Station of the North Metropolitan Electric Power Supply Co., at Willesden.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting. A Discussion will take place on the Report to the Council on the International Electrical Congress at St. Louis, by W. Duddell; and the Papers on "Systems of Electric Units," by Prof. Ascoli, Prof. G. Giorgi, Professors H. S. Carhart, G. W. Patterson and Dr. F. A. Wolff, published in Part 170 (last issue) of the *Journal*, pp. 171–228.

Röntgen Society.

8.15 p.m. Ordinary General Meeting at 20, Hanover-square. Exhibition evening.

FRIDAY, April 7th.

Manchester Students' Section: Institution of Electrical Engineers.

7 p.m. Annual General Meeting at the Salford Technical Institute.

8 p.m. Ordinary Meeting at Salford Technical Institute. Paper to be read: "Electric Cranes," by M. Jennison.

Royal Institution.

9 p.m. Evening discourse on "American Industry," by Alfred Moseley.

SATURDAY, April 8th.

Royal Institution.

3 p.m. Afternoon Lecture II. on "Some Controverted Questions of Optics," by the Rt. Hon. Lord Rayleigh, F.R.S.

"A PERTINACIOUS CURRENT."

At the Royal Institution last Friday evening, Sir Oliver Lodge discoursed on what had quaintly been announced as a "pertinacious current." This mysterious title must have raised in electrical minds serious misgivings as to the real nature of the subject of the lecture; for, considering the personality of the lecturer, the current might equally well have been psychical, social or merely physical. But doubts were dispelled on arrival in the theatre by the sight of the table groaning under a great load of inductoriums, condensers and vacuum tubes. At the very beginning of his discourse, Sir Oliver was good enough to satisfy all curiosity by an explanation. A pertinacious current is a continuous unidirectional discharge of electricity, obtained without cells, and under an E.M.F. so high that ordinary big resistances are easily over-ridden. The necessity of producing such currents by practical methods—that is, by a magnetic method, in contradistinction to the big battery method—had been thrust upon the lecturer by his experiments in fog-dispelling, where, of course, a high-potential unidirectional discharge is essential. A magnetic method has been found and, as many of our readers will remember, was described by Sir Oliver Lodge at a meeting of the Physical Society in November, 1903.

The method consists in using the mercury rectifier to trap in a reservoir the surges from an induction coil. The rectifier operates like a valve controlling the inlet of a cistern into which water is intermittently pumped. In this analogy the water stands for electricity, the pump for the induction coil, and the cistern for the Leyden jar of the electrical case. It was in the explanation of the internal action of the rectifier the interest of the evening mainly centred. Sir Oliver proposes the following excellent theory of the vacuum tube rectifier: He believes the current is carried through a rarefied gas chiefly by the positive particles, the electricity conveyed by the negative particles or corpuscles being comparatively small in amount. Anything which hinders the passage of the positive ions increases the effective electrical resistance of the tube. Now, the cathode rays, constituted as they are of corpuscles moving with immense velocities in the direction opposed to the much slower motion of the positive ions, may by the bombardment of the oncoming ions considerably hinder their direct advance. Indeed, as the vacuum of the tube is increased the plus carriers have increasingly greater difficulty in travelling from the anode to the cathode, and usually manage it only by creeping unobtrusively along indirect paths to those parts of the cathode from which the bombardment is least vigorous. In fact, it is found that the long-continued bombardment of the plus ions, which are probably merely the atoms of the rarefied gas, can drive them right out of the tube and so produce the well-known effect of increasing the vacuum. Portions of gas may even be added and driven out in succession in this manner, and when there are no positive carriers left conduction becomes very difficult. To ensure good conductivity, therefore, the positive carriers must be protected from the negative bombardment and must be given plenty of chance to reach the cathode.

This theory at once helps to an understanding, as Sir Oliver Lodge showed, not only of the main function of a mercury rectifier, but, besides, of the action of that small but very necessary adjunct to the mercury vapour tube—namely, the conducting coating outside the glass round the edge of the liquid mercury which acts as cathode at the bottom of the tube. This conducting Leyden-jar-like coating must be connected to the positive electrode by a wire outside the tube, or the tube is not a rectifier. The explanation of this phenomenon lies in the fact that the conducting coating when so connected establishes through the glass a strong electric field, which diverts the cathode stream from the centre of the vertical tube, thus leaving an open pathway for the positive carriers from the anode above. It is easy now to see why the tube is a rectifier, for if the outside terminals be imagined reversed, so that the mercury is anode and the upper iron electrode is cathode, a stream of undiverted cathode rays pours down the tube, stops the upward travel of the positive carriers, and renders conduction extremely difficult. Such a tube of average size will carry about 5 amperes from 100-volt mains when the plus ions move downwards, but practically nothing when they must move upwards.

Further, the theory proposed suggests new and efficient forms of rectifier. One such was described and exhibited by the lecturer. In it advantage is taken of the rectilinear propagation of the cathode rays, when they are free from the deflecting influences of a strong electric or a magnetic field. Here the cathode is a wire stretching vertically the length of the tube. The anode is a smaller electrode, surrounded by a horizontal narrow glass cone or cylinder. In this cone the positive carriers may reside in large numbers, well protected from the cathode ray bombardment, and, as fast as may be, escape from the open end of the cone with a fair chance of reaching the extended cathode. With such a tube Sir Oliver showed an interesting and instructive experiment. Reversing the terminals, the electrode in the cone becomes the cathode, and the negative corpuscles, by their bombardment, quickly eject the positive carriers from the region. On restoring to the terminals their proper signs an appreciable interval elapses before the tube lights up again in active conduction, showing at once the reality of the emptying process which had been applied to the region round the anode, and, besides, the comparatively slow rate of diffusion of the plus carriers back to their former home.

A number of effective experiments illustrated, during the hour, various applications—ranging from fog-dispelling and Rontgen-tube driving to the burning of a long wet string—of the pertinacious current afforded by Leyden jars kept supplied through a series of rectifiers with electricity from a large induction coil.

LIVERPOOL CORPORATION TRAMWAYS.

The annual report of the general manager to the Liverpool Corporation Tramways has just been issued by Mr. Bellamy. In the joint report to the Tramways committee on July 15th, the engineers and general manager stated:—

> The wheels of the German cars, which were the first to be used in Liverpool in 1898, were steel tyred, and the wheels of the American cars which followed were chilled cast-iron. The steel tyres "spread" in running, became loose and out of gauge, and were ultimately abandoned in favour of the chilled wheel, which was giving much better results on the American cars. The British manufacturers commenced the production of special steel tyres for tramcars about 1900, when their experimental use in competition with chilled wheels began. These experiments were carefully watched, and in May 1902, a number of selected tyres were placed in service in Liverpool, and later it was considered desirable to try tyres of all the representative makers. Fifty-two of the cars are now fitted with steel-tyred wheels, none of which have yet worn out, and, therefore, final figures cannot be quoted. Very divergent results have, however, been obtained, the mileage per unit of wear varying to the extent of 50 per cent., indicating the importance of selecting tyres of suitable composition. As a result of the experiments carried out for the last two years, a steel-tyred wheel is now being assembled and finished at Lambeth-road works, which will cost 50 per cent. less than the price at which such wheels can at present be bought, and which, it is believed, will afford a life considerably in advance of the average of these wheels, which may be estimated at 60,000 miles, the average mileage of chilled wheels in Liverpool being 35,000. It is hoped that on trial this new wheel will be found suitable for general adoption.

Since the date of that report over 100 cars have been fitted with new wheels, which are giving satisfactory results, and the work of general equipment is proceeding.

The total number of cars fitted with top covers and in service to date amounts to 317, out of a total of 350 the committee have ordered to be completed. As showing the effect of the top cover, it may be pointed out that the average maximum number of cars in service for 1904 was 398, as against 407 for 1903, while the passengers carried increased by 3,585,429. A census of passengers on a typical route has been taken under conditions which ensured the maximum requirement of passengers being recorded, and the car accommodation was found to be mostly in excess of the requirements.

The Liverpool plough guard has satisfactorily maintained its reputation for preventing persons getting under a car. Although during the year 123 people fell in front of the cars or were knocked down, and passed under the platform they were all sheered clear, only three cases of fracture occurring.

Passengers, Mileage and Receipts.

	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.
Passengers—Electrics	..	785,064	15,853,160	58,068,531	100,076,789	108,906,472	113,015,728	116,642,663
Horse cars	30,596,229	31,985,158	39,321,946	19,051,875	218,166	74,685	41,506	..
Omnibuses	7,812,855	9,001,812	8,596,344	5,247,552	813,825	354,428	..	..
Total	38,409,084	41,772,034	63,771,450	82,367,958	101,108,780	109,335,585	113,057,234	116,642,663
Mileage—Electrics	..	53,197	1,473,750	5,584 357	10,771,461	11,705,425	11,724,097	12,166,419
Horse cars	4,674,609	4,736,103	4,758,652	2,571,163	46,247	16,534	10,741	..
Omnibuses	1,338,573	1,490,458	1,368,144	945,346	152,355	68,856	..	..
Total	6,013,182	6,279,758	7,600,546	9,100,866	10,970,063	11,790,815	11,734,838	12,166,419
Receipts—Electrics	..	£4,087	£77,145	£284,759	£463,164	£504,304	£524,321	£540,850
Horse cars	£239,399	250,975	234,756	105,212	717	278	147	..
Omnibuses	51,344	59,145	47,658	27,603	4,502	2,146	..	..
Total	£290,743	£314,207	£359,929	£417,574	£468,383	£506,728	£524,468	£540,850

During the year six persons were killed, while the number of persons who met their death in Liverpool through vehicles other than tramcars during 1904 amounted to 30.

The ratio of fatalities to passengers carried on the railways, according to the most recent Board of Trade returns, amounts to 1 in 1,030,917, while that of the Liverpool tramways for 1904 was 1 in 19,440,444.

During the year 4,504 cars have been sent into the works for ordinary repairs, which shows an average running of 2,793 miles in each case. There are now five car depots in full service, the Litherland depot having been opened on October 18, 1904, for the accommodation of 44 cars operating the Bootle routes.

During the year the total number of emergency calls in connection with the overhead equipment amounted to 558. These calls are exclusive of 65 for the breakdown waggon, dealing with obstructions caused by vehicles of various descriptions having broken down on tramway tracks in different parts of the city, and requiring to be removed to facilitate tramway traffic. In every case the work in connection with the emergency calls has been carried out expeditiously, and with a minimum interruption to traffic. During the six days ending April 18th the whole system was operated without an emergency call. The cost of maintenance and renewal of overhead equipment during the last four years has been as follows:—1901, £8,955. 3s. 6d.; 1902, £6,223. 14s. 9d.; 1903, £4,672. 17s. 1d.; 1904, £4,808. 19s. 11d. The slight increase in the cost of upkeep as compared with 1903 has been brought about in consequence of the fixing of additional suspensions to all the section insulators. The connections to these have been found to be the weakest part of the system, and the cost of carrying out the necessary strengthening has been charged to revenue.

The total electrical energy used during the year 1904 for haulage and lighting of cars, &c., was 20,045,629 units, as against 17,978,718 units for the year 1903, an increase of 11·49 per cent. The following table indicates the annual increased energy used since 1900:

Year.	Units used per car-mile.	Percentage increase over preceding year.	Percentage increase over 1900.
1900	1·197	..	..
1901	1·289	7 per cent.	..
1902	1·365	5 "	14 per cent.
1903	1·448	6 "	20 "
1904	1·566	8 "	31 "

The following are the average prices per unit paid to the Electric Power and Lighting committee per unit during the four years 1901 to 1904:—1901, 1·2d.; 1902, 1·2d.; 1903, 1·098d.; 1904, 1·159d. The price charged for energy includes the total working and capital cost, and delivery of the current at the section boxes. The average of the weekly maximum number of cars in service during 1904 amounted to 389, as against 407 in 1903. The greatest number of cars in service on any one day was 467.

The increase of passengers for the year 1904 over 1903 was 3·2 per cent., and the receipts increased 3·1 per cent.

At the end of 1904, the total capital expenditure was £1,916,258, as compared with £1,863,185 of the previous year.

The following table gives a few of the most interesting figures in connection with the revenue and expenditure during 1903 and 1904:—

	1903.		1904.	
	Total.	Per car-mile.	Total.	Per car-mile.
REVENUE.	£	d.	£	d.
From passenger traffic	524,468	10·733	540,850	10·66
Miscellaneous sources	7,015	0·13	6,875	0·14
Total	531,483	10·86	547,625	10·80
EXPENDITURE.				
Maintenance and renewal of cars and fittings (including new life-guards, ventilators, emergency boxes, signal bells, &c.	37,882	0·775	42,722	0·842
Maintenance of tools & machinery	1,167	0·023	1,322	0·026
Maintenance of sundry stock	590	0·012	721	0·014
Repairs to sheds, &c.	1,744	0·035	1,799	0·035
Electrical energy—haulage, lighting cars, &c.)	80,956	1·657	94,937	1·872
Road and traffic expenses—				
Salaries—Wages to drivers, conductors, inspectors, &c.	121,651	2·490	121,205	2·390
Gravelling, &c.	1,729	0·035	1,404	0·027
Cleaning, &c., of cars	9,316	0·190	9,223	0·181
Cleaning and lighting sheds, &c.	2,483	0·050	2,509	0·049
Lighting routes	147	0·003	150	0·002
Tickets and punches	2,341	0·047	2,030	0·040
Repairs, &c., of knee aprons	213	0·004	44	0·0008
Licences	401	0·008	427	0·008
Advertising, printing & stationery	808	0·016	935	0·018
Uniform clothing, bags, &c.	3,442	0·070	4,374	0·086
Sundry charges	2,581	0·052	2,349	0·046
Maintenance and renewal of lines	21,144	0·432	25,119	0·495
Ditto, electrical equipment	4,673	0·095	4,809	0·094
Acknowledgments for privilege of affixing rosettes	158	0·003	158	0·003
Rental of lines in Bootle	5,842	0·119	5,858	0·115
General charges, including rates and taxes, management and office expenses, compensation and law charges, &c.	41,632	0·852	45,751	0·902
Total	340,900	6·968	367,846	7·246
Car-mile earnings	..	10·73	..	10·67
		% to mean cap exp.		% to mean cap. exp.
Working profit	190,020	10·09	179,780	9·38
Transferred to reserve, renewal and depreciation fund	64,162	3·43	52,218	2·73
Net interest & sinking fund charges	93,777	4·9	98,453	5·14
Contribution in aid of general rate	32,081	1·72	27,109	1·41

The percentage of operating costs to total revenue was 64·247 per cent. in 1903 and 65·9 per cent. in 1904. In 1903 the passengers carried per car-mile amounted to 9·66, but last year this figure was smaller by 0·08.

Royal Society.—Among the Papers down for reading yesterday was the following:—"The Determination of the Specific Heat of Superheated Steam by Throttling and other experiments," by A. H. Peake. Communicated by Prof. J. A. Ewing, F.R.S.

ELECTRICAL EQUIPMENT OF MESSRS. HARLAND & WOLFF'S SHIPBUILDING WORKS.

(Continued from p. 915.)

Variable speed motors, with controllers specially designed either for one or two voltages are being installed to a considerable extent, especially in connection with the lathes. Fig. 24 shows the construction of the "double voltage" controllers built by the Electric and Ordnance Accessories Co. for Messrs. Harland and Wolff. The two voltages are 220 and 440, and a wide range of speed regulation is allowed for, the controller and resistances being designed so that it can be left on any stop without injurious heating.

For all sizes up to and including 15 H.P. the following cycle of operations will serve to illustrate the different speeds at which the motors may be run. The shunt is excited at 440 volts and is switched on to the mains immediately before the armature circuit is completed.

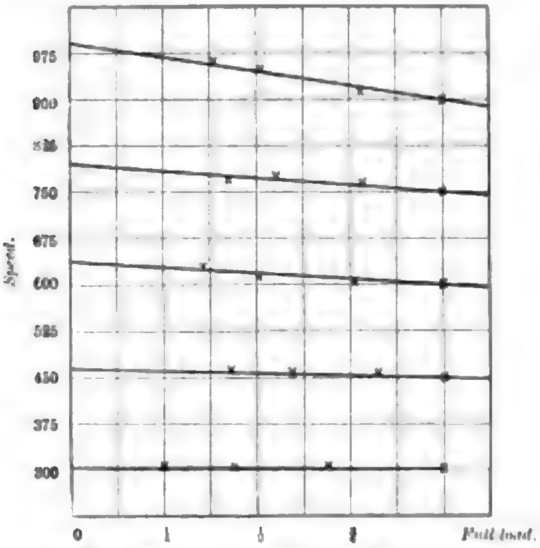


FIG. 23.—TEST ON 10 B.H.P. VICKERS VARIABLE SPEED MOTOR.
300-900 revs. per min.

Commencing from the "off" position and moving the controlling lever in a clockwise direction we shall get :—

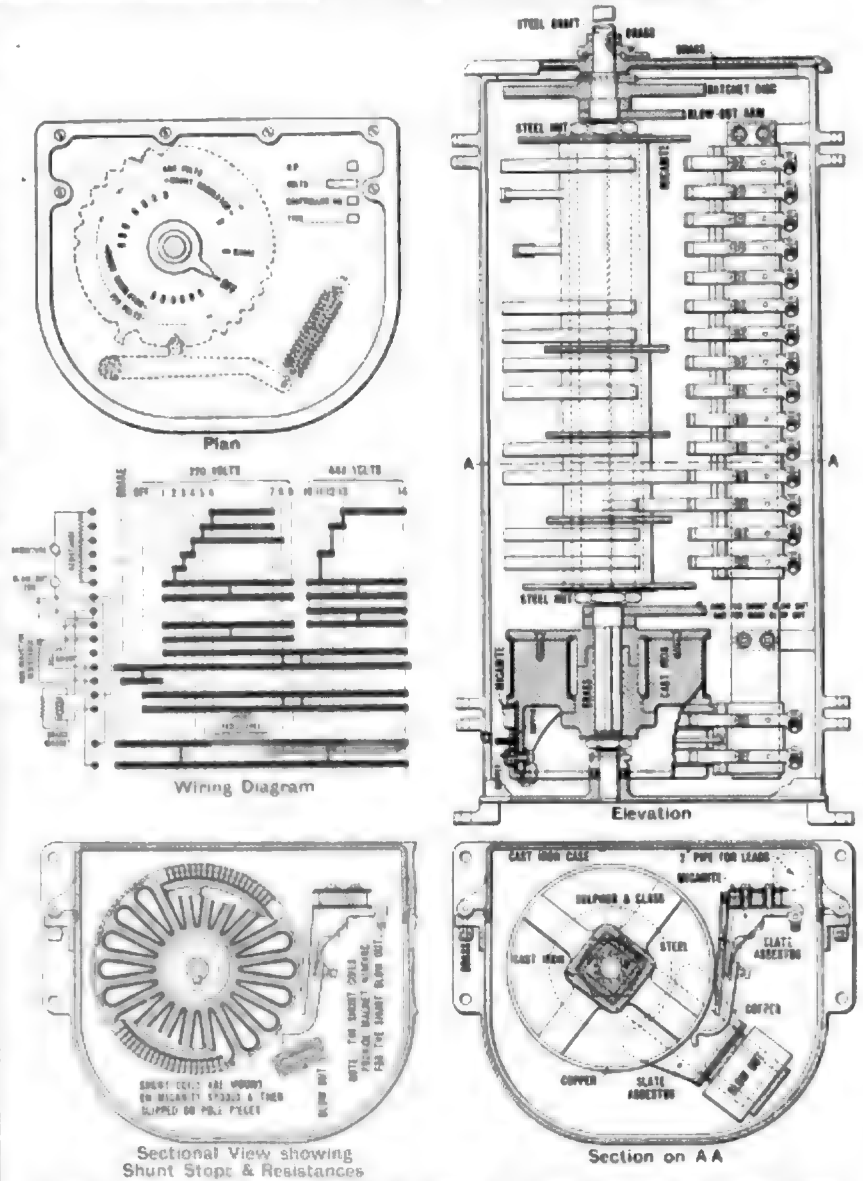
Off Position.
  (1) Brake magnet excited—Brake lifted.
  (2) Shunt resistance connected across kicking coil.

1st Starting Position.
  (1) Ditto as regards brake magnet.
  (2) Shunt excited across 440 volts, and no resistance in series with its winding, giving maximum strength of field.
  (3) Armature in series with all starting resistance across 220 volts.

2nd to 5th Starting Positions.
  (1) and (2) Ditto.
  (3) Armature starting resistance gradually cut out.

6th Running Position.
  (1) and (2) Ditto.
  (3) Starting resistance all cut out and armature direct on 220 volts, giving lowest normal speed.

Then follow 20 shunt regulating positions, resistance being inserted in series with the field winding. To obtain a further increase in speed the motor armature must be brought across the 440-volt mains. In order that the motor shall not have time to slow down, the next move must be made quickly. First, the shunt resistance is short-circuited to give a strong field, and then the armature resistance is inserted in two sections to reduce the arc formed on breaking before



STEEL SHAFT
BRASS
BRASS
RATCHET DISC
BLOW-OUT ARM
STEEL NUT
MICANITE
STEEL NUT
MICANITE
BRASS
CAST IRON
A
A
220 VOLTS
440 VOLTS
OFF
CAST IRON CASE
PIPE FOR LEADS
MICANITE
SULPHUR & GLASS
STEEL
CAST IRON
SLATE ASBESTOS
COPPER
COPPER
SLATE ASBESTOS
BRASS
BLOW OUT
SHUNT COILS ARE WOUND ON MICANITE SPOOLS & THEN SLIPPED ON POLE PIECE
NOTE. THE SHUNT COILS PROVIDE MAGNET WINDING FOR THE SHUNT BLOW OUT.
BLOW OUT

Plan

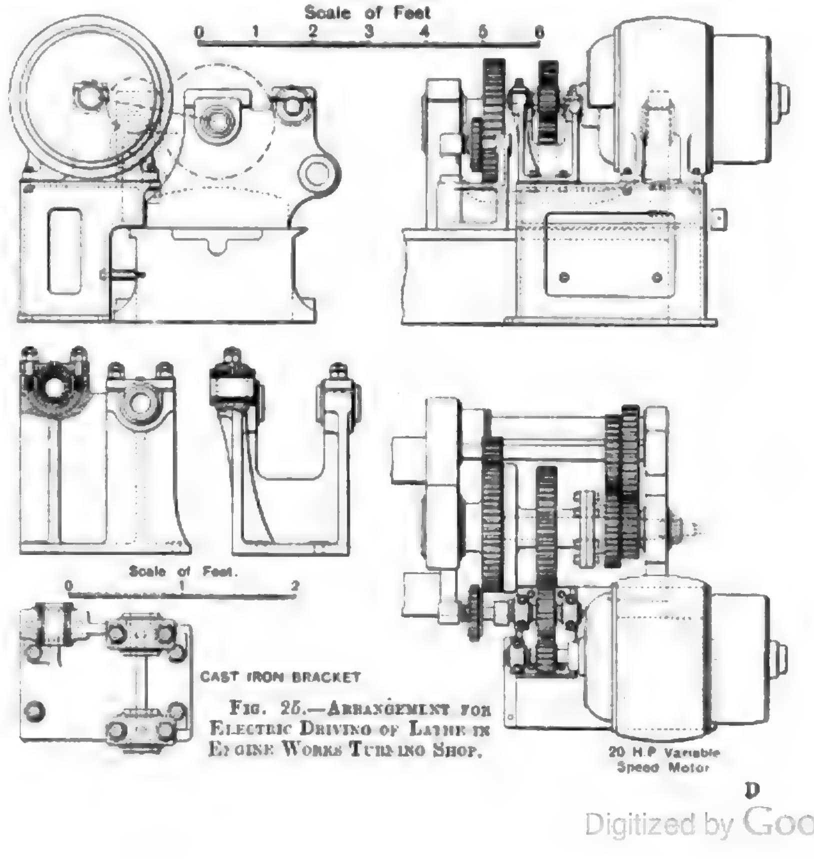
Wiring Diagram

Elevation

Sectional View showing Shunt Stops & Resistances

Section on A A

FIG. 24.—GENERAL ARRANGEMENT OF 15 H.P. DOUBLE VOLTAGE CONTROLLER 220–440 VOLTS.
Scale 1 : 10.



Scale of Feet
0
1
2
3
4
5
6
Scale of Feet.
0
1
2
CAST IRON BRACKET
20 H.P. Variable Speed Motor

FIG. 25.—ARRANGEMENT FOR ELECTRIC DRIVING OF LATHE IN ENGINE WORKS TURNING SHOP.

changing over to the first step on the 440-volt circuit. The next series of operations repeats that detailed on the 220-volt system with the exception that the armature resistance is cut out in three sections, *i.e.*, giving four speeds instead of six as on the lower voltage.

It will be seen that by this arrangement no fewer than 40 different speeds may be obtained entirely by shunt regulation. The single voltage controllers permit of 30 different speeds. These are apart from armature regulation, which is not employed as a general rule. All the controllers are fitted with contacts to which a magnetic brake can be connected, the shunt coil of the latter being de-energised when the controlling lever is moved in a counter-clockwise direction to a stop beyond the "off" position, thus allowing the gravity brake to act. It may be added that upon the field winding being cut off from the mains it is immediately short-ciruited through a non-inductive resistance, whose resistance is rather greater than that of the field itself. This prevents any damage from arcs which would otherwise be formed; this arcing would be severe owing to inductive effects, if the kicking coil were omitted.

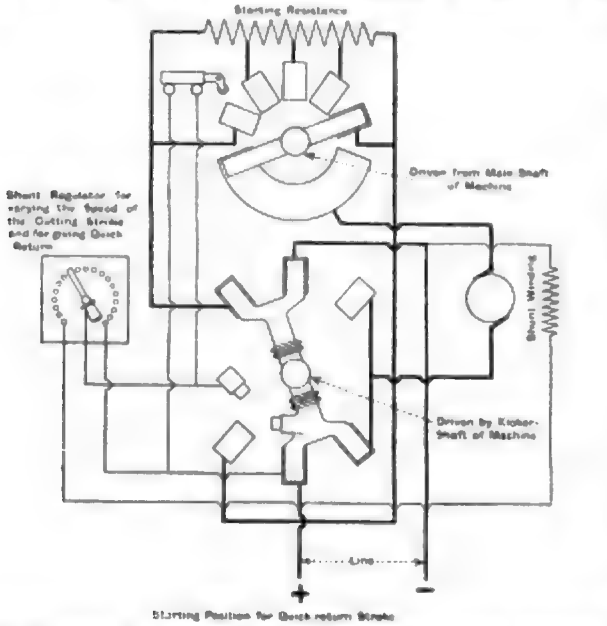
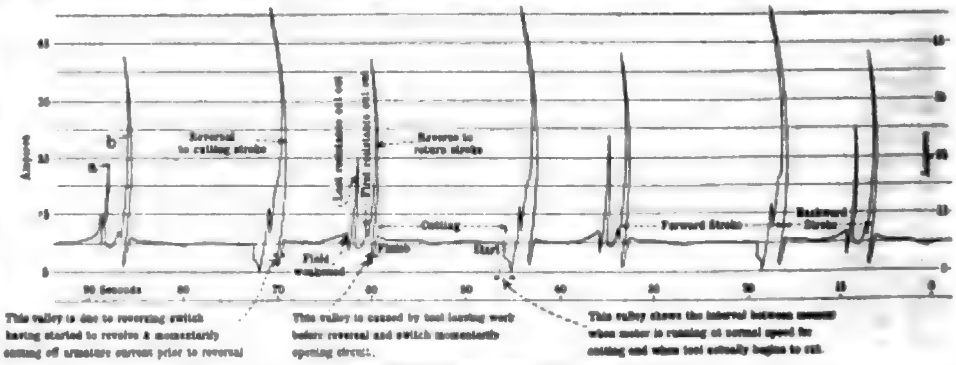

Starting Resistance
Driven from Main Shaft of Machine
Shunt Regulator for varying the Speed of the Cutting Stroke and for giving Quick Return
Shunt Winding
Driven by Kicker-Shaft of Machine
Line
+
−
Starting Position for Quick-return Stroke

FIG 26.—DIAGRAM OF CONNECTIONS FOR REVERSING SWITCH FOR PLANER.

In general appearance the controller is similar to those usually supplied in connection with cranes or on tramway cars. It is furnished either with a lever or handle of the tramway type, or, in the case of long lathes, where the operator may be at some distance from his headstock, with the shaft projecting at either end, to allow of the barrel being coupled to a splined shaft or other gear. In size it is approximately the same as an ordinary barrel type of tramway controller. The shunt rheostat is self-contained in the controller carcase, but the armature resistance is separate, this being contained in enclosed ventilated iron boxes. The resistance consists of iron grids painted with aluminium paint. The main barrel is of cast iron, and as each part is entirely self-contained, interconnections between different sections are entirely dispensed with. All the segments are firmly cemented to a square steel shaft by an insulating cement, a thick micanite washer being inserted between the separate parts. The actual contact plates are of stout copper, the whole being turned up true after assembly.



Readings in amperes at 440 volts.

FIG. 28.—TEST MADE ON SHANKS' VERTICAL AND HORIZONTAL PLANER (WALL CREEPER) DRIVEN BY VICKERS' 10 B.H.P. VARIABLE SPEED.

Continuous-current reversing motor with auto. electrical control. Work: Planing cast-iron cylinder column. Cut: ½in. Feed: $\frac{1}{16}$in. Revs. on cutting stroke: 250 per min. Revs. on return stroke: 486 per min. Travel of tool: 4ft. 4in. horizontally. Travel of cut: 3ft. 11in. horizontally. Rate of cutting: 16ft. 8in. per min. Rate of return stroke: 29ft. per min.

The shunt rheostat is on a drum fitted in the base of the controllers. The copper contacts are built up in the form of a commutator, while the resistance is wound on micanite bobbins, the wire used being double cotton-covered "Eureka."

The contact fingers are of stout hard-drawn copper, the links between these and the brass carriers being of laminated phosphor bronze to give a good spring. These carriers are carried upon and clamped to a mild steel bar rectangular in section, and are insulated from it by a micanite tube which fits over the bar and runs over its entire length.

Both armature and shunt contacts are protected by magnetic blow-out coils swivelled upon the main shaft; the shaft becomes one pole of the blow-out magnet, the magnetic path being directly across the point of contact of the fingers. As the coil is practically of the same length as the barrel, the magnetic effect throughout must be equal.

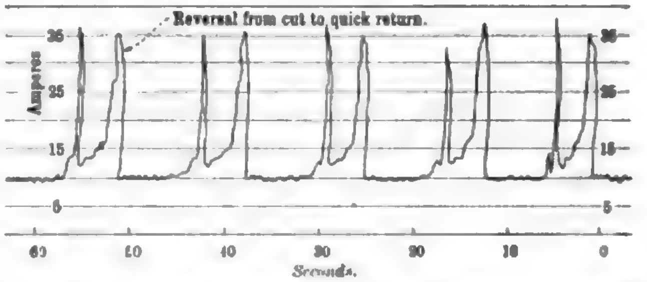


FIG. 27.—Test made on Horizontal and Vertical Planing Machine. Wall creeper: Speed of cut 16ft. per minute. Return 32ft. per minute. Weight of column and tool box reversed about 10 tons. ½in. cut, with one roughing tool $\frac{1}{16}$in. feed. Readings in amperes at 440 volts.

The carcase is of cast iron, arranged with fixing lugs, which allow of the controller being fixed in either an upright or horizontal position. It is advisable, where possible, to fix the controller in the upright position, as a ball bearing is arranged to take the weight of the barrel, which is necessarily rather great. The carcase is surmounted by a brass top with a mat surface. The front of the controller consists of a planished and black stove-enamelled sheet-steel cover which is fixed to the carcase by swivel bolts and section thumb nuts.

All the cables are brought through the bottom of the carcase.

The controller throughout is built with a view to its being used in damp places, all arc shields and spark guards being of fireproof ambroin, which is non-hygroscopic, while the case and all exposed parts in the interior are served with asbestos paint and stoved.

Fig. 23 gives the test curves of a variable speed motor, showing the speed variation as the load comes on at different initial speeds, *i.e.*, with various amounts of excitation as determined by the controller.

Fig. 25 shows the arrangement followed in adapting some of the lathes for electric driving. In this case it is seen that it has been necessary to employ an idle wheel, as the motor could not be got near enough to the lathe. Both the motor pinion and the idle wheel have bearings on both sides for the reasons explained in an earlier part of this article.

One of the most interesting applications of electric driving is the application of a variable speed motor to a planing machine, the accelerated speed for the return stroke being provided by the motor itself directly, without the usual complication of straight and crossed belt. This arrangement is due to Mr. A. D. Williamson, of Messrs. Vickers, Sons and Maxim, and was briefly referred to in Mr. Williamson's Institution Paper 18 months ago. The pair of switches shown diagrammatically in Fig. 19 are driven from the main and the "kicker" shaft of the planer. The switch driven by the kicker shaft reverses the motor at the end of the cutting stroke, and then the switch driven by the main shaft immediately inserts a resistance in the field circuit which raises the speed. At the end of the return stroke this resistance is short-circuited, to provide a strong field for reversal of the armature current. This cycle is plainly seen in Fig. 28, which is a load diagram taken during actual working conditions, and it may be compared with the diagram of the same machine working with straight and cross belts, which we reproduce (Fig. 27) from our issue of March 13. As the work done by machine in the two cases was different, too close a comparison of the areas showing the energy consumed would not be correct, but the main characteristics of the two curves may fairly be compared—to the advantage of the method with the reversing motor. The lost energy on the reversals is evidently less, although the momentary peaks appear higher owing to the suddenness of the change. It is interesting to note that in this case the "mountain," on change from the cutting to the return strokes, has two peaks—marked *a* and *b* in the diagram—the division into the two parts being due to the cutting out of the resistance in the armature circuit gradually after the reversal of the current. Other characteristics are pointed out on the diagram itself. Messrs. Harland and Wolff now propose to speed this tool up to about 18ft. per second. The motor, it should be mentioned, runs practically without sparking.

(*To be concluded.*)

THE YARMOUTH-GORLESTON SUBMARINE CABLE.

On March 7th an interesting piece of cable laying was carried out at Great Yarmouth by the Callender Cable and Construction Co. For no less than 14 years the question of carrying lighting and traction cables from Great Yarmouth to Gorleston, a neighbouring and much smaller watering place, has been discussed by the local authority. Mr. T. W. Cockrill, the borough surveyor, has submitted schemes for suspending the cables above the harbour, for building a subway and for erecting a transporter bridge. However, none of these methods was considered suitable, and eventually a trench, 7ft. deep, was dug across the harbour bed. This was the condition upon which the Board of Harbour Commissioners gave their consent. Great difficulty was experienced in dredging this trench, which was carried out under the direction of Mr. T. W. Cockrill by the Harbour Commissioners' dredger. It took nearly a fortnight to get the trench dredged out, as it was necessary to go back some 100ft. on either side of the proposed trench, and gradually take down the bed of the river to the required depth. Nearly 6,000 tons of material were taken out by the dredger.

When everything was ready Mr. Harold Hastings, assistant contracts manager of the Callender Company, proceeded to Yarmouth in order to superintend the laying of the cables. The three drums containing the three lengths of cable were mounted side by side across a lighter, and an outrigger was also mounted to guide the cables over the stern. Just before high tide the ends of the cables on the Gorleston side of the river were passed through holes which had been cut in the piles, and were made fast on the shore. A line was then stretched across from bank to bank exactly over the centre of the trench which had been taken out. Immediately the tide stopped flowing men commenced to haul the lighter across, as shown in Fig. 1. At the same time the cables ran out over the stern and dropped into their position in the trench. On arriving at the Yarmouth bank, the ends of the cables were taken off the drums one by one, and passed through holes cut in the piles, and secured in a trench dug on the land side of the piles. The actual crossing of the river was carried out in 10 minutes from the time the lighter left the Gorleston bank to the time it arrived at the Yarmouth bank.

The tide at Yarmouth is one of the swiftest on the coast, so that it was necessary to arrange everything to avoid any hitch, because once being caught by the tide would have meant a great fiasco. This was fully appreciated by all concerned, and every precaution against a hitch was taken with success. After the cables had thus been placed in position, a diver was sent down at each end to secure them to piles all the way up, and in addition to this they have been cased in with sheet piling. The depth of water at low tide in the river is 16ft., so that the depth of the cables is 7ft. lower—viz., 23ft.

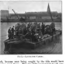


FIG. 1.—LAYING THE CABLES.

FIG. 2.—SECTION OF 0·15 SQ. IN. CONCENTRIC SUBMARINE CABLE.

Diameter over	Inner Conductor ([illegible])	[illegible]
" "	Pure and V.I.R.	[illegible]
" "	Tapes	[illegible]
" "	Outer Conductor ([illegible])	[illegible]
" "	Pure and V.I.R.	[illegible]
" "	Tapes	[illegible]
" "	Yarn	[illegible]
" "	1st Layer of Armour ([illegible])	[illegible]
" "	2nd " " ([illegible])	[illegible]
" "	Final Yarn	[illegible]

Each cable was 0·15 sq. in., single, insulated with pure and vulcanised India rubber, taped, heavily yarned, and armoured with a double layer of galvanised steel wires, finally yarned and compounded over all. There were three lengths of this, each 170yds. long. The distance from bank to bank was slightly over 90yds. Fig. 2. is a section of the cable.

TEMPERATURE TESTS ON INSULATING MATERIALS AND FIELD COILS.

The following is an abstract of the discussion which took place at the Institution of Electrical Engineers in connection with the Papers by Mr. E. H. Rayner, entitled "Report on Temperature Experiments carried out at the National Physical Laboratory," and Mr. Rud. Goldschmidt, "Temperature Curves and the Rating of Electrical Machinery." The Papers themselves were published in abstract in our issue of March 17.

Thursday, March 9th.

Dr. R. T. **GLAZEBROOK**, F.R.S., offered one or two words of explanation as to the experiments. When the Motors and Generators Sub-committee of the Plant Committee of the Engineering Standards Committee began its work, one of the problems before it was to define as clearly as it could the permissible temperature rise in machines of various patterns under working conditions. Considering the results obtained quite generally, it would appear that the properties of the materials were somewhat improved by heating up to 75°C. Perhaps, so far as resistance and the brittleness were concerned, the material did not always improve up to that temperature, but there were few cases in which it was seriously damaged, and at temperatures of 100°C. and over in many cases the dielectric strength of the various materials improved and the mechanical strength was not seriously impaired. When the higher temperatures, however, of 125°C. and 130°C. were reached, then weaknesses began to show themselves. This was proved by the results generally and also by independent similar tests made at Messrs. Crompton's and Messrs. Siemens' works. In the report some interesting facts were brought forward, especially the one as to the manner in which the temperature of cotton and other insulating materials changed as the moisture was dried up, and there was one very striking point—viz., that after a material had been heated for some appreciable time, and kept at that heat for some time and then allowed suddenly to cool, there were a great many cases in which there was a sudden rise of resistance. The author, in his investigations on the temperature of field coils, had made great use of the experiments made by Mr. Brown before the Institution some years ago, and the success was also due to the ready help from manufacturers. They also owed their thanks to the Engineering Standards Committee for allowing the results to be published

Thursday, March 23.

Prof. **SILVANUS P. THOMPSON**, F.R.S., said that Mr. Rayner's Paper was the first contribution that the National Physical Laboratory had made to the Institution *Journal*, and they would all look forward to further contributions with great interest. In that part of the Paper concerning the heating of coils there was much interesting matter, and no doubt it had not escaped either Mr. Rayner or Dr. Glazebrook that there were previous results which did not altogether tally with these—viz., those of Mr. Brown and also some made in America. However, they agreed in the main that the hottest part of the coil was not at either of the ends, and was nearer to the outside than the inside, proving once more what had already been more or less shown by earlier researches that when a coil was fixed upon an iron core the iron core did more than the air surface in getting rid of the heat. And this brought him to Mr. Goldschmidt's Paper, in which this very matter turned up. He had not been able to gather how Mr. Goldschmidt estimated the amount of cooling surface. Did he mean to imply that the cooling surface was simply the outside of the cylindrical surface of the coil, or did he mean the outside of the cylindrical surface *plus* the surface of the end cheeks, or the outside of the cylindrical surface *plus* the surface of the end cheeks *plus* the interior surface of the coil where it came up against the core? For, if the core was more important as an air-cooling factor than the air-cooled surface outside, the inside as well as the outside must be taken into account. After criticising at some length the wording of various passages in Mr. Goldschmidt's Paper, Prof. S. Thompson went on to say that, although the author had attempted to avoid mathematics, in doing so he had loaded his Paper with a good deal that was less easy to understand than the mathematical explanation would have been. The way in which a substance supplied with heat at a definite rate rose to its final value by exponential law was well known. All the temperature curves would be of the same shape; it was only a question of scale when applying the curve to a particular case. This was exactly what the author's diagram showed. Suppose there was a coil which was losing 0·214 watts per square inch, and the current density was 1,100 amperes per square inch in the copper, the final temperature would be the number of watts lost per square inch multiplied by 232, which gave exactly 50°C., as in the author's example. The initial rise of temperature was determined solely by the specific heat of the materials and by the density of the current in the copper, and the initial rise per minute could be calculated by simply squaring the current density and multiplying by 0·00000082. Multiplying the square of 1,100 by that long decimal it would be found that the rise of temperature per minute was 0·97°C. If they were going to rise to 50°C. and it rose 0·97deg. per minute it would take nearly 52 minutes to get to the top value, assuming no radiation to take place during this time. The time constant, therefore, was 52 minutes. But as there was cooling simultaneously, it would not get up to 50deg. in that time, but only to 63 per cent. of 50deg. At the end of half the time constant (*i.e.*, after 26 minutes in this example), the temperature would have risen to 40 per cent. of the final temperature (*i.e.*, 0·4 × 50 = 20 C.); after a time equal to twice the time constant, the temperature would have risen to 87 per cent. of the final temperature; and after three times the time constant, the temperature would have risen to 95·5 per cent. of the final temperature. For 20 years—ever since Mr. Esson read his Paper—we had stuck to one formula for calculating the probable rise in temperature of electrical machines, this rise being equal to the number of watts lost multiplied by 55, and divided by the number of square inches. Other people said this was not enough and that a figure of 75 was more correct. At the Oerlikon works the figure used was 66. But Mr. Goldschmidt gave 232 which was four times as much as Mr. Esson's figure. How was the discrepancy to be explained?

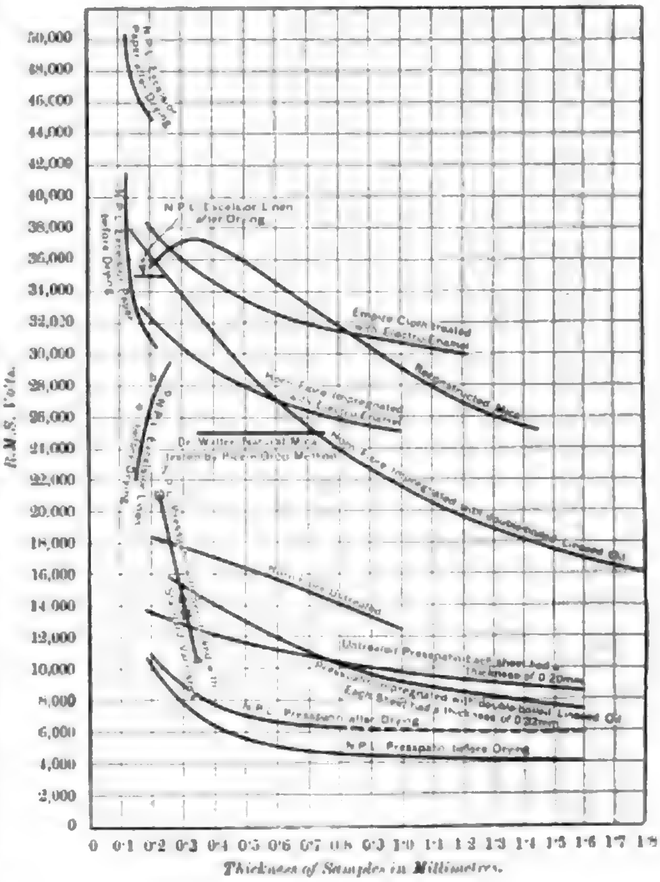


Fig. 1.

Mr. H. M. **HOBART** said he had made a few notes, which emphasised the importance of the investigation undertaken by Dr. Glazebrook and Mr. Rayner. The results they had obtained were certainly most interesting, but he would urge upon the authors the necessity of continuing their investigations until thoroughly reliable data on the subject had been obtained. To some curves deduced from their Paper he had added others compiled from data already in his possession. (See Fig 1.) If time permitted, many interesting comparisons could be pointed out from these curves. In no instance, however, were the conditions of the test

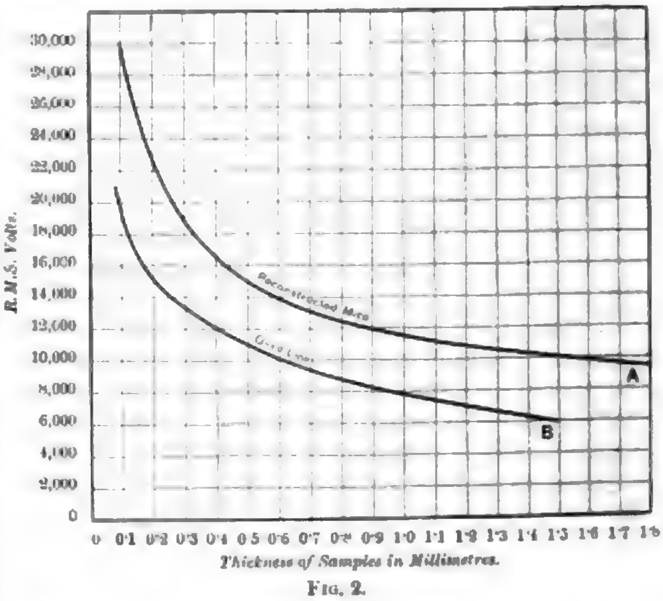


Fig. 2.

sufficiently specific to ensure results of maximum utility. The curves for his own data were equally faulty with those embodied in the Paper, in that two important conditions had not been observed, and these constituted the subject for his two principal criticisms of the Paper. In order to obtain thoroughly reliable data the following, amongst other conditions, should be carefully observed:—1. The materials should be thoroughly dried in a vacuum oven of moderate temperature for some considerable time immediately prior to the tests. 2. The voltage should be increased by small steps, and should be maintained constant at each step for definite intervals of, say, at least one minute, since the time of application often exerted a considerable influence on the disruptive voltage. The omission to observe either of these conditions would, in his opinion, detract greatly from the usefulness of the results. The study of the behaviour of insulating materials with regard to heating might be brought into three principal sub-divisions:—1st. The permanent effect sustained as the result of prolonged exposure to high temperatures. For this purpose the measurements should be made on the samples after cooling to the ordinary temperature. 2nd. The disruptive voltage as a function of the temperature of the samples at the time of test. To determine this, the samples should be tested in calorimeters maintained at given high temperatures. 3rd. The determination of the voltage at which perceptible heating developed in the sample as the result of the dielectric stress, and the determination of the voltage corresponding to given increases in temperature from this cause. In this connection Prof. Arnold had given data which he had compiled in Fig. 2. This phase of the question was of very great importance and required thorough investigation. While the change in the insulation resistance due to moisture, as determined by measurements of the ohmic resistance, was an interesting subject which had been ably treated in the Paper, there was no information in the Paper with regard to the effect of moisture upon the disruptive strength. This could be conveniently tested by placing the samples in a compartment filled with steam of low pressure and temperature, and measuring the change in the disruptive strength with the lapse of time. This test was the more important for English manufacturers, since the humidity of the atmosphere was greater in this than in most other countries. Tests as to the influence on the disruptive strength of prolonged immersion in oil should also be made. On the whole, he was of the opinion that the authors' investigation could with advantage be extended on the lines indicated, so as to increase our knowledge of a subject in which a vast amount of information was needed. It was interesting to note that for a 1,500kw., 600 volt, slow-speed continuous-current dynamo, the total cost for insulating material and for the labour of applying it, amounted to 5 or 6 per cent. of the total works cost of the machine. The armature insulation for such a machine cost some 30 per cent. of the cost of the enveloped copper, and the field insulation about 12 per cent. Mr. Goldschmidt had made a very interesting contribution to the study of the heating of insulating materials in pointing out that cotton had some six times the specific heat of copper, and in showing what important consequences this had on the temperature rise in apparatus for intermittent service.

Mr. **MILES WALKER** said everyone knew that the heating of field coils was due to a number of factors, the most important of which might be enumerated as follows:—(1) The number of square inches per watt; (2) the velocity of the air past the coils; (3) conductivity of the material; (4) ventilation, whether ventilated inside or not; (5) conductivity of the pole; (6) conductivity of the material between the coil and the pole; (7) provision made for the cooling of the pole; (8) the proximity of the coils; (9) the heat of the bodies in the vicinity of the coil. Some of these conditions had been very ably dealt with by Mr. Rayner, but the ordinary designer had to take all of them into account. Supposing there were a large number of machines from which it was possible to get data, and it was wanted to find out what were the conditions that conduced to cool running. It was necessary first to eliminate the two most important factors viz., the square inches per watt and the velocity of the air against the coils. That could be very easily done in this way. Work out for all the machines what the number of square inches per watt was. Then find out what the actual temperature rise was; then assume that if the conditions were the same the rise of temperature multiplied by the square inches per watt would be a constant. It was then possible to plot that constant against any other factor they wished to inquire into.

Mr. **A. F. BERRY** said that there were two methods of testing insulation: one was to treat it as a thing separate in itself and self-contained, and another was to treat it as part and parcel of the conductor or group of conductors to which it belonged. With varnish and varnished materials one was perfectly justified in adopting the first method—viz., the one which had been almost exclusively adopted in Mr. Rayner's tests. With high temperatures and the need for considerably more data, the only way of properly testing insulation was as part and parcel of the conductor which it isolated. The only way to produce cheaply now was to get more duty out of the material, and to get more duty out of copper it had to be run hotter.

Mr. **F. S. RUSSELL** thought the results in the Paper showed how dangerous it would be for the Engineering Standards Committee to fix a limit for the temperature rise to be allowed in electrical apparatus. The imposition of a temperature limit would be likely to have the effect of restricting improvements in electrical machinery. With regard to solid coils mentioned in the Paper, he had seen some such coils made with Berrite insulation which had been run at temperatures up to 240°C. for a considerable time, and they appeared to be quite as good electrically as they were before; in fact, the insulation resistance was higher and the mechanical properties better.

Mr. **ALEXANDER RUSSELL** said there was one suggestion he would like to make in connection with the earlier part of Mr. Rayner's Paper, viz., as to the method of measuring dielectric strengths of materials. Mr. Rayner had given it in volts per millimetre, and this was the ordinary way of giving it, but he took it that the dielectric strength ought to be measured by the maximum potential gradient, or the maximum electric force to which the material was subjected. If we could design our testing apparatus so that we could calculate this maximum force or dielectric stress, then it would be found that with thick and thin samples the volts per millimetre which measured the breaking strength would come out the same. M. Thury had lately published a very careful research on the sparking distances between two brass balls. Considering two brass balls each 1cm. apart and 1cm. in diameter, then when the effective voltage was 23,000 a disruptive discharge would take place. If these two brass balls were placed 8cm. apart then 63,000 volts were required to break down the air gap. This would give an apparent stress of about 800 volts per millimetre, as compared with 2,300 volts per millimetre when the balls were 1cm. apart. Moreover, the apparent voltage per millimetre would be less if they were placed at a very great distance apart, as Lord Kelvin had shown some time ago. In fact, the volts per millimetre would be less and less the further they were placed apart.

Mr. **J. S. PECK** asked the meaning of the following passage in Mr. Rayner's Paper:—"It was found that the alternating pressure required to break down a specimen fell with the frequency." He did not understand why this should be so. In fact, he would have thought it to be just the opposite, and he would like to know if the wave form of the machine had been taken at the different frequencies. He had seen apparatus in which, after it had been in use a number of years, the insulation had been completely carbonised, although actually its insulation resistance was very high, if anything, higher than originally. The great difficulty in testing apparatus for this purpose was to exclude the moisture absolutely. Many methods had been tried in order to accomplish this and one as good as any was to exhaust the moisture in a vacuum tank and to force an impregnating fluid into the apparatus in the tank at high pressure. Another method was to dry the apparatus in a vacuum tank and then seal it up so as to prevent the re-entry of the moisture. One firm that he knew of treated their 15,000-volt transformers by placing them in a case which was placed in a vacuum tank, the apparatus being heated inside the case and then hermetically sealed. This method was adopted to preserve the insulation during transit.

Mr. **R. GOLDSCHMIDT**, discussing Mr. Rayner's Paper, referred to the second part, dealing with the distribution of temperatures in the interior of field coils. The curves representing the distribution of temperature, he said, all had a definite shape; in fact they were all parabolas. The conclusion to be drawn from this was that the highest and mean temperatures had a quite definite relation to one another. He found that the difference between the maximum and the outside temperatures was about 50 per cent. higher than the difference between the mean and the outside temperature. If, for instance, the temperature measured by resistance was 40 deg. higher than that measured by thermometer, then the maximum temperature was 1·5 times higher than the temperature measured by thermometer. In connection with the reference to single field coils in Mr. Rayner's Paper, he said it was usual in practice, when measuring the resistance rise, to measure the resistances of the whole field system owing to the difference in temperature of the various parts of the apparatus. In cases, however, where particular value was set upon the guarantee figure the temperature ought to be measured on a single field coil only after finding out by thermometer which was the hottest.

Mr. **RAYNER**, in reply to the discussion on his Paper, said he had always found that the maximum temperature of a field coil was found at about one-third the depth from the inside. The limiting condition of all the fabrics used in the experiments was the brittleness. This was the whole point, and disruptive voltage was of no importance. With regard to Mr. Russell's remarks as to the voltage per millimetre, in his tests they had a rotary converter. The pressure curve was very smooth, although not quite a sine curve. A choking coil was used to give a fine adjustment, and this might have affected the curve slightly. He did not know whether Mr. Russell realised that in his experiments the surfaces were flat and not spheres. His own opinion as to drying-out apparatus was to place it in a vacuum and heat it up with steam. This was the quickest possible way.

The **PRESIDENT**, in proposing a vote of thanks to the authors, said he had been struck by the results of Mr. Rayner's experiments. They showed that the insulation of a cotton-covered field coil remained constant for a certain time until the temperature of the copper wire began to rise, when it went down in a most extraordinary way while the moisture was being driven out. This perhaps accounted for many failures in field coils in olden times.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"The Electromagnet." By C. R. Underhill. (London: E. & F. N. Spon, Ltd.). 6s. 6d.

"Science Abstracts." March, 1905. Section A, Physics; Section B, Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

"A Technological and Scientific Dictionary." Part VIII. Edited by G. F. Goodchild and C. F. Tweney. (London: George Newnes, Ltd.) 1s.

"Telegraphy." By Sir W. H. Preece, K.C.B., F.R.S., and Sir J. Sivewright, K.C.M.G. New edition (Text-books of Science Series). (London: Longmans, Green & Co.) 7s. 6d.

THE ELECTRICAL EQUIPMENT OF THE STEAMSHIPS "ANTRIM" AND "DONEGAL."

We recently had an opportunity of inspecting the electrical equipment of the steamships "Antrim" and "Donegal," which are run by the Midland Railway Co. between Heysham Harbour and Belfast. The equipment of the two vessels is fairly typical of the present practice in this direction with regard to small and medium-size steamers for such cross-Channel services. In addition to electric lighting the vessels are fitted with electrically-driven fans for forced draught and also for the hot-air heating system and ventilation.

The lighting circuits include about 340 16 c.p. lamps, and the four motors for each of the four stokeholds are rated at 20 B.H.P. each, smaller motors being used for the ventilation and hot-air plant. In the engine rooms of both ships it is noticeable that the electrical generating machinery is placed in a convenient and accessible position, there being a steam-driven dynamo on either side of the engine room.

The "Antrim," which was built by Messrs. J. Brown & Sons, of Clydebank, contains two Belliss-Lancashire steam dynamos, each having a capacity of 450 amperes at 110 volts. One set is sufficient for the whole of the load, the second one being held in reserve. Both engines and dynamos are of the makers' standard pattern. The engine is two-crank compound and runs at 450 revs. per min. The dynamo is mounted on the same bedplate, and is a 6-pole compound-wound machine. Each set has its own switchboard fitted with Ward-Leonard switch gear. There are eight main circuits as follows:—First-class promenade deck, first-class bridge deck, third-class accommodation, thermo-tanks and cattle fans aft, crew and cargo, engine and boiler rooms, searchlight and projector, thermo-tank forward. The circuits are brought to both switchboards and the switch gear is arranged with change-over switches so that any one of the circuits may be connected to either of the machines. Each of the four stokehold motors is connected to independent Royce starting switches near the dynamo, these switches being fitted with the usual no-load and excess release. In addition to the starting switch, in each case, there is a shunt regulating switch permitting a variation in speed from 3:1. The motors are of the 4 pole semi-enclosed type, made, as the dynamos, by the Lancashire Dynamo and Motor Co. They are directly connected to the fans, which run at from 250 to 650 revs. per min., the motor shafts being extended to receive the fan boss. The fans are of Messrs. John Brown & Co.'s own design.

The air-heating arrangements consist of five of Stewart's patent "thermo-tanks," these being small air chambers through which steam pipes are passed, and the air from which is forced through the heating pipes about the vessel by a small motor-driven "Sirocco" fan next to the chamber. A valve is provided by means of which steam may be admitted into the air chamber if desired. Two 10in. motor-driven "Sirocco" centrifugal fans exhaust the air from the cattle-holds, and it is stated that these work so efficiently that the presence of cattle is not noticeable to the passengers; we were unable to convince ourselves personally on this point, as on the occasion when we travelled by the two boats in question no cattle were on board.

Messrs. J. Brown & Sons, the builders of the vessel, have carried out the wiring on the "Antrim" themselves. Single lead-covered cable to Admiralty specification is used throughout for the wiring, which is on the single-pole system, the hull of the boat being used as the return conductor. As far as possible the wiring is exposed to view, brass clips being used to attach the cable to bulkheads, &c. From the switchboard single cables are run to various fuse junction boxes, each of these controlling a number of lamp distributing boxes from which a wire is run to each individual lamp. In the cabins special light-reducing lamps are used, these lamps having two filaments of 16 c.p. and 2 c.p. respectively. One end of each filament is connected to the usual lamp contacts, the other ends being joined together to the brass cap. By means of a two-way switch with off position, either filament can be switched on, thus giving a full light or small night light as desired. Electric bells are fitted for communication with all the cabins and saloons. A 9in. searchlight of the General Electric Co.'s portable yacht type is fitted on the bow to enable moorings, &c., to be picked up at night. Telephones of Messrs. Alfred Graham & Co.'s loud-speaking navyphone type are fitted on the bridge and in the engine room to enable the captain to communicate with the engine room staff.

Messrs. Siemens Bros. & Co. carried out the electrical work on the "Donegal." It is in most respects similar to that on the "Antrim," but Siemens dynamos and motors are employed, and Bumsted & Chandler fans for the stokehold. The motors for the latter are of the open type, but as a considerable amount of dust is carried in from the coal and ash galleys by the air drawn to the fans, the chief engineer on board has fitted holland covers over the motors to protect them.

On the "Antrim" it is customary to run one of the dynamos both for the lighting and power load, while on the "Donegal" one machine supplies the lighting and the other the motors, although both sets of circuits can be switched on to one machine in case of mishaps.

In conclusion, we would add a word as to the comfort of the boats. The times of departure and arrival are so arranged that the passengers can have a good night's rest on board, and the cabin and saloon accommodation have been designed and carried out with this object in view. We have little doubt that when this route to the North of Ireland is better known it will become the most popular one.

The interesting electrical plant at Heysham Harbour was fully described in *The Electrician* of June 24 and July 1, 1904.

PORTABLE WIRELESS TELEGRAPH STATIONS.

We published last year (*The Electrician*, Vol. LIII., p. 262) an illustrated description of the portable wireless installation which the Gesellschaft für Drahtlose Telegraphie intended to make use of in reporting the Gordon-Bennett motor car race. It will be remembered that the transmitting and receiving instruments were mounted on carts. Since then, according to information received from the company, further progress has been made, especially in the direction of lightness of apparatus, and the latest wireless equipment may be carried from place to place by 10 or 11 men. Ten men only are required when current is generated by a dynamo in the manner shown in Fig. 1, but 11 men are necessary if accumulators are used for supplying the current. The total equipment may also be loaded on three horses, the first horse carrying the masts, the second horse the transmitting and receiving instruments and the third horse either the dynamo or storage battery. Each piece of apparatus is placed in a bag of oilcloth for transport. The total net weight of a station is stated to amount to 441lb. when the dynamo is used and 530lb. when a storage battery is employed. Recent experiments, according to the company, have proved that a distance of about 15½ miles across flat country may be negotiated with these instruments

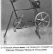


FIG. 1.—TREADLE ARRANGEMENT FOR GENERATING CURRENT FOR THE PORTABLE WIRELESS TELEGRAPH INSTALLATION.

arranged as indicated in Fig. 2, each mast being 10 metres (31½ft.) high. The masts weigh 44¼lb. apiece (including all tackle), this small weight being rendered possible by using steel tubes. When these are telescoped for transport their length is reduced to 12½ft. The stability of the masts is increased by cast-iron base plates and suitable stays, as shown in Fig. 2. Tinned copper cable, consisting of eight wires 0·4mm. in diameter, and supported by glass insulators, is used for the aerial wire. The small continuous-current dynamo shown in Fig. 1 has an output of about 100 watts. It weighs, complete with driving arrangement, some 65lb. When the dynamo is not employed a 16-volt (8-cell) battery is used, having a capacity of about 30 ampere-hours at a five hours' discharge rate. The accumulator cells are fitted in ebonite boxes, and these again are packed into two wooden boxes, each of which is 11¾in. high, 6¾in. wide and 1ft. 1½in. long, and weighs about 65lb. The transmitter is also mounted in a wooden box, this box measuring 1ft. 9in. by 9in. by 1ft., and weighing complete about 45lb. It contains, among other things, a Morse key, an inductor with hammer interrupter, a Leyden battery of six jars, the excitation coil tuned for a wave length of 400 metres (440 yards), a spark gap with zinc electrodes, &c. Even lighter is the receiving station, which weighs only about 33lb. It consists of an electrolytic detector of the Schloemilch type, a pair of telephone receivers, a condenser, four dry cells, a contact box and so on. These apparatus are mounted in a box 1ft. 8¾in. by 9¾in. by 9¾in.

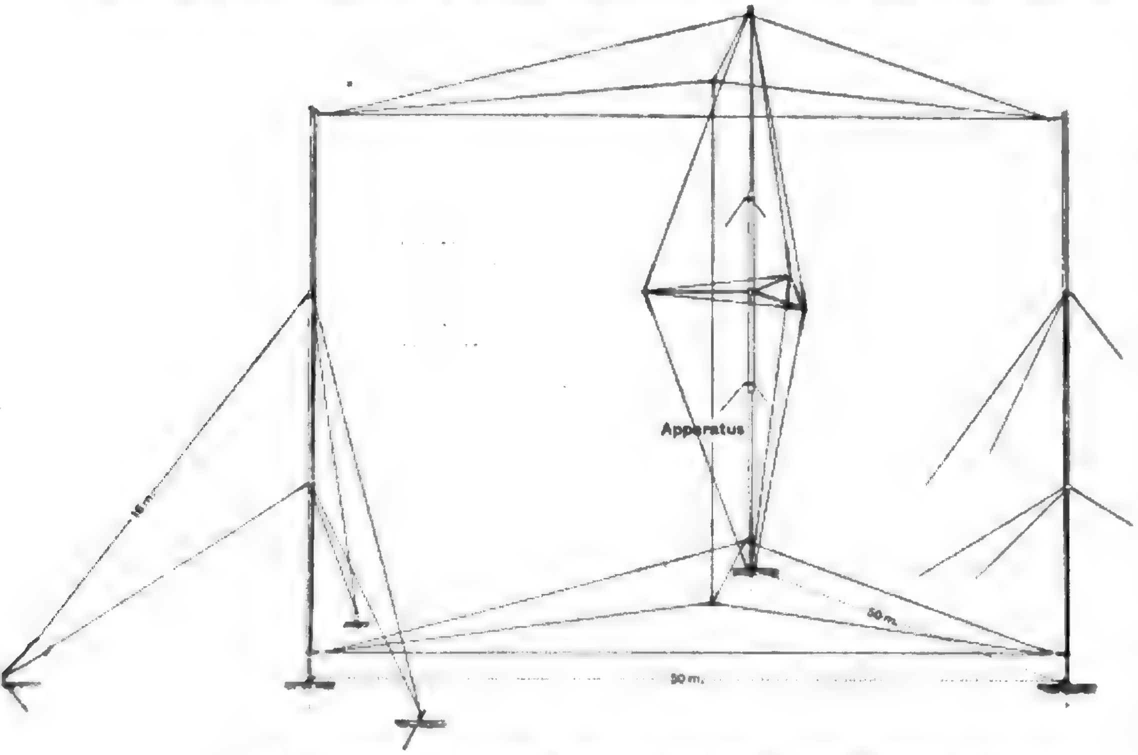


FIG. 2.—ARRANGEMENT OF AERIAL WIRES OF THE PORTABLE WIRELESS TELEGRAPH INSTALLATION.

RECENT DEVELOPMENTS IN ELECTRIC SMELTING IN CONNECTION WITH IRON AND STEEL.*

BY. F. W. HARBORD.

(Continued from page 921).

In the present stage of development, neither type of furnace can be regarded as a competitor to either the Siemens or the Bessemer processes for the production of rail and structural steel, and they can only compete successfully in the production of high-class crucible steel or steels for ordnance and other special purposes made in the Siemens furnace. In cases where very *large* steel castings are required of crucible steel quality, several electric furnaces, working so that they could be tapped into a common receptacle, before pouring the steel into the mould, should give excellent results and be much more economical than the crucible process. Under favourable conditions, electric energy might compete with gas as regards cost, but until it is possible to use furnaces of from 30 to 40 tons capacity the extra labour charges inseparable from small furnaces will prevent them from holding their own against the Siemens or Bessemer process. So far as the steel works engineer is concerned, there is no difficulty in designing a furnace of any size required, as furnaces, very similar in general design to the Héroult furnace, holding 200 tons of molten steel, are at present working both in England and America, and it only remains for the electrical engineer to arrange for the electrical heating without unduly weakening the roof or other parts of the furnace. Provided this can be done, under favourable conditions, where electric energy is so cheap that it can compete with producer gas as a heat producer, there is not the least reason why the present 5-ton electric furnace should not develop into a 40 or 50-ton furnace, in the same way that the 5-ton ordinary Siemens furnace has developed during the last 25 years.

The Resistance Furnace for Direct Smelting from the Ore.—With the exception of an experiment made at La Praz, by Mons. Héroult in one of his small furnaces, no direct smelting was investigated by the Canadian commission until they visited the works of Messrs. Keller, Leleux & Co. The experiments witnessed there were, from the Canadian standpoint, by far the most important, as they demonstrated the possibility of making pig, varying in composition to suit the requirements, either of the acid or basic Bessemer, the acid or basic Siemens or the foundry. From a commercial point of view, the manufacture of pig iron in the electric furnace is of little interest to the English electrician or metallurgist, as with our cheap supply of fuel no electric furnace can compete with a modern blast furnace. In Canada the conditions are different, as in some districts they have immense deposits of iron ore available, as well as water power, while no fuel suitable for blast-furnace purposes can be obtained except at prohibitive prices. I am informed that electric energy is actually being distributed in some parts of Canada for less than $10 per electrical horse-power-year, so that the possibility of developing their iron-ore resources by the electric furnace is a matter of great importance to the colony. In various other countries, especially the South American Republic, such as Brazil and the Argentine Republic, and various other parts of the world where blast furnaces are impossible at present, the electric furnace might do excellent work. The type of electric furnace used for the reduction of iron ore is practically identical with that used for the production of the various iron alloys which cannot be made in a blast furnace. Amongst these may be mentioned rich ferro-chrome of 60 per cent. chromium and above, ferro-tungsten and rich ferro-silican from 25 to 80 per cent., all of which are being largely used in the manufacture of various special steels for armour, projectiles, &c., and it is in this direction that the electric furnace is likely to develop in England so far as direct smelting is concerned.

The furnace used in the experiments at Livot is shown in Fig. 4. It consisted of two vat-shaped furnaces connected at their lower ends by a central well. Preferably four furnaces are grouped together, so that the metal as it is reduced collects in the central well. If four hearths are used, they can be divided into groups which are connected with each other in series, the two hearths forming each group being connected with each other in parallel. In such an arrangement the electric current will be broken during casting when the well is emptied of its contents, and this will not only interfere with the working of the furnace, but also with the working of the electric generators. To avoid this, a carbon block is built into the sole of each furnace, and these are connected by bars of copper, so arranged that they connect hearths of opposite polarity. As the flow of the current through the fused material decreases during casting, it flows through the sole of the hearths and copper conductors, and increases in direct ratio with the fall of the current in the fused mass connecting the hearth; and finally, when the hearth is emptied, the entire current flows through the outside conductors. After casting, the fused metal again collects in the central well or crucible, and re-makes the broken circuit, so that the current again begins to flow through the fused mass. These shunt connections prevent any irregularity or great variation in the distribution of the current, but for this arrangement at least two furnaces are necessary. In the event of the metal becoming chilled in the central well, it can be heated by a subsidiary electrode, provided for the purpose, to the required temperature for casting. In the experiments at Livet this central well was not used, as, owing to the furnace having stood for 12 hours while the necessary connections were made for placing the recording wattmeter in the circuit, the crucible became chilled, and some metal set in the bottom; the subsidiary electrode not having been installed, it was decided to tap each furnace independently from a tap hole in each. The iron-ore fluxes and coke were all broken to pass through a 1½in. ring and mixed on the floor, and then taken by a lift to a staging over the furnace, from which they were discharged by a shoot on to the furnace platform. The charging was done by hand, the materials being thrown into the furnace with a shovel.

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* Paper read before the Faraday Society on March 6.

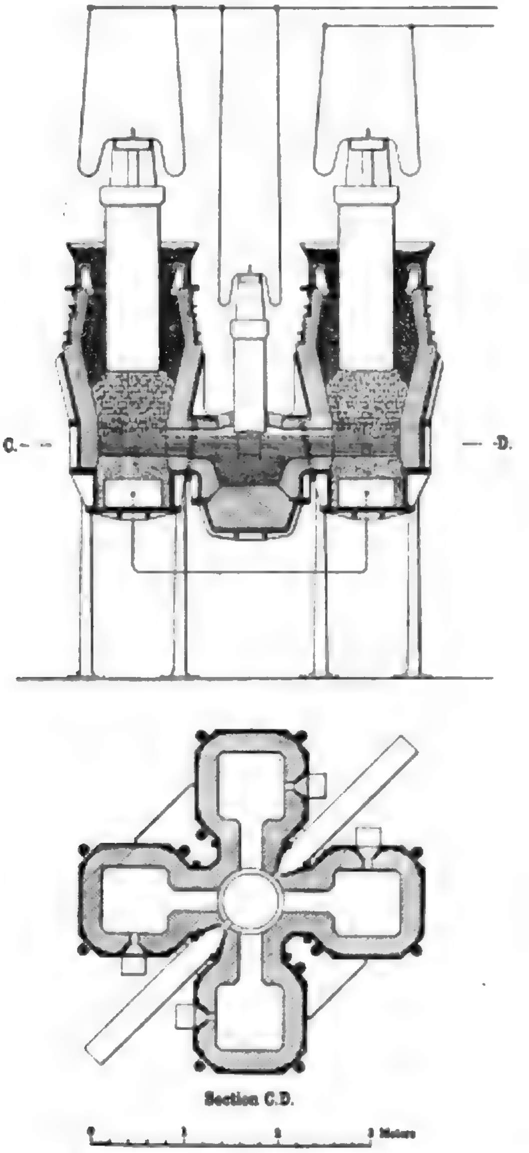

FIG. 4.—THE KELLER ELECTRIC HIGH FURNACE WITH PLURALITY OF HEARTHS.

In starting the furnace a small quantity of the charge was thrown into the bottom of the two furnaces and the electrode lowered upon it. The current was then switched on and passed from the electrode through the material to the bottom carbon block, and then by the outside copper conductor to the carbon block in the second furnace, and through the charge then to the other electrode. The charge in each furnace is heated by the resistance offered, and as the metal is reduced it collects on the bottom of each furnace and in the connecting canal, and when this connection is established the current flows along this from one electrode to another, the current passing by the exterior conductors gradually diminishing as the reduced metal increases. The electrodes are then raised and the furnace gradually charged until filled to the platform level. When fully charged comparatively little current passes through the external conductors; but on emptying the furnaces by tapping they act as a shunt and enable the furnace to be worked continuously without very greatly varying the load on the alternator.

The furnaces at Livet are operated with an alternating current generated direct on the alternator at the voltage required. The alternator is a revolving-field machine, has 16 poles and rotates at, approximately, 880 revs. per min., giving a periodicity of 50 cycles, and is directly connected to a horizontal-shaft water wheel controlled by a governor. The regulation of the electric input is effected chiefly by the vertical adjustment of the electrodes by hand, but this is supplemented when required by adjusting the alternator field and the water-wheel governor. The load is entirely free from violent fluctuations and hand regulation requires a very small amount of attention, so that one man could readily regulate four or five furnaces. If desired, however, little difficulty should be experienced in designing an automatic regulator that would fulfil all requirements and dispense with the services of this man. The electric energy was measured by a Thomson recording wattmeter obtained from Paris, and this was calibrated after the experiments were completed under the same conditions as to volts, amperes, cycles and temperature as those to which it had been subjected during the experiments. The current used in the first experiment was about 66 volts and 11,000 amperes, but varied from 63 to 68 volts and 10,600 to 12,000 amperes. The run lasted 55 hours, and the following are results from wattmeter reading and power-factor determination:—

Total dial reading of wattmeter	7,687
Constant of wattmeter, for kilowatt-hours	4·390
Total kilowatt-hours	33,700
Mean kilowatts	613
Mean power-factor from above determination	0·737
Mean kilo-volt amperes	832
Mean electrical horse-power	834
Total horse-power-hours	45,800
Total horse-power-years	5·23
Output of pig	9,868
Horse-power-years per ton of pig	0·53
Cost of electric energy per ton of pig, at 41s. 8d. per horse-power-year	22s. 1d.

The points to which special attention was given during the experiments were:—(1) Consumption of electric energy per ton of pig iron produced; (2) consumption of coke as reducing agent per ton of pig iron produced; (3) the yield of metal; (4) quality of the product. The materials were all carefully weighed, but the furnace having to stop before all that was weighed out was used, what was left had to be estimated and deducted, which probably introduced a small error, both as regards yield and consumption of coke; but as the yield was controlled by weighing the slag and determining the percentage of iron it contained, and as the slag from practically 10 tons of metal only contained 36lb. of iron, it is clear that all the ore charged was for practical purposes reduced. At first, the iron made was very grey and silicious, and contained 3·72 per cent. of silica, but on reducing the quantity of coke and altering the fluxes by removing some quartz from the charge, a very good grey iron was obtained. An average sample taken over three days' work gave the following analysis:—Total carbon, 4·200; combined, 0·800; graphite, 3·420; silicon, 1·910; sulphur, 0·007; phosphorus, 0·027; arsenic, traces.

On further reducing the silica in the charge, the slag became somewhat infusible, and white iron of excellent quality, low in silicon and sulphur, was obtained. As the furnace had been working very cold for a considerable time owing to 12 hours' standing for altering connections, and this could not be remedied without increasing the electric energy, which would have interfered with the correct determination of energy required for reduction, Mr. Keller decided to stop the experiment and start with another furnace. The first experiment had demonstrated that both grey and white iron suitable for foundry and steel-making purposes could be made, but it had not shown how far the composition of the pig iron could be varied at will; in fact, how far the variation in grade was under control. For Bessemer steel and acid Siemens steel manufacture, a grey pig iron with about 2·0 of silicon is generally used, and for basic steel a white pig iron with 1 per cent. or less of silicon and low in sulphur is advisable, and it was important to know how far these different grades could be produced as required, and I therefore requested Mr. Keller to start with grey iron, pass to white, and then return to grey. This was done, and the results showed that there was no difficulty in making any variety of iron required, the operation being well under control by slightly varying the charge and the current passing into the furnace. For the second experiment there was not sufficient time to have a complete analysis of the ore, &c., made before commencing, and Mr. Keller did not introduce sufficient lime, and this, with working the furnace at a very low temperature to economise the electric energy as much as possible, resulted in some cases in the production of iron extremely low in silicon and manganese, but high in sulphur. When, however, the temperature was maintained sufficiently high to reduce about 2 per cent. of manganese, a low-sulphur pig iron was obtained.

So far as one was able to judge from these experiments, the reactions as regards reduction and combination of silicon, sulphur, phosphorus and manganese with the iron are identical with those that take place in the blast furnace. The most necessary condition for the production of low sulphur pig iron in the blast furnace is the maintenance of a fluid basic slag, which is facilitated by the presence of manganese in the furnace burden. The experiments showed that under the conditions in which 2 per cent. of manganese was reduced and passed into the pig iron, excellent low-sulphur and low-silicon pig iron was obtained. They did not, however, experimentally demonstrate that such a pig iron could be made in the absence of manganese; but in view of the fact that by increasing the current, and so raising the temperature, a far more basic slag can be maintained than in the blast furnace, there is every reason to believe that low-sulphur pig iron would be produced under these conditions.

The following are the details of energy consumed:—

Length of run, hours	48
Mean volts on furnace	55·3
Mean amperes	7,247
Mean kilo-volt amperes	401
Total kilo-volt-ampere hours	19,240
Mean power-factor	0·564
Mean kilowatts	226
Total kilowatt-hours	10,480
Mean horse-power	308
Total horse-power-hours	14,750
Total horse-power-years	1·69
Output of pig iron, kilogrammes	6,692
Horse-power-years per ton of pig	0·25
Cost of electric energy per ton of pig, at $10 per horse-power-year	$2·50

It will be noticed that the total energy is less than one-half that used in the first experiment, which is due to the fact that nearly all the iron made was white, containing considerably less silicon and manganese; that a smaller quantity of fluxes was used, and a more silicious and fusible slag formed; and that the whole operation was conducted at the lowest possible temperature. In my opinion it would not be possible to make pig iron regularly with such a small consumption of energy, but a mean of the two experiments is approximately what would be consumed in actual every-day practice. This estimate is confirmed by figures given me by Mr. Keller as to the energy consumed in the manufacture of ferro-silicon alloys, and also by the result in a small furnace of M. Héroult's, in which about 18 cwt. of pig iron was made under very unfavourable conditions. The average amount of coke used as a reducing agent was 767lb. per ton of pig iron produced, and Mr. Keller estimates the cost of electrodes at about 8s. 6d. per ton of iron.

There appears not the least doubt that pig iron, to meet all the requirements of the foundry and steel manufacture, can be produced in the electric furnace, but it is only under exceptional circumstances that the latter can compete with the blast furnace. Where electric energy is very cheap and fuel very dear, the commercial production of pig iron becomes possible. In some of the South American Republics and similarly situated countries, provided ample water power is available, electric smelting should certainly hold its own; but it is impossible to define the exact conditions under which it can be successfully carried on, and only when all the facts are known can an opinion be given as to its feasibility. Taking the results obtained at Livet, where coke costs about $7 per ton and electric energy about $10 per electric horse-power-year, the cost of electric smelting is approximately the same as smelting in the blast furnace. It must be remembered, however, that the experiments at Livet were conducted in furnaces usually used for the manufacture of alloys, and it is only reasonable to anticipate that with a plant especially designed, and with further experience, economies would be effected.

Alloys.—Although no experimental investigation was made respecting the electric smelting of alloys by the Canadian Commission, I had the opportunity at Livet of seeing these manufactured on a considerable scale. The furnaces used were identical with those employed in the pig-iron experiments, and the only difference was in the alteration of the furnace mixture and in the regulation of the electric current to obtain the necessary heat required for particular operation. Ferro-chromes from about 45 to 60 per cent., and ferro-silicons from 25 to 80 per cent., were being made regularly, although 50 per cent. ferro-silicon was the alloy that they were making most largely at this particular time. In the manufacture of this alloy a very intense temperature is necessary to obtain a good tapping heat, and it is desirable to work with as little flux as possible, so that a very small quantity of slag is produced. The alloy is tapped into horizontal moulds holding about 2 cwt., and the little slag formed is raked off the surface of the alloy before it solidifies. In the manufacture of these alloys oxide of iron is not used as the source of iron, but selected steel scrap. In the case of chrome alloys it is desirable to use rich chrome iron ore. The demand for these alloys is, so far as I am able to obtain information, undoubtedly increasing, many steel foundries using nothing below 25 to 80 per cent. ferro-silicons, and some nothing below 50 per cent. The increasing demand for chrome and tungsten alloys for the manufacture of the various special steels required for ordnance and other purposes is too well known to need comment. Up to about 12 to 15 per cent. ferro-silicons and 40 per cent. ferro-chromes, the blast furnace is probably a more economical metallurgical appliance than the electric furnace, but for higher alloys the latter holds the field.

(*To be concluded.*)

FIRST REPORT TO THE STEAM-ENGINE RESEARCH COMMITTEE.*

BY PROF. DAVID S. CAPPER.

The Steam-engine Research Committee was constituted at the instance of the late Mr. Bryan Donkin to investigate and carry out research upon the initial condensation in steam-engine cylinders. Through the kindness of Messrs. Marshall, Sons & Co., of Gainsborough, a special engine was obtained at cost price, and erected in the Engineering Laboratory at King's College.

The engine thus obtained is a horizontal compound engine. The cylinders, which are side by side, are 6½in. and 11¼in. diameter by 14in. stroke, and the connecting rods drive cranks placed at right angles. Each cylinder is separately jacketed on the barrels and the ends, the supply and drain from the ends being separate from that for the barrel. Each cylinder is fitted with a Meyer expansion-valve adjustable by hand, so that the cut-off can be separately varied between one-quarter and five-eighths of the stroke. By grid valves on admission and exhaust sides, either cylinder can be arranged as a simple engine, and by blocking either of the Meyer plates the engine can be made single acting. In any of its varied adjustments the engine is as nearly as possible an ordinary commercial engine, clearance volumes and contact surfaces being kept as small as possible. The clearance volumes for the high-pressure cylinder are 0·025 cubic ft. at the front and 0·038 at the back; and for the low-pressure cylinder 0·053 cubic ft. at the front and 0·056 at the back. On the trials the low-pressure cylinder was not in use, the engine being run as a single-cylinder engine exhausting into a condenser, with the vacuum reduced to 2in. to 3in. of mercury. In this way the back pressure in the cylinder was kept constantly at atmospheric pressure. The volume swept through by the high-pressure piston is 0·269 cubic ft. at the back end and 0·254 at the front, after deducting the volume of the 1½in. diameter piston rod. The clearance space is therefore 12·4 per cent. of the cylinder volume at the back and 9·8 per cent. at the front end. The flywheel is 5ft. in diameter and water cooled. To ensure steady running at slow speeds, a second flywheel, 7ft. in diameter, was provided and fitted in halves, so that at speeds above 100 revolutions it could be readily removed. But after the preliminary trials the larger flywheel was found unnecessary and was removed, as, within the range of speeds required, the engine ran perfectly steadily without it.

The committee decided that the first series of trials should be made with the engine arranged as a single-cylinder high-pressure engine, non-condensing jacketed, the second series being a repetition of the first series, but without jackets. After a careful study of previous experiments it was further determined that the variables should be temperature and speed, cut-off and all other conditions being kept constant. Temperatures of 245°F., 280°F., 315°F. and 350°F. were chosen, so as to give equal intervals between successive trials of the series. These temperatures correspond to about 27lb., 49lb., 84lb. and 135lb. per square inch absolute respectively at the engine steam-chest. The chosen speeds were 50, 100, 150, 200 and 250 revs per min., corresponding to piston speeds of about 117ft., 233ft., 350ft., 467ft. and 584ft. per minute respectively. For reasons given below it was not found possible to adhere absolutely to these speeds and temperatures.

A large number of preliminary trials were made to determine the best cut-off, exact speeds and temperatures which could be accomplished with the plant, and to find the best methods of adjusting and working the measuring apparatus, &c. It was found that it was impossible to extend the range of speeds to the lowest limit of the engine—namely, 25 revs. per min.—without interfering with the upper limit, and it was likewise found that at the lowest temperature and pressure the auxiliary pumps could not be got to work. At the upper limit of pressure and lower limit of speed, and at the lower limit of pressure and upper limit of speed, trouble was found in keeping the conditions quite steady. After numerous attempts it was finally found necessary to work the boiler at a slightly higher pressure than that actually required, and to get the exact and steady temperature in the steam-chest by slight throttling at the engine stop-valve.

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* Abstract of a Paper read before the Institution of Mechanical Engineers on March 17th.

At the lowest temperature of the series, and in one or two other cases, this throttling was sufficient to cause superheating. The cut-off which was required to obtain the largest range was found to be three-eighths of the stroke, and this was adhered to throughout both series.

It is dangerous to draw conclusions of too general and sweeping a character from experiments upon one type of engine under one set of conditions, but it may fairly be claimed that the ground covered by this Report has never previously been surveyed with an engine showing more consistent and definite results, nor under conditions which enabled so detailed an analysis of the results to be made. The points which have been elucidated may be summarised as follows:—

First, leakage through the slide-valve, to the importance of which Messrs. Callendar and Nicolson have drawn attention, has been quantitatively determined under defined conditions, and has been shown to be nearly independent of speed of sliding surface and proportional to difference of pressure between the two sides of the valve. Further, it has been shown that the assumption that the leakage is inversely as the overlap of the valve is at least in the main well founded. And further that with well-fitted valves the leakage may amount to over 20 per cent. of the steam entering the cylinder and is rarely less than 4 per cent.

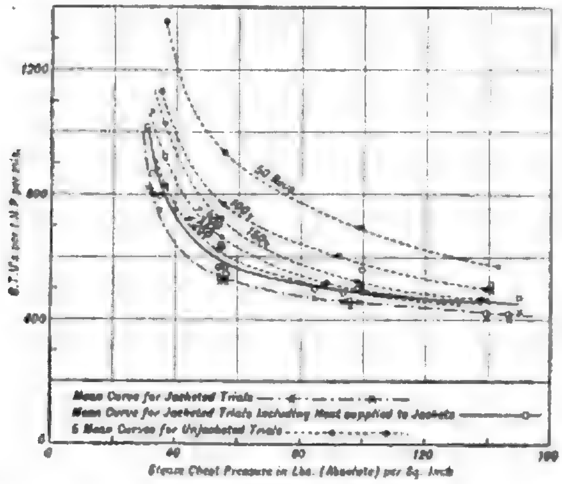

FIG. 1.

Second, it has been shown that for an unjacketed engine with a given ratio of expansion initial condensation, expressed as a percentage of the steam in the cylinder, *diminishes* with increase of initial temperature, while the total condensation per stroke *increases* with such temperature increase. This, though suggested by Messrs. Callendar and Nicolson's researches, has never previously been demonstrated with clearness, as if leakage is not allowed for, the results are obscured and even reversed, and the conclusions arrived at without leakage allowance are therefore unreliable.

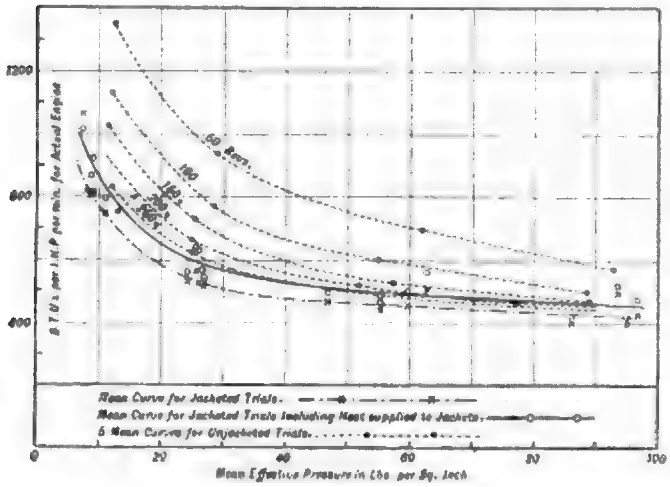

FIG. 2.

Third, it appears from the results here obtained that the re-evaporation for a given ratio of expansion is as great and sometimes greater without jackets than with them. This shows very clearly that the regenerative action of the cylinder walls with a given ratio of expansion is largely independent of their mean temperature. No quantitative analysis of re-evaporation is possible where leakage is not taken into account, as without the necessary allowance results would be largely illusory.

Fourth, it is possible from the results obtained to show the temperature when for any speed of revolution with a given rate of expansion the jackets will become unnecessary or wasteful. If the heat units per indicated horse-power per minute required by the unjacketed engine for each speed of the series be plotted either on an initial pressure or a mean effective pressure base the points for each speed will be found to lie on four curves, which become closer and closer to one another as the speed increases, and all converge to a point as pressure or temperature increases. If the heat consumption for the jacketed series be likewise plotted, it will be found that the points for the different speeds at each pressure lie irregularly round a point, their exact position being determined by the accidentally slight variations of the conditions of each trial. A fair curve through the means of these points will lie below the corresponding curves for the unjacketed trials, but if the heat absorbed in the jackets be included the resultant curve cuts the unjacketed curves at points which for each speed indicate the temperature and pressure at which the jackets cease to be economical. Such curves are shown on Figs. 1 and 2. It will be seen that the full black line, which is the resultant mean for the jacketed trials, cuts both the 250 and the 200-revolution unjacketed curves within the temperatures and pressures included within the scope of the present experiments, and the temperatures and pressures where the 150, 100, and even the 50-revolution curves would cut, can very closely be predicted. As far as the reporter is aware, this is the first time when an exact determination for a given engine and ratio of expansion of this point has been diagrammatically shown.

UNDERGROUND ELECTRICAL CONSTRUCTION.*

BY LOUIS A. FERGUSON.

Electric companies in the United States are practically committed to the drawing-in system of cables and conduit, and it is to such a system that this Paper refers particularly. What is commonly known as the Edison tube system has been used in the past extensively for low-tension work, and is still used to a limited extent, but on account of the relatively short life of the tube and the higher cost of repairs, its use in late years has greatly diminished.

Conduit.—Various forms of ducts are on the market for underground work, vitrified clay tile being used much more than all other kinds of conduit. There seems to be no good reason for using pump-log or ducts made of any inflammable material, particularly for electric light or power work. Cement-lined iron pipe has been used to a certain extent, but there has been some trouble with cables in these pipes, due to the lead on the cables being in contact with the iron ferrule at the ends of the lengths of pipe. Cement pipe is also used to a limited extent. Vitrified clay pipe is furnished in both single and multiple construction. Multiple conduit pipe usually has square holes and single duct either square or round holes. Conduit with square holes is preferable on account of the greater ease with which cables may be drawn in, and also on account of the large number of cables which may be installed in one duct. In general it is undesirable to pull several cables in one duct, but in cases of small cables it is necessary to do so to avoid wasting duct space.

Multiple duct is furnished in sizes ranging from two to nine ducts, and in lengths ranging up to 6ft., although the 6ft. lengths are not made to any great extent, on account of the danger of warping. 3ft. is the standard size for four and six-duct multiples. Nine-duct tile is difficult to handle, and four and six-duct sections are most generally used. There are two objections to the use of multiple duct as compared with single duct. First: Between any two cables in one piece of multiple duct there is only one wall; second, it is not possible to break joints as with single-duct conduit. These two things increase the liability of a fire in one duct reaching cables in adjoining ducts. In single-duct construction there are always two walls between adjacent cables, and all joints are broken, so that there is a very slight possibility of a burn-out in one cable reaching any adjoining cable. Single-duct construction is unquestionably the best, particularly for large companies, where a burn-out on a cable is liable to be severe on account of the large amount of power concentrated at that point.

The first cost of single and multiple tile is approximately the same. The cost of installing multiple duct should be approximately 15 per cent. less per duct foot than for single duct. The weight of single-duct tile is about 20 per cent. more per duct foot than for four and six-duct multiples. The lower cost of installing multiple duct is due to the lower freight charges, on account of the lesser weight, and also to the smaller cost for labour. It is usually necessary to employ a bricklayer for installing single-duct conduit, and multiple-duct may generally be installed with the better class of labourers.

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* Abstract of a Paper read before Section E of the St. Louis International Electrical Congress.

A good arrangement of ducts is secured by laying them not more than four wide and as high as necessary to obtain the required number of ducts. These ducts should be separated into two vertical rows where they enter the manhole, the separation being about 8in. The separating of the ducts should begin about 5ft or 6ft. back from the manhole. This arrangement gives two vertical rows of cables on each side of the manhole and leaves them much easier to support and protect than would be the case with three or more vertical rows. With an arrangement of ducts not more than four wide no cable can have more than one other duct between it and the surrounding earth, thus permitting good radiation of heat.

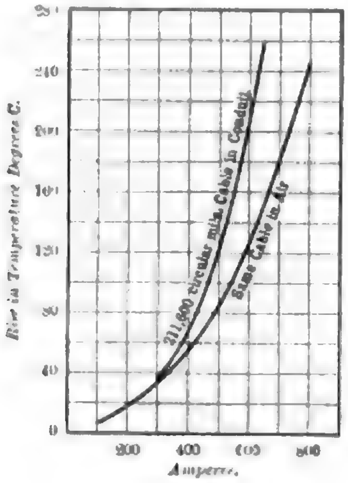


Fig. 1.

Cables.—Nearly all cables for underground work are insulated with either paper or rubber and are lead covered. For some purposes, such as the grounded side of street railway circuits, or the neutral of Edison three-wire systems, bare copper is satisfactory. Bare copper should not, however, be installed in the same duct with lead-covered cables. Paper-insulated cable is more generally used than rubber, on account of its lower first cost and also on account of its greater carrying capacity. Rubber cable will stand rougher use and may be more easily handled in extremely cold weather than paper cable. It is easier to protect the ends of rubber cables than those of paper, and for this reason rubber cable is sometimes used for mains and services on account of the large number of connections necessary for this work. It is not difficult, however, to safely instal paper-insulated cable for this class of work, and it is much more satisfactory to do this and thus carry only one kind of cable in stock. Paper-insulated cable is particularly suitable for feeders on account of its high carrying capacity. Within the past two years cable with varnished cambric insulation has been used for high-voltage work inside stations, and to a limited extent for underground work.

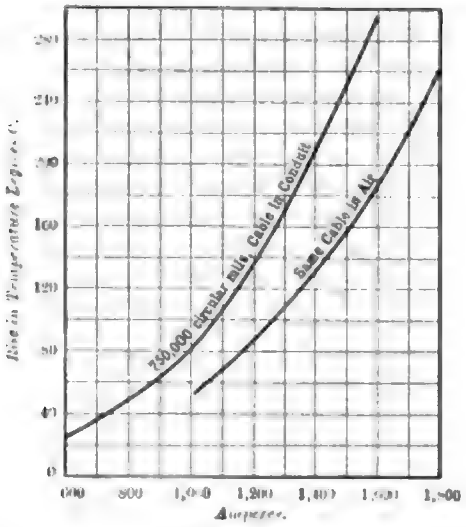


Fig. 2.

Single-conductor cable is commonly used for low-tension feeders in sizes ranging from 250,000 circular mils to 1,000,000 circular mils. Considerable saving in feeders may be made by using two-conductor concentric cable with pressure wires laid up with the outer conductor. Concentric cables for feeders are used mostly in the 1,000,000 circular mils size.' Its carrying capacity is less than that of two-conductor cables of the same size, and the cost is about the same. The saving is made in duct and manhole space and in the cost of installation.

Figs. 1, 2 and 3 show the carrying capacity of lead-covered paper-insulated cable in air and in conduit. These tests were made in a laboratory, the conduit consisting of a single duct of vitrified clay pipe surrounded with approximately 6in. of sand on all sides. Figs. 4 and 5 are the result of tests on 1,000,000 circular mils two-conductor concentric cable, the tests being made with the cable in the air. Concentric cable should be made with the inner conductor so much larger than the outer that the average loss in the two conductors will be the same. At maximum load the loss would be more in the inner than the outer conductor and less in case of light load.

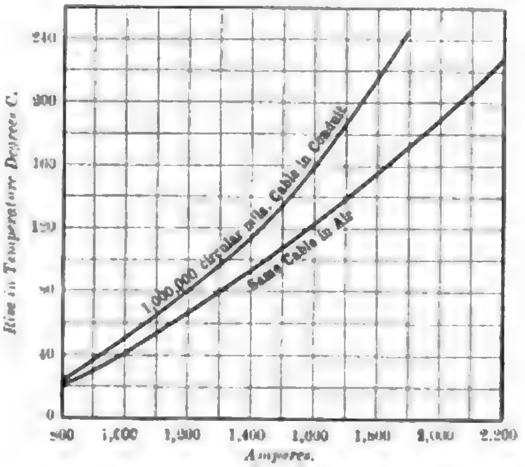


Fig. 3.

Single or multiple conductor cables, up to four conductors, are used on alternating-current primary distribution lines. Duplex cables with the wires laid side by side are sometimes used. This form of cable, with paper insulation, must be very carefully handled, as a slight bend edgewise is likely to crack the paper. If it is thought necessary to use this style of cable, it should be purchased with rubber insulation. It is not, however, a desirable form of cable, for the reason that two V shaped openings are left between the lead and the insulation, and there is danger of water finding its way into these openings when pulling the cable in wet ducts. For two-wire work a concentric cable or two single conductor cables is much safer than a duplex cable with the conductors side by side. Three or four-conductor cables make up well and are easily installed. A three or four-conductor cable admits of a split type of insulation, especially in cables with paper insulation; each

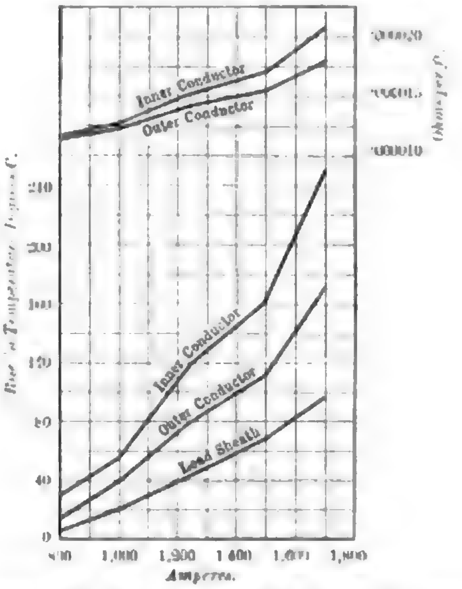


Fig. 4.—Showing rise in temperature and increase in resistance of 1,000,000 c.m. concentric cable with increasing load. 6·32in. inner paper wall; 5·32in. outer paper wall; 1·32in. lead wall.

conductor has the thickness of wrapping necessary to give the proper insulation between the conductors, and all of the conductors have a common wrapping, thus avoiding too much insulation between conductors in order to obtain a proper amount between conductors and ground.

Transmission lines for carrying large amounts of power from stations to sub-stations are nearly always three-conductor and made with the split type of insulation. Cables are in use in the United States and Canada carrying current at pressures as high as 25,000 volts, although a large part of cables in this class of work are operating at pressures between 5,000 and 15,000 volts. Table I. shows the thickness of insulation used by the different companies on cables of this kind. It will be seen that for paper cables the thickness of insulation between conductors ranges from 17 to 67 mils per 1,000 volts, and from 15 to 52 mils per 1,000 volts between conductors and ground. In other words, some companies are using a factor of safety three or four times that used by others.

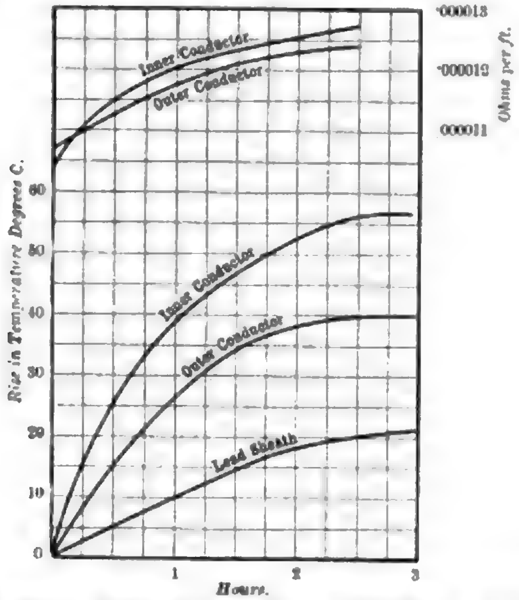


Fig. 5.—Curves showing characteristics of 1,000,000 c.m. concentric cable with current constant at 1,000 amperes. 6·32in. inner paper wall; 5·32in. outer paper wall; 4·32in. lead wall.

Installation of Cables.—All cables, excepting possibly those of small size, as well as those of a moderate size where a large amount is used, should be ordered in exact lengths, making the proper allowance for training in manholes and waste cable. Manholes should be located so that it will not be necessary to pull longer than 500ft. lengths of cable, although in special cases this distance may be extended slightly. Short lengths of small-sized cable may be easily pulled in by hand, but longer lengths or large cable will require a capstan, or some similar device, operated either by men or by horse. Within the past two years electric trucks with a motor-driven winch have been used for drawing in cables, and satisfactory reports from several companies using them have been received.

For work where a great deal of room is not required in manholes it is best to build them with the corners cut on the diagonal, so that the cables, on leaving the end of the duct, will follow the manhole wall easily without necessitating short bends. Iron racks are used ordinarily for supporting cables, and while this is the easiest way of doing it, there is the danger of stray currents crossing from one cable to another where iron brackets are used. This may be avoided, however, by putting small pieces of sheet rubber on top of the iron brackets. Manholes are sometimes built with chases in the side wall to provide support for the cables. This also serves the purpose of protecting the cables from fire due to adjoining cables. The third method of supporting cables, and also at the same time fireproofing them, is the use of split clay tile for covering the cables, the tile being supported on one or two light angle irons extending longitudinally through the manhole. At the ends of the manhole 45deg. curves are laid in reverse, so that cables are completely covered with tile through the manhole. This method is the safest one of the three and the most expensive. Its use is, however, warranted in protecting the important lines, such as high-tension transmission cables. Cables may also be fireproofed by covering them with a double wrapping of asbestos paper or tape, and binding this by means of brass or iron tape. This fireproofing is more easily installed than the split clay tile, particularly in crowded manholes.

Table I.—*Table showing Insulation used by different Companies on Three Conductor High-Tension Cables.*

Company.	Line Voltage.	Kinds of insulation.	Thickness of insulation in thousandths of an inch.			
			Between conductors.	Between conductors and ground.	Per 1,000 volts. Between conductors.	Per 1,000 volts. Between conductors and ground.
New York Edison..	6,600	Paper	312	312	47	47
N. Y. Metropolitan	6,600	,,	438	343	67	52
N. Y. Sub. Co. ..	11,000	,,	438	468	40	43
N. Y. Manhattan. .	11,000	,,	436	436	40	40
Buffalo-Niagara L.	11,000	,,	406	406	37	37
Buffalo-Niagara L.	11,000	Rubber	562	281	51	25
Chicago-Edison ..	9,000	Paper	406	383	44	38
Milwaukee	15,000	,,	500	437	33	29
St. Paul	25,000	,,	562	484	23	19
St. Paul	25,000	Rubber	436	374	17	15
Providence	12,500	,,	562	281	45	22
Montreal	25,000	Paper	562	406	22	16

Apparatus in Manholes other than Cables.—On a low-tension system employing an interconnected network of mains it is necessary to instal junction boxes at the street intersections, so that the feeders and mains may be disconnected in case of trouble, either automatically, by fuses blowing, or by removing the fuses by hand. It is necessary that these boxes be water-tight and still be easily accessible. Cast-iron boxes are used with suitable 'bus bars and cable terminals, the cable being brought in through the sides and bottom of the box, and the holes around the cables being made water-tight, either by means of stuffing boxes or wiped connections. These boxes are ordinarily made six-pole and two-way, the neutral connection of the three-wire system being omitted from the junction box. A rubber gasket is used to make a water-tight joint at the door. Junction boxes have been built for installation in the roof of the manhole, so that it is possible to get at the connections readily from the surface of the street in the same manner as in the Edison junction boxes for tube work. Service boxes are sometimes installed in manholes, but it is usually better to place them on the curb wall in the basement of the customer's premises.

Transformers for manhole use should be built with a watertight case. Primary fuse boxes should not be placed in manholes unless it is absolutely certain that the manholes can be kept dry. If an interconnected network of secondaries is used junction boxes should be installed and connections from the secondaries of the transformer carried to the junction box.

Connections between Overhead and Underground Lines.—In an alternating-current system operating both overhead and underground lines one of the most difficult places to protect is the connections between the two. This is ordinarily done by carrying a lead-covered cable up the pole in an iron pipe to within a few feet of the cross arms. The end of the lead cable should be protected with a suitable pothead and the connections made from the lead cable to the weatherproof wire by means of a short piece of wire with high-grade insulation. Varnished cambric insulated wire with an additional protection against the weather of two or three layers of friction tape, well painted, has been used for this purpose. It is well also to box in the lead-covered cables above the top of the iron pipe, taking the insulated wires out through bushings in the sides of the box. The boxing in of the lead cable and potheads is done both to protect them from the weather and from damage by linemen, and also to protect the linemen from coming in contact with the grounded lead while working on live wires.

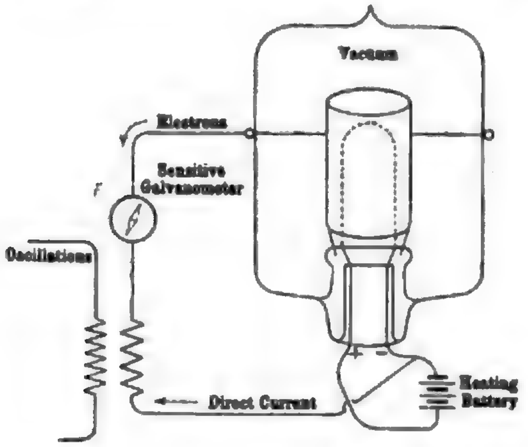
Ventilation of Manholes.—It may sometimes be necessary to use artificial ventilation for manholes where the heat given off by the cables is not sufficiently dissipated in the surrounding earth and by the manhole ventilation; this, however, would only be necessary in case of very large and heavily loaded lines. All ventilated manholes should have sewer connections. Ventilated manholes are a great help in allowing gas to escape from conduit lines and from the ground generally in their vicinity. On comparatively small conduit lines, also on small service manholes or handholes and on manholes located where sewer connections cannot be made, closed manhole covers should be used. These manhole covers are usually made of a double construction, the inner cover having a rubber gasket and being held tight against the rubber gasket by means of iron wedges or similar devices.

Metropolitan District Railway.—An official trial trip in an electric train on the Metropolitan District Railway between Ealing and Bow-road was made in the small hours of Tuesday morning after Monday night's traffic had ceased. It was stated that the trial was successful, but no date has yet been announced for the opening of the electric service on the Inner Circle and the District lines in connection with it.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by F. E. FOURNIER D'ALBE.]

A New Vacuum Rectifier.—J. A. Fleming has devised an electric vacuum valve which enables him to convert electric oscillations, however rapid, into continuous currents, with an efficiency approaching 100 per cent. This valve is of great use as a quantitative indicator of electric waves, though the fact that the resistance of the vacuum does not obey Ohm's law makes the apparatus imperfect in this respect. The inventor utilises the fact that electrons are expelled with ease from an incandescent conductor, but are not absorbed by it. Hence, a current of electrons will proceed from a hot terminal to a cold terminal (or, in the older style of description, a "current" will pass from the cold to the hot terminal), but not in the opposite direction. The cold terminal is a metallic cylinder kept cold by a circulation of water, while the hot terminal is a filament heated to incandescence. The connections are indicated in the diagram. If both phases of the incident current are to be rectified, two valves must be used, as in the case of the aluminium rectifier. The vacuum space enclosing the two terminals possesses a maximum conductivity corresponding to a P.D. of about 20 volts. The author interprets this as follows:—"In the incandescent carbon there is a continual production of electrons or negative ions by atomic dissociation. Corresponding to every temperature there is a certain electronic tension or percentage of free electrons. If the carbon is made the negative electrode in a high vacuum these negative ions are expelled from it, but they cannot be expelled at a greater rate than they are produced. Therefore, there is a maximum value for the outgoing current and a maximum value for the ratio of current to electromotive force, that is, for the conductivity. This fact, therefore, fixes a limit to the utility of the device. The current through the vacuous space is, to a very large extent, independent of the electromotive force creating it, and is at no stage proportional to it, or at least only within a narrow range of electromotive force near to the maximum conductivity. Whilst, therefore, the device is useful as a simple means of detecting electric oscillations, it has not that uniformity of conductivity which would make it useful as a strictly metrical device for measuring them. It can, however, perform the useful service of showing us how far any device for producing electric oscillations or electric waves produces a uniform or very irregular train of electric oscillations, and what changes conduce to an improvement or reduction in the efficiency of the transmitting device."



[J. A. FLEMING, *Proceedings* Roy. Soc., March 16, 1905.]

Momentary Stresses in Metals.—B. Hopkinson has studied the effect of a blow delivered by a falling weight on the lower end of a wire, the upper end of which is fixed. This problem occurs in the mounting of overhead wires and securing them against breakage by shock. Immediately after impact, a wave of stress (in reality a sound-wave) starts up the wire, and returns after reflection at the upper end. This reflection involves a doubling of the stress at the point of reflection, and hence the wire is most likely to break at or near its point of suspension. The general result thus obtained is that iron and copper wires may be stressed much beyond the static elastic limit and even beyond their static breaking loads without the proportionality of stresses and strains being substantially departed from, provided that the time during which the stress exceeds the elastic limit is of the order of $\frac{1}{1000}$ second or less. A possible explanation is that in the copper wire the value of Young's modulus for these extremely rapid extensions is 10 per cent. greater than for slowly applied forces. The difference between the adiabatic and isothermal elasticities, as calculated from the coefficient of expansion and Young's modulus, is not sufficient to account for the effect, which must be a true time effect if it exists.

[B. HOPKINSON, *Proceedings* Roy. Soc., March 16, 1905.]

Radium Rays and Phosphorescence.—G. T. Beilby has studied the phosphorescence caused by the Beta and Gamma rays of radium, and has attempted to trace the connection between the chemical and colouration effects and the luminescent effects of the rays. He finds that certain types of phosphorescence are due to the molecular movement or displacement which is produced by heat, by mechanically-applied stresses, or by radiant energy. Certain other types of phosphorescence are distinguished by their appearance in three stages, called primary, secondary, and revived phosphorescence or thermo-luminescence. These can be explained as due to atomic changes in which chemical affinity is the controlling factor. The phenomena of this type appear to support the view that a species of electrolysis occurs in solids exposed to the β or cathode rays; that the products of electrolytic dissociation are insulated or partly insulated from each other by the neutral molecules, as in a viscous electrolyte; and that it is the breaking-down of this insulation and the recombination of the ions which causes revived phosphorescence. An obvious application to illumination is to store energy in the form of this dissociation at a low temperature and to release it by heating. The storage may be very prolonged, as shown by the following observation: A polished lens of rock crystal, after exposure to the rays for four days, showed a patch of dark brown colouration at the spot where the rays had entered. On removal from the radium the coloured patch phosphoresced faintly. This could only be seen in complete darkness. After an interval of six weeks the lens showed no trace of phosphorescence at the ordinary temperature, but on heating it on a hot plate to rather over 100deg. the coloured patch glowed so brightly that it lighted up the rough edges of the lens and showed its complete outline quite distinctly. On raising the lens to a considerably higher temperature, probably over 250deg., it glowed more brightly, and then the glow ceased altogether. The brown colouration had now completely disappeared.

[G. T. BEILBY, *Proceedings* Roy. Soc., March 16, 1905.]

Electric Charge of Radium Emanation.—A. Battelli and F. Maccarone have endeavoured to decide between the view of Becquerel, according to which radium emanation consists of atoms which have lost an electron, and are therefore positively charged, and the views of Rutherford and MacClelland, who could discover no charge in the emanation. Working with a small Blondlot electroscope of small capacity, they found no certain indication of a charge. They conclude that the emanation does not consist of positively-charged atoms, nor of atoms charged negatively by losing positive electrons.

[BATTELLI and MACCARONE, *Physikalische Zeitschrift*, March 15, 1905.]

Projection of Electrons from the Anode.—E. Rogovsky has found that electrons may be projected from a positively charged electrode under certain conditions. He takes a Crookes tube as constructed for exhibiting the shadow of a cross exposed to cathode rays. But he reverses the connections, so that the cathode becomes the anode. The Ruhmkorff coil furnishing the current has a spark of some 4cm. The resistance of the primary is increased till the coil nearly ceases working. The shadow of the cross then appears on the wall of the tube in the well-known manner, although an electroscope still indicates a positive charge on the anode.

[E. ROGOVSKY, *Comptes Rendus*, February 27, 1905.]

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THE NEW PATENT PROCEDURE.

From the issue of the report of the Departmental Committee appointed to consider the working of the Patents Acts, up to the final stages in the passing, in 1902, of the Patents Act based on the Committee's recommendations, we constantly warned our readers of the unsuitability of the new proposals for the amendment of the patent law of this country. Little interest was then taken in the matter by the majority of those who should have been most concerned with it, and the Act was passed practically without opposition. The Act only became wholly operative on January 1st this year, and after less than three months' experience of its working a widely-signed memorial has been presented against it, or, to be more accurate, against one of the rules which have been issued to give effect to its provisions. This memorial, which appeared in last Monday's *Times*, was forwarded to the President of the Board of Trade by Sir LLOYD WISE, the distinguished patent agent, and is signed by a number of manufacturers, consulting engineers and patent experts. Briefly, the petitioners ask for an amendment of the rule by which, if the Examiner at the Patent Office considers that the subject-matter of the patent has been wholly or in part anticipated by previous patents, the patent may only be issued to the inventor bearing an officially-worded note enumerating these previous specifications. In itself, this may not seem a great grievance, for, at first sight, it would not appear unreasonable to refuse to grant the patent at all if it is invalid. And if the patentee thinks he knows better than the Examiner, and desires to take all risks, he is a brave man and will not fear the "ear mark" above referred to. The real reason for this loud chorus of disapproval on the part of our experts must therefore be sought below the surface, and it is not hard to find. It is simply that they have no confidence in the judgment of the Patent Office Examiners on the question of anticipations, and they think not without reason that, in the case of a good invention by a good inventor, the inventor himself will have a better knowledge of his subject than the Examiner, and be able to judge better than he whether the suggested anticipations really invalidate his patent. But the point that is still obscure is, what then can be the object of an official search at all? Since the main object of the new Patent Act is to provide for this search, we contend that this part of the Act is based upon a false principle altogether. We were almost alone in our condemnation of these clauses before the Act was passed, but now that its provisions have become effective all those who tacitly supported it before are now clamouring for the amendment of a rule which clearly does no more than put into effect the letter and spirit of the Act.

Until the recent amendment in our patent law, the Patent Office simply granted a patent to any inventor who applied for one and specified the nature of his invention in the manner officially prescribed. The grant of a patent constituted no guarantee as to the novelty of the invention, but by the excellent classification of the files of patents of all countries and the voluminous collection of technical books and periodicals in the free Patent Office library, the inventor was given every facility to ascertain for himself whether he had actually made a new invention or not. But in Germany and in America the Patent Office itself institutes a search before granting a patent, and four years ago, when the Departmental Committee reported, the unwholesome fashion of decrying our own customs in industrial matters in comparison with German and American methods was at its height. So a somewhat similar procedure had to be inaugurated in this country, but Parliament was too timid to give full authority to the Departmental Official, and thus the search is only a partial one, and the applicant may have his patent, even if the officials are of opinion that it is invalid. The search is merely made through the British patents of the preceding 50 years, and it must not follow from the grant of a patent, even without the official endorsement to which exception is now taken, that the specification describes a new invention. The same invention may have been described in its entirety in any or all of the British and foreign technical journals, or it may have been previously well known to the general public, but the Patent Office can take no official cognisance of this fact. Thus, if the inventor desires to satisfy himself that his patent is secure, he has still to make a complete investigation on his own account, but he has, nevertheless, to pay the extra fee of £1 now imposed to defray the cost of the partial search made in the Patent Office.

We cannot agree with Sir LLOYD WISE and his colleagues that it is only the new rules that are at fault. The whole new system introduced by Section 1 of the Patents Act of 1902 is based on a wrong principle; and the petitioners would have been better advised if, instead of begging Lord SALISBURY to amend Rules 9 and 10 issued by the Patent Office under this Act, they had asked for a new Act of Parliament revoking Section 1 of the Act altogether.

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Electricity Control. A Treatise on Electric Switch Gear and Systems of Electric Transmission. By LEONARD ANDREWS. (London: Charles Griffin & Co.) 12s 6d.

The author's excuse for this book is that no work has dealt thoroughly with the design of switch gear. He is right, but although Mr. Andrews' work is excellent there is still room for another book on this most important matter by a more impartial writer.

Two subjects are mentioned in the title—electric switch gear and systems of electric transmission—but while 176 pages are devoted to the former, and only 51 pages to the latter and more intricate question, this second portion of the book may be reviewed briefly. It gives three "examples of complete installations"—Edinburgh, Hull and Hastings—and finishes with a chapter on "Long Distance Transmission," the author wandering merrily over the whole subject.

The first part of the volume on switch gear contains a good descriptive account of a few of the best-known English switch gears and their arrangement, with a few well-known Continental and American examples thrown in. This part commences with a few notes on the general principles of switch-gear design which will be in accord with the opinions of most readers. A chapter on constructional details follows, in which a large part is devoted to rheostats, the author naturally thinking that the Cowan rheostat is the best. We next have a description of circuit-breakers. The author draws special attention to the use of horn-break blow-outs, and it appears that he considers it would be best to make the horns project horizontally—*i.e.* at an angle of 180deg., instead of an acute angle. Experimenting with the former arrangement, he found the arc was maintained for a shorter time, but it is unfortunate he did not carry his experiments a step further to see which type caused the greatest rise of pressure in the mains. Chapters on automatically-operated circuit-breakers, alternating reverse-current devices and arrangement of apparatus for parallel running follow. The examples of directly-controlled switch gear for high-tension systems are Ferranti, Cowan, Brush and Raworth, with special mention of Hastings and Glasgow, and brief descriptions are given of the indirectly controlled systems of Berlin, New York Metropolitan Street Railway and Niagara. As examples of low-tension switchboards, we have the Board of Trade traction panel, Newington, Edinburgh, Glasgow, Hackney, Willesden, Glasgow Exhibition and a little more than a page of letterpress and a few illustrations of the Boston motor-operated switch gear.

As the work aims at being a "treatise" we regret that the author has not devoted more space to the technical side of the question. The first thing we looked for in a work of this kind was the best material for switches, the insulation of switches, the proper cross-section and contact section for the different materials, the fireproof qualities of insulators, the current density to be used in 'bus bars and connections, and kindred subjects; but the information given on these matters is very meagre.

By far the most interesting portion of the volume is that which describes the author's own researches with both direct and alternating reverse-current circuit-breakers. The curves showing the behaviour of various circuit breakers designed to act on a reverse direct current are admirable, and the author is to be congratulated, especially in the results which are depicted of his Manchester dynamo type of cut-out; it is to be hoped that before long he will be able to show results equally conclusive with his alternating-current devices.

The illustrations, letterpress and general "get-up" of the book are all that can be desired.

Die Leitungen, Schalt und Sicherheitsapparate fur elektrische Starkstromanlagen. Part I. By H. Pohl. (Leipzig: S. Hirzel.) 1904. 20m.

This is the first part of the sixth volume of the "Handbuch der Elektrotechnik" edited by Dr. C. Heinke, and it deals, in the thorough German technical spirit, with the subject matter enumerated in the title, neither turning to the right hand nor to the left hand: not wandering off into pleasant by-paths as is a frequent and refreshing habit in our English technical works, but plodding on in the straight way set out for it.

The volume before us commences with a description of the materials suitable for electrical conductors, especially comparing aluminium and copper, and the various forms of stranding which are adopted by the principal German cable manufacturers. The heating of conductors follows, and very useful data from tests, taken at Munich Laboratory, of the voltage necessary to break down various insulators is given; the specific resistance, as well as the temperature and humidity of the air whilst the experiments were being carried out, is also mentioned. This first chapter, which finishes with a discussion on dielectric hysteresis and insulating material for cables, treats of matter that is of interest to electrical engineers all the world over, and the reader will find the results of a large number of experiments with very little theory. The second section deals with the manufacture of cables, followed by a description of the necessary tests during and after manufacture, concluding with details of a large number of special cables and their uses. Next we have all the best-known German switches described, including high tension, distant control, maximum and minimum, accumulator, as well as the smaller switches used in house installations. Sections on cut outs, safety devices for overhead wires and lightning arresters terminate the publication.

The volume is in every way complete. Full acknowledgement of the best English, American and French work is made. We have a full description of the best types of German manufacture; but it may be noted that the amalgamation of the various German companies has taken place since portions of the work have been printed, so that we shall shortly have the combined firms uniting the best of each in their newest goods.

National Engineering and Trade Lectures. Edited by BEN. H. MORGAN. **Vol. I, British Progress in Municipal Engineering.** By. W. H. MAXWELL. (London: Archibald Constable & Co.) 1904. 6s.

This is the first product of the excellent scheme of "National Engineering and Trade Lectures" designed to promote and extend British trade in colonial and foreign markets. Copies of the lectures, and the loan of lantern slides illustrating them, are to be available free of charge for lectures to technical societies, Chambers of Commerce and similar institutions, with the view of spreading abroad a better knowledge of the recent progress made in the various British industries. The present volume of three lectures, dealing with municipal engineering in its narrower sense, only touches on electrical engineering in the section on Refuse Destructors. This part of the book, as also the remaining portions, is written in a style that will appeal to the public for which it is intended, and if the succeeding volumes come up to the same standard the collection will be a valuable one. A little more discrimination should be shown, however, in the "Classified List of British Manufacturers," which follows each lecture; the whole object of the work is defeated if the names of British agents for large foreign manufacturing firms are included in this list, and the compiler has apparently not realised that an English name does not necessarily imply British manufacture. We are informed that the King has been pleased to accept a copy of the volume.

Lectures Scientifiques: A French Reader for Science Students. By W. G. HARTOG, B.A. (London: Rivington.) 1904. 5s.

Students desiring to acquire a knowledge of French terms employed in science will find this reader of considerable assistance, but it is unfortunate that the glossary is inadequate and not always accurate. The book contains extracts from Papers by French writers on Chemistry, Physics, Mathematics, Physiology and Botany. The passages on electrical subjects are antiquated, dating back to 1891; but this is partially compensated by the inclusion of some pages on radium and radioactivity in the "Chemistry" section. French characteristics have been retained to the extent of mis-spelling some of the names quoted in the book.

Private House Electric Lighting. By FREDERIC H. TAYLOR. (London: Percival Marshall & Co.) 1s.

This is a useful little work for the amateur and the wireman, but the omission of an index detracts from its value. The same remark applies to the lack of wiring tables. The work is avowedly not intended for those who may be seeking to aid their technical knowledge with regard to electric lighting.

Practical Electric Light Fitting. By F. C. ALLSOP. (London: Whittaker & Co.) 5s.

The sixth edition of this book is on similar lines to its predecessors and calls for little comment. Its character remains that of a work for wiremen, fitters, &c., all explanations being given in simple language, as free from technical terms as is consistent with the object of the book.

PHYSICAL SOCIETY.

At a meeting of the Physical Society, held in the Pender electrical laboratory, University College, March 24th, Prof. J. H. Poynting, F.R.S., president, in the chair, Mr. W. C. Clinton read a

"Note on the Voltage Ratios of an Inverted Rotary Converter."

The values of the voltage ratios usually given for an inverted rotary converter make no allowance for the resistance of the armature. In this note terms due to the effect of armature resistance are introduced into the ordinary theoretical equations. The resultant voltage on the alternate-current side is found to be less than that given by the usual rule. The calculation is only made for open-circuit conditions on the alternate-current side.

A Paper

"On the Flux of Light from the Electric Arc with Varying Power Supply,"

was read by Mr. G. B. DYKE. The Paper records the results of experiments made on the electric arc with the following objects:—(i.) To obtain a series of curves for alternating and continuous arcs of different lengths showing the relation between the mean spherical candle-power and the power supplied to the arc. (ii.) To compare the efficiencies of the alternating and continuous arcs under different conditions of arc length and power supply. The subject being too wide to deal with in its entirety the following restrictions were made:—The carbons used were 12mm. diameter cored (upper) and 10mm. solid (lower). The frequency of the alternating current was 80 cycles. The mean spherical candle-power was determined directly by means of an integrating photometer described by the author in a Paper read before the Society in November, 1904. Curves connecting the M.S.C.P. with the watts are given for eight arc lengths varying from $\frac{1}{16}$in. to $\frac{7}{16}$in., for both continuous and alternating currents. These curves are found to be straight lines which cut the axis of watts at points between 200 and 400 watts. Alternate and continuous current curves for the same arc-length are found to meet the axis of watts in the same point, showing the equality of the losses by dissipation of energy in other forms than that of light. For normal arc-lengths the alternating-current efficiency is about two-thirds of the continuous-current efficiency. If the arc-length is reduced below $\frac{1}{4}$in., the alternating-current curve rises towards the continuous-current curve until at an arc length of about $\frac{1}{16}$in. the two efficiencies practically coincide. On further reducing the arc-length the alternate-current curve rises above the continuous-current curve. An approximate analysis of the case of equal efficiencies is given, the results of which give an arc-length similar to that obtained experimentally.

Dr. J. A. FLEMING congratulated the author and referred to the practical value of the experiments. The ordinary method of comparing lamps by their M.H.C.P. was unscientific. What was wanted was the total flux of light per watt, and this important figure was obtained at once by the integrating photometer used by the author. Prof. Fleming instanced the case of a Nernst lamp and an ordinary carbon-filament lamp, pointing out that the ordinary tests indicated that the Nernst lamp was twice as efficient as the ordinary lamp, whereas a comparison of the total flux per watt showed an increased efficiency in the Nernst lamp of only 25 per cent.

Mr. PATTERSON expressed his interest in the Paper, and referred to the photometrical work at present being carried out at the National Physical Laboratory. He pointed out that the variation of the light from an electric arc necessitated a great number of readings in order to get a satisfactory mean value. The photometer used by the author only integrated the light in one plane, and it would be more satisfactory to integrate in two planes at right angles to one another.

A Paper

"On the Application of the Cymometer to the Measurement of Co-Efficiencies of Coupling of Oscillation Transformers."

was read by Dr. J. A. FLEMING. This Paper deals first with the latest pattern of instrument called by the author a cymometer, designed for the measurement of the frequency of electric oscillations, and also the length of long electric waves. It consists of a sliding tubular condenser, consisting of two brass tubes, separated by a thin ebonite tube, the outer tube being capable of sliding off the inner tube. Parallel with this sliding condenser is placed an inductance coil or helix, of bare copper wire, wound on an ebonite tube. The outer brass tube of the sliding condenser carries a collar, which in turn carries a rod with a crutch at the end resting upon the inductance coil. The circuit of the instrument is completed by a copper bar which joins one end of the inductance coil with the inner surface of the sliding condenser. When the outer tube of the condenser is moved by an insulating handle, the same motion reduces equally the capacity of the condenser and the portion of the inductance coil included in the closed circuit. The circuit therefore consists of a variable capacity and inductance in series. The author calls the square root of the product of the capacity and inductance in any position, the *oscillation constant* of the instrument. A scale is provided parallel with the inductance coil, on which is engraved the oscillation constant and the corresponding frequencies connected therewith by the formula $n = 1/2\pi\sqrt{CL}$. In addition to this, the instrument is provided with a vacuum tube, preferably a Neon vacuum, which is connected between the inner and outer surfaces of the condenser. The instrument is used in the following manner:—The copper bar is placed parallel and near to a circuit in which oscillations are taking place, and the handle of the instrument is moved, thus varying the oscillation constant, until the vacuum-tube glows most brightly. Under these circumstances it is known that the circuit of the cymometer is in resonance with that of the circuit being tested, and their oscillation constants are therefore the same, hence the scale reading gives the product of the capacity and inductance of the circuit being tested. The instrument is also provided with a rectangular wire circuit, the inductance of which is known. If this circuit is joined up with any unknown capacity and oscillations set up in it, the cymometer can be used as above, to determine the product of capacity and inductance in the circuit being tested, and the inductance being known, the capacity is, therefore, known also. Again, if we have any oscillation transformer, we can join up the primary and secondary circuits, so as to inductively oppose or aid one another. If we call L and N the inductance of the primary and secondary circuit respectively and M their mutual inductance, the effective inductances L_1 and L_2 of the two circuits joined in the two ways are respectively given by $L_1 = L + 2M + N$; $L_2 = L - 2M + N$. Hence we have $M = L_1 - L_2/4$ and $L + N = L_1 + L_2/2$. If, then, either L or N is separately measured, and if the resultant inductance of the compound circuit is measured, we can find the coefficient of coupling $M/\sqrt{LN}$ of the oscillation transformer. The inductance of any circuit can be ascertained for the high-frequency currents by the cymometer in the following manner:—The circuit to be tested is joined up in series with a known capacity, and the rectangular circuit provided with the instrument. Two measurements are then made: (1) When the inductance to be tested is included in the circuit, and (2) when excluded from it. If the observed oscillation constants under the two conditions are called $O_1 O_2$, then we have the following expression for the unknown inductance:—$L' = O_1^2 - O_2^2/C$. The instrument can also be used for measuring the oscillation constant or the frequency in an open oscillating circuit, such as that of a wireless telegraph aerial, and by means of it the wave-length which is being sent out from the aerial can be measured, and also the wave-length of waves being received on any aerial. The instrument can also be employed to analyse a compound oscillation taking place in a circuit and determine the component frequencies. It thus acts as an electrical equivalent of a spectroscope.

Dr. W. WATSON expressed his interest in the paper, and said that the cymometer, on account of its simplicity, would be useful for lecture purposes. He asked Dr. Fleming if he thought that any of the anomalous results which had been obtained in determining specific inductive capacity by methods involving the mutual induction between two circuits might be due to the fact that oscillations of two different frequencies were induced in the secondary circuit. Did a change in the coefficient of coupling affect the energy transmitted to a secondary circuit?

Prof. A. W. REINOLD said that the accuracy of the experiments depended upon the use of Neon tubes, and he expressed the hope that it would soon be possible to obtain them easily. Referring to the fact that oscillations in a circuit containing capacity and inductance induced in a neighbouring circuit oscillations of two distinct periods, he asked Dr. Fleming what it was that determined the energies of the two oscillations. He also asked how, when measuring the wave-lengths of waves incident on an aerial, the fact that two oscillations were necessarily induced in the cymometer affected the utility of the instrument.

Mr. A. CAMPBELL pointed out that ebonite was used as the dielectric in the sliding condenser, and asked if there was any variation in the capacity with change of frequency.

Dr. FLEMING, in reply to Dr. Watson's question, said that undoubtedly errors might result in employing methods involving the mutual induction of two circuits for the determination of specific inductive capacities if the observer were not acquainted with the peculiarities of coupled circuits and high-frequency oscillations. The general theorem involved is that if there be two circuits each having inductance and capacity, and oscillations are set up in one circuit by disruptive discharge in the other, then we have a compound oscillation set up in the secondary circuit which may be resolved into two frequencies which are different from the free natural frequency of each circuit separately. The theory has been fully worked out by A. Oberbeck ("Wied. Ann. der Physik," 1895). Hence, if it were assumed that the resulting oscillation in the secondary circuit, even if it had the same natural period as the primary, was a single oscillation of the same period, an error would undoubtedly be made. Oberbeck has not given expressions for the respective energies of the two oscillations, but he has shown that the two oscillations have different damping. The coefficient of coupling determines the respective energies of the two oscillations, but Dr. Fleming said he had not yet given sufficient attention to the theoretical side of the subject to be able to furnish expressions for the energies of the two oscillations. In reply to Prof. Reinold, he said that if the mutual inductance between the aerial wire and the cymometer were small, as it was in the case of the instrument exhibited, then the cymometer only detected the oscillations which existed in the aerial. There was no creation of duplicate oscillations in and by the cymometer itself. In reply to Mr. Campbell, Dr. Fleming said that it had been shown by Prof. J. J. Thomson and others that the variation in dielectric constant with frequency was very small or even absent in the case of ebonite. That was the reason why ebonite was chosen for the dielectric tube. In the case of glass there is a large change in dielectric constant with frequency. As regards the commercial production of Neon vacuum tubes, that subject was engaging his attention, and he hoped they might soon be placed on the market. The beautiful process devised by Sir James Dewar of absorbing the common constituents of air by cocoanut charcoal at low temperatures enabled neon and helium to be prepared from the air without much trouble.

PARLIAMENTARY INTELLIGENCE.

ELECTRIC LIGHTING BOUNDARY DISPUTE.

WEYBRIDGE AND WALTON ELECTRIC LIGHTING BILL.

This bill came before a Committee of the House of Commons, presided over by Mr. Agg Gardner, on Thursday last week.

Mr. C. BAGGALLAY, K.C. for the bill, said it was promoted by the Urban Electric Supply Co., which obtained a Provisional Order for the supply of electricity in Weybridge in 1900. An agreement was entered into between the council and the company on the question of price, the number of scheduled streets, and site of the generating station. In 1903, the neighbouring district council of Walton-on-Thames obtained an order for the supply of electricity, and entered into an agreement with the Urban Electric Supply Co. for a supply of energy. To this the Weybridge Council objected, and really, technically the company was committing a fault in supplying energy outside Weybridge without special consent either of Parliament or of the Board of Trade. The Board of Trade, therefore, warned the company on the point, and gave six months in which to make a different arrangement. Consequently, in 1903 the supply company applied for a Provisional Order to supply in Walton. But even this was not sufficient to comply with the Act of 1882 and the Electric Lighting Clauses Act of 1889, although it would have only meant that there was one company supplying in two districts with two orders, this came under the objection that they were associating themselves with some other person or body, whereas it was a fact that they were associating themselves with themselves. Apart from this the Weybridge Council objected on the ground that for the company to extend its area was in direct contravention of the agreement which he had referred to. But this was not so, and the Board of Trade granted the Walton order, and Weybridge did not oppose the confirmation of the order. But an application in July, 1904, of the Weybridge Urban District Council to the Courts resulted in an injunction restraining the company from supplying Walton from the Weybridge generating station until the company was duly licensed to do so by the Board of Trade. The company thereupon erected temporary generating plant in Walton, and had promoted this bill to remove the difficulty thus created. The Weybridge Urban District Council was the only opponent to the bill.

Mr. F. E. GRIPPER, chairman of the Urban Electric Supply Co., corroborated counsel's statements and gave general particulars of the company's works. The amount of money already spent on the Weybridge works was about £60,000. Extension was necessary, even for the future supply in Weybridge only, and there would be sufficient plant to supply in Walton.

Cross-examined by Mr. H. LLOYD, K.C., for Weybridge Urban District Council, he said the decision of Mr. Justice Joyce that an authority holding Provisional Orders for two separate districts could not supply both from one generating station in either of the two districts, had come as a bombshell to many dozens of undertakings doing this very thing. But it was only the accident that the position of this generating station in Weybridge was some distance away from the Walton boundary that prevented him supplying in both areas from the one station, for Mr. Justice Joyce had made it clear that if the company could obtain a private wayleave they could supply. They could not break up the streets. If the station was on the boundary they would do it.

But your station is not on the boundary and we need not discuss that?—But we can move our station.

Are you contemplating doing that?—We may do so if this bill is not passed.

Then I am afraid we shall meet again.

Further cross-examined as to the effect of the powers now asked for upon the purchase price of the undertaking in Weybridge, Mr. Gripper said the Weybridge Council had the option of purchasing the undertaking 10 years hence as a going concern, but there was no possibility of their exercising this option as, in the opinion of several members of the Council, the Local Government Board would not sanction the large sum—about £100,000—which would be required, the rateable value of the district being under £70,000. In any case the value would not be increased because the Council would only buy the Weybridge undertaking. If the undertaking of the company in Walton was purchased as well, the Weybridge Council would be entitled to supply in Walton and thus be compensated for the higher price which would have to be paid. If the Weybridge Council only purchased the undertaking in their district, the company would be glad to bind themselves to take power in bulk for Walton, on arbitration terms.

Mr. A. A. CAMPBELL SWINTON and Capt. E. I. BAX of the Westminster Electric Supply Corporation, gave evidence of the economy and general convenience to be gained by adopting the proposal of the Company.

Evidence was then called from Walton in favour of the bill.

The case for the Weybridge Urban District Council against the bill was that the proposal was a contravention of the agreement between them and the Urban Electric Supply Co.

The CHAIRMAN, without calling upon the promoters to reply, said the Committee found the preamble of the bill proved.

SWANSEA CORPORATION BILL.

On March 21st this bill came before a Committee of the House of Commons, of which Mr. Stevenson was the Chairman.

Mr. H. LLOYD, K.C., for the promoters, said the main object of the tramway portion of the bill was to supersede the provisions of the Swansea Tramways Act of 1882 as to purchase by the Corporation of Swansea of the tramways belonging to the Swansea Tramways and Improvement Co. He said the tramway company obtained powers to construct tramways in Swansea in the years 1874, 1878 and 1879, and for all these lines, under the Tramways Act of 1870, the company was the owner for 21 years. In 1882, however, the company secured a new Bill authorising them to construct certain further tramways and to incorporate the General Act of 1870, except in so far as the purchase terms of that Act were varied by the Act of 1882. Practically speaking, the variation of these terms were that the Swansea Corporation should be enabled to purchase all the lines of the company after a period of 21 years from the date of the construction of the tramways authorised under the 1882 Act. After then the company was to be granted a lease for a further 21 years. This period for purchase expired in 1906, and certainly at the time of the passing of the 1882 Act the opinion of all the parties concerned was that the Corporation should, as he had said, be enabled to purchase the lines at that date. The drafting of the clause, however, had not been what it should have been, and, consequently, some trouble had arisen between the promoters of the bill and the tramway company, which was the only opponent to this part of the bill. Up to 1897 there had been no difficulty, but subsequently a change came over the company after the majority of the shares were purchased by the British Electric Traction Co. The advisers of the British Electric Traction Co had taken the trouble to see whether they could not put some different interpretation upon the clause relating to purchase in the 1882 Act in spite of the fact that the opinion of the Swansea Tramways Co.'s directors, sworn in evidence at the time the 1882 Act was passed, was the opinion he had expressed above as being held by the Swansea Corporation. The view of the tramways company now, however, was that from the end of 21 years from the date of the 1882 Act the Corporation could purchase certain lines which were to be leased again to the company; that during the existence of that lease no further lines were to be purchased, but after the expiration of it certain other lines could be acquired, and so on until the whole of the undertaking of the company had been taken over by the Corporation and leased back to the company. If this opinion was to be accepted, the Corporation would not be able to absolutely acquire the undertaking of the company till 1993. As soon as it was known that the tramway company took this view the Corporation applied to the Court of Chancery to have the point cleared up, and the decision went against the Corporation. Obviously, it was a question of bad drafting, and the Corporation had promoted this bill to repeal the sections of the tramway company's Act of 1882, and substitute a clause having the same effect but more clearly worded. It was proposed in the bill, therefore, that the Corporation should acquire the undertaking of the Swansea company by notice within six months of Feb 28, 1906, or within six months of the expiration of every subsequent seven years. The purchase was to be made under sec. 43 of the Tramways Act of 1870, and the undertaking would be re-leased to the company. The bill further took powers to borrow a sufficient sum of money to complete the purchase, such sum to be repaid within 60 years.

Mr THOMAS, town clerk of Swansea, gave evidence to the effect that the reason why the Corporation did not oppose the company's bill of 1882 was the existence of the understanding that the whole of the undertaking would come into the Corporation's hands 21 years after the completion of the line authorised by that act

Mr BALFOUR BROWNE, K.C., who addressed the Committee for the tramways company, said the whole point came down to the fact that the Corporation took one view and the company another of the purchase clause of the 1882 Act and that the Chancery Court upheld the view of the company

Mr EMILE GARCKE, on behalf of the British Electric Traction Co., assured the Committee his company had not purchased the whole of the shares of the Swansea Tramways and Improvements Co. on the strength of the clause in dispute

The CHAIRMAN, after the Committee had consulted in private, declared the preamble of the bill not proved, thus upholding the decision of the Court of Chancery.

LONDON ELECTRIC POWER BILLS.

ADMINISTRATIVE COUNTY OF LONDON AND DISTRICT ELECTRIC POWER BILL.

Monday, March 27.

Earl Camperdown's Committee of the House of Lords resumed consideration of this bill.

Sir ALEXANDER BINNIE, called on behalf of the promoters, expressed the opinion that the route of the ring main was one which would tend to the minimum inconvenience. The streets most crowded with pipes and wires had been avoided to a large extent. The method proposed by the promoters would prevent the continual breaking up of the streets. He had gone into the estimates for land and generating station foundations and considered them, if anything, too high.

Cross-examined by Mr. VESEY KNOX on behalf of several local authorities, Witness said he was one of the consulting engineers to the Underground Electric Railways Co. of London, whose generating station at Lot's-road had cost £1,300,000 for 76,000kw. He had not compared the cost per kilowatt there with the cost per kilowatt of the proposed stations. Apparently it was much higher, but he did not consider the two stations were comparable. For instance, the turbo-generators were not so large as was intended by the promoters, nor were they manufactured by Messrs. Parsons.

Mr. A. STENNING, surveyor, considered the estimates for the land of the Greenwich, West Ham and Fulham generating stations in the bill were quite ample. He was of the opinion that the promoters should be placed under the same exemption from the London Building Acts as was now enjoyed by the London gas companies. The fact that the buildings would be of iron and fairly well isolated rendered the application of the Building Acts unnecessary He believed that the Lot's Road generating station of the Underground Electric Railways Co. of London was exempted from the Building Acts. The only reason the promoters asked for this exemption was that the London County Council would have to approve the plans. He admitted that generating stations were treated as special buildings under the Building Acts, and as such were liable to special provisions, and not to the general provisions of the Acts.

Mr. C. H. MERZ was recalled as to the factors which had determined the definition of the area. Generally speaking they had taken a limit of 10 miles from the generating stations. As to the inclusion of Chislehurst, Bromley was on the south of Chislehurst, and in order to supply in Bromley they might have to lay a main through Chislehurst, and the Bromley Company, which supplied in Chislehurst, did not object. With regard to the line separating the industrial and non-industrial areas, this was drawn at the point where the factories practically ceased to exist.

Cross-examined: The inclusion of Chislehurst in the industrial area was to supply the Bromley Rural District, which was a possible area for the erection of factories. Further, it was impossible to split up the area into bits of industrial and bits of non-industrial.

Mr. FREEMAN, K.C., asked Mr Merz for a copy of the Home Office return relating to factories referred to in his previous evidence. An application had been made to the Home Office for this, and the reply received had been that the only return of the kind in existence was a confidential one which could not be seen, and one which ought not to have been made public.

Mr. MERZ said he had obtained the information from the Home Office, which was preparing statistics in connection with the Report of the Royal Commission on London Traffic. All the information he had received had not, however, been used for the purpose of his evidence.

The CHAIRMAN said that whatever information Mr. Merz had received must be placed at the disposal of the opponents.

The Hon. J. D. FITZGERALD intimated that this concluded the case for the promoters.

The case for the opposition was then opened by

Mr. RALPH NEVILLE, K.C., on behalf of the following nine electric supply companies which had presented a joint petition:—Brompton & Kensington Co., Charing Cross & Strand Co., Chelsea Co., London Electric Supply Co., Metropolitan Electric Supply Co., St. James' & Pall Mall Co., South London Co., South Metropolitan Electric Light & Power Co., Westminster Co.

Counsel said he did not propose to deal with the evidence of the promoters, but to confine himself to the policy of the bill. His companies had expended some £8,000,000 upon their undertakings, and the contention he had to submit was that under the Electric Lighting Acts of 1882 and 1888 no monopoly was intended, but that competition should be allowed. The competition, however, was more or less of a defined character, viz., between holders of Provisional Orders. The competition threatened by the bill was not a competition which was in any sense the competition contemplated at the time of the passing of the 1882 Act, but one quite different and of a much more serious character The promoters were asking to be placed on an entirely different footing to the present undertakers, and stated that by being allowed certain privileges they would be able to supply electrical energy at a very cheap rate. In fact they asked to be made the spoilt children of the legislature without regard to the expenditure of the shareholders of the existing companies. After recounting the difficulties under the 1882 Act, Mr. Neville took up Mr. Merz's suggestions as to the want of development of the electrical industry in London. He admitted that we were more backward in London than in most places; but this was not so much the fault of the companies as to the dislike of manufacturers to scrap their existing plant until it was worn out or needed renewal. The present electrical business in London was the growth of a few years: in fact, the demand for electricity in London had increased by leaps and bounds during the last year or two. The electric supply companies now supplied 27,500,000 units per annum for power purposes, which worked out at 7,851 units per 1,000 head of population which was better than the supply per 1,000 head of the population in Birmingham, Sheffield, Glasgow, Manchester and Edinburgh. The conditions as to purchase placed upon all the existing electric supply authorities were most important from the financial point of view. They had either to regard their undertaking as leaseholds, and divide their profits regardless of the fact that they came to an end after 42 years—an impossible position having regard to the raising of extra capital near the end of the term—or they must provide a sinking fund to replace the capital.

The CHAIRMAN: Are you not purchased as a going concern?

Mr. NEVILLE: No. The terms are at the then value of our undertaking without any allowance for goodwill

Continuing, Counsel said that the dividends hitherto paid by all the electric supply companies in London had averaged just 4 per cent., and there were only 26 years of their period left unexpired. Having succeeded in placing the business on a very much better basis than hitherto, the companies were confronted with competition from a new company seeking to reap the benefit of all their exertions by asking for easier terms than had ever been granted before. As an instance that hitherto it had not been the intention of the legislature that any new electric companies in London should be put under better conditions than the old ones he might mention that all provisional orders would expire at the same time—viz., 26 years hence—so that the later provisional orders had a much less period than 42 years. Moreover, there was no precedent for a power bill covering an area which was practically wholly provided with electrical supply; further, it had been the rule to exclude all large towns from the areas of power companies. It was true that Bristol was included in the area of a power company, but in that case there was hardly another authorised distributor in the whole area, a far different condition of things to that obtaining here. Then, again, was it fair that the promoters' generating stations should be exempt from the London Building Acts, when all the existing stations were subject to them, a fact which had placed the companies at a great expense. Further, all the existing authorities were bound to supply anyone who wished for a supply, the only limitation being that they should pay at least 13s. 4d. per quarter. Neither could the companies give preference as to price to any consumer compared with any other consumer under similar conditions. With regard to the maximum prices in the bill, they were so hedged round with protective clauses that the effect of them was perfectly nugatory. For instance, the supply to a power consumer resolved itself into a question of who could supply cheapest. The fact that the authorised distributor's consent was reasonably or unreasonably withheld could not come within the purview of the arbitrator, and really it was instituting an expensive arbitration to determine a matter which the consumer could settle for himself—viz., who could supply the cheapest. With regard to supply to authorised undertakers, any disagreement was to go to arbitration, and by the list of matters which were to be referred to the arbitrator the schedule price was not to be taken into account, and the arbitrator had to fix the price.

The Hon. **EVAN CHARTERIS** said this was not the intention of the promoters.

Mr. **NEVILLE** said this was the interpretation which he put upon the clause, and, further, there had to be a contract for seven years, plus 40 per cent. on the capital outlay. Further, the sums paid in this way as rental were not to be taken into account in determining the sliding scale of dividends. Therefore a consumer might be paying to the company a total price per unit far above the actual price per unit, and so the company could pay a higher dividend than they were actually entitled to. The promoters were fully alive to the fact that they could pick and choose their consumers, because Mr. Ferranti in his evidence had admitted it. What the promoters really hoped to do was to oust all the existing authorities from generating electricity.

The **CHAIRMAN**: That is rather a strong word to use, but in the main their object is to supplant all the present undertakers. I do not think they will deny that.

Hon. **EVAN CHARTERIS**: As generators, yes.

Mr. **NEVILLE**, continuing, said this would result in their obtaining a monopoly. All the present authorities would be squeezed out from generating current and would be dependent upon the promoters for a supply. Was that a desirable state of things? When this was arrived at, very little would be heard of 0·75d. per unit, and there would no doubt be a rise in price within the limits of the bill. It was inconceivable that a second power company would be authorised for London, and thus the promoters would be one controlling trust, without any competition whatever. Supposing the sanguine hopes of Mr. Merz were not realised, a very great deal of harm would have been done to the present authorities. If only 5 per cent. of the largest consumers of the existing companies were abstracted there would be a 50 per cent. reduction in total sales.

Hon. **EVAN CHARTERIS** said the promoters were quite willing to cut out the section of the bill giving them power to supply public lighting direct, but as this placed an obligation upon the promoters he thought the public lighting authorities should be head before this course was adopted.

Some discussion here took place as to the powers of the promoters to distribute. At the end,

Mr. **NEVILLE** said that the promoters, under the clause of the Bill giving the power to apply for or take a transfer of Provisional Orders, would be able by this means to secure distributing powers, and to show that they took this seriously he had only to point to the fact that they asked for the full period of 42 years before any such Provisional Orders could be purchased. Dealing with the demand which the promoters had shown to exist, counsel said that only one instance had been quoted as not having been dealt with, and this was for a small crane at Messrs. Nightingale's, which would have brought in a revenue of about £10 or £12 a year. That had been left unsettled, because Mr. Nightingale had died, but a contract had been settled with his successor. In fact the view taken by the promoters of the capacities of the existing companies was a very unfair and one-sided one, and this he hoped to prove by his evidence.

Mr. **J. H. CONACHER**, general manager of the Metropolitan Electric Supply Co., first gave in detail the dates of the registration of the various electric supply companies in London, together with the dates at which they commenced supply. The earliest was the Chelsea Co., which obtained a Provisional Order in 1886. The total authorised capital of the nine companies referred to above was £11,299,000; the amount expended to December 31 last was £7,562,000, and the capital which the companies could still raise was about £5,000,000. The total authorised capital of the whole of the London companies was £17,258,400, and the amount expended at Dec. 31, 1904, was £12,185,000. The authorised capital of the companies outside London was £564,284, and the capital expenditure £421,247. The local authorities in London had spent about £5,000,000, and the local authorities outside London about £2,000,000, and the total capital spent in the areas of the Administrative County of London Company's bill on electric supply was £20,000,000, irrespective of tramways, up to the end of last year. The expenditure was increasing at the rate of about £2,000,000 per year. With regard to the statutory obligations of the electric supply companies of London, witness explained that in each case there was a compulsory area in which certain streets were named where mains had to be laid whether there had been a demand for a supply or not, and outside this compulsory area the company could be made to lay mains to give a supply at the request of two occupiers or owners if they guaranteed to take a supply for two years, and the total revenue of the two consumers must be equal to 20 per cent. of capital outlay involved. This limit does not apply after two years. These obligations had entailed the expenditure of a large amount of capital long before there were consumers to pay for the mains. Similarly, in connection with street lighting, the company was bound to supply any lamps within a distance of 75yds. of their mains without any revenue beyond the price of the current. Thus it would be seen that these obligations were very onerous, especially as regards the small consumers, and the present companies' business consisted largely of these. For instance, the Metropolitan Company had 13,800 consumers, of which only 268 exceeded £100 per annum in revenue, and the revenue of these 268 consumers was only 1·94 per cent. of the total revenue. Therefore it was their desire to get all the large consumers possible in order to make more remunerative the small consumers above referred to. On the question of purchase by local authorities, Mr. Conacher explained the restriction placed upon the electric supply industry, details of the 21 years' purchase clause of the 1882 Act, and how the period has been extended to 42 years under the 1888 Act. Under these conditions the company had to keep up the plant in an efficient condition to the very end, a state of affairs which affected the earlier companies more than the later ones, because of the necessity to keep replacing the old-fashioned plant by the more up-to-date plant. In spite of all this the price to the consumer had been continually reduced. The magnitude of the business of the London companies was well illustrated by the following:

Units sold.

1900	54,250,000
1901	62,388,000
1902	75,149,000
1903	87,120,000
1904	111,425,000

The horse-power connected to the companies' mains, was 35,151, whereas Mr. Merz has taken 34,236 H.P. as the total for the whole area and divided it over the entire population of the area of the Bill, namely 6,365,390, which gave 5·4 H.P. per 1,000 head of population. The real population in the companies' area was 2,374,000, which gave 14·8 H.P. per 1,000 population. In his opinion, however, even this was not a fair comparison, as his figures for population included such highly residential districts as Kensington, &c. The London companies supplied 26,500,000 units for power, not including tramways, last year, and making a comparison of this with other large towns he found that per 1,000 head of population the number of units came out higher than any other town in the United Kingdom except Bradford. Speaking generally for the supply companies of London, he could say that they were all capable of meeting any demands that might arise in their own areas, and the plant installed had a margin of nearly 50 per cent. This was the normal rating, and not the overload rating which had been heard so much of in the promoters' case. The network of mains which had been laid by the companies in London had cost £4,000,000, and he knew of no new conditions by which the Administrative Co. could supply cheaper than the existing companies. It all depended on the load. If the present companies got the load which the Administrative Bill was calculating on they could supply as cheaply. For instance, at the Willesden station of the Metropolitan Electric Supply Co. there was 13,000kw. (normal rating) of plant, and another 3,000kw. had just been added, with room for at least six times that quantity, or 100,000kw., which would be larger than the first station which the promoters proposed to build, the normal rating of which in 1910, would only be 60,000kw. Similarly, at the Bow station of the Charing Cross Co. there was at present 18,000kw. of plant installed, with room for extensions up to 72,000kw. Again, the Grove Road station of the Central Electric Supply Co. had 10,000kw. installed, with room for extensions to 80,000kw. The total output which these three companies would be able to meet, therefore, was 250,000kw. or 350,000 H.P.; in fact, the station which the promoters now proposed was simply that which the London companies had had in their minds for many years, and which was now being developed as he had shown above as a result of their having realised the advantage of concentration.

Tuesday, March 28.

The Hon. **J. D. FITZGERALD**, K.C., on behalf of the promoters, referring to Mr. Neville's criticisms of the maximum prices in the bill, said he admitted that there was a certain ambiguity in the clauses, but the intention was that the maximum prices should be real and not sham prices, and any alteration of the wording that was necessary to make the matter quite clear the promoters would be willing to have made.

The **CHAIRMAN** said the committee would like to have one of the Provisional Orders of the opposing companies, so that they would then have the conditions under which the promoters proposed to supply and those under which the existing companies were now supplying.

Mr. **CONACHER**, continuing his evidence, referred to the Deptford station of the London Electric Supply Corporation, which was capable of enlargement to 100,000kw. Other riverside stations were the Bankside station of the City of London Co., capable of extension to 40,000kw.; the Greenwich station of the South Metropolitan Co. to 30,000kw., and the Wandsworth station of the County of London Electric Supply Co. to 17,000kw. Of course the enlargement of these stations would necessitate the expenditure of further capital for plant, but not of land, and many of the companies held capital in hand to go on with extensions. These were all the larger companies, and his knowledge of the smaller companies was that they were all equally able to supply any demand that might arise in their areas. In fact, there was absolutely no necessity for the creation of a company such as that proposed by the Administrative County of London Bill. The whole growth of power supply had been since 1901, both in London and all over the country. This might be shown by the growth of the motor load of the following six companies: Chelsea, Metropolitan, St. James's, Westminster, Charing Cross, South Metropolitan and the South London Co's. The total motor load in 1900 was 3,040 H.P.; 1901, 4,714 H.P.; 1902, 7,015 H.P.; 1903, 11,275 H.P.; and 1904, 14,600 H.P. As examples of the percentage of the total units sold used for motors, Mr. Conacher mentioned the following: The Metropolitan last year sold 15,233,000 units, of which 726,000 were for motors; the Chelsea Co. sold 3,112,000 units, of which 662,000 were for motors; the South London Co. sold 10,530,000 units, of which 6,190,000 were for motors (including a supply to the L.C.C. tramways); the Westminster Co. sold 14,500,000 units, of which 1,876,000 were for motors; and the Charing Cross Co. sold 15,596,000 units, of which 2,452,000 were for motors. The Charing Cross Co. had power to supply to authorised distributors in Stepney, Poplar and Bethnal Green by agreement, all of which were in the industrial area. With regard to the concentration of plant, this was first done by the London Electric Supply Corpn. at Deptford, where 10,000kw. units were proposed, but the start was premature, and for various reasons was unsuccessful. But since then several London companies had erected large generating stations, such as those at Willesden by the Metropolitan Electric Supply Co., the Bow station of the Charing Cross Co., and the station of the Central Electric Supply Co. The costs at Willesden now were exactly comparable with those at Newcastle four years ago before the tramways and railway were working. The costs were 1·42d. at Willesden, against 1·62d. at Newcastle. The Metropolitan Co. was actually scrapping some of their plant and stations and transferring the business to Willesden. In a few years he hoped to supply all their customers from Willesden. Dealing with the question of tariffs, witness dealt with Mr. Merz's statement with regard to the quotation made by the Metropolitan Co. to the Marylebone Borough Council, but the actual fact was that the Borough Council asked for a quotation for a supply during periods which would leave all the good customers to be supplied from the Council's own station and leave all the bad customers to the company. Yet these were the very cases which were excluded from the maximum prices in the bill and came under the stand-by clause. His opinion of the effect of the bill was that it enabled the promoters to pick and choose its customers. On the other hand, the London companies were only too anxious to secure every customer, and very seldom asked for the 20 per cent. guarantee which they were entitled to ask for in the non-compulsory area. With regard to the proposed supply under the Bill to canal, docks, tramways and railways, he maintained that, so far as the latter two were concerned, there was nothing in their Provisional Orders to prevent the present companies supplying them, even if the energy were used outside the district, but in order to clear the matter up—there having existed a doubt concerning it—many London companies were including a clause in their power bills, which would also come before this Committee. With regard to canals and docks, there would be direct competition between the new company and the existing companies. Summing up, he mentioned that the scheme of the bill was inapplicable to the area owing to the large number of existing undertakers.

Cross-examined by the Hon. J. D. FITZGERALD for the promoters: He agreed that the maximum prices in all previous power acts was much higher than that in the present bill, but the charges in the present bill were so governed with protective clauses that his opinion was that they were inoperative. In arriving at the horse-power per 1,000 population he had taken the population of 1901 and the horse-power of 1904, but the population was not increasing in any great numbers in many of the areas; the tendency was for the population to get further away from London. He had taken the 1901 figures from the census, which, as regards the City and West Central districts, only gave the night population, but this he considered was compensated for by including the neighbouring districts, in which many of the day population of the City and West Central districts resided. The Metropolitan Electric Supply Co. did not supply any railway, tramway, canal, dock, &c., and only to a small extent for Government departments.

Then tell me, what part of your existing business can we compete for?—Street lighting.

What street lighting do you do?—Practically none.

Therefore under the Bill the promoters could not compete to any practical extent with your existing business?—Except for Government departments.

But that, you say, is only a very small matter; therefore we could not compete for 1 per cent. of your present business?—I am looking to the future.

Continuing: The last dividend of the Metropolitan Co. was 10 per cent. There was now 2,550 H.P. of motors connected to their mains, but he could not say how much H.P. of steam and other plant there were in their district. They sent their canvassers round to persuade all they could, but no report was made as to the number of H.P., &c.

The CHAIRMAN interposed that he specially noted this remark, in view of what the promoters had said—that no effort had been made to push the motor business in London.

Witness, continuing, said that the Willesden works had cost £520,000, and there was 13,500kw. of plant (normal rating). Coal cost 12s. per ton, delivered. The fact that their coal bill was higher did not necessarily mean that a higher price would have to be charged, and he could not admit that the Metropolitan Co. was not in a position to supply as cheaply as was proposed by the promoters. It was not fair to compare the present works costs of the London companies with the proposed costs of the Administrative County of London Co., because the conditions would not be the same. The promoters were basing their costs upon a large tramway, railway and bulk supply, and no such supply at present existed in London. As to the offer to the Marylebone Council, it was quite true that an offer had been made to supply current not at the "peak" hours and that the price was an average of 1·75d. per unit untransformed, but there were such special conditions attaching to Marylebone that the offer took the nature of an arrangement to fit in with a special case. Dealing with the St. James Co., in answer to Mr. Fitzgerald, witness admitted that there was no present business that could be competed for by the promoters. Similarly, he could not think of any competition with the Chelsea Co. except by the promoters forming subsidiary companies to obtain competing Provisional Orders. The Westminster Co. would be largely affected in the matter of street lighting. He did not know what the cost of coal was, nor the consumption of coal per kilowatt, nor the cost per kilowatt of the Charing Cross Co.'s Bow station.

Mr. FITZGERALD: Then how can you tell the Committee that these companies can supply as cheaply as we can?—I feel satisfied that we can if we get the same load that you anticipate.

Continuing: The power bill of the Metropolitan Co. had the same provision originally, that a power user could use 20 per cent. of the current for lighting, but this had since been struck out, and the only power now sought was to supply to authorised distributors. There was competition in one part of the Metropolitan Co.'s area and no competition in another. He admitted that the price was higher for some purposes in the competitive area than in the non-competitive area. Witness promised to hand the opponents a table giving the published tariff for power of the various companies, as well as the percentage of the total units sold used for power purposes.

Mr. L. H. HORDERN, manager of the Westminster Electric Supply Corporation, said that his company was now erecting a new motor generator station at Eccleston Place, and had just completed another at Duke Street. Thirteen per cent. of their total units were for power purposes. The promoters estimated that, by 1910, 36 per cent. of their sales would be "bulk" supply, but he did not think there was any possibility of that coming to pass. The Westminster Co. made special arrangements with special consumers, and therefore it was not fair to compare the published tariff of the existing companies with that proposed by the promoters. A table was handed in showing the present costs of generation in London under various conditions. For instance the cost of generating current purely for motor purposes was as low as ·7d. per unit, and it rose up to 2·06d. per unit for a purely lighting load. As the promoters had taken 1910 for their estimates he thought 10 per cent. should be taken off his figures given above. Present day prices would have been impossible a few years ago and the price would undoubtedly decrease with time, owing to the increasing demand and the extra uses to which electricity was now being put. If any adverse effect were produced upon the present companies by the introduction of the new company, it would fall very hardly on the small consumers, who formed a large portion of the Westminster company's business. This effect would be emphasised if a proportion of the large consumers were abstracted. He maintained that the existing business would be competed for, and in the case of the Westminster Co. over 2,000,000 units a year were sold to the local authority, which the new company might be able to take away. In speaking as to whether present business would be affected, it must always be borne in mind that the companies had expended considerable capital for future extensions, and if the development of the motor load was checked it would be a serious matter as far as the prices for lighting were concerned.

Wednesday, March 29.

Mr. HORDERN continued his evidence. He made further comparisons between the present position of the London companies and the Newcastle Co. when their motor load was in the same stage of development as was now the case in London. He also handed in a table showing that at present the Westminster Co. was actually supplying at lower prices than those proposed in the bill. But there would be competition with the Westminster Co. to a very marked degree as to Government departments, railway depots, public lighting, &c. Already the Westminster and St. James' Co.'s, were taking energy in bulk from the Central Electric Supply Co., and to that extent the principle of the promoters' bill was already in existence.

Cross-examined by Mr. H. LLOYD, K.C.: At present the Central Electric Supply Co. charged 1d. per unit, but he anticipated that this would be reduced to ½d. per unit. He did not think the Westminster Co. could generate at the works costs proposed by Mr. Merz, viz., at 0·154d., but it was also his opinion that Mr. Merz would be unable to fulfil his expectations. It might be true that the works costs at Carville were 0·12d. He had not estimated the lowest figure at which the Central Co. could generate. The Westminster Co. was supplying the London, Brighton & South Coast Railway for lifts, and any supply required for traction could be supplied from the Central Co. It was to the advantage of the Westminster and St. James' Co.'s to take a bulk supply from the Central Co.

Mr. LLOYD: You have already told us that the Central Co. cannot generate at the works costs which we propose: therefore if a bulk supply is advantageous is it not more advantageous to take it from us at the prices in the bill which are cheaper?—What is to become of the Central Co.?

Further cross-examination: The average price received by the Westminster Co. for current for power purposes was 2·017d. per unit last year. Up to date for the present year it was 1·8d. per unit.

At the end of a somewhat long cross-examination comparing the prices to be charged by the new company and those charged by the present companies, Mr. LLOYD said the promoters were willing to transform the current supplied in bulk and to individual power consumers at the prices in the bill.

Mr. R. STEWART BAIN, managing director of the London Electric Supply Corpn., described the area which this company supplied, and said the capacity of their generating station at Greenwich was 10,000kw., with plenty of room for extensions. Part of their district was in the industrial area. The price for power had been reduced so far this year by 27 per cent. They supplied 6,000,000 units to the London County Council tramways last year, and there was a contract for three years. By the end of that time they anticipated that other business would compensate for this. There would be no difficulty in his company supplying as cheaply in 1910 as the prices scheduled to the bill.

Cross-examined by Mr. FITZGERALD: He supplied 475,000 units for power purposes last year exclusive of the tramways, and the average receipts per unit were 1·8d. The price of the coal at Deptford was 10s. 3d. per ton, and the average coal consumption per unit generated, 4lb. The works costs at Deptford were last year 1·12d. This year they had been 0·9d. per unit. The capital cost per kilowatt was £50.

Re examined: The large capital expenditure was the result of the company having been one of the pioneers. The reduction in works costs had been the result of the acquisition of a large power load. What he feared most was the clause in the bill giving the promoters power to make arrangements with other bodies, by which it would be possible to buy up one of the competing companies in his area, and by selling for a time at a loss, to ruin the London Electric Corpn. The existing London companies were expressly forbidden to amalgamate by their Provisional Orders.

Prof. A. B. W. KENNEDY, F.R.S., electrical engineer to the Westminster Electric Supply Corpn., spoke as to the general ability of the existing companies to meet all the demands likely to arise in their districts. With regard to the number of the existing stations the companies had been obliged to erect stations in the areas granted in their orders. It would be impossible for the existing companies to take a supply in bulk from the promoters, because of the purchase of the undertakings by the local authorities, for, if the stations were scrapped, the companies would lose all the benefit of their capital expenditure on them. The great drawback had been the need for continually replacing old plant, but even Mr. Merz's stations would be antiquated in some years' time. For instance, it was his opinion that in 15 years' time there would not be three-phase generation, but single phase. On the question of capital cost per kilowatt, he believed the Stuart-street station of the Manchester Corporation, which he designed, had the lowest cost yet reached, which was £24 per kilowatt. This would have been reduced to £18 per kilowatt if the work had been in London. An advantage to the existing companies would be for the restriction to be removed that current supplied by them could only be used within their own area. They would then be able to supply any tramway or railway company.

Cross-examined: He had had no experience of turbine working, but had received tenders for turbines which were higher in cost than reciprocating engines and lower in efficiency. The capital cost of the engine and dynamo at Stuart-street was £9 per kilowatt, and he did not know that a tender had been received for a similar size turbine plant—viz., 2,500kw. at £3 5s. per kilowatt.

Mr. H. W. SPRUNT, manager of the South London Electric Supply Corpn., spoke as to the efforts made to develop the power load of the company.

Cross-examined: The total units sold for power purposes last year, exclusive of the temporary supply to the London County Council tramways, were 274,000, at an average price of 1·8d. per unit. The capital cost of the station was £70 per kilowatt. The coal consumed per unit generated, 5lb.; works costs, 0·91d. per unit; total cost, 1·07d.

Re-examined: The low costs of his company last year showed the importance of a tramway load.

Major CARDEW, late electrical adviser to the Board of Trade, was the next witness. He stated that he was a director of the London, Brighton & South Coast Railway, which company was now considering the question of electric traction, tenders having been received. Speaking generally, with regard to the existing London companies, he said he was of the opinion that there was no likelihood of their being unable to meet any demands made upon them. He had acted for the Clyde Valley Power Co., from whose area Glasgow was excluded, and a very large part of the area of the present promoters was very similar to Glasgow. With regard to Major Marindin's report, it was the opinion of himself and the companies that the effect of that report was that the existing companies should not be disturbed during their period of tenure.

Mr. E. W. SEALE, secretary and manager of the Charing Cross (West End & City) Electricity Supply Co., said that as far back as 1893 both the "St. James's Gazette" and the "Globe" had taken current from his company for driving their printing presses. In 1901 he had offered energy to the Borough Councils of Poplar, Bethnal Green and Stepney in bulk on the lines of the proposed bill. At that time the price was high, but in January this year they had offered West Ham Tramways a supply at ¾d. per unit, as against the 1·66d. per unit at which the Corporation generated. But even upon these terms the West Ham Corporation would not take a supply. He had also had negotiations with several railway companies. One of the firms who had supported the promoters' bill had actually just signed a contract with his company for taking a supply in "bulk." In his district the amount of lighting which the promoters would be able to do was very considerable, for in many cases the 20 per cent. of the current taken for power would represent the whole of the lighting required. Dealing with the possibility of harm which the new company might do, he instanced the possibility of the promoters securing control by some indirect means, for instance, of the London Electric Supply Corp., in order to kill the companies which competed in the London Company's area. The effect of this would also be ruinous to neighbouring companies, for their shares would go down immediately. In his opinion, the new company would be practically a State-aided concern, by reason of its exemption from the many restrictions under which the existing companies had to work.

Cross-examined: The average price received for power by his company was 2d. per unit, but so many of their consumers were very short-hour users, and by the second schedule of prices in the bill dealing with such consumers, the price of the promoters might be as high as 1s. and would vary down to below one halfpenny.

Col. CROMPTON disagreed with Mr. Merz's estimates, which he stated were so extraordinary that a mistake must have occurred. The opinion seemed to be that a saving could be made by reason of the gigantic size of the station, but the saving only amounted to a very small proportion of the total costs of selling electrical energy. The lowest figures for cost of generation had been reached in stations of quite moderate size, and there were many in which the costs were as low as those proposed by the promoters. For instance, the total costs to the Kensington Co. at their low-pressure switchboard were 0·715d. per unit which was to be compared with 1·25d., which was the cost of the bulk supply, when converted, which he understood from one of the answers given by Mr. Merz. Consequently it would cost 74 per cent. more for them to take current from the new company than it cost them at present to generate. The costs of distribution, put forward by the promoters, were the most extraordinary ever seriously submitted to a Parliamentary Committee before; in fact they were less than one-third of the costs ever obtained. The distribution had nothing whatever to do with the size of the undertaking. The Wood-lane works were at present negotiating for supply to three lines of railways. One of the greatest difficulties which had had to be contended with in connection with the development of motor load in London, was the large number of very efficient private generating plants in which the costs were as low as 0·6d. and to which there was practically nothing to be added for distribution. He considered it extremely unfair to take an average of all the London undertakings in order to arrive at the £51 which Mr. Merz had given as the cost per kilowatt, because that sum included a large amount of money spent in pioneer work and which ought not now to be taken into account in making comparisons with the existing undertakings.

The CHAIRMAN: But the money has been spent?—Yes, but it has been largely written off since.

Continuing: He did not think for a moment that Mr. Merz would get the gigantic load factor which he anticipated in London.

Thursday, March 30.

Col. CROMPTON, continuing his evidence, said that all companies which took a bulk supply from the promoters would have to put down large accumulators in order to ensure a perfectly steady current, and this would tend to raise the price to the consumer. On the question of the antiquated plant in existing stations, he said that no provision was made for antiquation in the case of the promoters, and now, more than ever in the history of the electrical industry, it was dangerous for electrical engineers to launch out too far, owing to the rapid developments being made. Every prudent company should put aside large sums for depreciation. With regard to the advantage which the promoters anticipated from the use of cheap coal, witness said he had used the identical coal which the promoters proposed, at Chelmsford, costing 10s. 6d. a ton, but found that its value deteriorated very rapidly through trans-shipment and exposure to the air, and eventually its thermal value was very much reduced.

Cross-examined by the Hon. J. D. FITZGERALD: The 0·715d. of the Kensington & Knightsbridge Co. did not include anything for management, rates and taxes and capital charges and depreciation. But he had looked at the question from the point of view of what advantage his company would get by taking a bulk supply from the promoters. In comparing this figure of 0·715d. with the 0·154d., the promoters' works costs, it must be remembered that it included the cost of distribution, whereas Mr. Merz's figure did not. He was not aware that the Tyneside costs were 0·04d. for the first two months of this year, but a reliable figure of costs was not arrived at until the works had been in operation for some time. At Newcastle the plant was all new and, therefore, the effects of wear and tear, breakdowns, &c., had not been felt. The last dividend paid by the Kensington & Knightsbridge Electric Lighting Co. was 12 per cent. and the average dividend from the commencement was 7 per cent.

Mr. J. S. HIGHFIELD, chief engineer to the Metropolitan Electric Supply Co., spoke as to the effect of load-factor upon the cost of generation and handed in tables illustrating this.

Sir RALPH LITTLER, K.C., then addressed the Committee on behalf of the City Corporation. He said that already in the City there were two companies supplying, and, in respect of both, the City Corporation had the right of purchase in 1914. One point in connection with his case, therefore, was that should this company be able to supply the existing companies at such a price that their generating stations, which were outside the City, might be discontinued, in 1914 it might be that he would only have mains to buy, and therefore would be compelled to take current from the promoters. Further, should the promoters acquire either or both of the existing companies, the period at which the City Corporation could then purchase the undertaking from the Power Company would be 42 years. But at present the City had an absolute right of purchase in 1914. In addition to this the City Corporation objected to any further interference with their streets. Therefore, he asked that the City be excluded altogether from the bill, or, at any rate, that the promoters should not come into the City without the consent of the Corporation. Such a proposition as that of the promoters was premature in view of the present condition of electrical science.

Lord ROBERT CECIL, K.C., next called evidence on behalf of 16 local authorities in the area of the bill.

Mr. PHILIP DAWSON, of the firm of Messrs. Kincaid, Waller, Manville and Dawson, handed in tables giving details of the electrica works of all the above authorities. The average load factor of an ordinary London lighting station was about 12 per cent, and an increase of the load-factor reduced the capital charges and the works costs. The tables showed a gradual decrease of the works costs and the prices charged as the output and load-factor increased. But he did not believe that in actual practice the promoters would get the load-factor they anticipated, especially if they did not get the tramway and railway load. There was very little probability of a tramway load because all the existing tramway authorities had their own supply. Further, he had no confidence in outside sources of supply, especially for large quantities. Railway companies were more likely to erect their own generating stations, as they could generate as cheaply as a power company, and there would be practically no addition for distribution. Witness absolutely disagreed with the estimates of Mr. Merz, for they were far below anything yet obtained, and also very different to the results of actual practice. The site of the Greenwich generating station would require piling, and expensive works would be required for the foundations. If the local authorities could secure a 35 per cent. load-factor they would be able to supply at ¾d. per unit.

Cross-examined by Mr. H. LLOYD: He admitted that the capital cost per kilowatt of many of the London stations was high; for instance, at Battersea and Shoreditch it was about £56. In answer to Mr. Lloyd, who pointed out several inaccuracies and ambiguities in the tables, Mr. Dawson said the figures had been supplied by the officials of the various authorities.

Mr. C. H. WORDINGHAM spoke as to the capabilities for extensions at the various borough council electricity works. At Fulham, Hammersmith, Battersea and Poplar, there were the same condensing facilities which the promotors sought to have. In most cases the supply of electricity for power purposes had been extensively pushed. For instance, in Hammersmith, there was only about 800 H.P. of steam-driven plant in private works. All the remainder were worked electrically. The case of the promoters rested on three assumptions—viz., a large supply by reason of many large power users, decrease of cost of generation by large units and the advantage of the generating station sites. With regard to the first, he questioned whether any one of the railway or tramway companies, for instance, would take a supply from the promoters, while as regards the two latter assumptions, he did not consider there was any advantage in the proposals of the bill as compared with the existing stations. He specially apprehended trouble from breakdowns on the ring main.

Cross-examined: He did not know that the ring main would consist of 12 cables, and that arrangements were made for automatically cutting any faulty cable out of the circuit. But he had not much faith in such devices.

The committee adjourned until to-day (Friday).

[The following correction should be made in the footnote at the bottom of the first column of page 933 of our last issue: 20,000 H.P. represents, approximately, the motors connected to the mains of the County of London Co. and the City of London Co. together, and not to the County fo London Co. alone, as stated.]

GREAT NORTHERN, PICCADILLY & BROMPTON RAILWAY (No. 1) BILL.

On Monday Mr. Compton Rickett's Committee of the House of Commons commenced consideration of the Great Northern, Piccadilly & Brompton Railway (No. 1) Bill, the principal object of which is to extend the existing railway from its terminus on the north side of the Strand to Waterloo. The opponents to the bill were the London County Council, the Central London Railway Co., and others.

Mr. BALFOUR BROWNE, K.C., who explained the objects of the bill, gave a history of the company, which was authorised some years ago under another name and since amalgamated with the Great Northern & Strand Railway Co. The lines now owned by the Great Northern, Piccadilly & Brompton Railway Co., which was the name of the two combined companies, extended from Finsbury Park to Holborn and on to Piccadilly and Brompton. From Holborn a line was authorised down to the north side of the Strand, and the principal object of the present bill was to construct an extension of it to the Waterloo station of the London & South Western Railway Co. The line would be constructed under the Strand to the Victoria-embankment and thence under the river Thames. By the new scheme it was proposed to construct the Strand station in Surrey-street, instead of at the crescent of the new thoroughfare now being constructed in the Strand by the London County Council. The object of this change was to make the junction more convenient.

Mr. C. T. YERKES, Chairman of the Underground Electric Railways Co. of London, Ltd., said that the Great Northern, Piccadilly & Brompton Railway would be opened, probably, to the public in about 18 months' time, and about £3,650,000 had been spent upon its construction up to date. The Underground Co. would construct and equip the new line to Waterloo and find the necessary capital.

Mr. A. ROSS, engineer to the promoters, put in estimates of the cost of construction, amounting to about £320,000. The line would be a single line worked on the shuttle system, this having been decided upon for economical reasons, although there was no tube railway that he knew of worked as a single line.

Sir C. OWENS, general manager of the London & South Western Railway Co., supported the scheme.

After some cross-examination by Mr. Lloyd, K.C., for the Central London Railway Co.

The CHAIRMAN said the proposal to run the railway in the manner suggested would demand the serious consideration of the committee, and they would like to have figures as to the difference in cost between constructing tube lines now and at some future time, having regard to the fact that if the line was doubled a few years hence there would be the necessity to re-erect the construcional work in the river Thames.

Mr. ROSKILL, K.C., for the promoters, promised to have the figures prepared.

Mr. ERSKINE POLLOCK, K.C., intimated that an agreement had been arrived at between the London County Council and the promoters.

On Tuesday Mr. YERKES was recalled on the question of working the proposed line in a single tunnel. He said that the additional cost of building the line in double tunnels would be £120,000. If the line were constructed now as a single line the estimated cost of reinstating the staging in the Thames at a later period would be £15,000.

Sir DOUGLAS FOX having expressed the opinion that the railway could be worked as a single line without any danger,

The CHAIRMAN intimated that the Committee were unanimous that a single tunnel could not be sanctioned, but any suggestion the promoters might have to make would be fully considered. If a single tube was insisted upon, however, the part of the bill relating to the construction of the railway would be refused.

On Wednesday, the promoters agreed to a clause to the effect that the railway should be constructed with separate tunnels for up and down traffic before it was opened for traffic.

The bill was therefore ordered to be reported for third reading.

SCOTTISH TRAMWAY PROVISIONAL ORDERS.

Wemyss Tramways.

The Commissioners who have been appointed under the Private Legislation Procedure (Scotland Act) to consider the Scottish provisional orders deposited this session, commenced their consideration of the Wemyss Tramways Order on Saturday last at Edinburgh. The counsel for the promoters were Mr. M'Clure and Mr N. J. Cochran-Patrick. The petitioners against the order were the North British Railway Co., and the Kirkcaldy and Dysart Waterworks Commission.

At the commencement, Mr. M'Clure objected to the locus of the Kirkcaldy and Dysart Waterworks Commissioners whose opposition, he said, was mainly on the question of electrolysis. He contended that they had ample protection under the Tramways Act of 1870. The Commissioners, however, allowed the locus.

Mr M'CLURE, in opening the case for the bill, said that it was a proposal by Mr. Randolph Wemyss, of Wemyss, to construct an electric tramway 7¾ miles long from Kirkcaldy through Dysart and Wemyss to Buckhaven and Leven. His object in promoting this tramway was that the district was totally without means of communication at present, and the development of the towns which the tramways would touch had been considerably retarded in consequence. With regard to the opposition of the North British Railway, he said it was largely on the question of competition, and the railway company specially asked that goods traffic should not be allowed over the tramways. As this, however, was an important part of his case he could not agree to it.

Mr. RANDOLPH WEMYSS was then called and described the district and the industries carried on there, and refused to give way to the railway company's proposal that goods traffic should not be carried.

Local evidence was then called in support of the order.

On Monday, Mr. STEPHEN SELLON gave particulars of the cost of the proposed line. He said the gauge would be 3ft. 6in., and the total cost £52,000. His estimate of the revenue from the lines was £12,031 per annum from the passenger traffic. The working expenditure he put at £7,200 per annum, leaving £4,800, and after paying 5 per cent. interest on the capital, £2,200 per annum would remain. This meant that the company's receipts per mile would be £1,400, but as a matter of fact he had never constructed a tramway in Scotland or England where this figure was so low.

Under cross-examination, Mr. SELLON stated that in Birmingham and South Staffordshire the tramways companies had full powers to carry goods.

Evidence was then called on behalf of the North British Railway Co. on the question of competition.

On Thursday further evidence was called on behalf of the North British Railway Co., but the Chairman found the preamble proved. The decision precluded the use of goods traffic upon the tramways beyond 500lb. per consignment in packages and parcels.

TRADE MARKS BILL.

The Trade Marks Bill has passed its first reading in the House of Commons. The bill was brought in by Mr. Moulton, Mr. Eve, Mr. Cripps, Mr. Butcher, Sir Albert Rollit, Mr. Cawley and Mr. Robson, and the three main objects they have had in view are:—(1) To make the legislation which defines the essentials of registerable trade marks and the procedure for registering them more in accordance with the wishes and needs of the commercial community. (2) To separate the fundamental provisions of that legislature from the provisions relating to procedure. The latter is made by the bill more elastic, and capable of being readily modified as experience shows best, and they are therefore relegated to rules which can promptly be amended if necessary. (3) To correct defects in the working and arrangement of the present acts, so as to render the legislation simpler, more intelligible and more effective.

A complete set of rules is scheduled to the bill. These will be the rules when the new legislation commences. They will, however, be capable of being amended from time to time by the Board of Trade, subject to their being submitted to Parliament by being laid on the table of each House.

In the preparation of the bill every effort, it is stated, has been made to ascertain the views of those who are most interested in trade marks, and also those who have the greatest familiarity with the administration of the present acts and the judicial decisions thereunder, and it is believed that the provisions of the present bill accord with these views in all substantial matters.

Briefly, the bill is intended to consolidate and amend the law relating to trade marks and to dissociate the law relating thereto from that relating to patents and designs.

The bill was unanimously approved by the Association of the Chambers of Commerce at its last conference.

On Tuesday, in the House of Commons, it was agreed that the committee to consider the bill should consist of the following:—Mr. Blake, Mr. Butcher, Mr. Cripps, Mr. Eve, Mr. Fison, Mr. Fletcher Moulton, Sir W. Palmer, Sir C. Renshaw and Mr. Tillett.

OTHER ELECTRICAL BILLS.

The Chelsea Electricity Supply Co.'s Bill was before the unopposed Committee of the House of Commons on Thursday last week. It seeks powers for the extinction of the founders' shares of the company, and the issue of ordinary shares in lieu thereof. The bill was ordered to be reported for third reading.

The *Shropshire and Worcestershire Electric Power Bill* and the *Baker Street Bill* will now proceed unopposed

In the House of Lords on Monday, the *Tyneside Tramways Bill* and the *Metropolitan District Railway Bill* were read a third time.

The *Charing Cross, Euston & Hampstead Railway Bill* was further considered by Mr. Compton Rickett's committee of the House of Commons on Monday. It will be remembered that an adjournment was made on Friday last week, as reported in our last issue, in order to enable the Westminster City Council and the promoters to come to an agreement with regard to the underground station at Charing Cross. The Committee now found the preamble of the Bill proved with certain alterations as to the construction of the entrances to the subway.

The *West Cumberland Electric Tramways Bill* came before the Unopposed Committee of the House of Lords on Tuesday, and was ordered to be reported for third reading. The object of the bill is to extend the period for exercising the powers conferred by the West Cumberland Tramways Co.'s Act of 1901 and 1903.

The *Metropolitan Railway Co.'s Bill* came before the Unopposed Committee of the House of Lords on Tuesday, and was ordered to be reported for third reading. The object of the bill is to authorise the acquisition of the undertaking of the Harrow & Uxbridge Railway Co., to provide for the consolidation of certain preference stocks of the company, to empower the company to enter into agreements as to the supply of electricity and to raise additional capital, &c. The new capital sought is to the extent of £800,000, with one-third borrowing powers.

In the House of Commons on Wednesday, the *London United Tramways (Extension of Lines) Bill* was read a second time.

It has been reported to the House of Lords that the *Buenos Ayres Grand National Tramways Co. Bill* has been dropped. The object of the bill was to confirm an agreement for the amalgamation of the Buenos Ayres Grand National Tramways Co. and the Buenos Ayres New Tramways Co., to increase and re-arrange the capital, deal with the arrears of dividend on the preference shares of the Grand National Tramways Co., and modify the rights of the preference shareholders and holders of debentures and debenture stock issued by both companies

TELEGRAPHIC COMMUNICATION WITH LIGHTSHIPS.

In the House of Commons on Monday.

Mr. BUCHANAN asked the Secretary to the Board of Trade whether there was telegraphic communication of any kind between the Wolf or Longships lighthouses and the shore; and, if not, whether it could be established at an early date in view of the recent loss of life in the wreck of the ship "Khyber."

Mr. BONAR LAW, in a printed reply, said there was no telegraphic communication between those two lighthouses and the shore; but both stations were able, owing to their proximity to the mainland, to communicate with the shore on clear nights by means of special signalling lamps provided for the purpose. Communication from the Longships could also be made by day by semaphore or explosive rocket, and by night by explosive rocket. Communication by wireless telegraphy was about to be established between six lightships and the shore, and if the experiment was found to be successful the system would no doubt be extended to other outlying light stations. He could only say, at present, that the case of these two lighthouses would receive consideration.

METROPOLITAN PNEUMATIC DISPATCH BILL.

In the House of Commons on Wednesday, Sir J. DIMSDALE asked the Home Secretary whether his attention had been called to the bill for incorporating a company under the name of the Metropolitan Pneumatic Dispatch Co. for the purpose of laying pipes for pneumatic dispatch under the streets of the County of London; and whether, having regard to the fact that a Royal Commission has under consideration the state of London streets and the best mode of preventing congestion of traffic, he would oppose the grant of further powers, for breaking up the streets and impeding traffic, to a private company until that Commission had reported.

Mr. BENN also asked the same question.

Lord STANLEY, in reply, stated that the London County Council and the City Corporation had made representations to him with regard to this bill, pointing out the great inconvenience which would result to the inhabitants of London from such an extensive interference with the streets as was contemplated by it. He shared this view and was unable to see that any advantage to the postal service could be derived from such a system of pneumatic dispatch that would counterbalance the evils arising from the construction of the underground tubes. He viewed with disfavour the proposals of the bill and was strongly of the opinion that the measure should not be proceeded with until the Royal Commission on London Traffic had issued its report.

UNDERGROUND TELEGRAPH WIRES.

In the House of Commons on Tuesday, in reply to Sir A. Agnew,

The POSTMASTER-GENERAL said that with the exception of a small section where there had been some difficulty owing to differences with the road authorities—now fortunately settled—the line of underground telegraph pipes was completed to Glasgow. The cable would be drawn in along the whole of that line during the year 1905-6. He was not in a position to extend the underground line to Edinburgh at present, but there would be little chance of serious interruption of communication with that city when Carlisle and Glasgow, with a number of independent lines to Edinburgh, were both on the same underground system. Permanent cables had also been laid between London, Warrington and Liverpool and from Warrington to Manchester and Carlisle, and a temporary cable had been drawn in between Manchester, Bradford and Leeds.

PADDINGTON ELECTRICITY EXHIBITION.

The Paddington Electricity Exhibition was opened on Saturday last at the Queen's-road Baths, Bayswater, London, W., and is to remain open until April 8. The exhibition has been organised by the Metropolitan Electric Supply Co., the statutory suppliers of electricity in Paddington borough, for the purpose of directing the attention of residents of the locality to the numerous modern applications of electricity to lighting, heating and power. The Mayor of Paddington performed the opening ceremony, and spoke in glowing terms of the future of electricity. At the luncheon which followed, this sentiment was echoed by Mr. F. L. Harris, M.P., who drew particular attention to the increasing sale of current by the company for power. The Mayor of Holborn and Sir Melvill Beachcroft, chairman of the Water Board, also made suitable remarks.

There are quite a large number of novelties which distinguish this exhibition from others recently opened. The general arrangement, too, is artistic and bright, and the exhibition is altogether well worth seeing. Most of the novelties are in the nature of electric fittings, some exceedingly pretty and original designs being shown. Exhibitors are supplied both with alternating and continuous-current, the temporary sub-station of the Metropolitan Co. in the building taking the form of an ordinary stand. Alternating current is brought into the building at 1,000 volts and is transformed down by four 50kw. transformers to 200 and 100 volts respectively. Continuous current is generated at the company's stand by a number of small motor-generator sets. There are 34 lighting and power circuits in all, each of which showed an insulation resistance of not less than 1 megohm on test.

As at all recent shows of this character, the Dowsing Radiant Heat Co. have on view a large and varied assortment of their patent luminous electric radiators. Standard-sized radiators of four lamps are said to consume 1 unit per hour, but this may be reduced by one-half by switching off a pair of lamps. One radiator is sufficient for a room 12ft. square and of ordinary height. This firm also exhibit the apparatus used in the Dowsing radiant heat and light treatment (as employed on the hospital ship "Maine") besides a number of other medical appliances in which electricity plays a prominent part.

Messrs. Veritys Limited exhibit dynamos, blowers, fans and all kinds of fittings for electric lighting and power. Their excellent show includes a spark coil of huge dimensions and a large range of "Aston" radiators, including some examples made of aluminium.

A neat collection of arc lamps, motor starters, switchboards and general electric fittings has been brought together by the Westminster Engineering Co. Attraction is excited here by the electric welding apparatus shown in operation. The welding current is alternating and obtained at a pressure of about 2 volts from a small transformer built in the box-shaped base of the apparatus. When the weld is completed the current is automatically switched off.

Messrs. Babcock & Wilcox show one of their silent gravity bucket conveyors, which is periodically set in motion. In addition, this firm shows a number of models of their boilers, mechanical stokers, water softening and purifying plant, &c.

An exhibit which calls for special attention, on account of its comparative novelty, is the magnetic separator for separating iron and steel from other metals and materials, shown by the Hardy Patent Pick Co. This separator is already largely used in foundries for separating iron from brass, and it is also suitable for extracting iron and steel from destructor refuse. In the machine shown the current consumption is 6 amperes at 75 volts. The separator consists of a cylinder placed with its axis not quite horizontally, but with one end higher than the other, so that when revolved, material introduced at the higher end will gradually make its way out at the lower. This cylinder is placed upon rollers, which enable it to be easily revolved, and leave the inside without obstruction for the passage of the material through it. Inside the cylinder are about 22 magnets, extending along the greater part of its length, and forming slightly projecting ribs inside it in the direction of its length. These magnets are excited by a dynamo, with which they are automatically connected and disconnected during the revolution of the cylinder. A tray or shoot is fixed inside the cylinder near the top, but not connected with it in any way. When the magnets, during the revolution of the cylinder, are passing over the tray or shoot, they are disconnected with the dynamo, and so drop on the tray any pieces of iron or other magnetic substance they have picked out of the material, and during the remainder of their revolution with the cylinder they are in connection with the dynamo, and so magnetised and ready to pick out any magnetic substance. (The separator is shown to the right in the illustration which we give below of Messrs. Henry's stand.)

The latest electric light fittings in wood are the striking feature of the stand occupied by J. N. Henry (Ltd.). These fittings receive immediate and well-merited attention from visitors. They are made to suit all the recognised English styles in furniture, and the makers have taken great pains to reproduce the true details of form, carving and inlay. A centre table on this stand is furnished, as will be seen in the accompanying illustration, with two beautifully-designed wooden white fittings at either side, in which lamps are fixed, and at the base a well for water is provided in which fresh-cut flowers can be kept. The centre-piece is available also for cut blooms, the very pretty hanging lamps affording a soft bright light. No visitor should miss this stand.

Stand of Messrs. J. N. Henry (Ltd.).

Messrs. R. N. Cunningham & Co.'s stand is arranged under a huge shade, requiring no less than 65yds. of green cloth. At the apex of the shade is a flame arc lamp, which is said to be of 6,000 c.p. The fittings of this stand include many original and artistic designs, and there is also an electric fan which oscillates to and fro, the movement being obtained by an ingenious arrangement which makes use of the draught of air produced by the fan.

One of the neatest stands in the exhibition is that of Messrs. G. T. Banks & Co., who show a great variety of decorative fittings. This firm was entrusted with the lighting and decoration of the band-stand, which looks exceedingly fine. A novelty shown here is Banks' electric lighting surface board, which is covered on one side with a cloth interwoven with parallel metal braids, alternate braids being connected together and with one terminal of the electric current supply by a flexible cord. Connection between the electric lamp, electric motor, or other piece of apparatus with these braids is made by pins which are pushed into the cloth until they come into contact with the braids. This electric lighting surface board may be employed for many purposes. We were shown how it is used for domestic purposes. The electric board in this case was in the form of a narrow strip inserted between the leaves of an ordinary table, so that the electric cushion was flush with the surface of the table. An ordinary table cloth covered the table, and a portable electric lamp anywhere on this table could be lighted by pushing two pins with small porcelain heads into the electric cloth. The pins are connected to the lamps by two flexible conductors.

Messrs. Haddleigh Thapp & Co. have a good display of electric light fittings, heating and cooking apparatus, laundry irons, bed warmers, and so on. The electric stoves shown have resistances built up of alternate strips of mica and resistance metal, it being claimed that this construction is both efficient and reliable. Another speciality of this firm is an improved electric candle.

Messrs. Falconer & Co. have some beautiful specimens of artistic metal fittings on view, the object of the firm being to avoid ostentatious designs and to produce fittings of tasteful appearance and fine workmanship.

The Sir Hiram Maxim Electrical and Engineering Co. have on show at their two stands (Nos. 20 and 22) all kinds of electric lamps and fittings, including a goodly array of the type of arc lamp supplied to the Underground Electric Railways Co. in large quantities after severe trial. These are lamps burn in series of five, and when any one is switched off, or fails for any reason, an equivalent resistance is inserted automatically into the lamp circuit, so that the lighting is not interrupted. The company's new type of shade-carrier lampholder is in evidence, and the Maxalite candle lamp is conspicuous on this stand.

The British Westinghouse Co. show motors and accessories in large numbers. Among the instruments is a 5-ampere 200-volt 50 ~ Westinghouse single phase integrating wattmeter with glass cover. This meter is practically a form of alternate-current induction motor, and has no moving contacts or commutators. It is said to measure correctly on inductive and non-inductive load. Amongst the auxiliary apparatus shown is a power-factor meter and a single-phase synchroscope, the latter instrument indicating the phase relation of alternators about to be paralleled.

A number of electrically-driven "Blackman" fans, ranging in diameter from 18in. to 96in., are exhibited by the James Keith & Blackman Co.

The Langdon-Davies Motor Co. show a number of alternating and continuous-current motors, some separate and some coupled to machinery, such as a "Bendall" chaff-cutter, a boot-finishing machine, a sausage-chopping machine and an organ blower.

The Shredded Wheat Co. show the manner in which wheat is shredded by electrically-driven machinery, and then baked in an electric oven.

The "[illegible]" electric heaters, which we have quite recently described, are exhibited by the Electrical Corporation.

Electric Flashlights (Ltd.), show a number of signs which are alternately illuminated from behind. The periodical switching on and off is, we are informed, not effected by a motor or by clockwork but by a simple contrivance worked by the heating effect of the current.

Electric fittings of all descriptions are displayed by Messrs. E. Brightwell, Frederick Sage & Co., Ivor E. Halsey & Co. and L. Wheatland & Sons.

In connection with any display in the West of London of domestic appliances associated with "the house beautiful," the name of William Whiteley naturally comes to the fore, and, consequently, the visitor to Paddington Electricity Exhibition will be prepared to find a large range of all kinds of domestic appliances at this firm's stand. West London's "Universal Provider" is prepared to supply electrical articles of every kind, and examples of many of the best-known electrical manufacturers' goods are shown by Messrs. Whiteley. Keen competition in the price of a well-known make of incandescent electric lamp was a noticeable feature at this stand on the occasion of our visit.

Electric lifts and accessories are shown by Messrs. Waygood & Co., and a fine assortment of motors of sound design and manufacture by the Morris-Hawkins Electrical Co. and by the Crypto Electrical Co.

Instruments, transformers, switches and many other well-made electrical accessories are displayed at the stand of Messrs. Elliott Bros., and telephone and telephone accessories by the National Telephone Co.

A Sunbeam electric light bath for treating gout, rheumatism, lumbago and other complaints, is shown by Mr. C. M. Hobson.

The miscellaneous exhibits include various kinds of electric signs in operation, embroidering and engraving by electricity, and, finally, we may mention the Radium exhibit, where the wonders of radium are shown by means of a spinthariscope.

Holborn and Finsbury Exhibition.—We learn that this exhibition has proved successful beyond the most sanguine anticipations. The attendance has been large every day, and the class of visitors such as to lead to considerable business being transacted. This success must be very gratifying to all concerned. The speciality which the County of London Electric Supply Co. has always made of power supply in the Clerkenwell, Holborn and St. Luke's districts, and which has attracted a very large number of power users, is emphasised by the exhibition, and will, doubtless, result in a large and immediate demand for a considerable extension of this company's operations in connection with power supply.

LEGAL INTELLIGENCE.

United Motor Industries (Ltd.) v. Clark.

In this action plaintiffs claimed damages £61 from defendant, Mr. C. O. Clark trading as Oliver, Clark & Co.) for alleged negligence in wiring the plaintiffs' stand at the recent Automobile Show at Olympia, where a fire broke out on one of the stands owing to an electric cable fusing in a show-case belonging to plaintiffs. The hearing of the case occupied two days, and judgment was given for defendant, who had installed the electric light at 34 other stands at the exhibition without any fault being found in respect of any one of them. Expert evidence for the defence left no doubt as to the cause of the supposed fire – viz., celluloid being placed in too close proximity to the electric lamps.

His Honour accordingly gave judgment for defendant on both claim and counter claim, with costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Birmingham Corporation require a tramways inspector, between 25 and 45 years of age, and with knowledge of tramway-track construction. Applications by April 12.

Mr. David C. Rattray, assistant engineer to the Lancashire & Yorkshire Railway Co., has been appointed chief engineer in the place of Mr. W. B. Worthington, who joins the Midland Co. Mr. A. Watson, resident engineer to the company at Bolton, has been appointed assistant engineer.

In the place of Mr. J. W. Drew, who is retiring, Mr. N. W. Prangnell has been appointed chief mains engineer of the Metropolitan Electric Supply Co.

Mr. R. H. Roberts has been appointed by Marylebone (London) Council inspector of electric cable trench reinstatement work.

Mr. Eldin S. Moulden has been appointed an instructor in electrical engineering at the South Australian School of Mines and Industries, Adelaide.

Bath.—To cover excess expenditure on electric lighting extensions, the Council have decided to apply for sanction to a further loan of £9,400.

Belfast.—The city electrical engineer (Mr. Victor A. H. McCowen) is to report upon the demand of the British Electric Traction Co. for a supply of at least 150,000 units per annum for the Cavehill and Whitewell tramway.

Bexley.—The Council have decided to adopt a scheme of assisted wiring of consumers' premises and also to supply lamps.

Brentford.—The Council have considered the report of the clerk (Mr. S. Woodbridge) on the recent Board of Trade inquiry with respect to two applications for a provisional order for the district. The Board were inclined to grant an order to one of the applicants, but required the Council to indicate which of the two schemes they considered the more satisfactory.

Camberwell (London).—Under the Electric Lighting Areas Act, 1904, certain portions of the authorised areas of electricity undertakers within the boroughs of Southwark and Bermondsey and also of the South London Electric Supply Corpn. and Lewisham Companies have been transfered to Camberwell, and the London Electric Supply Corpn. recently applied to Camberwell Council for a certified map of the altered area, but the Council have instructed the town clerk not to certify this map "having regard to the difficulties which might arise in the future in reference to the purchasing power of the Council."

The Council have accepted the offer of the County of London Electric Supply Co. to provide a stand-by supply for the Old Kent-road baths at 3½d. per unit, "provided no gas lights for illuminating purposes are installed, except in the washhouse portion," but pilot gas fittings are to be allowed in certain parts.

Chelsea (London).—The Council have now accepted the terms of the Chelsea Electricity Supply Co. for the supply of electric current for lighting the new baths.

Chester.—The Tramways committee recommend the Council to proceed with extensions of the electric tramway, estimated to cost £17,000. These extensions were decided upon some time ago, but deferred pending consideration of the substitution of motor 'buses.

Last week Ald. H. T. Brown submitted the annual financial budget.

The income of the electric tramways for the year not yet finished would (he said) be £9,462, against £8,916 in preceding year. The expenses amounted to £9,237, including interest on loan and sinking fund. The surplus on the year's working on the 25th inst. was £224. 7s. 10d. There was no reserve fund, and, so long as the loan period lasted, all renowals and repairs must be met out of revenue.

The income from the electric lighting undertaking for the 12 months was £17,123, compared with £16,584 in 1903. The profit was £108. 5s. 11d,

Chili.—Messrs. Manuel and Horacio V. Ortuzar have been granted a concession for the construction and working for a term of 10 years of an electric tramway between Santiago de Chili and San Bernardo.

Cleethorpes.—The Electrical committee have been requested to open negotiations with Grimsby Street Tramways Co. with a view of arranging for the company to retain control of the power station for a further period of five years. The draft agreement with Messrs. Foote & Milne for supply of electric energy has been forwarded to Mr. C. S. Vesey Brown for report. Mr. Brown has also been asked to state whether, in the event of the Council lighting the King's Parade with electricity, he would recommend Nernst or arc lamps.

Companies to be Struck Off Register.—The "London Gazette" for March 28 contains a list of companies which will be removed from the register of joint stock companies in three months, unless cause is shown to the contrary. These include the following:—Cowper Coles Zinc Extraction Synd., Edison Telephone Co. of London, Electric & Magnetic Co., Electric Tramcar Synd., Electrical Wonder Co., Herculite & Electrical Mfg. Co., New British Incandescent Electric Lamp Co., Reno Electric Stairways & Conveyors (reg. Feb. 20, 1902), Tramway Starting & Stopping Co.

Customs Decisions.—The Australian Commonwealth authorities have recently decided that electrical machines used for the same purpose as Röntgen apparatus, and used only by physicians, shall be admitted, as surgical instruments, free of duty.

The Japanese Customs authorities have increased the duty on submarine telegraphic cables and underground telegraphic lines or cables imported into Japan by 10 per cent. ad val., thus raising the duty to 20 per cent. ad val.

East Ham.—On Tuesday the Council ratified the agreement with Ilford Council whereby the tramway from the eastern boundary of East Ham to Ilford Broadway is leased for seven years to East Ham Council at 6d. per car mile run over the section.

East Ham Corporation is responsible for all third party risks of the cars, while Ilford is liable for accidents through defects in the permanent way and overhead lines.

The lease may be re-considered in the event of the horse tramways to Stratford being electrified.

Electric Motor Delivery Vehicles.—Mr. E. M. Trowern, secretary of the Retail Merchants' Association, Toronto, Canada, has recently returned from Detroit and Cleveland, where he has inspected the motor delivery waggons and drays in use in those cities. He has presented a report which is favourable to the adoption of the electric motor delivery system. It is stated that recent developments indicate that the delivery of parcels and even heavier goods by electric motor vehicles is probable in Toronto.

Electrical Exhibition, 1905.—The first meeting of the executive committee took place on March 21. Mr. E. Cunliffe-Owen, C.M.G., Secretary of the Metropolitan Electric Supply Co., was unanimously elected chairman, and Mr. C. S. Northcote (Veritys Limited) was elected deputy-chairman; the appointment of Mr. W. Davenport as secretary was confirmed. It was decided that the exhibition shall take place at Olympia from Sept. 25 to Oct. 21 inclusive. Sir W. H. Preece, K.C.B., was unanimously invited to accept the presidency of the exhibition. The managers appointed were Messrs. Bridges and Smith, Balfour House, Finsbury Pavement, London, E.C., and to these gentlemen all enquiries respecting the allotment of space should be addressed. The following is the executive committee of the exhibition (the Municipal Electrical Association having still to elect their representative):—

Baynes, S. W. (Borough Electrical Engineer, St. Pancras).
Bevis, H. (General Electric Co.).
Bishop, O. H. (Edison Swan Co.).
Butler, H. W. (Electrical Power Storage Co.).
Cunliffe-Owen, E. (Metropolitan Electric Supply Co.).
Dobson, Sydney T. (St. James' and Pall Mall Electric Light Co.).
Elder, T. C. (Brush Co.).
Kingsbury, J. E. (Western Electric Co.).
Northcote, C. S. (Veritys Limited).
Oppenheimer, H. (International Electric Co.).
Packenham, W. L. (Crompton and Co.).
Patchell, W. H. (Charing Cross (West-End & City) Electricity Supply Co.).
Portheim, Roland S. (Bruce Peebles and Co.).

The managers of the exhibition, Messrs. F. W. Bridges and G. D. Smith, have had many years' experience in connection with successful trade exhibitions at the Agricultural Hall, Earl's Court, and elsewhere.

Electricity in Mining.—In a report on the coal industry of the United States for 1903 it is stated that the increase in the use of electrically-driven mining machinery in the West Virginian mines has been remarkable. The total number of machines in use in 1898 was 86. In 1903 there were 788, of which 55·2 per cent. were driven electrically. In the bituminous coal mines of the United States there were in use in 1903 435 electric locomotives and 391 dynamo-electric machines; in the anthracite mines 81 electric electromotives and 81 dynamo-electric machines.

Erith.—The Council have received sanction to a further loan of £19,878 for electric lighting.

Exhibition.—A six days' electrical exhibition was opened at the Town Hall, Cromer, on Monday. The promoters are Edmundson's Electricity Supply Corpn., who are working the local electricity works under lease from the Council. The profits are to be given to a local hospital.

Forthcoming New Books and New Editions.—"The Electrician" Printing & Publishing Co. (Ltd.) announce the issue shortly of "Electricity Meters and Their Management," by C. H. W. Gerhardi; "The Electricians'" Primers, in 3 volumes (Vol. I., Theory; Vol. II., Electric Lighting, Power and Traction; Vol. III., Telegraphy, Telephony, Electro-Chemistry, Electro-Metallurgy and Miscellaneous; "A Digest of the Law of Electric Lighting, Electric Power, Electric Traction, &c.," by A. C. Curtis-Hayward, A.I.E.E., solicitor; "The Steam Engine Indicator and Indicator Diagrams," by W. W. Beaumont; "Electric Motive Power and Gearing," (revised by Mr. G. Thomas-Davies); "Submarine Telegraph Cable Laying and Repairing," by H. D. Wilkinson; "'The Electrician' Wireman's Pocket Book," by F. C. Raphael.

Frome.—An inquiry was recently held into the application of the Council for sanction to a loan of £7,030 for electric lighting extensions, &c.

The clerk (Mr. H. E. Ames) said the amount was made up of a deficit of £1,483 on original contract, cost of decreasing size of one of the original engines £551; new engine, dynamo, boiler, pipe work, &c., £4,150; meters, &c., £316; additional lamp posts, £230; and engineering contingencies, £400. £28,500 had already been borrowed and it was expected that the increasing demand for current would necessitate an application for a further loan of £10,000 next autumn.

Huddersfield.—The accounts of the electricity department for the year to Dec. 31 last show total capital expenditure £175,972. 16s. 8d., an increase of £2,465. 5s. 5d.

The net revenue was £25,506 4s. 11d., working expenses £12,044. 0s. 3d. The Electricity committee have charged all capital items direct to revenue as a form of special depreciation. The gross profit was £13,410. 1s. 8d., plus £288. 6s. 9d for bank interest. Interest charges were £5,003. 12s., £4,819. 11s. 5d, was put to redemption of loans, and £3,875 5s. to aid of borough rate. 1,587,161 units were sold, compared with 1,559,960 in previous year. There are 2,047 private consumers, with the equivalent of 140,161 8 c.p. lamps against 1,888 and 132,582 respectively at December, 1903.

Inland Telegraph Rates.—The Postmaster-General has informed a correspondent that he has no intention of proposing any reduction in the telegraph rate.

Japan.—At the extensive copper mine at Besshi a large electrical plant is being erected, which when completed will provide motive power for all the trolley cars, trams and machinery in use at the mine. From this mine 5,000 tons of copper were taken in 1904.

Leeds.—The receipts of the Corporation tramways department for the year ended March 25 were £295,000, an increase of about £17,000 on 1904.

Of the 64,223,666 passengers, 4,761,417 paid ½d., 50,778,052 1d., 1,424,136 1½d., 6,150,880 2d. and 1,089,181 3d. During the preceding 12 months the total was 60,739,294. The average receipts per car-mile amounted to just over 10d., a slight decrease on the preceding year.

Leeward Islands.—Telephone services exist in Antigua, St. Kitts and Dominica, in each case managed as Government departments. In Antigua there are 146 instruments in use and 260 miles of line, in St. Kitts 84 instruments and 251 miles, Dominica 45 instruments and 130 miles. In Dominica the telephone extends to a distance of 52 miles, connecting up the important planting districts in the north of the island.

Light Railways.—The Board of Trade have extended the time for completing the Colwyn Bay and Llandudno Light Railway.

The Light Railway Commissioners have issued the draft of the Maidstone Corporation Light Railways (Extension) Order.

The standard gauge was originally specified, but this has been altered to a 3ft. 6in. gauge. A clause has also been inserted for the protection of the Kent County Council, providing that "in constructing certain of the proposed tramways Maidstone Corporation shall pave the whole width of the metalled portion of the road on which the tramways are laid with wood blocks, or where the gradients are unsuitable with granite setts, and shall make good all footpaths, gullies and drains interfered with."

The extensions of the Cheltenham & District Light Railway Co. were officially inspected on Tuesday.

The Board of Trade have confirmed the Basingstoke and Alton Light Railway Order, 1905, amending the 1897 Order as to speed.

Llanelly.—A provisional agreement has been made between the Council and the South Wales Electrical Power Distribution Co. in regard to electricity supply and electric tramways, and the Council have conditionally decided to withdraw their opposition to the company's bill. The company has agreed to contribute £1,000 towards costs already incurred by the Council and to a penalty clause, and have met the Council on other points.

London County Council.—At Tuesday's meeting it was agreed to loan Battersea £7,306 and St. Pancras £5,370 for electric lighting.

Lighting the Embankment Gardens.—The Parks & Open Spaces Committee recommended an expenditure of £1,000 for lighting electrically the Villiers street section of the Victoria Embankment Gardens.—Referred back.

Tramways.—The Highways committee recommended that £150 be allowed to the chief officer of the tramways for the purpose of visiting, during the Easter recess, New York, Washington, Boston and other cities in the United States.

The same committee recommended that an underground conduit system of electric traction be adopted for the construction of certain tramways in the Council's southern area; that the estimate of £351,000, submitted by the Finance committee, be approved for this work; and that the Highways committee be authorized to obtain tenders for execution of such works. The length of the tramways affected is 17½ miles of single line.—Postponed for a week.

Long Eaton.—An inquiry was held last week into the application of the Council for permission to borrow £5,500 for electric lighting.

The clerk (Mr. Edwin Williams) said £20,000 had been already borrowed for electricity works, which were started in January, 1903, and the net profit for the year ended March last (at which time there were 215 consumers) was £231. The electrical engineer and manager (Mr. Frank Worrall) said the present plant capacity was equivalent to 13,600 8-c.p. lamps.

Macclesfield.—The Board of Trade have extended the electric lighting order 1901 to the end of 1905.

Manchester.—The Electricity committee decided on Wednesday to appeal against the judgment in "Midwood *v.* Manchester Corporation" reported in our last issue.

Marylebone (London).—Mr. Arthur Wright, consulting electrical engineer to the Council, has informed the Electric Supply committee that he recently became a direct shareholder in the Reason Mfg. Co. (Ltd.) and that in all probability he will shortly be made a director.

Motor Vehicle Law.—At West London Police Court on Monday, Claud Clench, electrical engineer, was summoned for driving a motor car in a dangerous manner, and for neglecting to have a distinguishing number affixed to the general identification mark.

Defendant was driving a car belonging to the Whitlock Automobile Co., Kensington, in King-street, Hammersmith, on March 7, when a brougham in front of him suddenly stopped, and, in order to avoid colliding with the brougham or a tramcar that was travelling alongside, he turned his car into the curb and knocked down a sandwichman who was standing there. For the defence evidence was given that the affair was accidental, and it was contended that a man who acted, as defendant did, for his self-preservation could not be held liable for injury done to another person. Defendant had voluntarily agreed to compensate the sandwichman. The magistrate dismissed the summons.

On a second summons Mr Firth, who defended, alleged that not defendant but London County Council was responsible for the absence of a number on the identification plate. Under the act each manufacturer was assigned an identification mark, and the mark of the makers in question was "A L R." Nothing was said by the Council's officials about a number. Counsel contended that the section of the act, though badly drafted, implied that only a number was necessary in addition to the identification mark when the manufacturer had more than one car in use.

The Magistrate: It is quite a new point. It seems the Council's mark assigned to your client is null and void, but whether that relieves him from the consequences of an infraction of the act is another matter. It is an extremely difficult legal point, and I shall take time to consider it. The summons was adjourned.

Newcastle-on-Tyne.—The double-decked covered-in cars on the tramways having proved successful, it has been decided to cover 22 more of the same type of cars.

Parcel-Carrying on Tramways.—The scheme devised by Manchester Tramways committee for carrying parcels will be inaugurated on Monday.

The scheme will be adopted not only within the city and the area of Greater Manchester, but also for despatch to any part of the kingdom and abroad. A special sub-committee will have charge of the department, with Mr Ald. Bowes as chairman. Vans will call at each of the sub-depots and receiving offices frequently during the day, and at warehouses, shops, or other places of business, for collection of parcels, on application to chief parcels office. Stamps for prepaid parcels may be purchased at face value in numbers of 25 upwards. Within the area of Manchester and Salford and a portion of Stretford a parcel not exceeding 14lb will be carried for 2d., under 28lb. 3d., under 56lb. 4d., under 112lb. 6d. A slightly higher rate will be charged for collection and delivery beyond the city area. Special parcel-carrying cars are to run over the city system, ordinary passenger service cars being used for parcels up to about 56lb. Messengers will deliver parcels up to 28lb. to any address within reasonable distance of the depot or line of route. There will be an express messenger service, and parcels not exceeding 14lb. can be placed immediately in charge of special express messengers, who will take them to any destination within half mile of any Manchester tram terminus or line of route at low fixed charges. Conductors of Manchester Corporation passenger cars will receive at any stopping place written applications for a parcels van to call at any address within the prescribed area. The committee have further made arrangements to act as agents for all railway companies.

Parcel Post to America.—The Postmaster-General announces that arrangements have been made for an official parcel post service with the United States, in addition to the service already maintained through the agency of the American Express Co. The new service comes into operation to-morrow. The limit of weight for parcels will be 4lb. 6oz.; and the postage 2s. per parcel. There will be no non-postal charges apart from Customs duty. The insurance system will not apply to parcels sent by the new service, and Customs duty must in every case be paid by the addressee.

Penny Post to Australia.—The Postmaster-General announces that arrangements have been made for the reduction of the letter postage to Australia to 1d. per ½oz. The change will take effect to-morrow (Saturday). The postage on letters from Australia to the United Kingdom will at the same time be reduced to 2d. per ½oz.

Personal.—We are informed that Mr. John R. Dick, having completed the term of his agreement as one of the managing directors of the Reason Mfg. Co. (Ltd.), has decided to retire from the board on April 10.

Presentations.—A timepiece was recently presented by the staff of York Corporation electricity works to Mr. A. V. Wardrop, who leaves to become chief electrical engineer at Elland.

Mr. Wm. Grant, manager of Rotherham tramways, on leaving to take up a similar position at Ayr, has been presented by the staff with a silver tea and coffee service and waiter.

Mr. R. Jones, station superintendent at Rotherham, on leaving for Southend-on-Sea, has been presented by the staff with a case of drawing instruments and a framed photograph of the members of the staff.

Ship Lighting.—The new Japanese battleship, the "Kashima," launched from Elswick shipyard last week, is fitted with a very complete electric lighting and power plant.

For lighting about 1,250 incandescents are used, and there are six powerful search-lights. For ventilation there are a number of electric fans, and electric motors are employed for driving machinery on board. There is also an elaborate installation of telegraphs, voice pipes and telephones and a wireless telegraph equipment.

Southwark (London).—The Council have refused the offer of the County of London Electric Supply Co. to supply electric current for street lighting at 2d. per unit.

The Board of Trade have written to the Council for their observations upon the description of an additional system proposed to be adopted by the London Electric Supply Corpn., stating, also, that the Board proposed to approve the company's application for sanction to connect part of their electrical circuits with earth, subject to certain conditions.

The communication has been referred to a committee.

Suicide.—Dr. Javier Los Arcos, a former Director-General of Posts and Telegraphs of Spain, committed suicide on the 24th inst. by throwing himself into the sea at Badalona, near Barcelona.

Telephone Operators' Union.—Some of the National Co.'s operators in Dundee have formed a union to organise an appeal to Parliament to ensure that the services of all the company's Dundee staff be retained when the company's undertaking is taken over by the Government.

Thefts.—Within the past month telegraph wires running by the side of the River Lea have been cut and carried away on nine separate occasions. About 9cwt. of wire, value over £86, has been taken. At North London Police court on Tuesday three men were charged with the offence and remanded.

Torquay.—The Council have been asked by the L.G.B. to supply further information in support of the recent application for sanction to a loan of £42,000 for new electricity works.

Wandsworth (London).—The Board of Trade have been asked to nominate a referee to settle a difference between the Council and the L.C.C. on the subject of tramway feeder pillars on the Clapham–Tooting line.

Water Power in Italy.—It is announced that Ancona Provincial Council have voted a money prize for the best scheme for utilising the water power of the Senteno for electrical and other industrial purposes, including the operation of an electric line to connect the two lines of railway which run on each side of the Misa valley. It is estimated that the project would involve an expenditure of 2,000,000 lire.

Numerous schemes for the utilisation of the water powers available in Italy are attracting the attention of capitalists, and almost daily concessions are being granted to contractors and others for putting these schemes into operation. During the past few months the financial and industrial journals published in the chief cities of Italy have described many schemes of this character.

West Ham.—The Treasurer, in his estimates for the coming year, has made provision for an anticipated deficiency of £2,000 on the electric lighting undertaking. £8,000 has been contributed from profits of the tramways in relief of rates for the current year.

The Treasurer states that he has postponed the estimate for the coming 12 months until September, owing to the uncertainty as to the dates on which the lines now being electrified will be completed, the period the cars will be running, and the increased capital charges.

Wireless Telegraph Notes.—The Gesellschaft fur Drahtlose Telegraphie, of Berlin, inform us that the Dutch Government has ordered four wireless telegraph stations on the "Telefunken" system for training telegraph operators. The station at Scheveningen has been re-equipped so as to be able to transmit over 400km. (250 miles). Two ships equipped with this wireless telegraph system have been ordered to the Dutch East Indies to undergo tests as to the behaviour of the apparatus in hot climates. It is stated that the Government of Ecuador has also decided to instal two stations, one at Guayaquil and the other at Puna. Two experimental equipments for fortresses have been supplied to the German military authorities. Other sets have been installed on a pilot steamer, and in seven stations in connection with war ships. A number of other installations on order are in progress of construction.

Electrical Chess Club.—The members of this club encountered the General Electric Co. Chess Club on Thursday last, when the "Electricals" beat the "Generals" by 5½ to 2½.

Dinners.—The annual dinner of the Brighton Contract department of the National Telephone Co. was held at Brighton on Friday, Mr. H. Julius Maclure in the chair. Mr. F. Roberts, responding to the toast of the company, said that at present they were adding 40 lines a week to the National system.

The annual dinner of the employés in Lowestoft Corporation's tramway and electricity departments will take place at Lowestoft this (Friday) evening.

Dance.—Robertson Electric Lamps Fire Brigade held a very successful Cinderella dance at Robertson Hall, Brook Green, Hammersmith, London, W., on Saturday last.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1905 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date (to Feb. 22), and the Directorial Division of the new volume has been corrected up to February 11th, 1905. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. The number of large sheet Tables, &c., has been increased, and the 1905 Edition of this indispensable work is offered as the most complete book of the kind ever published.

Among the chief features of the Handbook Division are Notes of the Year on Electric Traction and Electric Power, Turbine Notes, Electric Lamp Notes, Wireless Telegraph Notes (very full), Parliamentary Summary, Legal Decisions, and a complete set of all the chief documents used by Government Departments affecting the Electrical Industry (including the new "Special Mining Rules," issued Feb. 22).

TENDERS INVITED.

Luton Town Council invite tenders for supplying and erecting certain plant and machinery at the electricity works, Luton, in accordance with plan and specifications of the electrical engineer (Mr. W. H. Cooke, M.I.E.E.), Town Hall, Luton, from whom further particulars after April 15. Tenders to the town clerk (Mr. Geo. Sell), Town Hall, Luton, by 4 p.m. May 10. See also an advertisement.

Johannesburg Municipal Council invite tenders for supply and erection of switchboards and accessories for their new direct and alternating-current power station. Specifications, &c., from the consulting engineers (Messrs. Mordey & Dawbarn), 82, Victoria-street, Westminster, S.W., to whom tenders by noon April 27. See also an advertisement.

The Municipal Council of George Town, *Penang*, invite tenders for supply and delivery, f.o.b., of a 300kw. steam dynamo, motor generator, balancer, switchboards, &c. Specifications, &c., from the consulting engineers (Messrs. Preece and Cardew), 8, Queen Anne's-gate, Westminster, S.W. Tenders to Mr. R. M. Christie, 4, East India avenue, London, E.C., by noon April 18th. See also an advertisement.

Hammersmith (London) Borough Council invite tenders for supply of boiler flues and economisers, high-pressure steam pipes, steam and feed-water pipes, exhaust steam water heater and circulating water pies. steam valves and feed-water heaters and coal elevator. Tenders to Town Hall, Hammersmith, by 4 p.m. April 5.

Batley Corporation invite tenders for permanent way construction and paving of Bradford road tramway route, overhead equipment, steel poles, &c., feeder cables, conduits and accessories. Tenders to the town clerk (Mr. Jos. Hanson Craik) by April 17.

Tenders are wanted by 4 p.m. April 12 for electrical engineers' work at the Union of London & Smith's Banking Co.'s new bank at *Batley*. Plans, &c., of Walter Haustock & Son, Branch-road, Batley.

Manchester Electricity committee invite tenders for supply, delivery and erection at Dickinson-street generating station of high and low-tension switchboards. Tenders to chairman of Electricity committee, Town Hall, Manchester, by April 4.

The Lancashire & Yorkshire Railway Co. (*Manchester*) require tenders by 10 a.m. April 3 for 12 months' supply of stores, including signal and telegraph fittings, signal, telegraph and electric light wires, &c.

London County Council require tenders by 10 a.m. April 4 for eight 500kw. induction motor-generators for electric tramway substations, and also for wiring material, low-tension cables, cable boxes, &c. Specifications from County Hall, S.W.

The Clyde Navigation Trustees require tenders by April 10 for electric power generating and lighting plant for *Clydebank Dock*. Particulars from Mr. G. H. Baxter, 16, Robertson-street, Glasgow.

Clyde Navigation Trustees also want tenders by noon April 17 for supply of boilers and superheating apparatus for *Clydebank Dock*.

Colchester Electric Light and Power committee invite tenders by April 5 for independent surface-condensing plant and electrically-driven pump.

St. Marylebone (London) Council invite tenders for supply, delivery and maintenance for two years of house meters. Tenders before 4 p.m. April 4 to the town clerk.

Aberdeen Corporation invite tenders for one surface condenser with air pump, oil separator, &c. Tenders to the city electrical engineer (Mr. J. Alex. Bell) before noon April 19.

Glasgow Corporation also invite tenders by 10 a.m. April 5 for tramway stores for one year from June 1.

Nuneaton and Chilvers Coton Electricity committee invite tenders by April 10 for cables and joint boxes.

Horsham Council invite tenders by April 18 for a steam balancer set and steam and exhaust pipes.

Erith Council invite tenders by 4 p.m. April 17 for wiring car depot and workshops.

Sydney (New South Wales) Council require tenders by May 30 for a six-cell refuse destructor and flag-making plant. Specifications, &c., from office of Agent-General for New South Wales, Victoria-street, London, S.W.

The magistrates of the City of *Utrecht*, Holland, invite tenders before April 8, for 20 complete electric motors for the city tramways. Specifications from the Town Clerk.

Dax (France) Municipality invite tenders by May 14 for a concession for the electric lighting of the town for 35 years. Particulars from and tenders to La Mairie de Dax (Landes).

Tenders will be opened on April 10 at the Ministry of Marine, *Madrid*, for the provision of an electric lighting installation on board the cruiser "Cataluña." A deposit of 9,500 pesetas is required to qualify a tender and a local agent is a practical necessity, as a foreigner entering into contracts for the performance of public works in Spain is compelled to renounce by public act all rights to which he may be entitled by the law of his own country so far as his contract is concerned, and to accept any administrative decision that may be issued respecting questions arising from that contract.

TENDERS RECEIVED AND ACCEPTED.

Southend-on-Sea Council have accepted the following tenders:–

Stirling Boiler Co. (two boilers) £2,972.
Electric Construction Co. (350kw. steam dynamo), £2,946.
J. Carter & Sons (economiser), £614.
General Electric Co. (two motor-driven feed pumps), £602.

The tender of the Hart Accumulator Co., for renewal of positive battery of 132 cells at £331, and 10 years' maintenance at £39 per annum, has also been accepted.

Woolwich Guardians have accepted the tender of W. T. Henley's Telegraph Works Co. for supply of 900 yds. of 19/14 mains at £230. 5s. 3d. per mile, and 450 yds. of 19/16 at £157. 11s. 10d per mile. Callender's Cable & Construction Co. tendered at £230. 10s. and £157. 15s., Siemens Bros. & Co. at £230. 5s. 6d. and £157. 12s., and the Western Electric Co. at £210. 5s. 6d. and £128.

Erith Council have accepted the tender of J. T. Jarvis & Sons for assisted wiring of consumers' premises at 10s. 6d. per point. Other tenders were W. Dickinson 10s. 9d., G. A. Moore 12s. 6d., Woodville Electric Co. 12s. 10d., Hooper, Nearey & Co. 14s., Ward Bros. 14s.

Fulham (London) Council have received the following tenders:—

Condensing Plant.

	28in. vacuum.		26in vacuum.
Worthington Pump Co. (*accepted*) ..	£1,383	....	**£1,119**
Schwarz & Co.	2,145	....	—
Balcke & Co.	1,949	....	—
Ashwell & Nesbit	1,941	....	1,881
Summers & Scott	1,720	....	1,430
Thornton & Co.	1,709	....	1,625
Wheeler Condenser Co.	1,681	....	1,395
Storey & Sons	1,656	....	1,331
Cole, Marchent & Morley	1,579	....	1,214
Belliss & Morcom	1,572	....	1,392
Carrick & Wardale	1,544	....	
Bertrams Limited	1,505	....	1,251
Scott & Co.	1,481	....	1,256
Musgrave & Co.	1,481	....	—
Mirrlees Watson Co.	1,475	....	1,145
Masson & Scott	1,470	....	1,205
Bailey & Co.	—	....	1,450
Richardsons, Westgarth & Co.	1,486	....	1,185
Combe, Barbour & Co.	1,405	....	1,355
Mather & Platt	1,388	....	—
W. H. Allen, Son & Co	—	....	1,192

Boilers.

Stirling Boiler Co. (*accepted*)	**£2,211**	Hewitt & Kellett	£2,154
B. R. Rowland & Co.	2,722	Babcock & Wilcox	2,050
Danks & Co.	2,413		

The tender by Fraser & Fraser was informal.

Economisers.

The tender of E. Green & Son was accepted at £2,640. There were eight tenders, varying from £2,105 to £2,751. 10s.

For the supply of eight stokers, five tenders were submitted by four firms, and these varied in amount from £875 to £1,669. The tender of the Underfeed Stoker Co. was accepted for four stokers at £454.

Gloucester Town Council have accepted the following tenders:—H. & T. Danks, boilers; Phœnix Dynamo Manufacturing Co., steam dynamo (Sisson engine); Mirrlees-Watson Co., condensing plant; Edward Le Bas & Co., pipe work; India Rubber Co., feed pump; J. Gurney, buildings.

The South-Eastern & Chatham Joint Committee have placed a contract with W. R. Sykes' Interlocking Signal Co. for equipping about 12 miles of line between London Bridge and Grove Park with their system of electric signalling at a cost of about £7,000.

Derby Tramways committee have accepted the tender of W. Griffiths & Co. for extending the tramways at £18,689. 2s. 9d., and that of the Brush Co. for four tramcars.

The Metropolitan Electric Tramways (Ltd.) have recently placed an order with Peter Brotherhood for an air compressor for car cleaning purposes, &c.

Middlesex County Council have accepted the tender of the Metropolitan Electric Tramways to connect the Wood Green tramways with the lines at Bruce-grove, Tottenham, at a cost of £380.

Middlesex County Council have accepted the tender of Mr. Clift Ford at £6,711 for connecting Archway-road to Tally Ho Corner, Finchley, tramway lines, with car sheds at Woodberry-grove.

Hull Corporation have accepted the tender of Siemens Bros. & Co. for the supply, &c., of mains and cables for 12 months ending March 31, 1906.

Islington Guardians have accepted the tender of Pryke & Palmer for annual supply of electrical fittings and sundries.

Faversham Council have accepted the tender of Mr. J. Smith for wiring town hall, market, &c.

East Ham Council has placed an order with Callender's Co. for traction feeder cable at £247.

BUSINESS NOTICES.

The electrical industry will learn with satisfaction that the goodwill of the electrical branch of the old-established Sir Hiram Maxim Electrical and Engineering Co. is not to be allowed to lapse. We have good reason to believe that an arrangement has been come to by which the entire electrical department, together with the electrical staff, of the Sir Hiram Maxim Company, have been taken over by a company specially formed for the purpose, with an entirely fresh board of directors. Mr. A. W. Hill retains his position as manager of the new company.

Messrs. O. J. Steinhart, Ph.D., F.C.S., and J. L. F. Vogel M.I.E.E., M.I.M.M., hitherto carrying on business as Steinhart & Vogel, 91, Blackfriars-road, London, S.E., as technical chemists and metallurgists, and also managing directors of the Tungsten and Rare Metals Co. (Ltd.), announce that they are entering into an arrangement with Mr. T. C. Cloud, A.R.S.M., M.I.M.M., F.C.S., F.I.C., late manager of the Wallaroo Smelting Works, South Australia, to amalgamate their business, and in future the joint firm will be known as Steinhart, Vogel & Cloud. The firm's office will be 4, Lloyd's-avenue, Fenchurch-street, London, E.C., with laboratory and works at Feltham, Middlesex.

Mr. Arnold G. Hazzard, consulting electrical engineer, 10, Victoria-street, London, S.W., has recently taken into partnership Mr. Henry S. Watson, and the style of the firm will be Hazzard & Watson. Mr. Watson, who has taken an engineering degree at Cambridge, has had experience of large power schemes, and latterly, whilst with the British Westinghouse Co. has undertaken the equipment of factories, shipbuilding yards, and blast furnaces for motor driving as his special branch.

Mr. Hilliard Stephens, A.M.I.M.E., A.M.I.E.E., 38, Victoria-street, S.W., notifies that he has severed his connection with Mackenzie Bros., and has been appointed sole London agent (engineering section) to the Falkirk Iron Co.

Messrs. Samuel Raphael Cohen, Ernest Raphael Cohen and Lewis Charles Ingram, electricians, &c., 6, Park-parade, West Kensington, London, W., have dissolved partnership. Debts by Mr. Ingram.

Messrs. Ralph Gooch Tyler and Wm. Evan David Duncan, 28, New Bridge-street, London, E.C. (trading as Tyler & Duncan) have dissolved partnership. Debts by Mr. Tyler, who continues.

The Electrical Engineering and Maintenance Co. have removed to 49, Lime-street, London, E.C.

Mr. W. H. Booth, C.E., has removed his office to 55, Queen Anne's Gate, Westminster, S.W.

LIQUIDATIONS, &c.

The Electric Turbine Gas Retort Charging & Discharging Machine Co. (Ltd.) is to be wound up voluntarily. Mr. W. K. Wenham, 27, Martin's-lane, London, E.C., is liquidator.

A meeting will be held on May 2 at 49, Queen Victoria-street, London, E.C., to receive an account of the winding-up of British Columbia Telephones (Ltd.).

A meeting will be held on April 29 at 13, Basinghall-street, London, E.C., to receive an account of the winding-up of Electric Lighting Boards (Ltd.).

Electric Lamps for Sale.—In the liquidation of the Sir Hiram Maxim Electrical & Engineering Co. (Ltd.), 44, Gillingham-street, Pimlico, London, S.W., tenders are invited (for order of the Court) for purchase of about 300,000 high-class incandescent lamps, for voltages ranging from 30 to 260 and from 1½ c.p. to 32 c.p. Catalogues and forms of tender may be obtained from Messrs. W. H. Smith & Son, solicitors, Gresham House, London, E.C., or of the auctioneers, Messrs. Wheatley Kirk, Price & Co., 86, Watling-street, London, E.C., and Albert-square, Manchester. Tenders must be in by April 14. See also advertisement.

Plant for Sale.—Mr. James B. Coll, Newton Abbot, Devon, has for sale some electric lighting plant, including Crompton dynamos, horizontal engines, arc and hand lamps, pendants, switch and distributing boards, cable, &c. See also advertisement.

Factory Sites to Let.—Messrs. Woodhouse & Davidson, 10 and 11, Lime-street, London, E.C., have some conveniently situated freehold factory sites for sale within 10 miles of London. See an advertisement.

"City of London Directory."—This old established directory of the City of London, which has reached its thirty-fifth annual edition and is published by W. H. & L. Collingridge, of the "City Press," Aldersgate-street, London, E.C., price 12s. 6d., has now been issued for 1905. A work of reference of this kind appeals to a large class outside commercial circles from the fact that there is a mass of information relating to the great City Companies, educational matters, biographical notes of the more prominent City Councillors and officials, besides notes relating to many of the historically interesting local divisions of the City. The new edition shows evidence of having been carefully revised, and, in order that the information of a special character should be complete, the London County Council committees have been inserted to meet the needs of those who may have business with County Council and Corporation committees acting jointly in connection with London local matters. The reason the "City of London Directory" is not published until this apparently late date is that much of the information is not available earlier. We consider that everything is in favour of this delay, as a very large proportion of the changes which take place in official quarters occur in the early months of the year. The directory is well printed and strongly bound.

"Technical Words, Terms and Phrases."—Messrs. Marlborough & Co., 51, Old Bailey, London, E.C., have published this little work, compiled by C. A. Thimm and W. von Knoblauch (bound cloth 2s. 6d.). There are two sections, English-German and German-English, and amongst the 4,000 words there are only a limited number of electro-technical terms. The accuracy of the translation of some of these is not above suspicion. We may instance power (translated Pulver) and powder (translated Kraft.) There is, however, sufficient in the book to make it useful to the general public.

The "Wirt" Dynamo Brush.—We described and illustrated this metal brush in *The Electrician*, Vol. LIII., p. 1,009, and are now able to give some further particulars. The brush consists of copper leaves sandwiched between a series of anti-friction metal leaves of increasingly high resistance, so that the brush cuts out and cuts in each armature coil through resistance, which tends to prevent sparking. At the same time the friction losses due to the brush bearing on the commutator are reduced to a minimum, as the coefficient of friction is said to be much smaller than that with a carbon brush. This property makes the brush valuable for alternating-current machines also. The composition and sequence of the resistance metals vary with the type of machine for which the brushes are intended. For dynamos which supply large currents at low voltages, this brush is particularly applicable. Such is the case, for instance, with dynamos for plating and other electrolytic purposes, and we learn that "Wirt" brushes have been employed for collecting up to 5,000 amperes from one commutator. These composite brushes are supplied by J. Dobbie & Sons, 146 and 147, Houndsditch, London, E.C., who are the sole licensees and makers, in lengths ranging (in steps of ⅛in.) from 6in. to 12in., in widths from ⅜in. to 1¼in., and in thicknesses varying from 3/16in. to ⅜in. A number of favourable testimonials accompany the new list of these brushes, which is just issued, and also useful instructions as to the care of "Wirt" brushes.

Catalogues, &c.—Messrs. Chamberlain & Hookham, Solar Works, New Bartholomew-street, Birmingham, forward a copy of their new catalogue, the opening pages of which are devoted to a historical review of electricity meters, written by Mr. George Hookham. Then follows a list of about 300 supply stations where Hookham meters are used. Subsequently various types of Hookham meters are described and their action explained. This firm is making a new class of switchboard case for battery meters, either in polished black enamel with raised parts nickel or copper-plated, or of polished brass with glass front and sides. The new Hookham watt-hour meter is designed for circuits in which there is considerable fluctuation of voltage, such as tramway or power circuits. For this purpose the ampere-hour type is modified by substituting an electromagnet for the permanent magnet for field purposes. The permanent magnets are, however, still retained for the brake. Although the armature is considerably larger than in the ordinary ampere-hour meter, its weight is, nevertheless, borne by the mercury, so that there is no tendency for the pivots to wear.

Messrs. Ferranti, Hope & Co., of Manchester, have sent us their latest catalogue containing a number of detail pamphlets describing and illustrating their switchboards, distribution boards, switches, fuses, arc lamps and a number of accessories for power and lighting work. A new and neat design amongst the switches is the "Ajax" ironclad motor switch, a sample of which has also been sent us. The general construction of the switch is clearly shown in the appended illustration. It is double-pole and the break is quick and positive. The contact brush is of phosphor bronze. It is sometimes contended that switch handles are not made strong enough to withstand rough usage. This point has apparently received special attention by the makers, as the switch arm of the "Ajax" is of ample size and is connected in a good mechanical manner to the mechanism which operates the contact brushes. The cover is provided with a slot through which the switch arm protrudes, and it can be easily removed for inspection. If desired, the case is lined with asbestos. These switches are designed for currents ranging from 20 to 200 amperes and for any voltages up to 500.

"AJAX" IRONCLAD MOTOR SWITCH.

Barometric Jet Condensers is the subject treated in leaflet 167, issued by the Worthington Pump Co., 153, Queen Victoria-street, London, E.C. The list is illustrated.

The Electrical Co., 121-125, Charing Cross-road, London, W.C. have ready a new set of lists, comprising wall sockets and plugs (No. 143), projector Nernst lamp particulars (No. 146), a group of three-phase motors as supplied to the Western Australian Government, and two fine views of the generating station equipped by the Electrical Co. at Grand Hornu Colliery. The projector Nernst lamps are made for any supply voltage and are designed for lantern and photographic illumination enlargers and animated picture projectors. They can be fitted to any lamp-holder by means of an adapter. The burner, detachable from the lamp, is composed of three filaments, each burning in series with one resistance. These filaments are supported by small brackets on the front of the burner, which can be separately detached for renewal, each being provided with two small connecting plugs for the purpose.

Siemens Electrical Appliances (Ltd.), 61-62, Watling street, London, E.C., have ready several new leaflets illustrating and describing automatic claw switches, electric measuring instruments, dental appliances, &c. The accompanying illustration shows an ammeter for testing incandescent lamps for both direct and alternating current up to 32 c.p. and 250 volts.

We have received two illustrated lists and some samples of a new and ingenious plug for plugging brick or stone walls. The chief feature is that the wedge is automatically driven into the plug while it is in the hole in the wall, and thus the expansion only takes place in the brick and cracking of the plaster or other surface preparation is avoided. We understand the "Clincher" plug is obtainable of all wholesale supply houses, ironmongers, &c.

A list of tachometers and tachographs has been prepared for publication by Moul & Co., 76-78, York-street, Westminster, London, S.W. Copies of the list can be obtained on application.

A well-illustrated and complete list of machine tools manufactured by J. Butler & Co., of Victoria Works, Halifax, has been issued, and comprises a very large number of the chief tools used in machine shops. This is one of the most comprehensive lists of machine tools that has come before us.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from March 22 to 28, with the ports of destination :—

Aden, £139 *Africa*—Alexandria, £557 (including £504 telegraph material); Cape Town, £594; Durban, £1,411 (including £22 telegraph material); East London, £4,176 (including £259 telegraph material); Port Elizabeth, £190 (including £160 telegraph material); Port Said, £13. *Argentina*—Buenos Ayres, £220 (telegraph material) *Australasia*—Brisbane, £81; Christchurch, £34; Fremantle, £395; Lyttelton, £10; Melbourne, £162; Otago, £22; Perth, £22; Sydney, £909; Wellington, £277. *Belgium*—Ostend, £16. *Canada*—Montreal, £32. *Ceylon*—Colombo, £65. *China*—Shanghai, £24 (telegraph material). *Denmark*—Copenhagen, £25. *Germany*—Bremen, £10 (telegraph material); Hamburg, £21. *Gibraltar*, £150. *Greece*—Piræus, £10 (telegraph material). *Holland*—Amsterdam, £270 (including £123 telegraph material); Rotterdam, £104 (including £12 telegraph material). *Hong Kong*, £10. *India*—Bombay, £1,018 (including £111 telegraph material); Calcutta, £725; Madras, £24. *Japan*—Yokohama, £318. *Malta*, £111. *Mexico*—Coatzacoalcos, £35. *North Atlantic*, £3,100 (submarine cable). *Portugal*—Lisbon, £12 (telegraph material). *Siam*—Bangkok, £23 *Straits Settlements*—Singapore, £177 (including £36 telegraph material). *Surinam*, £13. Total £15,505, against £22,247 in the corresponding week last year (March 22 to 29).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

January 6, 1905.

311 J. B. West. Apparatus for testing resistances.*
313 A. Miller. Attaching conductors to terminals.
315 W. P. Thompson (Pflüger Accumulatoren-Werke Act.-Ges., Germany). Plates for secondary batteries.*
320 B.T.-H. Co. and B. Hopps. Electric power-transmitting mechanism.

January 7, 1905.

334 F. Burks. Manchester. Electrical therapeutic apparatus.
341 W. G. Hays. Manchester (A. Goldstein, C. F. Patterson, R. L. McElroy and J. E. Shepherd, U.S.) Thermostat.*
343 Bruce Peebles & Co. and J. L. La Cour. Liverpool. Converting multiphase into continuous current.*
352 H. P. Davis and F. Conrad. Protective apparatus for alternating-current circuits. (Date applied for, Jan. 20, 1904, date of application in U.S.)*
354 Evershed & Vignoles and S. Evershed. Electrical measuring instruments.
368 B.T.-H. Co. and J. Gray. Vapour electric apparatus.
369 A. McLeod Jackson. Vapour electric apparatus. (Date applied for, Jan. 9, 1904, date of application in U.S.)*
370 O. O. Kruh. Vapour electric apparatus. (Date applied for, Jan. 8, 1904, date of application in U.S.)*
374 Akt. Ges. Brown, Boveri & Co. Electromotors for single-phase current. (Date applied for, Jan. 8, 1904, date of application in Switzerland.)*

January 9, 1905.

380 W. Ainsley. Durham. Insulated roller contact block for electric traction.
381 W. Parr. Birmingham. Electrically lighting gas lamps.
393 F. A. Hunter. Wales. Controlling the luminosity of electric lamps and their consumption of current.
400 G. Harrison. (The Albert and J. M. Anderson Mfg. Co., U.S. Controlling electric and other circuits.*
401 B.T.-H. Co. (G.E. Co., U.S.) Under-running collectors for electric railways.
402 B.T.-H. Co. (G.E. Co., U.S.) Thermal electric cut-outs.
403 B.T.-H. Co. (G.E. Co., U.S.) Electric heaters.
404 B.T.-H. Co. (G.E. Co., U.S.) Switches.
406 B.T.-H. Co. (G.E. Co., U.S.) Resistances.
410 R. J. W. Grasset. Electrical hydro-pneumatic governor for marine engines.*
416 H. J. Trautmann and J. L. Copping. Insulators.
417 H. J. Trautmann and J. L. Copping. Switches.
424 C. M. Jacobs. Single lines of railway on the staff or other electric systems.
432 G. B. Bryan. Arc lamps.

January 10, 1905.

436 O. D. Lucas. Mercury vapour lamps.
446 W. Bransfield. Sheffield. Apparatus for testing and indicating intensity of current conductors.
493 O. T. Blathy. Measuring the intensity of currents.*
512 P. Dawson. Electric generators.
513 A. P. Zani. Alternating-current commutator motors.*
514 A. P. Zani. Winding for motors, generators, and the like.*
521 P. Meusnier and G. Mounier. Secondary batteries.
522 B.T.-H. Co. (G.E. Co., U.S.). Electric oil switches.
523 B.T.-H. Co. and F. Holden. Electricity meters.

January 11, 1905.

530 H. Courtean. Rickmansworth. Electric railways and trains.
534 Veritys (Ltd.) and F. S. Worsley. Birmingham. Double carbon arc lamps.
535 J. Smith. Glasgow. Lighting electric lamps by a self-connecting pole.
542 J. Maclean. Glasgow. Switch or cut-out.
571 W. McLellan and C. H. Merz. Method of and apparatus for indicating or checking the efficiency of electric train or car driving.

January 12, 1905.

605 H. E. Bennett, J. Rodda and T. H. Rule. Cornwall. Separating bodies capable of being magnetised from others.
608 J. Maclean. Glasgow. Portable electric drilling machines.
617 T. E. R. Phillips. Construction of splicing ear for trolley wires.
618 W. J. Fry. Controlling the feeding mechanism of arc lamps.

January 13, 1905.

689 R. Duckworth, H. Duckworth and D. Kerr. Preston. Automatic current feeder for electric railways.*
693 S. H. Penning. Incandescent lamps.
700 H. Heinicke. Transformers for high-tension currents.*
718 B.T.-H. Co. and E. B. Wedmore. Reverse current cutouts.

January 14, 1905.

760 E. E. W. Butt. Birmingham. Inspection cover.
766 F. Lutz. Sparking plugs.
776 A. P. Zani. Alternating-current electromagnets.*
778 A. G. Bloxam. (F. E. Polzeniusz and R. B. Goldschmidt. Belgium.) Accumulator plates.
789 Union Elektricitäts-Gesellschaft. Electric heating of electric vehicles. (Date applied for, Jan. 16, 1904, date of application in Germany.)*
795 F. F. Bourdil. Microphones. (Date applied for, Jan. 28, 1904, date of application in France.)*
797 A. B. Tubini. Cutout apparatus.

January 16, 1905.

835 E. L. C. Mollard and G. F. Griffin. Apparatus for condensing steam and generating electricity.
839 A. J. Boult (E. W. Smith, U.S.). Storage battery negative pole plates.*
850 J. A. Orme. Trolley heads.
881 F. Wieland. Apparatus for indicating consumption of electric energy and loss of current.*

January 17, 1905.

883 R. H. Jones. Colwyn Bay. Electrical immovable contact-breaker and switch for ignition purposes on petrol motors, oil and gas engines.
923 F. Conrad. Electrical measuring instruments. (Date applied for, Jan. 20, 1904, date of application in U.S.)*
934 A. H. Nicholson. Apparatus for producing high potential discharges, particularly for igniting charge of an internal combustion engine,

948 A. B. Tubini. Construction of cutout apparatus.
950 L. S. Wilks. Bell pushes.
952 M. Latour. Electric motors. (Date applied for, Jan. 13, 1904, date of application in France.)*
954 A. Churchward. Vapour electric apparatus. (Date applied for, Jan. 18, 1904, date of application in U.S.)*
955 S. Ferguson. Vapour electric apparatus. (Date applied for, Jan. 18, 1904, date of application in U.S.)*
956 H. I. Wood. Vapour electric apparatus. (Date applied for, Jan. 18, 1904, date af application in U.S.)*

January 18, 1905.

967 H. Willis. Bristol. Semi-portable electric hand lamp.
991 J. Lehmann. Electric switching apparatus.
1,000 P. Schmidt, R. Schott and A. Schildburger. Apparatus for winding bands, filaments or similar covering upon cables, bars and tubes.*
1,004 W. D. S. Brown and A. Greenwood. Dynamo electric machines.
1,009 C. P. Elieson. Electrical connections for secondary batteries.
1,015 A. Galanti and R. Barbeti. Storage batteries.
1,017 A. Larsen. Electrolytic treatment of gases.
1,022 J. C. Dear. Switches.

January 19, 1905.

1,065 M. C. Burt. Incandescent electric light bulbs.*
1,072 R. Gerow and G. H. Gerow. Incandescent lamps.*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each

1904.

2,644 Donovan. Clutch couplings for arc lamps.
2,939 Bullock and Robin. Electric ignition for explosion engines.
3,072 Nash and Eachus. Cutouts for overhead electrical conductors.
3,386 B.T.-H. Co. (G.E. Co., U.S.A.) Electric motor control systems.
5,919 Dunn. Speed regulation for electromotor driven machinery. (Date applied for, Aug. 20, 1903.)
7,418 Hutton. Hydrometer for use with storage batteries.
7,429 Waterhouse and Simplex Steel Conduit Co. Metallic conduits.
7,838 Trotter. Medico-electrical apparatus.
8,549 Houston and Erskine. Ships' telegraph.
8,558 Tweedale, Tweedale and Smalley. Electric stop motions for cotton spinning.
13,927 Jones (Long Arm System Co.) Electrically-operating bulkheads, &c.
16,820 Sallis. Electric winding for clocks, &c.
18,144 Harris. Purification of air and generation of ozone.
19,168 Thompson (Berliner Maschinenbau Act. Ges. vorm. L. Schwartzkopff.) Alternating-current electrical machinery.
21,580 Gustafson and Carlstedt. Contact devices for electric clocks. (Date applied for, Oct. 8, 1903.)
22,171 Elektrizitats Act.-Ges. vorm. W. Lahmeyer & Co. Switchboards to protect persons from injury. (Date applied for, Dec. 31, 1903.)
23,090 Stone. Increasing the effective radiation of electromagnetic waves. (Date applied for, Oct. 30, 1903.)
24,470 Hewitt. Gas or vapour apparatus. (Date applied for, Nov. 24, 1903.)
24,781 Blackmore. Process of reducing aluminium and other metals and making alloys thereof.
26,837 MacGahan. Apparatus for indicating faults in three-phase circuits. (Date applied for, Jan. 20, 1904.)
26,915 Dempster. Arc lamp electrodes. (Date applied for, Dec. 10, 1903.)
26,916 Steinmetz. Arc lamp electrodes. (Date applied for, Dec. 10, 1903.)
26,918 Harden. Arc lamps and electrodes. (Date applied for, Dec. 10, 1903.)
26,919 Harden. Arc lamp electrodes. (Date applied for, Dec. 10, 1903.)
26,948 Mills (Edison). Storage batteries.
27,011 Kuch. Vapour electric apparatus. (Date applied for, Dec. 12, 1903.)
27,449 Fairweather (Huff). Electrostatic separation.
27,755 Aron and Runge. Counting mechanism for electricity meters.
27,887 Weintraub. Vapour electric apparatus for wireless signalling and other purposes. (Date applied for, Dec. 21, 1903.)
28,349 Dixon. Generation and distribution of electricity.
28,453 Soc. anon. pour la Travail Electrique des Metaux. Continuous-current motor. (Date applied for, May 10, 1904.)
28,467 Thompson (Deutsche Gasglühlicht Act-Ges. Auergesellschaft). Incandescent lamps.
28,543 Manquais. Electric junction and like boxes.
28,554 Boult (Hoskins). Thermo-electric couples.
28,608 Regnart & Hunter Electric Candle Lamp Co. "Electric candle" lamps.
28,628 Rosemeyer. Arc lamps.
28,629 Birnbaum. Drop signals for telephone stations.
28,722, 28,723, 28,724 and 29,054 Schwabe. Incandescent lighting devices.
28,920 List and Ritchie. Thermostatic device for indicating when motor car or other lamps are extinguished.
28,962 Richard. Galvanometers. (Date applied for, Feb. 3, 1904.)
29,307 Frey. Switches for incandescent lamps.
29,386 Gutzmann. Electrical generators having double-shaped armatures.
28,123 Birkmann. Counting apparatus for meters.
29,048 Renault. Terminals. (Date applied for, May 2, 1904.)
29,059 Renault. Electric ignition plugs for internal combustion engines. (Date applied for, May 2, 1904.)
29,233 Albion Motor Car Co. and Murray. Low-tension electric ignition devices for internal combustion motors.
29,310 Lorel. Electric dumb-bells and similar appliances.
29,347 Stern. Transformer.
29,428 Ribbe. Automatic photographing telegraphs.

COMPANIES' MEETINGS AND REPORTS.

Bournemouth & Poole Electricity Supply Co. (Ltd.)

The eighth ordinary general meeting was held on Thursday last under the presidency of Mr. Aymon H. Sanderson.

The SECRETARY (Mr. H. B. Renwick) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: The general progress of the company's business is satisfactory. There has been a substantial increase in the gross revenue receipts, in the lamps applied for and in the units sold. The capital expended during the year was £31,404. 18s. 5d. in mains, buildings and machinery. The sum we have invested in the Richmond (Surrey) Electric Light & Power Co. has been increased by a further £8,500 advanced at interest. The gross receipts, as you will see by the report and accounts, have increased from £35,658. 6s. 7d. to £40,414. 4s. 6d. The increased receipts from sale of current alone represents £4,140 8s. 5d. Most of the items on the debit side show increases, and this is only natural seeing there has been such considerable increase in the number of units generated and sold. You will notice that repairs have been exceptionally heavy, largely brought about by the reconstruction works which have been going on at our central supply station, but such large expenditure on repairs is hardly likely to occur again for some time to come. The total of the increased cost is £2,184. 4s., bringing the total expenses to £16,624. 16s. 7d. Turning to net revenue and taking account of the balance from 1903 (£9,246. 4s. 11d.) the total is £33,025. 10s. 10d. Deducting interest, preference and ordinary dividends already paid and amounts written off, &c., there is a balance to credit of net revenue of £15,764. 13s. 9d. It will be seen that depreciation has had placed to its credit £500 in excess of last year, which, although it is not as satisfactory as we could wish, is a substantial increase in the right direction. Although we are only paying 7 per cent. on the ordinary shares, against 8 per cent. last year, the amount requiried to pay that dividend is greater than in 1903 by nearly £1,500. The decreased dividend is due to the fact that much of the capital which has been expended has been up to the present time unproductive, but this expenditure will prove remunerative in the future. We have opened up many entirely new areas, all of which promise a profitable return in due time. It is one of the features of our business that we have first to lay our cables before we can commence supply, and many consumers hesitate to adopt electric lighting until they find that the supply is satisfactory. We can claim a record in the number of lamps applied for, and also in the number of units sold. Our increased lampage is equivalent to 21,051 8 c.p., against 19,542 lamps for 1903, the total at December last being 121,589 lamps of equivalent 8 c.p. The progress since the end of the year is equally satisfactory. The units sold in 1904 amounted to 1,703,229, against 1,520,002 for the previous year, an increase of 183,227. We have applied for a provisional order for Wimborne, and if we succeed in this application we shall supply this area from our existing station in the Bourne Valley. As the limit of our capital and borrowing powers is exhausted, we propose to provide further funds as necessity arises by an increase in the share capital of the company from £300,000 to £500,000 in 10,000 preference and 10,000 ordinary shares of £10 each, the borrowing powers being increased from £150,000 to £300,000. Resolutions to this effect will be submitted to you. There will be no further issue of capital, however, during the present year. With regard to the Richmond Company, this continues to make progress; although their dividend has not increased, the position of the company has much improved. In the area supplied by the Bournemouth & Poole Company we have now 95 miles of roads laid with distributing mains, exclusive of feeders, &c. The total number of consumers connected to the mains is over 2,000, with a total lamp connection equivalent to 118,573 8 c.p. lamps and motors of a capacity of 283 H.P. In Bournemouth electricity for motive power is becoming increasingly popular, and we have introduced a system of hiring motors on reasonable terms. Tramways will shortly be running between Bournemouth and Christchurch, and we are under contract to supply the necessary current and have been ready to do this for some time. This should prove a very remunerative addition to our day load. I now move the adoption of the report and accounts.

The VICE-CHAIRMAN (Dr. J. Atkinson Hosker) seconded the motion, and endorsed the chairman's remarks as to the very favourable prospects of the company. With regard to the prospects as these were affected by their Christchurch station, Christchurch abutted on the eastern end of Bournemouth, and was a district rapidly progressing. Tramways were going through to Christchurch, and would be running by August next, and electric tramways always brought residential property. It would be seen by the figures put before them that they were able to account for something like 80 per cent. of the number of units generated, which was very satisfactory. He would point out that something like 10 per cent. of their gross profits was going to the tax-gatherer, and this was certainly too large an amount to be exacted for such a purpose. He asked the shareholders to do what they could to bring about legislation which would change this condition of things.

Mr. TUCKETT said that as they had reached a period when, presumably, they might rely upon a 7 per cent. dividend, was it not time to have the dividends declared half-yearly? He had heard a remark made that the company were laying mains in the district even before there was any demand for a supply, but he hoped that that was not the case, as he understood that electric lighting companies generally refused to lay mains before they were assured of at least 20 per cent. return on the capital involved in that cable.

The VICE-CHAIRMAN: I should like to answer that remark. I admit that certain extensions should not be made until you can see a promising return for the outlay, but in the case of a building estate being developed it was best to put in the mains at once. The gas companies would do so and would not wait until there was an application for gas. The builder, in the course of his construction work, if there is a main in front of the house would wire it for the electric light, but if there is no main he does not put in the installation, so that the opportunity for the supply company is lost. Regarding the payment of half-yearly dividends, he thought that was a matter the directors might carefully consider and probably carry out

The resolution was then carried unanimously, as was a further resolution approving the dividends recommended by the directors.

The **CHAIRMAN** then put the resolution approving the increase of the capital of the company, as above mentioned.

Mr. R. **PERCY SELLON** seconded the motion, which was carried unanimously.

The retiring directors having been re-elected, and the retiring auditor reappointed, a hearty vote of thanks to the chairman, directors and staff was proposed and carried unanimously.

The **CHAIRMAN**, in thanking the shareholders for the vote of thanks, said he was glad they had decided to include the staff in the resolution, for they fully deserved the thanks of the shareholders. Mr Renwick, the secretary, gave a vast amount of time and attention to the business of the company, and was unsparing in his trouble in doing the best he could for them. For Mr. Brightman, also, the same could be said. Their local secretary was also a good servant, and they owed much to his good work. They had also received valuable assistance from their consulting engineer, and were much indebted to him for his able technical assistance. Mr. Ingram, resident engineer at Bournemouth, was an able man, and had the entire confidence of the board. There were many others of the staff who deserved to be mentioned, and with the assistance of all these gentlemen it would indeed be surprising if the Bournemouth and Poole Co. was anything but successful.

The proceedings then terminated.

National Electric Construction Co. (Ltd.)

The eighth ordinary general meeting was held on Friday last, Mr. R. Stewart Bain, C.A., presiding.

The **GENERAL MANAGER** and **SECRETARY** (Mr. W. B. Cownie) having read the notice convening the meeting.

The **CHAIRMAN** said: When I met you last year I expressed regret at the result of that year's working, which showed a loss of nearly £4,000, but I anticipated I would be able to give you a more favourable account next time, as we had commenced work on contracts with the boroughs of Carnarvon, Bo'ness, Holyhead and Kildare, and with the Musselburgh electric lighting and tramway order, which we had reason to believe would result in substantial profits being made. The whole of these contracts have now been completed, and the result is that, instead of a loss, there is the very substantial profit of nearly £20,000. On the Musselburgh electric tramways, which were opened in December, we had carried up to March 9 425,000 passengers, and we are of opinion that this undertaking will become a valuable property. The Holyhead and Kildare contracts were completed last year, to the entire satisfaction of the local authorities, and the Bo'ness and Carvarvon undertakings were opened last month. These installations have also given entire satisfaction, and the applications which we have already received for current are satisfactory. I mentioned last year that we had concluded contracts with the boroughs of Paignton, Wisbech and Basingstoke, and since then we have concluded an agreement with Ormskirk. From the accounts you will see that management expenditure amounts to £6,594 this year, compared with £4,310 last year. This apparent increase is due to the re-arrangement of the accounts under this head. On the other side the revenue from free-wired installations shows a decrease from last year. This is because we have sold a number of installations to local authorities or companies with whom we had contracts, and we have not included the minimum payments from any of these authorities. The profit on contracts completed and in progress has increased from £853 to £25,933, the results from the various contracts I have mentioned. The balance brought down is £19,939, and reserves and depreciations amount to £10,111, compared with £3,254 last year. On the debit side of the balance-sheet is the mortgage of £8,000, which we hope to be able to pay off very soon. We have made a commencement with reserve, and although the sum of £500 is small, considering the large amount we have written off for reserves and depreciations, it will serve as a commencement. The reserve against capital charges and town lighting installations (£3,000) is ample to meet this contingent liability. The amount due to sundry creditors (£40,366) is due to the great amount of work we had in hand at the end of the year; but £20,000 of this has now been paid off. We have made a commencement to write down the item "Purchase of business," and our intention is to largely increase this contribution as our funds permit. Free-wired installations have decreased from £50,817 to £48,621. We have written off a further sum of £3,069 for depreciation. Contracts in course of completion, which stood at £13,123 last year, have increased to £49,000. The item of £2,047 is for expenditure already incurred in connection with new tramway and lighting schemes. Our stock, which last year stood at £10,003, has decreased to £9,163, and we have also written off £1,200 for depreciation on this item. As regards our future, the prospects are distinctly favourable. In addition to contracts which I have already mentioned, we have concluded two agreements, one for laying down an electric tramway in a town on the South Coast, and the other for taking over an electric lighting and tramway order in the Midlands, both of which we believe will be very profitable, and will occupy us for the next 18 months. In addition, we are applying for powers for the extension of the Musselburgh and District tramways, and we have applied for powers for making a new tramway between Edinburgh and Queensferry. I congratulate the proprietors on the great change which has taken place in our prospects during the past year, which is very largely due to the ability and energy displayed by our staff, and principally to our very able manager (Mr. Cownie). I now move the adoption of the report and accounts.

Mr. W. H. **FOWLER** seconded the resolution, which was carried.

Mr. L. B. **SCHLESINGER** moved the declaration of the dividend for the year, and said that, thanks to Mr. Cownie's able management and the indefatigable co-operation of Mr. Mitchell, their engineer, and the other members of the staff, they had been able to present a very satisfactory balance-sheet. Ours is a company whose profits cannot be gauged beforehand. Some years they may be large and some small. We shall, no doubt, have many similar undertakings to that of the Musselburgh Construction Syndicate, and when we bring them before you we hope you will give the directors all the financial support they require. We have already two in view, and they will be brought before you in due course. Not only will it pay you handsomely by realising a good profit on your separate investments in the different construction syndicates, but it will also enable our company to earn good and substantial dividends. The Musselburgh Construction shares we hold are very valuable, and will, I firmly believe, bring us in a profit of at least 30 per cent. Our future schemes will, I hope, be equally advantageous.

Mr. J. T. **JERVIS**, M.I.C.E., F.R.G.S., seconded the motion, which was carried unanimously. The retiring directors (Mr. Jervis and Mr. Schlesinger) having been re-elected, and Messrs. Monkhouse, Stoneham & Co. re-appointed auditors, a cordial vote of thanks to the chairman and staff terminated the proceedings.

British Insulated & Helsby Cables (Ltd.)

The ninth ordinary general meeting was held on Monday, Mr. E. K. Muspratt, J.P., in the chair.

The **CHAIRMAN** moved the adoption of the report and accounts and said, having regard to the continued keen competition the results would be regarded as satisfactory. The increased price of rubber to which he had previously referred had further augmented, while the selling price of this class of goods had remained unaltered. It would be seen that £21,000 had been written off freehold and leasehold property, plant, machinery, &c., against £18,500 in the previous year. In addition to depreciation they had written off a further £8,500 to special reserve and had transferred the usual £5,000 to debenture stock redemption which fund now amounted to £15,000. After providing for these sums, for debenture interest, preference dividend and other charges, there remained for distribution £27,114. The directors recommended a further 4 per cent. on the ordinary shares, making 8 per cent. for the year. This left £7,114 to] be carried forward. He believed the balance sheet as a whole would compare very favourably with those of others engaged in the same line of business. The increase in capital expenditure of £27,252 was necessary in order to provide new machinery, &c. Their freehold and leasehold property, &c., had been well depreciated, £127,000 having been written off since 1897. The company continued to do a satisfactory business with all its best customers, including the great Corporations and Government Departments, and during the year had begun and completed one of the largest contracts ever placed in this country for cables—that with the Underground Electric Railway Co. of London. Their investments amounted to £563,897. This money was invested principally in the Midland Electric Corpn. for Power Distribution (Ltd.) and in the Electric Supply Co. of Victoria (Ltd.). Their interest in the former undertaking was now £176,000, and in the latter £284,728. The reports from Victoria were satisfactory, the position being that the electrical undertaking at Bendigo was practically completed and working well, while the construction work in the town of Ballarat was expected to be in working order about July. With regard to the future, owing to various causes there appeared to have been less inducement to municipalities to lay out capital in electrical undertakings, and there had not been much activity in the promotion of companies for electrical purposes. That, however, was gradually passing away, money was easier and the country, he thought, generally was recovering its prosperity. On the whole the company had had its fair share of orders during the past year, and he believed that would continue, for wherever their cables had been put down they had given complete satisfaction. He then moved the adoption of the report and accounts.

Mr. J. S. **HARMOOD BANNER**, M.P., seconded the motion.

Mr. **MENZIES** said there was an addition of £27,252 on capital account, but was there not also practically an addition of £40,000 in Australia to their capital expenditure? Did the £129,000 profit include any profit on their investments? When were they likely to have any profits from the Midland Power Co.?

Mr. **CRANE** asked why nothing had been written off patents and goodwill.

The **CHAIRMAN** said he had dealt fully with all the points raised by Mr. Menzies except that relating to the Midland Power Co. Owing to the depression of trade in the Midlands progress had been rather slower than they had anticipated; but they were gradually obtaining new customers. It was very difficult, in a country where many manufacturers were not quite up to date, to get them to take electric power, even though it would be of enormous advantage to them. They were now earning a profit which would go towards meeting debenture interest, which this company had guaranteed. As regarded patents and goodwill, they figured in the assets at £246,133. He would be glad to see the whole item struck out, and to see machinery, &c., depreciated even to a greater extent; but they could only deal with their earnings or profits. He thought their profits were very fair, and that they had dealt with them in the best way they could in the interests of the company. Having written off £8,500 to special reserve, £5,000 to debenture redemption and £21,000 for depreciation, he thought they had written down their property very well indeed; and it was all the same whether written off in that way or against goodwill and patents.

Mr. BANNER said the £120,000 profit included interest received on investments, but not profits on realisation of investments. When they sold their Australian interests they hoped to make a profit, but they were careful not to anticipate. Nearly the whole of the year's profit of £129,000 was profit on trading.

The resolution was then carried unanimously.

The dividend on the ordinary shares of 4 per cent. (making 8 per cent. for the year) was then agreed to, and the retiring directors (Mr. James Taylor and Mr. G. Crosland Taylor) were unanimously re-elected, and the auditors reappointed, after which a vote of thanks to the chairman and directors was carried unanimously.

Mr. BANNER, in putting this motion, said the fact that their balance in hand and in the bank was £114,108, against £71,000 last year, might be regarded as very satisfactory. This had not previously been referred to, and was well worth noting.

BROMLEY (KENT) ELECTRIC LIGHT & POWER CO. (LTD.) The report for 1904 states the lamp connections have increased from 47,030 to 56,198 8 c.p. The income from sale of current has increased from £9,843. 3s. 8d. to £11,366. 5s. 4d. Considerable additions have again been made to generating plant and mains to meet increased demand. Including £34. 18s. 6d. from last year, there was a profit of £8,286. 8s. 11d. After payment of interest, &c. (£2,526. 17s. 6d.), £5,759. 11s. 5d. is available for dividend. The directors recommend a further dividend at the rate of 7 per cent. (making 5½ per cent. for the year). £1,800 is placed to renewal reserve.

BROWETT, LINDLEY & CO. (LTD.)—The report for 1904 states that owing to depression in the engineering trade the works have been only partially employed, the output being less than half that for 1903. The gross profit was £5,394. The net result of the year's operations was a loss of £14,850, to which must be added £3,998, making £18,848. The directors consider the company is handicapped by being builders of high-speed engines only, and have under consideration the manufacture of other types.

BRUCE PEEBLES & CO. (LTD.)—The net profit for 1904, after making all necessary charges, was £28,792. 7s. 6d., which, with £354. 5s. 1d. brought forward, makes £29,146. 12s. 7d. Preference dividend has absorbed £5,760. 16s. 10d., and the directors now recommend a dividend of 6 per cent. on the ordinary shares (less tax), requiring £5,706. 5s. 0d. £4,000 is written off preliminary expenses and £7,000 is placed to reserve. The cost of the new East Pilton works originally estimated at £53,000, came to £93,000. The turn-over for the past year has been more than double that of the previous year, and the booked orders considerably exceed those of the previous year. The debentures and shares in power and traction companies, acquired in part payment of certain contracts, have been valued at considerably under par, and they believe the valuation to be reasonable. Owing to increased business the shareholders will be asked to sanction the creation of 10,000 additional preference and 10,000 additional ordinary shares of £5 each, and to increase the borrowing powers to the extent of £50,000.

BUENOS AYRES & BELGRANO ELECTRIC TRAMWAYS CO. (LTD.)—The total receipts for 1904 were £171,355 and expenditure £93,452, leaving £77,918, which, with amount (£2,479) brought forward, has been carried to net revenue. After providing for various fixed charges, there remains £42,336. Preference dividend absorbs £20,250. The directors now recommend a balance dividend of 2s. 6d. per ordinary share, tax free, (making 4 per cent. for the year), absorbing £20,000.

EVERED & CO. (LTD.)—After providing for interest, &c., the net profit for 1904 was £6,607, making, with £4,143 brought forward and £3,500 transferred from the equalisation of dividends fund, £14,250. The directors recommend a dividend of 7½ per cent. for the year (tax free), including the interim dividend already paid.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—The directors' report states that at Dec. 31, the equivalent of 64,915 8 c.p. lamps was supplied, against 54,806 in 1903. The profit on revenue account was £9,051. 1s. 9d., and there were further profits on installation work, &c. Putting £1,700 to depreciation, there was a net balance for distribution (after allowing for interim dividend at rate of 4 per cent. per annum) of £2,058. 18s. 3d. A dividend at the rate of 7 per cent. is now recommended (making 5½ per cent. for the year). It is proposed shortly to make a further issue of 4½ per cent. debenture stock ranking with the £50,000 first debenture stock already issued.

GREAT NORTHERN TELEGRAPH CO. (LTD.)—This company announce that, according to an approximate computation of receipts and expenditure for 1904, the net receipts amount to £480,000, which the directors propose to distribute about as follows:—Reserve and renewal fund, £56,000; pension fund of staff, £8,000; remuneration to directors, £2,500; dividend equalisation fund, £53,500; dividend and bonus of 24 per cent. (5 per cent. of which has already been paid), £360,000. The amount carried forward will be about the same as last year.

GREENOCK & PORT GLASGOW TRAMWAYS CO.—The total outlay on electrical construction account to Dec. 31 last was £186,034. 11s. 4d. The revenue for 1904 was £30,583. 5s. 9d. and expenditure £21,359. 2s. 10d., leaving a profit of £9,224. 2s. 11d. After adding £2,093. 9s. 1d. from last account the total is £11,317. 12s. £1,780 is placed to sinking fund reserve, preference dividend requires £3,500, and 4 per cent. ordinary dividend £4,600, leaving £1,437. 12s. carried forward. Six additional cars have been purchased during the year, making 36. The number of passengers carried was 6,644,388, compared with 6,200,778 in 1903. The average receipts per passenger were 1·08d. against 1·13d. The average working expenditure per passenger (apart from rentals, &c.) was 0·62d. against 0·57d.

LIVERPOOL DISTRICT LIGHTING CO. (LTD.)—The report for 1904 states that the demand for electricity continues to increase, the number of units sold being 246,943, against 187,197 in 1903. The revenue was £5,884, against £4,218. The number of 8 c.p. lamps supplied on Jan. 1, was 16,517, against 14,000 at the same date in 1904. Through a most unfortunate and unprecedented occurrence (bad debts), principally on the contracting business, the directors find it impossible to declare any addition to the 2 per cent. interim ordinary dividend paid in August. The small balance (£262) is carried forward and the whole of the debt referred to (£1,879) has been written off. Otherwise the balance (£2,142) would have been available for dividend.

At the meeting on Wednesday Col. A. H. Holme said he was sorry to say that in the contract and manufacturing business they had been unfortunate, having made bad debts amounting to £1,879. 8s. 5d. They had allowed one or two firms—one in particular—to have credit when they ought not to have done. They were in a large way of business, and the directors were quite unaware that they had a large debenture bond over them, which prevented their company recovering by execution. The law in this respect was most anomalous, and many instances of the kind had arisen of late. The directors had tried to upset the debenture bond but without success.

MERSEY RAILWAY CO.—At the meeting last week the chairman (Mr. J. Falconer) stated, that since the introduction of electric traction the total revenue had increased by 42 per cent. The additional booked passengers carried during the last half-year numbered 504,099. Compared with the half-year ended December, 1902, when they were working under steam, the increase in passengers was 1,813,168, or 64 per cent. The increase in the receipts for season tickets was £1,395, or equivalent to 53 per cent. Their working expenses had rather diminished than increased, and even if their revenue were to go up so as to double itself he believed their working expenses would not be much increased over what they were at present. In the week of excessive fog, in December, they carried 260,431 passengers, against 190,000 normal, an increase of something like 40 per cent., and they earned £2,188, against an ordinary £1,100. That abnormal traffic was quite conveniently accommodated in their railway, and they did not hear of a single complaint. They had reduced the first-class fares so as to induce some of the people who travelled third-class to travel first-class, and had adjusted their prices all round. The proposal to link up the system with the Lancashire and Yorkshire Railway on the Liverpool side was being considered.

NEWMARKET ELECTRIC LIGHT CO. (LTD.)—At the meeting on Monday Mr. G. H. Verrall, J.P., stated that during the past year 1,737 8 c.p. lamps had been connected, making the total at the end of 1904 18,190 lamps. There was a balance net profit of £1,312. 4s. 10d. after meeting all charges, and the directors recommended a dividend of 4½ per cent. He called attention to the Nernst lamp, by which, he claimed, the cost of lighting large buildings was reduced by 40 to 50 per cent.; and said that the cost of light at his own residence last year had been 12 per cent. less than in 1898, when he used gas.

PERTH (W.A.) ELECTRIC TRAMWAYS (LTD.)—The gross receipts for 1904 were £69,411. 5s. 8d., yielding a profit of £25,360. 4s. 6d., against £22,971. 10s. 4d. in 1903. After paying debenture interest, sinking fund for First Debenture Stock and trustees' fees, the balance is £14,180. 17s. 6d., which is carried to profit allocation account. After adding balance from last year (£3,232. 1s. 1d.) and £500 proportion of interest on guarantee deposit, and deducting £9,000 for preference dividends (paying all arrears to date), £450 dividend tax in Western Australia and £500 for accrued debenture interest, there is £7,962. 18s. 7d., out of which the directors propose to add £5,000 to reserve, leaving £3,462. 18s. 7d. to be carried forward. During 1904 about one mile was added to the track, and during January, 1905, the mileage authorised under the original Perth concession was completed, making the total track now in operation owned by the company nearly 22 miles, and 2¼ miles extra are being operated under contract. To accommodate the increasing traffic more cars are necessary. The additions to the power plant are approaching completion. A concession has been obtained for extending the company's system to North Perth, which will add about one mile to the existing mileage, and the company has made an agreement with Victoria Park Council for leasing a tram line connecting the existing system with that district.

At the meeting Mr. R. C. Ogilvie said the general prospects of traffic for the current year were very promising. Many references had appeared in the newspapers with regard to the probable effect of the competition of motor 'buses on tramway undertakings, but those best qualified to judge were of opinion that motor 'buses could not successfully compete with well-organised electric tramway systems, although under certain conditions they might become very valuable feeders. At any rate, so far as Perth was concerned, although three motor 'buses had been introduced, the company's traffic continued to increase.

TAUNTON & WEST SOMERSET ELECTRIC RAILWAYS & TRAMWAYS CO. (LTD.)—Total capital expenditure to Dec. 31, 1904, was £20,853. 3s. 2d. The total revenue for the year was £2,948. 1s. 7d., and working expenses £2,771. 5s. 3d. After paying interest charges, &c., there was a deficiency of £481. 2s. 9d.

TYNEMOUTH & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The total capital expenditure on the electrical construction and equipment of lines to Dec. 31 was £86,213. 12s. 4d. The total revenue for the past year was £15,423. 12s. 7d., and working expenditure, including interest, £9,458. 4s., leaving a profit of £5,965. 8s. 7d. £1,500 is placed to depreciation and reserve, preference dividend absorbs £1,500, and a dividend of 7 per cent. on the ordinary shares £3,035. 15s. 6d. The construction and electrical equipment of the light railway to Whitley Sands is nearly completed. Contract tickets are now issued on the company's lines and a satisfactory number have been taken up.

UNITED ALKALI CO. (LTD.)—At the meeting on Friday Mr. John Brock said the deliveries of their goods had been somewhat lower in 1904 than in 1903, due mainly to the increase of manufacture in other countries and to strikes and short time worked in various trades using the goods. Prices had remained in most cases at the low level of 1903, and for several articles had been even lower. In the metallurgical branch of their business both prices and demand had favoured them, and they looked forward to the future with confidence. They would have to spend money in the improvement of machinery and development in linking up the two properties in Spain by a tramway, by improving the means of the transit of the ore to the port of shipment, &c. The action brought against them by the Acetylene Co. for alleged infringement of patents had been finally decided in their favour by the House of Lords. The action had involved them in heavy expenses, which they had written off out of revenue. The gross profit was £411,584, or £26,899 more than in 1903, and the net profit (after payment of interest) £219,019. Adding £80,047 from previous account and deducting £15,000 transferred to debenture redemption fund, there remained £284,066. The dividend on the 7 per cent. preference shares was being paid, £50,000 was transferred to depreciation and £43,762 carried forward.

W. T. GLOVER & CO. (LTD.)—At the meeting yesterday (Thursday) the directors' report was presented for the year 1904. The manufacturing profit was £32,828. 8s, 5d., and dividends on investments, rents and miscellaneous receipts came to £1,978. 2s. 8d. After deducting general expenses (£20,964. 12s. 5d.) and interest and other charges, &c. (£2,552. 16s. 4d.), and taking into account balance from last account (£7,309. 4s. 9d.), less £1,000 voted for directors' remuneration, the balance was £17,598 6s. 8d. Debenture interest came to £4,250, and interest on loans to £1,722 16s. 9d. Adding £3,648. 19s. 2d. to reserve the balance profit was £7,976. 10s. 9d. The directors regret they do not feel justified in recommending any dividend.

WILLANS & ROBINSON (LTD.)—In the report of the directors dealing with the operations of the company for the half-year to Dec. 31, the directors express regret that these operations have resulted in a loss, as regards the Rugby business, of £19,895. 1s. 4d., and as regards Queen's Ferry of £22,876. 14s. 10d., or £42,771. 16s. 2d. in all. £18,054. 1s. of this, however, represents depreciation and £5,127. 2s. 9d., the valuing down of sundry stocks, &c., not arising directly out of the half-year's work, and these sums do not represent actual diminution of the liquid assets of the company. As the debit balance brought forward amounted to £37,180. 6s. 11d., there is now a debit balance on profit and loss account of £79,952. 3s. 1d. The directors have thought it right to exercise fully as great prudence in the matter of depreciation as in the times when the affairs of the company were most prosperous. The extremely unfavourable trade conditions of the past year, leading to a reduction in prices unprecedented in the history of the company, have resulted in a heavy loss even in the engine-building section of the business. The directors, are, however, glad to report that the steam turbine business is developing rapidly, and promises to become a valuable speciality. A friendly arrangement has been entered into with Messrs. C. A. Parsons & Co., and the company has taken a licence enabling it to work under the patents of the Hon. C. A. Parsons. The company has also valuable patents of its own under which it will continue to work. The attempt to find a purchaser for the Queen's Ferry business, or even for the works, has had no success, as in the present state of the trade was perhaps to be expected. Work was necessarily carried on during the half-year, though under very great disadvantages, in order to complete existing contracts for boilers. Repeat orders, upon satisfactory terms, having resulted, the directors propose to continue the manufacture of tubes and boilers upon the present modest scale, in the hope that the business will grow to be self supporting. This result may be contributed to by the steel manufacture, which, after being abandoned in May, 1901, was re started at the beginning of the now current half year, with every prospect, so far as can be judged at present, of proving profitable. The directors are satisfied that it is better under present circumstances to run the Queen's Ferry works than to close them. Mr. T. O. Lazenby has retired from the board on account of ill-health. The vacancy has not been filled, and the board propose that the number of directors, raised last year to seven, be reduced to five as before. Capt. H. R. Sankey, who retires by rotation, does not offer himself for re election.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

BRITISH AUTOMOBILE DEVELOPMENT CO (LTD.) (84,013.)—Reg. March 24, capital £100,000 in £10 shares (5,000 preference), to carry on business of engineers, manufacturers of motors, motor lorries, motor cycles, traction and other engines, locomotives, automobiles, &c., propelled by electricity, gas, oil, steam, compressed air or other motive power, dealers in railway, tramway, electrical and other apparatus, &c. The subscribers are E. Garcke, W. L. Madgen, C. H. Dade, H. S. Day, W. J. Greer, S. A. Sillen, T. Bower. Reg office, Donington House, Norfolk-street, London, W.C.

ELECTRIC IGNITION CO (LTD.) (83,914.)—Reg. March 22, capital £10,000 in £1 shares (5,000 preference), to acquire the business carried on as the Electric Ignition Co., and to carry on the business of manufacturers of appliances of all kinds for electric ignition and internal combustion engines, manufacturers of electrical and mechanical appliances, electricians, engineers, founders, &c. First directors, R. F. Hall and H. Lewis. Reg office, Royal Wellington Works, Sampson road North, Birmingham.

ELECTRO-MEDICAL SUPPLY CO. (LTD.) (83,885.)—Reg. March 22, capital £6,000 in £1 shares, to acquire and carry on the business of manufacturers of electrical medical battery apparatus and accessories, &c., carried on at Harp-lane, London, E.C., by J. Richert & Co. First directors, J. Richett, E. I. Pronk and A. E. Davis. Reg. office, 61, New Cavendish-street, London, W.

MEXICAN POWER DEVELOPMENT SYND. (LTD.) (83,932.)—Reg. March 22, capital £5,025, 5,000 shares of £1 each and 1,000 B shares of 6d. each, to construct, control and manage in Mexico or elsewhere, electric, steam and other railways and tramways, electric storage, power and lighting works, &c., and to carry on the business of carriers of passengers and goods, electrical engineers, electricians, manufacturers of and dealers in railway, tramway, electric and other apparatus, &c. Reg. office, Basildon House, Moorgate-street, London, E.C.

STATUTORY RETURNS.

EASTERN TELEGRAPH CO. (LTD.)—Return to Feb. 8 gives the capital as £6,000,000 in £4,000,000 ordinary and £2,000,000 preference stock, of which £5,999,800 has been taken up and paid for in full. Mortgages and charges, £1,887,704.

ELECTRICAL CANAL HAULAGE CO. (LTD.)—Return to Feb. 20 gives capital as £3,000 in £1 shares, of which seven have been taken up. £7 has been received. Mortgages and charges, nil.

EUROPE & AZORES TELEGRAPH CO. (LTD.)—Return to Feb. 9 shows the capital to be £200,000 in 20,000 shares of £10 each, of which 18,146 have been taken up. £10 per share has been called up on 12,578 and £125,780 has been received. 5,568 shares are considered as fully paid. Mortgages and charges nil.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—In the return to March 9 capital is £350,000 in 50,000 ordinary, 10,000 first preference and 10,000 second preference shares of £5 each, of which 21,000 ordinary, 10,000 first preference and 10,000 second preference shares have been taken up. £5 per share has been called up on 15,968 ordinary, 10,000 first preference and 10,000 second preference shares, and £179,840 has been received. £25,160 is considered as paid on 5,032 ordinary. Mortgages and charges, £90,000. Debenture stock issued by company in conjunction with Notting Hill Electric Lighting Co., £152,500.

LONDON ELECTRIC WIRE CO. (LTD.)—In return to Feb. 15 capital is £150,000 in 20,000 ordinary and 10,000 preference shares of £5 each, of which 15,807 ordinary and 5,956 preference have been taken up. £5 per share has been called up on 8,087 ordinary and 5,956 preference and £70,215 has been received. 7,720 ordinary shares are considered as fully paid. Mortgages and charges, nil.

NERNST ELECTRIC LIGHT (LTD.)—Return to Feb. 6 gives capital £90,000 in £1 shares, of which 89,580 have been taken up. £1 per share has been called up on 57,500 and the remainder are considered as fully paid. No mortgages or charges.

NEWCASTLE & DISTRICT ELECTRIC LIGHTING CO. (LTD.)—According to return to March 7 capital is £300,000 in 30,000 shares of £10 each, of which 29,750 have been taken up. £9 per share has been called up on 20,000 and £5 per share on 9,750 shares and £228,649 has been received, leaving £101 in arrears. Mortgages and charges, £86,085.

NEWCASTLE UPON-TYNE ELECTRIC SUPPLY CO (LTD.)—Return to March 16 gives capital as £750,000 in 75,000 preference and 75,000 ordinary shares of £5 each, all of which have been taken up. £5 per share has been called up on 64,241 preference and 67,029 ordinary shares, and £656,050 has been received, leaving £300 in arrears. £93,650 is considered as paid on 10,759 preference and 7,971 ordinary. Mortgages and charges, £250,000.

NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)—Return to March 21 gives capital as £200,000 in 16,452 ordinary, 2,998 preference and 550 founders' shares of £10 each, of which 10,852 ordinary, 2,998 preference and 550 founders' have been taken up. £10 per share has been called up and £144,000 has been received. Mortgages and charges, £64,000. Mortgages and charges guaranteed jointly by company and Kensington & Knightsbridge Electric Lighting Co., £152,500.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—Return to Feb. 28, 1905, gives capital as £300,000 in 40,000 ordinary and 20,000 preference shares of £5 each, all of which have been taken up. £5 per share has been called up on 39,650 ordinary and 20,000 preference, and £298,250 has been received. £1,750 is considered as paid on 350 shares. Mortgages and charges, £150,000 3½ per cent. debenture stock and £168,438 4 per cent. guaranteed debenture stock of Central Electric Supply Co., being half total loan capital.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)—In return to Feb. 24 capital is £100,000 in 20,000 shares of £5 each, of which 12,000 have been taken up. £60,000 has been received. Mortgages and charges, £58,000.

TELEGRAPH CONSTRUCTION & MAINTENACE CO. (LTD.)—In the return to March 14, capital is given as £448,200 in 37,350 shares of £12 each, all of which have been taken up and paid for in full. No mortgages or charges.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD).—Return to March 8 gives capital as £800,000 in 110,000 ordinary and 50,000 preference shares of £5 each, of which 110,000 ordinary and 28,151 preference have been taken up and paid for in full. Mortgages and charges, £250,000.

MORTGAGES AND CHARGES.

ELECTRICAL BLEACHING CO. (1904) (LTD.)—Issue on March 17 of £2,000 debentures, part of series created Dec. 21, 1904, to secure £14,000, charged on company's undertaking and property, present and future, except uncalled capital. No trustees, but title deeds of company's property are lodged with a safe deposit company in joint names of F. R. B. Lindsell and J. H. Hayes. Previously issued of same series, £12,000.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Mar. 25	1,094	− 31	43	57,391	+ 5,066
Airdrie	,, 17	198	− 7	11	2,125	− 5
Ayr Corporation	,, 25	193	+ 23	45	12,991	+ 664
Barnsley	,, 17	157	...	11	1,642	+ 54
Barrow	,, 17	199	+ 78	11	1,981	+ 295
Bath Electric Trams, Ltd.	,, 22	657	+ 109	12	6,507	+ 560
Birkenhead	,, 26	975	− 1	...	...	...
Birmingham Corporation	,, 25	300	...	12	20,116	...
*Birmingham & Mid.	,, 17	1,782	+ 218	11	15,136	+ 2,167
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 23	454	+ 142	51	47,817	+ 6,372
Blackpool and Fleetwood	,, 26	257	+ 37	12	2,275	− 59
Blackp'l, St. Anne's & Lytham	,, 23	202	+ 25	21	2,791	...
Bolton Corporation	,, 24	1,771	+ 157	52	91,772	+ 956
Bournemouth Corporation	,, 23	1,151	+ 144	‡51	53,063	+ 2,130
Bradford Corporation	,, 25	2,969	+ 319	51	292,449	+ 31,363
Brighton Corporation	,, 25	860	+ 130	51	49,523	+ 3,924
Brisbane Tramways	Feb. 1	2,418	+ 32	5	9,462	+ 578
	,, 8	2,458	+ 106			
Bristol Trams & Carriage	Mar. 24	4,763	+ 316	7	31,395	+ 579
Buenos Ayres & Belgrano	Feb. 19	3,063	+ 103	19	12,290	− 686
	,, 26	3,062	− 86			
Buenos Ayres Elec. Trams	,, 15	1,119	...	8	6,565	...
Burnley Corporation	Mar. 25	1,053	+ 168	25	12,161	+ 3,874
Burton Corporation	,, 26	308	+ 19	¶51	17,218	...
Calcutta Tramways Co.	,, 25	a68,055	+ a2,845	12	a689,666	+ 58,998
Camborne-Redruth	,, 27	96	+ 5	21	2,195	− 160
Cardiff Corporation	,, 23	1,961	+ 115	51	102,789	+ 2,186
Carlisle Tramways Co.	,, 25	148	− 91	12	1,714	− 194
Central London Railway	,, 25	7,025	− 255	12	96,153	+ 918
Chatham & Dist. Lt. Rys.	,, 22	655	+ 166	12	6,825	+ 900
*City of Birm'gh'm Tram Co.	,, 17	6,502	+ 467	11	57,606	+ 2,478
City & South London Rly.	,, 26	1,628	− 223	13	25,901	− 2,543
Colchester Corporation	,, 23	180	...	8	7,610	...
Cork Electric Trams Co.	,, 18	454	+ 77	12	6,816	+ 105
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 17	412	− 34	11	4,006	− 209
Dover Corporation	,, 26	173	+ 5	52	11,044	− 101
Dublin & Lucan Railway	,, 24	102	+ 3	12	1,132	+ 32
Dublin Southern District	,, 24	798	+ 71	12	52,465	+ 360
Dublin United	,, 24	3,755	+ 178			
Dudley—Stourbridge	,, 17	789	+ 49	11	8,012	+ 237
Dundee Corporation	,, 23	794	+ 34	¶20	36,745	+ 391
East Ham Council	,, 25	771	+ 161	51	36,659	+ 2,190
Gateshead & Dist. Trams	,, 17	882	+ 45	11	9,356	+ 806
Glasgow Corporation	,, 25	14,793	+ 1,231	†34	610,916	+ 31,077
Glossop	,, 25	118	+ 23	[illegible]	1,294	+ 146
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 17	198	− 17	11	2,012	− 214
Gt. Northern & City Rly.	,, 23	1,601	+ 635	12	19,756	...
Greenock & Port Glasgow	,, 17	571	+ 110	11	5,600	+ 698
**Halifax Corporation	,, 21	2,618	+ 156	51	72,869	− 4,540
Hartlepool Tramways	,, 17	242	− 6	11	2,602	+ 17
Huddersfield	,, 25	1,224	+ 117	51	68,796	+ 4,894
Hull Corporation	,, 25	3,069	+ 99	51	111,190	+ 11,172
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	,, 22	125	− 13	15	2,704	− 486
Ipswich Corporation	,, 21	369	+ 52	51	23,039	...
Isle of Thanet Co.	,, 25	141	+ 66	25	7,041	+ 133
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	,, 17	93	− 5	11	973	− 56
Kilmarnock	...	...	...	...	...	...
Kirkcaldy Corporation	,, 22	109	+ 10	8	799	+ 15
Lanarkshire Trams Co.	,, 25	659	+ 79	13	7,548	+ 639
Leeds Corporation	,, 25	5,653	+ 563	52	285,578	+ 19,152
Leicester Corporation	,, 25	1,916	...	12	21,418	...
Liverpool Corporation	,, 18	10,075	+ 542	11	107,800	+ 4,483
Liverpool Overhead Rly.	,, 26	1,528	− 73	13	19,036	− 494
*London County Council	,, 19	12,819	+ 2,129	§50	684,045	+ 141,911
Lowestoft	,, 25	130	+ 7	12	1,458	...
Maidstone Corporation	,, 23	118	...	26	4,566	...
Manchester Corporation	,, 25	12,515	+ 1,002	51	618,295	+ 10,740
Mersey Railway	,, 25	1,510	+ 67	12	19,079	+ 1,296
Merthyr	,, 17	187	− 6	11	1,881	− 110
*Metropolitan Elec. Trams	,, 17	1,463	+ 691	11	20,317	+ 6,773
Middleton	,, 17	164	+ 13	11	2,787	+ 226
Musselburgh	,, 16	142	...	14	2,828	...
	,, 23	213				
Nelson Corporation	,, 22	120	+ 21	52	6,001	+ 1,434
Newcastle-on-Tyne Corp.	,, 25	3,577	+ 120	12	42,468	+ 132
Newport (Mon.)	,, 25	525	+ 19	25	12,641	+ 1,756
Northampton Corporation	,, 24	369	+ 261	49	13,199	+ 6,924
Oldham, Ashton & Hyde	,, 17	520	+ 6	11	5,228	+ 59
‡Oldham Corporation	,, 24	2,964	+ 490	52	65,334	+ 6,990
Perth (W. A.) Elec. Trams	,, 24	1,330	− 15	12	17,566	+ 1,267
Peterborough	,, 17	107	− 1	11	1,057	− 67
Poole and District	,, 17	224	− 31	11	2,540	− 20
Portsmouth Corporation	,, 25	1,691	+ 339	§51	94,400	+ 6,874
Potteries	,, 17	1,578	+ 77	11	17,665	+ 450
Reading Corporation	,, 23	684	+ 66	...	...	...
Rochdale Corporation	,, 26	490	+ 309	52	14,047	+ 7,742
Rotherham Corporation	,, 24	484	+ 10	51	23,063	+ 2,517
Rothesay	,, 17	44	− 2	11	490	+ 37
Salford Corporation	,, 17	3,516	+ 239	51	207,259	+ 10,426
Sheerness	,, 15	61	+ 17	11	579	+ 105
Sheffield Corporation	,, 16	4,569	+ 505	[illegible]	210,566	+ 8,314
Southampton Corporation	,, 22	675	+ 36	51	45,263	− 2,636
Southend Corporation	,, 22	567	+ 50	51	17,471	+ 1,665
Southport Tramways	,, 17	240	+ 12	11	2,417	− 60
S. Staffordshire Trams.	,, 17	679	− 58	11	6,952	− 434
Stockport Corporation	,, 24	540	+ 130	51	27,307	+ 8,735
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	,, 17	557	+ 132	11	4,985	+ 176
Swindon	...	...	...	...	...	...
*Taunton Trams	,, 17	45	− 4	11	431	− 57
Tynemouth and District	,, 17	182	− 29	11	1,831	− 310
Tyneside Trams Co.	,, 21	286	+ 56	12	3,898	+ 500
Wallasey District Council	,, 25	706	+ 108	§51	37,461	+ 2,747
Walsall	,, 25	470	...	12	5,303	...
Warrington Corporation	,, 23	317	+ 12	51	16,243	+ 643
West Ham Corporation	,, 24	1,364	...	...	55,105	...
Weston-super-Mare	,, 16	29	...	11	255	+ 41
Wigan Corporation	...	...	...	...	...	...
Wolverhampton Corpn.	,, 24	729	+ 215	51	38,790	...
Wolverhampton District	,, 17	252	+ 6	11	3,682	+ 190
Worcester	,, 17	277	+ 43	11	2,711	+ 734
Wrexham	,, 17	91	− 8	11	1,006	− 26
Yorkshire Woollen District	,, 17	559	+ 30	11	5,918	− 665

(a) These comparisons are with the corresponding period last year. † Minus 5 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 5 days. ** Fortnight. * Partly electrical.

STANLEY ELECTRIC CARRIAGE CO. (LTD.)—£6,000 6 per cent. debentures, created and dated Jan. 23, 1905, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees. Holder, Major-Gen. Sir E. H. Sartorius, K.C.B.

CITY NOTES.

MEMORANDA (March 23).—Bank rate 2½ per cent. (since March 9, 1905). Price of silver 26 3/16d. per oz. Consols 91 1/16—91 3/16 for money, 91 1/8—91 3/16 for account; 2½ per cent. annuities 89¾—90¼. Consols Pay Day, April 5. Stocks and Shares Continuation Days, April 11 and 26; Ticket Days, April 12 and 27; Pay Days, April 13 and 28; Mining Share Carry-over Days, April 10 and 25.

BABCOCK & WILCOX (LTD.)—A dividend of 25 per cent. (compared with 17 per cent. for 1903) has been declared.

BRISBANE (QUEENSLAND) ELECTRIC SUPPLY CO. (LTD.) The "Australian Mining Standard" says the business of this company has been taken over by the City Electric Light Co. (Ltd.). The Orders in Council authorising the company's operations are for a period of 42 years. The new company has an authorised capital of £100,000.

CANADIAN & UNITED STATES STREET RAILWAYS.—It is announced that the New York Central Railway Co. are endeavouring, with the aid of British capital, to bring about an amalgamation of the interests of the owners of 300 miles of electric railways in Buffalo, Toronto, Hamilton and St. Catherines, the various lines running to Niagara Falls, and the Lake Steamers & Electric Development Co. of Niagara Falls, the object being to improve travelling facilities by connecting up all the existing and authorised lines in these districts.

PERFECTA SEAMLESS STEEL TUBE CO. (LTD.)—On Thursday last week a resolution in favour of winding-up the company voluntarily was passed. Debentures stand for £31,000 and trade creditors £8,500. Stock is valued at £32,000, book debts £11,000, machinery £33,000 and buildings about £20,000. An amendment that the company be reconstructed was lost by the casting vote of the chairman. The resolution was only carried by the casting vote of the chairman. A poll was immediately taken, and the chairman (Mr. G. G. Brodie) said there was the necessary two-thirds majority to carry the motion. No dividend has been paid for some years.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered a further issue of 5,000 £5 fully-paid ordinary shares of *W. T. Henley's Telegraph Works Co. (Ltd.)* to be quoted in the official list. The committee have been asked to grant a quotation to a further issue of 12,000 £5 fully-paid ordinary shares of the *United River Plate Telephone Co. (Ltd.)*

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., Mar. 29.	Rate per cent. Yielded.	Dividend Due.	Business, Week to Mar. 29. Highest.	Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	3/0	Anglo-Argentine Ord. Shares	8½–8¾	3 7 7	Ap, Oc	8½	8⅜
5	2/6	Do. 6% Cum. Pref.	5¾–6¼	4 5 1	—	5⅞	5¾
St.	6%	Do. Permanent 6% Deb. Stock	140 –145	4 3 11	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	105 –107	4 14 6	—	106¼	105¾
10	6%	Barcelona Tramways Ord.	12 –12½	2 6 2	—	12⅛	12
10	5/0	Do. 5% Cum. Pref.	9½–10	5 0 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	98 –100	4 10 0	—	..	..
100	5%	Do. 5 per Cent. Debs.	99 –102	4 18 1	—	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1 – 1½	..	..	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	3½–4½	6 17 3	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	96 –98	4 11 10	..	..	..
St.	6%	British Columbia Elec. Rlwy Def. Ord.	104 –107	5 12 2	—	106½	..
St.	5%	Do. Pref. Ord. Stock	100 –103	4 17 2	—	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 –10½	4 10 11	—	10¼	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Dbs	105⅞–107⅞	4 5 9	..	106½	106¼
100	4½%	Do. Vancouver Power Debs.	98 –102	4 8 3	..	101½	..
5	1/6	Buenos Ayres and Belgrano Ord.	3¾–4	5 12 6	—	3⅞	3⅞
5	3/0	Do. 6 per Cent. "A" Cm. Pref	5½–6¼	5 2 2	—	..	..
5	3/0	Do. "B"	5½–6½	5 6 5	—	..	..
St.	5%	Do. 5 per Cent. Debs.	107 –109	4 11 8	—	..	—
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	103 –106	4 15 3	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	97 –99	5 1 0	..	..	..
5	3/0	Calcutta Tramways ex rights	5¾ 6	3 12 8	—	5¾	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 –108	4 3 4	—	..	..
1	0/6	Cape Electric Tram Shares	1¼ 1½	4 11 4	—	..	—
St.	6%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red.)	103 –105	4 17 2	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	101 –103	4 17 3	Ja, Jul	..	..
[illegible]	5%	Montreal St. Ry. St'g 5% Mort. Debs. (1908)	101 –104	4 16 3	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 –106	4 5 9	—	..	..
St.	5%	Perth (W.A.) Elec. Trams, 1st Mt. Deb. Stk.	105 –108	4 12 6	..	..	..
		ELECTRICITY SUPPLY.					
5	3/0	Calcutta Electric Supply Ord.	8 –8½	3 12 5	—	8½	8¼
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½–3½	..	..	..	..
St.	5%	Do. 5% Debs.	80 –81	6 9 11	..	..	..
10	..	Havana Electricity Co. Shares	9½–10½	—	—	9½	9⅜
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	¼–½	..	—	..	..
1	..	Rand Electric	1 –1¼	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	100 –102	4 8 9	Ap, Oct	..	...

*In calculating the yield, allowance has been made for accrued interest but not for redemption.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Mar. 29.	Rate per Cent. Yielded.	Dividend Due.	Business Week to Mar. 29. Highest.	Business Week to Mar. 29. Lowest.
				£ s. d.			
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
1	..	Bath Elec. Trams Pref. Ord.	[illegible]	..	..	..	..
1	11·6d.	Do. 5% Cum. Pref.	1⅛—1¼	4 14 1	–	..	..
St.	..	Do. 4½ 1st Mort. Deb. Stock (red.)	103—106	..	..	104½	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	99—101	..	..	99½	99
10	9%	Bristol Tramways and Carriage Ord.	18—18½	4 17 4	Feb, Aug	..	–
10	6%	Do. Cum. Pref. (fully paid)	10—10¼	5 16 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	105—107	3 14 10	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	9½—9¾	6 2 11	..	9⅝	9½
10	6/0	Do. 6 per Cent. Cum. Pref.	10¼—11¼	5 7 10	Feb, Aug	11	11
St.	5/0	Do. 5 per Cent. Perpetual Debs	123—125	4 0 8	–	124	123
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	98—100	4 10 0	–	99¾	98¾
St.	4%	Central London Ordinary Stock	93—95	4 4 2	June, Dec	93	..
St.	4%	Do. 4 per Cent. Pref. Stock	101—103	3 17 8	–	102½	102
St.	4%	Do. Deferred Stock	55—56	4 12 1	–	..	..
100	4%	Do. 4 per Cent. Debs.	110—112	3 11 5	–	..	..
5	2/6	City of Birmingham Trams 5% Cm. Prf.	4½—4¾	4 17 8	–	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	101—104	3 17 8	..	..	..
St.	1½%	City and South London Rly. Con. Ord.	44½—45½	4 18 11	Feb, Aug	45	44½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120—123	4 1 4	Feb, Aug	..	..
St.	5%	Do. (1896)	118—121	4 3 8	..	..	..
St.	5%	Do. (1901)	115—118	4 4 9	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109—111	3 12 1	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	14¼—14¾	4 2 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	16¼—16¾	3 12 9	–	..	..
10	4 0	Gt. Northern & City Rly. Prf. Ord. (4%)	6—6½	3 12 0	–	..	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	6¼—6¾	4 4 2	..	..	..
10	9%	‡ Imperial Tramways Ord	17¾—18	5 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—15	4 0 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	103—110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3—3½	7 2 11	–	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90—92	4 7 0	–	..	..
10	1¼%	Liverpool Overhead Railway Ord	3¼—3½	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10—10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10—10½	4 15 3	–	10¼	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	98—101	4 0 0	–	100½	98¾
St.	..	Mersey Con. Ord. Stock	4—7	..	–	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10—13	..	–	..	..
1	..	Metropolitan Electric Trams Def	[illegible]	..	–	..	..
1	0/6	Do. 5% Cum. Pref.	1—1⅛	4 14 1	–	1	..
St.	4½%	Do. 4½% Deb. Stock	106—107	4 5 6	..	106½	106
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1—1½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	9¾—10¼	4 17 6	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9½—10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103—107	4 4 11	–	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	–	..	..	..	..
1	–	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
	5%	Underground Elec. Rys. Co. of London	99½—100½	4 19 6	..	100¼	97½
St.	1½%	Waterloo and City Ord.	92—94	3 6 5	June, Dec	93½	–
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	99—103	4 0 0	Jan, July	..	..
10	..	Amazon Telegraph	2¼—2¾	..	Jn, Dec ..	..	..
100	..	Do. 5% Debs. (red.)	71—76	..	..	76	73
St.	17/6	Anglo-American	61—62	4 7 3	F,My,Ag,N	62½	61¾
St.	25/0	Do. Preferred	108—109	5 0 11	F,My,Ag,N	109	108
St.	2/6	Do. Deferred	15¾—16¼	..	F,My Ag,N	17¼	15¾
100	$2	Commercial Cable Capital Stock	230—240	3 6 8	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	98—100	4 0 10	Jn Ap,Jy,O	99½	..
10	5/0	Cuba Submarine Ord.	8¾—9¼	5 5 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	17—18	5 11 1	Feb, Aug	18¼	..
5	2/0	Direct Spanish Ord.	3½—3¾	5 11 9	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8½—9	5 11 2	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	101%—103%	4 7 10	Jan, July	..	..
20	8/0	Direct United States Cable	11¼—11¾	5 3 5	Ja,Ap,Jy,O	11⅝	11½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100—102	4 7 7	Jn, Dec ..	..	..
St.	35/0	Eastern Ordinary	144—147	4 15 6	Ja,Ap,Jy,O	146½	144½
St.	17/6	Do. 3½ per Cent. Pref. Stock	92—94	3 14 5	Ja Ap,Jy,O	93½	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107—109	3 13 5	May, Nov	108½	108
10	2/6	Eastern Extension	14½—14¾	5 1 8	Ja,Ap,Jy,O	14⅝	14½
St.	4%	Do. 4 per Cent. Deb. Stock	106—107	3 14 9	Feb, Aug	106¼	105½
100	4%	* Eastern & S. African 4% Mrt. Deb. 1900	100—102	3 18 5	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%—103%	3 17 8	May, Nov	..	..
10	8/0	Great Northern (of Copenhagen)	38—40	3 16 0	Jan, July	39½	38¾
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100—102	4 8 3	June, Dec	101¼	..
25	12/6	Indo-European	47—49	5 2 0	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99—102	3 18 5	June, Dec	..	–
10	4/0	West African Telegraph Shares	8—8½	5 17 5	–	..	..
9½	..	West Coast of America	[illegible]	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	100—102	3 18 5	Jan, July	..	..
10	..	West India and Panama	[illegible]	..	May, Nov	..	..
10	7/0	Do. 6 1st Pref.	8½—9	7 4 5	May, Nov	8¾	..
10	–	Do. 6 per Cent. 2nd Pref.	5—5½	..	May, Nov	..	..
100	6%	* Do. 6 per Cent. Debs.	103—105	4 15 3	Jan, July	..	..
10	8/0	Western Telegraph	13¾—14¼	4 18 7	Mr,Jn,O,D	14¼	13¾
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101—103	4 17 1	June, Dec	..	–
St.	4%	Do. 4% Deb. Stock (red.)	103—105	3 16 11	–	103	..
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid,	5¾—6¼	5 1 9	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	[illegible]	2 11 9	..	..	..
St.	6%	‡ National Co. Pref. Stock	109½—110½	5 8 7	–	110	109½
St.	5%	† Do. Def. Stock	103—105	4 16 2	..	104½	103½
10	6/0	† Do. 6 per Cent. Cum. 1st Pref.	13¼—13½	4 8 11	Feb, Aug	..	..
10	6/0	† Do. 6 per Cent. Cum. 2nd Pref.	13—13½	4 12 4	Feb, Aug	..	..
5	2/6	† Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5¾	4 8 11	Feb, Aug	[illegible]	[illegible]
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	100—102	3 8 7	June, Dec	101½	101¼
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103½—105½	3 15 10	..	104½	104¼
1	0/7½	Oriental	1¼—1½	4 4 2	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛—1⅜	4 11 6	..	..	..
St.	30/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101—104	..	..	..	–
5	2/0	United River Plate	7—7½	5 6 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4 17 9	June, Dec	5¼	–
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	107—109	4 11 9	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	6/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5¼	5 14 4	–	..	..
10	5/0	Globe Telegraph and Trust	10—10½	5 0 0	Ja Ap,Jy O	10¼	10⅛
10	3/0	Do. 6 per Cent. Pref.	14½—14¾	4 0 8	Ja Ap,Jy,O	14⅝	14½
100	6%	Submarine Cables Trust (Cert.)	125—128	4 15 9	April, Oct	..	..

Share.	Last Dividend	Name.	Price Wed., Mar. 29.	Rate per Cent. Yielded.	Dividend Due.
				£ s. d.	
		ELECTRICITY SUPPLY.			
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12¾—13¼	6 5 6	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9¾—10¼	4 7 10	..
10	6/0	Do. 6% Cum. Second Pref.	11—12	5 0 0	–
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	105—107	4 4 1	–
5	2 0	Bromley (Kent) El. Lt. & Power Shares	5¼—5¾	3 9 7	..
St.	4½%	Do. Do. 1st Debs	103—106	4 4 10	–
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10—11	4 10 11	..
5	3/6	Do. 7 per Cent. Pref.	10—10½	3 6 8	Mar, Sept
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105—108	3 14 1	–
5	4/0	Charing Cross (W. End & City) El. Sup. Co.	8—8½	4 14 2	Feb, Aug
5	2/3	Do. 4½ per Cent. Pref.	5¼—5¾	3 17 0	Feb, Aug
St.	4%	Do. 4% Deb. Stock (red.)	105—107	3 14 9	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	5—5½	4 4 9	–
5	2/3	Do. Do. (1903)	5—5½	4 7 10	..
5	5/9	Chelsea Electric Supply Ord.	6¾—7¼	4 2 8	March ..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109—111	4 1 1	Jn, Dec ..
10	7/0	† City of London Electric Lighting Ord.	11—12	5 0 0	Feb, Aug
10	6/0	† Do. 6 per Cent. Cum. Pref.	15½—16	4 5 9	Jan, July
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	125—127	3 18 8	Jn, Dec ..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	103—105	4 5 9	..
10	4/0	County of London Elec. Supply Ord.	9¼—10	4 0 0	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12¾—13¼	4 14 1½	Mar, Sept
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	110—113	4 0 2	–
St.	4½%	Do. Second Deb. Stock Prov. Certs.	104—106	4 6 7	–
5	2 0	Folkestone Electricity Supply Co. Ord.	5¼—6	4 11 9	–
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101—104	4 6 7	–
5	3 6	Hove Electric Lighting Ord.	7¾—8¼	5 3 0	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	101—103	4 9 1	..
5	7/0	Kensingtn. & Kngtsbdg. Ord.	12—13	4 12 4	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	103—104	3 17 3	–
3	1/7½	London Electric Supply Ord.	2¾—3	3 0 0	–
5	3/0	Do. 6 per Cent. Pref.	5¾—6	5 0 0	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	99—101	3 19 2	Mr,Jn,S,D
10	11/0	† Metropolitan Electric Sup. Ord.	17¾—18¼	5 0 0	April, Oct
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼—5¾	3 16 5	Jan, July
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110—115	3 18 3	Jn, Dec.
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.	97—99	3 10 5	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	99—101	4 9 1	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	12¾—13	5 5 5	Feb, Aug
5	8%	† Newcastle Elec. Supply Ord.	7¼—7¾	5 2 7	Feb, Aug
5	5%	† Do. 5 per Cent. Non-Cum. Pref.	6—6½	4 2 5	Feb, Aug
1	[illegible]	† Northern Counties Elec. Sup. 17/- pd	16/3—16/9	3 2 2	Mar, Sep
10	8/0	† Notting Hill Electric Ord.	14½—15½	4 0 0	March
100	4%	Do. 4 per Cent. 1st Mt. Debs.	103—106	3 17 0	..
5	4/6	† Oxford Electric Ord.	6¼—6¾	5 16 0	March
St.	4%	Do. 4% Deb. Stock	[illegible]	4 0 0	..
5	9/6	St. James' & Pall Mall Elec. Ord.	11¼—11¾	5 0 0	Feb, Aug
5	3/6	Do. 7 per Cent. Pref.	8¼—8¾	4 0 0	Feb, Aug
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98—100	3 10 0	–
5	4/0	Smithfield Markets Electric Sup. Ord.	2¾—3¼	5 19 7	–
St.	4%	Do. 4 per Cent. Deb. Stock	79—86	4 16 5	–
5	4/0	† South London Electric Supply Ord.	3¼—4¼	4 11 3	–
1	..	South Metrop'n Elec. Lt. & Power Ord.	½—1	..	–
1	0/6½	† Do. 7% Cum. Pref.	1¼—1½	4 17 0	–
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. Accom.)	107—110	4 2 3	–
5	2/6	Urban Electric Supply Ord.	5⅛—5⅜	4 17 0	–
5	2/6	Do. 6% Cum. Pref.	5⅛—5⅜	4 14 8	..
St.	..	Do. 4½% 1st Mort. Deb.	105—108	–	..
5	7/6	Westminster Electric Supply Ord.	12—13	5 7 8	Mar, Sept
5	2 6	Do. 5 per Cent. Cum. Pref.	6¾—7¼	3 14 0	–
		ELECTRIC MANUFACTURING, &c.			
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	¾—1	5 6 6	..
1	6d.	Aron Elec. Meter 6% Cum. Pref.	[illegible]	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6¼—6¾	6 3 8	July, Feb
5	3 0	Do. 6 per Cent. Pref.	5½—6	5 0 0	Jan, July
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101—104	4 5 6	–
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	99—101	4 9 1	–
5	3/0	British Westinghouse 6% Pref.	3—3½	9 4 7	–
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	91—96	4 6 0	..
3	..	Brush Electrical Engineering	¼—½	..	March
3	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½—2	6 0 0	Mar, Sept
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	92—96	4 14 9	Mar, Sept
St.	4½%	Do. Perpetual 2nd Deb. Stock	79—82	5 9 9	Jan, July
5	5/0	Callender's Cable Con. Ord.	11—11½	5 8 6	Jan, July
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5½	4 7 0	Jan, July
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	106—108	4 3 8	Nov, May
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	¾—1	4 9 5	–
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	91—96	4 18 0	..
1	0/6	Chadburn's (Ship) Telegraph Ord.	1—1¼	3 17 0	..
1	7½d.	Do. 6% Cum. Pref.	1—1¼	5 6 9	..
2	1/6	Crompton and Co. (Nos. 1 to 54,000)	2¼—2½	5 5 6	Jan, July
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96—98	5 2 6	Jan, July
5	10/0	Dick, Kerr & Co. Ord.	8—8½	5 17 8	Sept
5	3/0	Do. 6% Cum. Pref.	6¼—6¾	4 13 0	Sept
St.	4½%	Do. 4½% Deb. Stock	100—102	4 4 1	..
5	–	Edison & Swan United ("A" Sh.) (£3 pd.)	1—1¼	..	Feb, Aug
5	..	Do. (£5 paid)	1¾—2¼	..	Feb, Aug
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	90—95	4 14 2	June, Dec
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	80—91	5 9 11	..
5	2/6	Edmundson's Elec. Corp. Ord.	[illegible]	5 9 10	H'ly-yearly
5	3/0	Do. 6 per Cent. Cum. Pref.	6¼—6¾	4 15 8	–
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106—108	4 3 8	..
2	1/7½	Electric Construction Co.	1½—1¾	6 6 0	July
2	2/9½	Do. 7 per Cent. Cum. Pref.	2¼—2½	5 13 9	July
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97—99	4 0 10	Jan, July
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90—95	5 5 5	–
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10	5 0 0	–
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	91—96	4 3 4	..
5	10/0	† Henley's Telegraph Works Ord.	17½—18	5 15 6	Feb, Aug
5	2/3	Do. 4½ per Cent. Pref.	7¾—8¼	4 8 11	Feb, Aug
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	109—111	4 1 1	Feb, Aug
10	6/0	India Rubber, Gutta Percha, &c., Wrks.	16—17	2 18 10	Feb, Aug
100	4%	† Do. 4 per Cent. 1st Mort. Deb (red.)	100—103	3 17 8	Mar, Sept
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11—11½	4 7 8	Mar, Sept
12	24/0	† Telegraph Construction & Mainten'ce.	35—36	4 14 8	Mar, July
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	103—106	3 16 2	Jan, July
5	–	Willans and Robinson Ord.	1—2	–	Apr, Oct
5	–	Do. 6 per Cent. Cum. Pref.	2—3	–	Apr, Oct
	4%	Do. 4 per Cent. 1st Mort. Debs.	75—80	5 0 0	May Nov

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to

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NOTES.

THE large expenditure of money by Local Authorities, and the enormous municipal debt of the country, a subject upon which much has been written and far more has been spoken, came up for discussion again last week. Lord AVEBURY chose it as the subject of an address at a recent general meeting of the London Chamber of Commerce, and pointed out that during the last 10 years the outstanding loans of Local Authorities in England and Wales had increased to the extent of £142,000,000 and now amounted to £343,000,000, while, if Scotland and Ireland were included, a grand total of £407,000,000 was arrived at. During this period of 10 years, the rates and taxes had increased to such an extent that now they amounted to £130,000,000 a year more than they did 10 years ago, this increase being about equally divided between rates and taxes, and Lord AVEBURY reminded his audience that part of our taxes went to the "exchequer contributions" in aid of rates. He protested against such municipal businesses as electricity supply undertakings being run at a loss, as statistics showed that they did. Later in the week Mr. GERALD BALFOUR referred to the same subject, and his remarks, coming from the new President of the Local Government Board and addressed to the Association of Municipal Corporations, must be taken as significant although they were delivered in the course of an after-dinner speech. According to the report in *The Times* Mr. BALFOUR said, on the subject of Municipal Trading :—

> It had been asked whether any limit could be placed upon this apparently continually-growing excursion of municipalities into the sphere hitherto reserved for private enterprise. He did not wish to lay down any abstract economic doctrine upon this subject; he was rather disposed to think that a limit would presently be imposed by the very nature and necessities of the case. Year by year Parliament imposed upon municipalities new and arduous duties. This process could not continue for ever. There must be an end to it somewhere, and he ventured to think that even the most intrepid town councillor would ultimately feel that he was bound to cry "Hold! Enough!"

So far as the electricity supply business is concerned, however, it is almost too late to put the brake on to municipal expenditure. Parliament having, rightly or wrongly, recognised this branch of business as a fit one for Local Authorities to embark upon, and the local authorities having availed themselves of the opportunity thus given them, it is necessary that the undertakings already established must be extended as the demand arises for further supply of electricity. Even if a Local Authority avails itself of a bulk supply from a neighbouring company, as it could do in London, or from a power company, as in some parts of the provinces, a complete solution of the problem is not arrived at, as the distribution network has still to be extended.

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OUR esteemed contemporary, the *Engineer*, in its last issue, devoted a leading article to "Electric Locomotives." Taking, as an example, the New York Central locomotives, it admits that a steam locomotive of equal weight could not accelerate a given train so rapidly, and therefore the electric locomotive has the advantage on that score. The article then wanders from its title into a discussion of the relative cost of working main line traffic by electric and steam power. The most positive conclusion arrived at is "that there is very good reason to think that haulage on main lines by the electric locomotive would be more expensive than the present system." In support of this opinion we are told that "the cost of coal per mile on our tube railways is very nearly twice that required for steam locomotives." No figures or references are given to substantiate this statement, but the assertion is "crystallised" thus: "To propel a given train by steam requires, say, 36lb. of coal per mile; to do the same thing by electricity costs 72lb. or thereabouts per mile." We believe that 36lb. is usually taken as an average figure for main line passenger trains, but, of course, no train of similar weight and length runs on any of our tube railways, and the conditions of short runs and high acceleration preclude any comparison on a weight basis. It has also been shown by Mr. MACMAHON that the tractive effort on a tube railway is considerably greater, *cæteris paribus*, than on an open line. So that our contemporary's comparison of coal consumption is between things unlike, and by no means justifies its assertion.

* * *

WE have had the curiosity to look for the possible origin of that 72lb., and think it may be derived from Mr. HERBERT JONES' Paper descriptive of working results on the Waterloo & City Railway. On p. 750 (February 24, 1905) of *The Electrician* will be found two tables. The first gives the result of two tests of coal and water consumption, giving respectively 4·51lb. and 4·97lb. of coal per unit over two 24-hour runs. The second table shows that on a certain day the 100-ton trains used 4·83 units per train-mile. Taking the higher figure of 4·97lb. of coal per unit, 24lb. of coal per train-mile results, and assuming 300 tons for the weight of a main line train, the figure of 72lb. per train-mile appears. Whether the figure was obtained in this way or not is of little importance, the absolute unlikeness of the things compared needs no emphasis.

* * *

A BETTER comparison might have been made of the results of steam and electric haulage on the Mersey Railway, where an increased revenue of 42 per cent. is earned with diminished working expenses, comparing electric and steam working; but it would be foolish to draw the conclusion that a similar result will follow the electrification of every main line. It is unfortunate that an engineering journal of the highest standing should admit to its leading columns superficial and misleading statements on a subject of great importance, instead of making use of its prestige and ability to collect and digest the available facts.

* * *

ELECTRIC furnaces have ever been a fascinating subject for research, and to the more imaginative they are pregnant with almost illimitable possibilities. A valuable contribution to the subject has been made by Messrs. HUTTON and PATTERSON in a Paper, the first part of which was presented to the Faraday Society on Tuesday. The carbon tube furnace which they described is an exceedingly useful piece of apparatus for obtaining high temperatures, and in spite of the fact that the presence of carbon is undesirable in certain processes, yet this type of furnace is capable of very wide application. For instance, in one case, the authors succeeded in obtaining a temperature of 1,200 C. in 30 minutes, after which it continued to rise at about 7deg. per minute, while in another case, with an expenditure of 295 amperes at 8·2 volts, platinum was melted in 16½ minutes. The second part of the Paper will give fuller details of the results obtained in the experiments with this class of furnace.

* * *

THE question of solid links *v.* fuses in network boxes, and the ventilation of street boxes, have formed subjects of questions to Ministers in the House of Commons, which, as a rule, does not concern itself with matters of technical detail in electrical engineering. The former question arose out of the Manchester fire case, which was decided in the Law Courts a fortnight ago, and we are pleased to note that the Board of Trade officially approves of the use of the fuse links which their electrical adviser has consistently recommended unofficially for many years. We cannot endorse the suggestion however, that this is an "improved system" recently brought forward. On the subject of ventilating street boxes, it appears that the leakage of gas into street boxes for telephone cables has been giving considerable trouble recently, and we should recommend the Post Office engineers to study the methods adopted by electric lighting engineers for ventilating their boxes as a remedy for the nuisance.

* * *

SUCTION gas plants have only of late been used in this country to any extent, and it is not surprising that many engineers otherwise well informed are still rather in the dark as to the action, capacities and limitations of this new type of power plant. Much information on these points may be gathered from Dr. F. H. BOWMAN'S excellent Paper which was read before the Leeds Local Section of the Institution of Electrical Engineers on March 16th, and of which an abstract appears elsewhere in this issue. While assigning the proper places to plant using bituminous and non-bituminous fuel, the author offers the somewhat questionable advice: "When the works . . . . are amidst large manufacturing premises, where smoke and fumes are so prevalent that a small increase in quantity will make no difference, bituminous plant may be employed." If every newcomer acted on this advice the atmosphere in that particular locality might become unbearable, and it would be but small consolation that this state of things had been brought about in imperceptible steps. The results obtained by Mr. J. WHITWORTH on a 12 H.P. suction-gas engine, supplied with gas from a Dynamic-gas producer, are very good. The figure of 0·835lb. of anthracite coal per brake horse-power-hour at full-load compares favourably indeed with anything yet published concerning other gas engines of similar size, and it approximates to the 0·744lb. of coal consumed per brake horse-power-hour in a 250 H.P. Deutz, double-acting, producer-gas engine, the tests on which were reported in brief in *The Electrician* of November 25th, 1904, p. 205.

* * *

LAST week we commented, in our leading article, on a petition presented by Sir LLOYD WISE to the President of the Board of Trade with reference to the rules framed under the new Patents Act. It was contended by Sir LLOYD WISE and his co-petitioners that the rule of officially "ear-marking" a specification considered invalid by the Examiner is not in accordance with the spirit and letter of the Act. The petition submitted that such notification should not be in the nature of an official expression of fact, as that would seriously depreciate the value of a patent. A counter-petition has now been submitted by some 76 registered patent agents, amongst whom are 16 members of the Chartered Institute of Patent

Agents. It is pointed out that as the rules now stand, any reference inserted under the compulsion of the Comptroller shall be inserted in certain words which will distinguish it from a reference inserted voluntarily by the applicant. The signatories to the counter-petition argue quite reasonably that unless the compulsory reference is allowed to remain distinguishable in this way, an injustice will be done in all those cases where voluntary references are inserted, as these will be brought under the suspicion of being no longer voluntary. It is also submitted that in possible cases of misjudgment by the Comptroller, a serious injustice would be done when a reference was compulsorily made in a specification without any opportunity being given to the applicant to protest that the insertion of the reference was not a voluntary act of his own, but was forced on him against his judgment by the Comptroller. We must confess entire agreement with the counter petitioners, for if the official condemnation of a specification be liable to confusion with a voluntary reference, then the rule under which it is inserted cannot be in accordance with the provisions of the Act. Doubtless, some step will have to be taken to remedy a state of affairs which is raising such a chorus of disapproval from all sides, and the best possible way out of the difficulty is to abandon the compulsory search and admit that this section of the Act is not practicable. It should, in fact, be repealed.

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THE Government has not yet brought in its promised Bill for the institution of a Ministry of Commerce, but in the meantime a private members' Bill with the same object has been read a first time in the House of Commons. There is, of course, little prospect of this Bill proceeding further than through its initial stages, but yet it may be of interest to note that its effect, if it were passed, would be very different from that of the Government Bill, which will probably do little more than transform the Board of Trade and Local Government Board into a Ministry of Commerce to take over the same duties as the two Departments. The Bill introduced by Mr. LOUIS SINCLAIR and supported by Sir ALBERT ROLLIT and his friends, on the other hand, does not propose to abolish either of these Boards, but to transfer some of their duties to the new department. Included in the transfer would be the railways and tramways section of the Board of Trade, but not the department which carries out the work of the Board in connection with the Electric Lighting Acts; Mr. TROTTER, the electrical adviser to the Board of Trade would, therefore, be cut in half. The work of the Home Office in connection with the Factory Acts and Coal Mines Regulation would also be transferred to the Ministry of Commerce. It is, however, unnecessary to examine the Bill in detail, as there is practically no likelihood of its becoming law.

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THE fate of the staff of the National Telephone Co. when the Company's system is taken over by the Government in 1911 has been the cause of some anxiety in interested quarters. Under the Agreement with regard to the purchase of the system in 1911, an agreement which now awaits ratification by the House of Commons, it is merely stated that "it is probable" that the Postmaster-General will be prepared to take into his service "a considerable proportion of the Company's staff," but he will not accept any obligation as regards pension and similar matters, the intention being that if any compensation or pension is given this should come from the Company. A large section of the Company's staff, and especially the older members, desire to have some more definite assurance that they will lose neither their position nor their prospects of a pension when the transfer takes place. Those earning salaries of over £100 per annum have, since 1896, contributed to an old-age pension fund to the extent of 2½ per cent. of their salaries (the Company contributing a like amount), and the age limit in the National Telephone Co.'s service is 65 instead of 60, as in the Post Office. Should their employment suddenly cease in 1911, they will, of course, benefit to the extent of twice the money they have contributed to the fund, plus interest, but as telephony is a special business, they would find it difficult to obtain work in other occupations. We believe that there is no precedent for the Government acquiring a business of this nature without taking over the staff as well, but it is doubtful whether there is any need to bring pressure on the Government on this point. When the business of the National Telephone Co. is transferred to the Government, there should be an increase rather than a decrease in telephone activity, and it is probable that not only will the services of the National Telephone Co.'s present staff be fully requisitioned, but that the number of officials and employees will have to be augmented considerably.

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THE case of the Sudbury Corporation v. the Empire Electric Light and Power Co., reported in another column, although in itself involving no issue of great importance, should be studied by those local authorities and companies who have entered into an agreement for the transfer of their powers under an Electric Lighting Provisional Order. The actual transfer of Provisional Orders not having been permitted by the Board of Trade since 1899, great care should be taken in the wording of any agreement by which a company takes the lease of a Local Authority's Provisional Order, or in any other way undertakes the execution of the entire work under the Order. In such cases, obviously, the safest course to pursue would be to obtain a revocation of the original Order and the issue of a new one to the company.

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THE London County Council must now be congratulating themselves on having obtained at last a majority in the House of Commons in favour of tramways on the Thames Embankment. It is still uncertain, however, that Parliament will sanction these, as the majority on the second reading of the Bill was only obtained by the casting vote of the Speaker, and the point will doubtless be raised again on every stage of the Bill. It has not yet been definitely proved that the convenience of the proposed line of tramways to the public is likely to be so great that objections to the disfigurement of the Embankment should be set aside. If the beauty of the finest thoroughfare in London is to be marred, let it not be at the hands of the electrical engineer.

Lord Kelvin.—We are pleased to announce that Lord Kelvin continues to make excellent progress. His condition is now so satisfactory that it is not considered necessary to issue any further bulletins.

Steam Turbines in Hungary.—A Hungarian correspondent informs us that at present there are no manufacturers of steam turbines in Hungary, and that there may be a good opening for British manufacturers of this class of engine in the above-mentioned country, as well as in the Balkan States.

Summer Visit of the Institution of Electrical Engineers.—We learn that the Institution of Electrical Engineers do not propose to make a visit abroad this summer, and possibly not next year. It is probable, however, that next summer the Institution will invite a return visit from representative foreign societies to this country.

Röntgen Congress in Berlin.—According to the *Elektrotechnischer Anzeiger* a congress of medical and other scientific men interested in the history and development of Röntgen rays and their applications, is to take place in Berlin from April 30th to May 3rd. There are to be a number of sectional meetings, and an exhibition of apparatus and photographs.

Cable Interruptions.

	Date of Interruption.
Cayenne—Pinheiros	**Aug. 13, 1902**
Heisi-Issa (Yemen)—Camaran	**Oct. 22, 1902**
Tarifa—Tangier	**Jan. 18, 1904**
Jamaica—Colon	Jan. 10, 1905
Fort de France—Paramaribo	April 2, 1905
Pernambuco—Para	April 6, 1905
Maranham—Ceara	April 6, 1905

Municipal Ownership in America. The *Morning Post* states that Judge E. F. Dunne has been elected Mayor of Chicago, the election having chiefly turned on the question of municipal ownership of the Chicago tramways. There are over 1,000 miles of tramway lines in Chicago, and their value is estimated at $200,000,000. Most of these are owned by the Chicago City Railway Co., but the franchises of 75 per cent. of them have recently expired. However, the company still retains 95-year franchises on the remainder, which serve the business section of the city, and the new Mayor, it is stated, will make it his business to annul these franchises, and thus secure control of the tramways for the municipality. It is anticipated that the legal proceedings will occupy about two years!

Lightning Conductors.—In a Paper on this subject read before the Dublin Local Section of the Institution of Electrical Engineers on March 9th, Mr. P. H. Stewart referred to various methods of installing lightning conductors and the principles which governed them. He emphasised the necessity of securing a good connection with earth and advocated taking a conductor from each aigrette direct to earth instead of connecting the aigrettes together and running one conductor to earth. The stanchions and girders of a steel framework building should always be thoroughly earthed, otherwise they constituted additional danger, but if properly earthed they were an element of safety. He had known an instance of lightning striking a timber mast in preference to a copper conductor hanging parallel to it 5ft. or 6ft. away. In the discussion, Mr. Mark Ruddle expressed the opinion that lightning conductors should be as free from bends and joints as possible.

Telephony.—In the fourth, and last Cantor lecture at the Society of Arts last Monday Mr. H. Laws Webb compared telephonic communication in point of speed, cheapness and convenience with all other manners of sending and receiving messages. The speaker then enumerated and explained a score of different systems of telephone rating, apparently favouring the message rate. The sub-division of the telephone system of large cities into telephone districts, each served by one exchange, was next dealt with, and the function of the junction lines for inter-connecting these district exchanges was explained. The huge amount of work of a non paying character which the telephone business entails was illustrated by two figures, one corresponding to the total telephone connections and disconnections during a year, and the other relating to the increase in telephones during the same period. In a certain system 20,000 connections or disconnections were made, while the increase in subscribers' telephones amounted to 5,500 only. In another actual case the figures were 87,500 and 37,000 respectively. The development of the telephone system in various countries and cities was then commented upon. Amongst the countries America comes first with 44·8 telephones per 1,000 inhabitants. England is a long way behind, with only 8·7 telephones for the same number of people, while Austria-Hungary ended Mr. Webb's list with 1·55 telephones per 1,000 inhabitants. Coming to the cities, it was pointed out that Stockholm led with 137 telephones per 1,000 inhabitants, the corresponding figures for New York, London and Madrid being 68·7, 20·2 and 4·3.

Serious Short-Circuit at Niagara Falls.—On February 23rd the Niagara Falls Power Co. suffered from the most serious short-circuit that has ever taken place in the big power houses at Niagara Falls. Three employés of the company were changing the connections between a 2,300-volt transformer and a small transformer used for lighting. They were at work in the switch chamber and cable subway under switchboard No. 1 in power house No. 1. The insulation of the conductors became ignited and the fire spread to the cables beneath the switchboard. Fire appliances, such as powder and chemicals, were used without extinguishing the fire, and it was necessary to call the city fire brigade. The firemen used their chemicals, but finally had to throw water on to the fire to quench it. All the auxiliary wiring leading to the instruments and field rheostats was practically destroyed, putting the five 5,000 H.P. generators operated from this switchboard out of service temporarily. The local trolley service was interrupted for 1¼ hours, while the long-distance load was off for about 20 minutes. The load normally carried by the five generators interrupted was transferred to other machines within a few hours and the company's full service resumed. All three men were severely burned and were quickly removed to the Memorial Hospital, where one died early the next morning. A careful investigation revealed the fact that the men had made two or three mistakes in making connections, and had any one been avoided the short-circuit would not have occurred.

Opening of the Exeter Tramways.—The official opening of the Exeter Corporation electric tramways took place on Tuesday. There are 2¼ miles of double track and an equal length of single track, and the gauge is 3ft. 6in. The rails are of the girder type, weighing 90lb. to the yard, and the points and crossings are of Messrs. Hadfield's manganese steel. Of the four steepest gradients, there is one of 1 in 11½, one of 1 in 13, one of 1 in 16 and one of 1 in 19. Two curves have each a radius of 35ft., and these are the sharpest in the system. Siemens lead-covered cables, laid in stoneware ducts, are employed as feeders, and centre poles, side brackets and span-wire construction are used according to the requirements of the routes. There are at present 12 cars, which were built and equipped at the Preston works of Messrs. Dick, Kerr & Co. They are of the double-deck type, with a seating capacity of 20 inside and 22 outside; the stairways are of the semi-reversed type, and each car weighs 8½ tons empty, and is 26ft. over all. Two 25 B.H.P. motors are fitted to each car, and, owing to the exceptionally severe gradients in Exeter, special provision has been made to prevent the cars from running backwards when brought to a standstill on an incline. To this end the controller is fitted with more contacts (14 in all) than is usually the case in the same firm's standard tramway controllers. By means of the additional contacts the motors are short-circuited when the motorman's handle is moved to the "off" position. They would, therefore, act at once as powerful generators should the car for any reason run backwards, and the car could in no case attain any considerable speed down the gradients. The cars are, however, also provided with hand brakes and Newell magnetic track brakes, and Philipson lifeguards have been fitted. In the car shed there is accommodation for 15 cars, and power to the system is supplied from the new generating station described in *The Electrician*, Vol. LII., p. 280. Since the publication of this description, a 200kw. generator has been added for the tramway supply, and there is, in addition, a motor-generator of equal rating which is driven directly off the high-tension bus bars of the two-phase lighting system, and delivers continuous current to the tramways. The construction of the new system of tramways has been carried out to the specifications of Mr. J. E. Waller, Mr. Thomas Moulding, city engineer and surveyor, and Mr. H. D. Munro, city electrical engineer, acting jointly. The generating plant has been installed under the superintendence of the city electrical engineer.

Bridging the Zambesi.—Another link in the Cape to Cairo Railway is now being made by the construction of the railway bridge across the Zambesi River, just below the Victoria Falls. The Victoria Falls are 420ft. high, and 1,900 yards wide, or two and a half times the height and twice the width of the Falls of Niagara. The Cape to Cairo Railway, which has recently been completed from Cape Town to the Zambesi (1,635 miles), and is now being carried on towards Tanganyika, traverses the peninsula of rock immediately in front of the Falls, and will cross the gorge by the bridge just below the "Boiling Pot," as the narrow outlet is called through which the whole river rushes after its tremendous fall. The clear span of the arch, which has just been completed, is 500ft., and owing to its height above the river—400ft.—no staging or scaffolding has been employed in its erection. It has, therefore, been built out from each bank of the ravine, on the cantilever principle, until the steelwork of the arch met in the centre. The bridge, which is sufficiently wide for a double line of railway, has been built by Sir Douglas Fox & Partners, the engineers of the Rhodesia Railways Co. In order to carry across the gorge the materials for the northern half of the bridge and the rails for the extension northward, an electric cable-way of a novel type has been employed. One end of the cable is attached to a rigid tower, and the other end to an inclined hinged support, which is loaded with a heavy weight to counteract the sagging of the cable as the conveyer travels along it. The carrier is suspended from two travelling wheels running on the rope, and consists of a frame carrying a chair for the driver, and the electric motor which propels the apparatus. The conveyer is capable of carrying a load of 10 tons, and can transport 800 tons of material across the river in one day, the amount of railway construction plant which will have to be carried over the river before the work is finished being estimated at 40,000 tons. An interesting picture of the work in progress and a map of the district is given in the *Graphic* of Saturday, from which journal the above particulars of the scheme have also been taken.

Paralleling a 5,500kw. Turbo-Alternator.—The February issue of the *Electric Club Journal* gives an account of the operation in parallel of the 5,500kw., 25∽ Westinghouse turbo-alternator supplied to the Interborough Rapid Transit Co., of New York, and erected in the Seventy-fourth Street power house. This was the first Westinghouse unit of this size to be put in service, and it at once carried loads as high as 8,000kw., and for considerable periods loads between 7,000kw. and 8,000kw., were of common occurrence. Within a few days after the machine was put in service, and while operating in parallel with six of the slow-speed 5,000kw. machines in the same station, a short-circuit occurred among the main leads at a point between the turbo-generator and the switchboard. This tripped the automatic switches on all the slow-speed machines, which were set at almost three times full-load current, but did not trip the safety switches on the turbo generator on account of the fact that the arc was so violent that it burned off the leads to the safety devices for this particular machine, though these leads were in a separate conduit. It was necessary to cut the turbo-circuits off by hand, and the short-circuit therefore continued on this machine some little time before it was cut out. Careful examination of the generator showed that it was absolutely uninjured in any way, as far as could be determined, and was ready for service immediately afterwards, but could not be thrown in with the other machines on account of the main leads to the switchboard being burned off. The machine has been in service with heavy loads since these leads were replaced. It is run in parallel with the other machines in the station and the only notable difference between its operation and that of the low-speed machines is due to the difference in the speed regulations of the two types of engine. The steam turbine is adjusted so that it regulates much more closely than the low-speed engines and, in consequence, takes the fluctuations in load. When it is operating in parallel with the slow-speed machines, the latter carry a much steadier load than when the steam turbine is cut out, the turbine unit appearing to take all the fluctuations when it is in circuit. Some months ago a series of tests was made to determine the paralleling qualities of turbo-generator units. At full voltage the machines ran perfectly in parallel. Fluctuations in speed were so slight that periods from one to 15 seconds could be obtained for synchronising. When the voltage was reduced to 60 per cent. of the normal, the machines would carry the full current without any evidence of hunting. The voltage was further reduced and tests were made, until about 15 per cent. of the rated voltage was obtained. Under these conditions the machines still remained in parallel when carrying full-load current, but the conditions of paralleling were not perfectly stable, the load being transferred from one machine to the other at an irregular but not rapid rate. As the synchronising power varies approximately as the square of the voltage, it was extremely low in the last test cited. It is evident, therefore, that but small interaction is required between such machines to maintain parallel operation.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, April 7th.

MANCHESTER STUDENTS' SECTION: INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. Annual General Meeting at the Salford Technical Institute.

8 p.m. Ordinary General Meeting at the Salford Technical Institute. Paper to be read: "Electric Cranes," by M. Jennison.

ROYAL INSTITUTION.

9 p.m. Evening discourse on "American Industry," by Alfred Moseley.

SATURDAY, April 8th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture II. on "Some Controverted Questions of Optics," by the Right Hon. Lord Rayleigh, F.R.S.

MONDAY, April 10th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m Special Meeting, when Col. R. E. B. Crompton will deliver the Thirteenth James Forrest Lecture on "Unsolved Problems in Electrical Engineering."

TUESDAY, April 11th.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER LOCAL SECTION.

7.30 p.m. Annual General Meeting at the University. A Paper will afterwards be read on "Labour-saving Formulæ," by Julius Frith

INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW LOCAL SECTION.

8 p.m. Meeting at 207, Bath-street. Mr. W. W. Lackie will deliver his reply to the discussion on his Paper on "Earthing," and a Paper on "Fittings" will be read by Harold Watson

WEDNESDAY, April 12th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7.30 p.m. Meeting at 92, Victoria-street, Westminster, S.W. Paper to be read: "Some Notes on the Measurement of Resistance," by A. Cummington.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.

7.30 p.m. Meeting at the University. Paper to be read: "The Eddy Current Brake for Motor Testing," by Dr. D. K. Morris and G. A. Lister.

THURSDAY, April 13th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "The Alternating-currrent Series Motor," by F. Creedy. The Address to the Joint Meeting at St. Louis, by B. J. Arnold, Past-president of the American Institute of Electrical Engineers, will be discussed in conjunction with this Paper.

INSTITUTION OF ELECTRICAL ENGINEERS: DUBLIN LOCAL SECTION.

8 p.m. Meeting at the Royal College of Science. Paper to be read: "Notes on the Softening and Purification of Water for Steam raising," by L. J. le Clair.

FRIDAY, April 14th.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when the Steam Engine Research Committee's Report will be further discussed. The President will also deliver his Address.

PHYSICAL SOCIETY.

8 p.m Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "On Ellipsoidal Lenses," by R. J. Sowter; (2) "The Determination of the Moment of Inertia of the Magnets used in the Measurement of the Horizontal Component of the Earth's Field," by Dr. W. Watson; (3) Exhibition of a series of Lecture Experiments illustrating the Properties of Gaseous Ions produced by Radium and other Sources, by Dr. W. Watson.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Law of Pressure of Gases below Atmosphere," by the Right Hon. Lord Rayleigh, F.R.S.

ELECTRICAL EQUIPMENT OF MESSRS. HARLAND & WOLFF'S SHIPBUILDING WORKS.

(Concluded from page 957.)

Among the motors employed at the works, the "ventilated but rainproof" motor supplied by Messrs. Laurence, Scott & Co. has some points of considerable interest. The object of

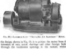
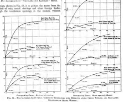


FIG. 29.—LAURENCE-SCOTT "VENTILATED BUT RAINPROOF" MOTOR.

the design, shown in Fig. 29, is to protect the motor from the intrusion of rain, metal shavings and other foreign bodies through the ventilation openings in the motors, without making the motors "totally enclosed" and so considerably increasing their size and cost, when the duty involves continuous running as in the case of machine tools. This protection simply takes the form of suitably shaped hoods fixed over the ventilation openings. Attention may also be drawn to the compact gearing illustrated in the figure. A countershaft, placed below the armature, is driven by the motor through gearing which is enclosed in the gear case seen on the right of the illustration. The lower halves of the bearings of this shaft are cast in one with the bedplate, and the gear-case forms an outer bearing for the countershaft. This disposition of the parts conduces to stability and rigidity, and adapts itself particularly well for the driving of many machine tools, both by belt and by spur gearing. Another incidental advantage is that the motor is above the level of the oiling arrangements for the gear case, so that no oil is likely to overflow into the motor.

As has been mentioned in the first part of this article, the pressure of the current for the portable tools on the ships and in the fitting-out jetties and docks is reduced to 110 volts, this pressure being considered safer than 440 volts on account of the number of wandering cables and temporary connections which must of necessity be used. Moreover, in some of the installations of ships under overhaul require to be fed at 60 volts and others at 80 volts, these lower voltages must on occasion be available. Current at these pressures is supplied from two motor-generator substations, and the specification with regard to the voltage range and regulation of these is interesting. Messrs. Harland & Wolff required that the generator part of these machines should be designed to give, as far as possible, straight line terminal characteristics at three initial no-load voltages, viz., (a) 60, (b) 80 and (c) 100 volts, and further be capable of being set to give various degrees of over-compounding up to 50 per cent. rise between no load and full load, the curves remaining as straight as practicable between their limiting points, whether the shunts are self-excited or separately excited, and between the speed range of 650 and 610 revs. per min.



Corresponding Curves. Machines self-exciting. Corresponding Curves. Shunts separately Excited.

FIG. 30.—THE LAURENCE-SCOTT 60-KW. COMPOUND GENERATOR WITH DIVERTER ACROSS SERIES WINDING AND REGULATING RESISTANCE IN SHUNT WINDING.

Speed varies between 630 revs. at no-load to 655 revs. at full load.

Thus, when feeding a short line, it should be possible to work with, say, 3 per cent. or 15 per cent. over-compounding, or, on a longer feeder, with as much as 30 per cent. over-compounding as desired, without sparking at the brushes when in fixed position, and with the usual limitations as to heating, &c.

Only one firm, Messrs. Laurence, Scott & Co., complied with all the requirements of the specification, and this firm has

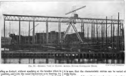


FIG. 31.—GENERAL VIEW OF GANTRY SHOWING DOUBLE CANTILEVER CRANE.

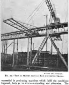


FIG. 32.—VIEW OF GANTRY SHOWING ROPE CANTILEVER CRANES.

succeeded in producing machines which fulfil the conditions imposed, both as to over-compounding and otherwise. The adjustment of the over-compounding is arrived at by shunting the series field winding with resistance strips or "diverters," the length of the shunt being adjustable by means of sliders. Fig. 30 gives the result of tests on these machines, from which it is seen that the characteristic curves can be varied within wide limits.

The feature of the works to appeal most prominently to the ordinary visitor is the enormous gantry, shown in Figs. 31 and 32, placed between two of the shipbuilding slips at the south end of the yard. The height over all is 185ft. (actually one-sixth of the height of the Eiffel tower), and the length from end to end of the gantry 600ft. A man can just be distinguished in Fig. 31 as a speck on the gantry to the right hand of the double cantilever crane near the middle of the illustration. The double cantilever crane extends 120ft. on either side of the gantry, and can thus serve any part of the ships building on the two slips, and it will take loads up to 3 tons. Its rate of longitudinal travel is 400ft. to 600ft. per minute, depending on the load and wind pressure, and the rate of cross travel is 400ft. to 800ft. per minute. The speed of hoisting is 200ft. to 250ft. per minute with maximum load. The rails are 18ft. apart on the main track. It is driven by a single motor, with reversing clutch. The motors are of an American

FIG. 33.—FURNACES.

make, the gantry and crane having been built by the Brown Hoisting Machine Co. of Cleveland (U.S.A.). The length of the double cantilever is 230ft. over all, and the trolley travel on it 216ft. In addition to the double cantilever crane there are two side cantilever cranes, for taking heavy riveting machines. One of these side cranes is seen very clearly in Fig. 32. These cranes have each two bridges travelling at the rate of 20ft. per minute, and each capable of dealing with a load of 10 tons, with a hoisting speed of 10ft to 16ft. per minute. The speed of travel of the cantilever itself along the gantry in this case is 50ft. per minute. These cantilevers extend 102ft. from the centre line of the gantry. The motor for the longitudinal traverse of each of these cranes is, of course, independent of the motors for the two bridges on each, there being, therefore, three motors in the crane house, one for moving the whole cantilever along the gantry, and one for the motion of each of the bridges along the cantilever. On each bridge are two motors, one for cross traverse and one for hoisting, and these can be controlled from the ship.

The rated horse-power of the 15 motors employed is as follows:

Double Cantilever Cranes.

80 B.H.P.—situated in upper house.

Side Cantilever Cranes.

Two of 50 B.H.P. for crane travel.

Four of 1¼ B.H.P. for bridge travel in and out. These are placed in the operators' house.

Four of 1¼ B.H.P. for trolley cross traverse—placed on the bridges.

Four of 6 B.H.P. for hoisting on trolleys.

In addition to the gantry cranes there are 33 electric travelling cranes of 5 to 50 tons' capacity in the works. All the newer travellers have each three-series continuous-current motors. Several of the older cranes which have been converted from either rope or square shaft driving are driven by single compound continuous-current motors, supplied by Messrs. W. H. Allen, Son & Co., and have been speeded up on the average 70 per cent., whilst one 30-ton crane now runs over 150 per cent. faster than originally. Some of these are provided with armature-resistance speed control for use when, as occasionally happens, two cranes, which differ in speed, require to work together, or when an abnormally low hoisting speed is requisite—as for lifting patterns out of the sand in the foundry. This effects the same character of speed regulation as obtains with a series motor, and, being seldom employed, the power losses are negligible. The majority of the controller resistances are metallic, either Sturtevant or B.T.-H., but a few are of the liquid type. The total connected brake-horse-power of the cranes is 710, but the average daily demand seldom exceeds one-third of this.

Fig. 33, taken before the work was completed, shows the shipyard feeders leaving the culvert from the power house. There are no less than 60 sets of feeders, all paper-insulated, lead-covered cables of the British Insulated & Helsby manufacture. They are chiefly three-core, but in some cases (such as heavy continuous-current cables) are single core, and the average feeder has a sectional area of 0·2 sq. in., the largest being 0·5 sq. in. All the cables pass out of the station through Doulton conduits built in the engine-house wall at the back of switchboard and are carried in a fenced-in cable-way having tiers of galvanised iron troughs in which the cables are merely laid. From thence they pass underground, those going to the ship yard being drawn through a cast-iron culvert lined with earthenware ducts underneath the Queen's road, with a ventilated draw-in chamber placed at each end, and from thence they run underground on the solid system to the various feeding centres. All the lead sheathing is bonded continuously, whilst that of the different feeders is also bonded together at all feeding points where it is earthed; the lead covering is similarly effectively earthed at the station by the galvanised-iron troughing. The conductors are not earthed at any point of the system, whether they carry three phase or continuous current.

The lead-covered feeders terminate in cast-iron boxes or "pot heads" of inverted-bottle shape filled with jointing compound, carefully sealed against moisture. Either vulcanised rubber tails pass out of the bottles, or the conductors themselves enclosed in grey-rubber sleeves. All underground wiring beyond the feeding centres is of vulcanised rubber-insulated cable in Howard asphalt troughing.

The feeding centres consist of groups of fuse boxes, the system being designed to reduce sub-station work to a minimum. The arc lights are switched on and off from the station, but each group of 4 to 8 can be independently controlled at the feeding centres if required, such as when portions have to be kept burning for overtime.

All the branch wiring from the feeding centres is B. I. & H. vulcanised rubber 2,500-megohm cable, and, except where underground, is run in steel pipes supplied by the New Brotherton Tube Co. Steel insulated pipes are used where there is liability of internal condensation. The wiring is encased throughout, the pipes terminating in metal covers round the terminals at the one end and in metal fuse boxes at the feeding centres.

Motors are grouped on sub-mains, with separate fuse however to each, automatic cut-outs being only employed where there is special reason.

In concluding this article, we must once more express our admiration of the manner in which the work of conversion to electric driving has been carried out. The expenditure has doubtless been heavy owing to the large extent to which individual motor drive has been adopted, but it is certain that the economies in power and, what is more important still, the increased output of the shops, will justify this outlay within a very brief period.

ELECTRICITY METERS.*

BY C. H. W. GERHARDI.

(Continued from page 916.)

"O.K." Continuous-current Ampere-hour Meter.—The "O.K." meter brought out some years ago by the British Thomson Houston Co. has been improved from time to time and is a very good little meter for circuits of from 1 to 15 amperes.

It is somewhat similar in principle to the Electrical Compay's ampere-hour meter, the chief difference being that the armature coils instead of being laid on a metal cylinder are, in the "O.K." meter, laid on a non-metallic one. The Foucault brake is, therefore, absent. Fig. 53 shows the latest type of this meter, and, as will be seen, the armature rotates between the poles of a strong inverted horseshoe magnet. The cylinder, on the outer surface of which the four armature coils are laid, is hollow, and being fixed to the main spindle at the bottom only, allows a tube of iron to be placed inside it which reduces the air-gap. Enough clearance is left at either side to allow the armature to rotate without touching the magnet or this "keeper." The main spindle passes down through the centre of the tube and the commutator is fixed on its lower end. The bottom of the spindle is polished and rests on a spring-seated jewel, whilst a worm on the upper end of the spindle works the wheel train. The brush gear is extremely neat; each brush is stamped out of a piece of silver and loosely slid on a small rod forming the brush support. The required tension is produced by a fine spiral spring, one end of which is fixed to the brush and the other to an adjustable clamp which grips the bottom of the brush supporting rod.

The main current passes through a short length of platinoid wire so chosen as to have a drop of about 0·5 volt at full load. The armature is in parallel with this wire: when a current flows the armature runs up to a definite speed accelerating until the back E.M.F. nearly equals the E.M.F. supplied to the brushes due to the drop in the shunt. In this condition there is only just enough current taken by the armature at an extremely small voltage to overcome the static friction.

The armature rotates at a very high speed (as high as 250 revs. per min. at full load in some sizes), and thus friction, even at low loads, has very little effect. The torque also is so large, being about 28 gramme-cm. at full-load, that increase of friction seems to have very little effect except at the smallest loads. There being no compensation for friction the curve droops slightly at low loads. A difference of 2 to 2½ per cent. has been found to be a usual figure between full and one-tenth loads.

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* From a forthcoming book to be published by "The Electrician" Printing and Publishing Co. All rights are reserved.

The meter is adjusted at high load by increasing or decreasing the pressure across the armature by shifting the little connector (seen to the right of Fig. 33) down or up the platinoid shunt. The dials of these meters, as will be seen from the figure, are very bold and their value plainly marked. The three black dials indicate fractions, and 0·0001 of a Board of Trade unit is easily read; for the last dial is divided into a hundred parts. It is thus quite easy to get a very accurate test by a dial run in a few minutes. The meter is very useful as a testing instrument, for instance, for ascertaining the ampere-hours passed through other meters or apparatus during a long run, thus avoiding constant regulation of the current. The accuracy with which it can be read, together with the ease with which its constant can be checked during a run, render it very suitable for such work.

The cover beds in a groove in the back fitted with felt and forms a dust-tight joint. A hole in the bottom of the cover allows the brush bracket, commutator and jewel screw to project below for easy inspection without breaking the main cover seals. A dome covers this gear up and is sealed up by the same seal as the terminal box cover.

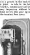

FIG. 33.—LATEST TYPE OF O.K. METER.

The Benson Meter.—This meter, which is another example of the mercury type of motor meter, is chiefly made as a pre-payment meter. The action of the meter depends on the rotation of a copper disc or armature immersed in a bath of mercury in a magnetic field. Fig. 34 is a front elevation of the meter out of its case, whilst Fig. 35 is a sectional view looking at the front half. In this meter there are two distinct magnetic fields. One is constant and practically closed, and consists of the two iron plates A and B joined together by hardened steel pillars, CC (which are permanently magnetised), the soft-iron pole pieces K_1 and E, and the soft-iron core D. This field has its greatest effect at low loads, causing the meter to start well.

The second magnetic field is that generated by the main current passing through the coil K wound round the soft-iron core D. This field also passes through the mercury bath, and the plates A and B, which are separated by the large air gap (the permanent magnets C being saturated). The open magnetic circuit has the advantage of doing away with residual magnetism, and also enables the meter to be overloaded without the curve being seriously altered. The surfaces of pole-pieces E and E_1 are coated with insulating material between their edges and the top of their slant.

The current passing from the positive terminal through the iron and steel parts enters the mercury bath at the centre of the pole-pieces; it then flows radially through the bath and disc (at right angles to the field) to the ring F, to which one end of the coil is soldered, and through the coil to the negative terminal. Eddy currents generated in the same disc provide the necessary brake force. The field strengths are so proportioned that no adjustment of the curve is necessary, and the raising or lowering of it is done by the insertion in the wheel train of change wheels of different ratios in order that the reading may be Board of Trade units without using a constant. The change wheels may be replaced without taking off any other part of the wheel train, thus avoiding any chance of introducing friction, when replacing, by leaving the worm and worm-wheel too tight in gear. The disc and bath are made conical, and as the disc is open at the top of the cone there is little chance of air bubbles remaining under it and so interfering with the low-load results. The meter is open to the objection of all meters which contain mercury—namely, it entirely depends on what happens to it in its journey from the test room to the consumer's premises if sent out with its main cover sealed. The meter is also made with the permanent magnet field replaced by an electromagnetic field produced by a shunt coil connected between the two supply mains. With such meters it is necessary to exercise care in connecting them into circuit, as the shunt field might be connected up so as to act in opposition to the main field. The meters are internally connected up for the main terminals to be put on the positive main—*i.e.*, the positive main terminal to the "station" side of the positive main and the negative main terminal to the "house" side of the same main, the shunt terminal being connected to the negative main. If the meter is to be inserted in the negative main the ends of the shunt winding must be reversed, as in this case the shunt terminal will be connected to the positive main of the supply.

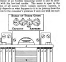

FIG. 34.—FRONT ELEVATION OF BENSON METER OUT OF CASE.

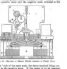

FIG. 35.—SECTION OF BENSON METER LOOKING AT FRONT HALF.

The constant marked on the back of the clockwork is either the number of revolutions of the main spindle per ampere per minute or the revolutions of the main spindle for 10 Board of

Trade units. The meter has a high torque for this class, with a rather high drop. From tests made on a 200-volt 5-ampere meter a drop of 1·55 volts and a full-load torque of 2·67 grammecm. were obtained. The static friction being very small, owing to the armature being almost floated in the mercury, and the wheel train well made, the constancy of the accuracy would probably depend more on the cleanliness of the mercury and the permanence of the magnets than on the increase of mechanical friction.

(To be continued.)

WIND GAUGE AND RECORDER ON THE FURNESS RAILWAY.

It will be remembered that an extraordinary accident occurred some time ago at the Levens viaduct on the Furness Railway. During a violent gale, a train standing on the viaduct was actually blown over on its side. To avoid the possibility of any similar accident occurring in the future, an apparatus was installed which fulfils the duties of a watchman over the weather and warns the signalmen at each end of the viaduct if the wind should be blowing with a force sufficient to render the passing of a train over the viaduct dangerous.

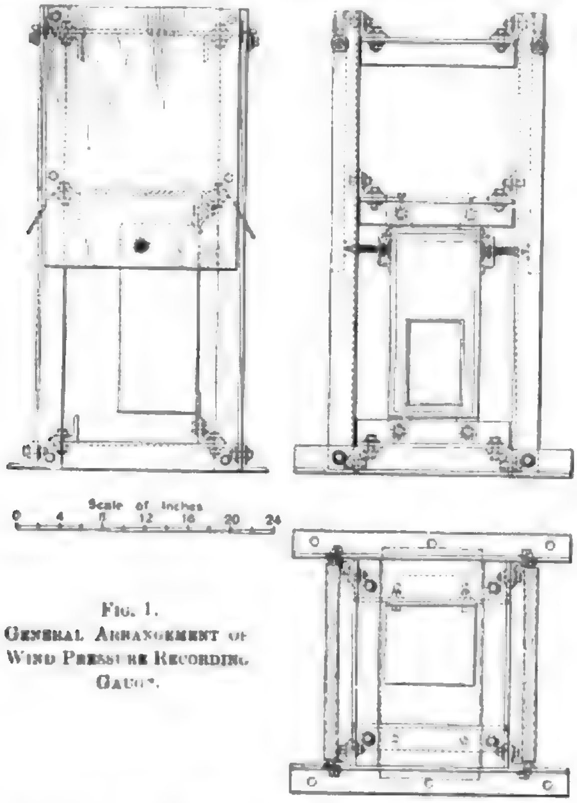

Fig. 1.
General Arrangement of Wind Pressure Recording Gauge.

The recorder is mounted in a frame built up of steel angles (Fig. 1); on two sides of the frame boards are carried on hinges and are kept normally in the vertical position by means of springs, which are similar in construction to those used in ordinary steam engine indicators. The strength of the spring is so reckoned out in relation to the area of the board that a given pressure of so many pounds per square foot can be recorded on the paper chart which is moved by the clock of the recording instrument at the rate of 1in. per hour. Two pens are fitted—one being controlled by each board. If the pressure on either board remains constant then the pen will continue to draw a straight line, but an increase or a decrease of pressure will give a deviation of the line at a point on the paper corresponding to the time that this change of pressure takes place. To ensure proper working periodical tests are made, and a lever equivalent to 32lb. weight is tried on the gauge each time the lineman visits the instruments, so as to ascertain that all is in good order. The recording instrument was supplied by Messrs. Elliott Bros.

In connection with the recorder is an electric bell circuit, so arranged that the batteries at the two signal boxes at either end of the viaduct are in opposition until the pressure of wind blowing at right angles to the viaduct rises to 32lb. per square foot, at which pressure contact is made at a point marked "A" in Fig. 2. The current from both batteries then flows, the relay armatures are drawn up, local batteries come into play and the warning bells ring and continue to do so as long as the force of the wind is dangerous—that is, equal to or exceeding 32lb. pressure per square foot.

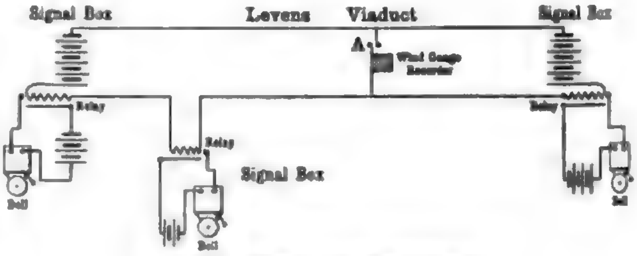

Fig. 2.—Diagram of Connections.

Since the erection of the apparatus more than 18 months ago on no occasion has the wind exceeded a pressure of 5lb. per square foot. The installation was erected by the railway company's electrical engineers, Messrs. J. B. Saunders & Co., of Westminster.

ELECTRICALLY HEATED CARBON TUBE FURNACES.*

BY R. S. HUTTON AND W. H. PATTERSON.

The provision of a satisfactory device for leading the current to the ends of the tube, and the protection of the tube from contact with the air or other material capable of reacting with the carbon to burn it away, are very important points. It is, moreover, a very great advantage to jacket the tube closely with some substance, which, whilst not tending to combine with the carbon, forms an efficient heat-insulator. Even with the most carefully constructed system of exterior concentric tubes with intermediate gas spaces a great amount of heat is carried away by convection currents in the gases, and consequently much more power has to be expended in the tube to attain any required degree of temperature than when the tube is closely jacketed by some material of low thermal conductivity.

The first furnaces made use of in our experiments were constructed of Acheson graphite, a tube being bored from a solid rod of about 3cm. diameter, as shown in Fig. 1. The tube was screwed to graphite plates, which served to lead in the current, the graphite plates being held between thick copper clamps, mounted on stands capable of sliding on a smooth plank; to these clamps the cables were connected. One of the sliders was balanced so as to more easily admit of expansion of the tube without fear of breakages. For heat insulation the graphite tube was surrounded with magnesia, or, later, carborundum held in place by brickwork not shown in the figure. On account of the very great shrinkage of calcined magnesia this material was not found satisfactory as a jacketing material, as after the tube has been in use for a short time fissures are formed, which allow the air to come into contact with the carbon, thus considerably curtailing its life; probably by using fused magnesia in the form of powder, better results could be obtained, and experiments in this direction are now in progress. Both for these graphite tubes and also for the forms of furnace described later, carborundum has been found to be an excellent jacketing material. It is a fairly good heat insulator, and has the advantage of being a reducing agent, consequently protecting the carbon from burning away. For instance, one of the smaller tubes, after 10 or 12 experi-

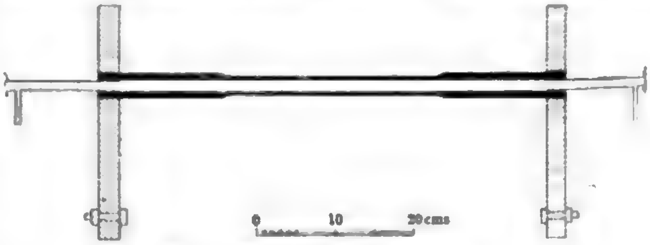

Fig 1 Graphite Tube Furnace.

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* Abstract of Part I. of a Paper read before the Faraday Society on Tuesday.

ments, in nearly all of which it had been heated well above the melting point of platinum, was found to have altered only to a quite insignificant extent in internal and external diameter. This material has been used in a fine granular condition (the grains just passing through a sieve 180 meshes to the linear inch). So soon as the graphite has attained a fairly high temperature, these grains frit together, forming an adherent, tube-shaped, jacket around the graphite, which serves to strengthen and protect it. The material to be heated in this furnace is placed in a small boat made of graphite or ordinary agglomerated carbon, the bottom of the boat being shaped so as to touch the tube at only a few points, and thus not itself to conduct any appreciable amount of the current. The temperature is estimated by having a number of small carbon holders on each side of the boat, with pieces of various metal wires placed upright in them.[*] At approximately the melting point of the metal the wire sinks and disappears from view. For higher temperatures little cones of pure alumina or magnesia have been used, but more recently an optical pyrometer has been obtained, which it is hoped will prove very serviceable for experiments of this kind. The thicker ends of the graphite tube and the graphite plates get too hot to admit of a rubber or cork stopper being used; the glass tubes which serve for the gas inlet and outlet were therefore fixed with a plug made of fine asbestos string.

For most of our experimental work we have made use of agglomerated carbon tubes. The amorphous carbon, being very hard, cannot be machined in the simple manner which is possible with graphite, and even grinding with carborundum wheels is a somewhat laborious operation: it was therefore decided to adopt a quite different method of making the electrical connections. The ends of the carbon tube A, A_1, Fig. 2, which may with advantage be somewhat roughened by filing, are electro-coppered, and then soft-soldered to thick copper tubes, just large enough to slip over them. The copper tube is provided for a short distance with a brazed-on water jacket, B, which effectively cools the joint and protects it, even when very high current-density is necessary; at the further end of the copper tube a copper clamp, D, connected with flexible cables, leads in the current. By soft-soldering the carbon to copper tubes with brazed water jackets, it is always possible to replace the carbon easily without any fear of injuring the joints of the water jacket. The length over which the soldered joint has to be made obviously depends on the size of carbon tube and the strength of current to be sent through it, but with this water cooling the necessary surface of contact is surprisingly small. A special experiment was carried out to test the perfection of these joints. One of the smaller tubes was surrounded with calcined magnesia, and heated with 300 amperes until the tube was practically completely destroyed. After cooling, the core was examined, and found to have burnt away to a mere shell right up to the copper: the joint, however, was still undamaged: and not even a drop of solder had melted out of it. Glass tubes C are connected to the ends of the copper tubes by rubber stoppers, and serve for the passage of gas and for observation of the progress of the experiment.

For the earlier experiments, carbon tubes 30cm. long, 15mm. internal and 20mm. external diameter were employed; these were jacketed as before with carborundum, which was generally kept in place with an external asbestos tube and asbestos washers fitting tightly up against the ends of the water jackets. The horizontally placed tube is capable of taking a number of small crucibles containing the material to be heated, but it is hoped to use these and still wider tubes in a vertical position, in which case a useful means of heating larger crucibles will be available. With these large tubes it is advisable to use some sort of diaphragm near the ends to prevent the radiated heat from burning the surface of the rubber or cork stoppers, which, as the copper is effectively cooled by the water jacket, can serve to attach the gas inlet and outlet extensions; with the small tubes there is no need to take this precaution. During the past few months tube furnaces of this simple type have been in constant use and have been found to work satisfactorily. The rapidity with which a very high temperature can be obtained and the regulation of that temperature by simple variation in the strength of the current renders their use very convenient. On the other hand, by starting with a relatively small current it is possible to raise the temperature as slowly as desired and thus not to exceed any required maximum. Without the more trustworthy data, which it is hoped to obtain by the use of the optical pyrometer, it does not seem advisable to hazard any estimate of the highest temperatures which can be reached with this method of heating.

Owing to the porosity of the carbon tubes at high temperatures, it is difficult, even with a fairly rapid current of hydrogen, to keep the gas in contact with the heated material free from carbon monoxide Since this was highly desirable in some of the experiments we have been carrying out, a modified form of construction was adopted for this special case. In the first modification the carbon tube was surrounded with a water-cooled, gas-tight metal jacket through which hydrogen was passed, but with this arrangement the convection currents in the external gas carry off an enormous amount of heat, and a very high current-density is required to reach even moderately high temperatures. On the other hand, when the carborundum-jacketed tube is, as a whole, surrounded with the gas jacket, the gas in the inner tube still contains 1 or 2 per cent. of carbon monoxide, which is probably due to the carborundum containing a small amount of unreduced silica. The arrangement finally adopted (see Fig. 8) has worked well, and is, moreover, considerably more efficient than when a bare carbon tube is surrounded with a large gas enclosure. The central carbon tube AA_1 (30cm long, 15mm. internal, 20mm. external diameter) forms the heating tube proper, and alone carries the current; it is surrounded by another carbon tube EE_1 (3·0cm internal diameter), which is jacketed with carborundum as a heat-insulator. Both carbon tubes are provided with water-cooled copper-tube extensions BC and FH, a gas-tight joint between the two tubes being made by the rubber stoppers P. Glass extensions, M, serve, as in Fig. 2, for the passage of gas through the heated tube, and for observing the progress of the experiment. Hydrogen is passed through the space between the two carbon tubes, as also through the inner carbon tube, and in this way it is easy to keep the gas in contact with the heated material almost absolutely free from oxygen compounds.

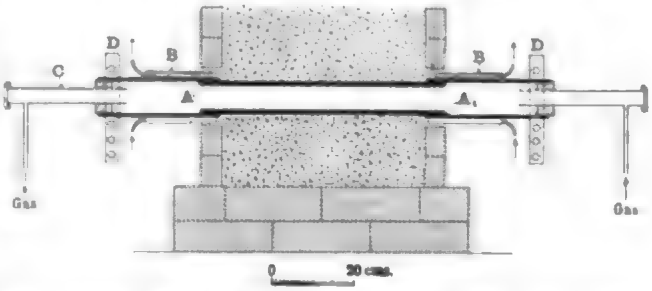

FIG. 2.—SIMPLE CONSTRUCTION OF AGGLOMERATED CARBON TUBE FURNACE.

In all our experiments we have had to use continuous current, although obviously low-tension alternating current obtained by the use of a transformer would be much more convenient, particularly with the large-sized tubes. In many laboratories the high currents required will certainly be a hindrance to the employment of such carbon tube furnaces, but in these cases it may be an advantage to increase the resistance of the tube by some such method as that proposed by E. Ruhstrat and E. W. Grimmer,[*] who cut a spiral on the carbon tube, and thus form a more or less narrow helix, which can be made to take quite small currents at correspondingly higher voltage.

In view of the prospect of shortly having fairly trustworthy data as to the temperature variations during the experiments, it is thought advisable to retain for a later Paper full details as to the current and voltage readings at different temperatures. The following are only approximate values, which will, however, suffice to indicate the conditions under which the experiments have been carried out. The readings are those observed when the temperature indicated had been reached, and since the resistance obviously decreases as the temperature rises, they must not be taken to indicate mean values.

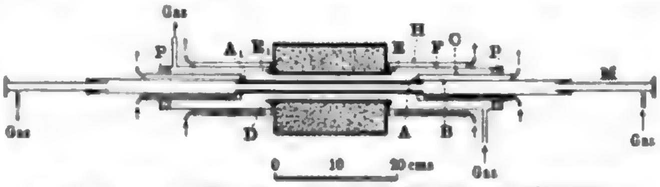

FIG. 3.—SPECIAL TUBE FURNACE FOR EXPERIMENTS IN PURE GAS ATMOSPHERE.

Important differences manifest themselves according to the type of furnace construction adopted. With a bare tube surrounded with a gas jacket, a given current very soon brings the carbon up to a temperature which remains more or less constant, or at the most only continues to rise very slowly; on the other hand, with carbons closely jacketed with a granular material, which is a good insulator, the temperature continues to rise for a very long time, and in this way, with a much smaller current and expenditure of power than is required in the previous case, a high temperature can be *built up*. As the temperature rises, however, the jacketing material becomes an electrical conductor, and even pure oxides at or near

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[*] The practical constancy of temperature throughout the central portion of the tube was determined by having a number of small boats containing projecting nickel wires at regular intervals, and noting, when the temperature was slowly raised, that those in the central 15cm. melted at very nearly the same time.

[*] Brit. Pat. 24,472, November 18, 1903.

Type of furnace.	Jacketing material.	Observations.
Graphite; 26cm. long, 2·6cm. external, 1·5cm. internal diameter.	Carborundum.	283 amps. at 9·2 volts melted nickel in 26 mins.; 320 amps. at 9·6 volts melted nickel in 13 mins.; platinum in 16½ mins.
Agglomerated carbon; 25cm. long, 3cm. external, 1·5cm. internal diameter.	Carborundum.	140 amps. at 7·7 volts melted nickel in 30 mins.; platinum in 49 mins.
Agglomerated carbon; 25cm. long, 3cm. external, 1·5cm. internal diameter.	None; bare tube surrounded with hydrogen.	245 amps. at 14·6 volts required to melt nickel (15 mins.).
Agglomerated carbon; dimensions, &c., as Fig. 3.	Carborundum outside outer carbon tube.	200 amps. at 21 volts melted nickel in 3 mins.; current increased to 180 amps. at 15 volts, melting platinum in further 8½ mins.
Agglomerated carbon tube; 66cm. long, 8·6cm. external, 4·7cm. internal, as Fig. 2.	Carborundum.	400 amps. at 8·5 volts gave 1,200°C. in 30 mins.; temp. still rising 7° per min.; 800 amps., at 13·9 volts melts nickel in 12 mins. and platinum in further 9½ mins.; later much hotter and takes 900 amps. at 11·1 volts.

their fusing point become good conductors, and by carrying some of the current tend to limit the temperature attainable. Further experiments are required to show the relative behaviour of different materials in this respect. One of the great advantages of such furnaces over those in which the heat is obtained from an electric arc or a granular resistance material lies in the fact that the temperature can be much more easily regulated and kept constant. There is such a vast amount of physical and chemical high temperature work which can only be carried out when the heating is under perfect control that we feel confident in finding numerous applications for these carbon-tube furnaces.

A TIME ELEMENT THERMAL CUT-OUT.

A new type of thermal cut-out, to act only after an over-load has lasted a predetermined time, is being put on the market by Messrs. Griffith & Blibent. Its principal parts are a closed corrugated receptacle A of sheet metal, in form of a disc, containing a quantity

FIG. 1.—DIAGRAMMATIC SKETCH OF THERMAL CUT-OUT.

FIG. 2.—THERMAL CUT-OUT CONNECTED TO MOTOR SWITCH.

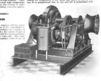
of ether, and a small resistance coil placed underneath the ether receptacle, both being enclosed in a brass box, as shown in Fig. 1. The whole or part of the current in the circuit to be protected passes through the resistance coil, which begins at once to heat up, thus raising the temperature of the metal disc above it, and the coil may be so proportioned that its rise and fall in temperature with fluctuating current will be commensurate with the temperature variations in the electric apparatus it protects. For instance, when starting up a motor, it will take a given current a longer time to raise the temperature of the motor to a certain value than when the motor has already been warmed up. Similarly, a longer time will elapse before the air above the resistance coil assumes a given temperature after having completely cooled down than after having been heated up by previous service. As a rule the resistance coil is so designed that about 2½ watts are dissipated per second during ordinary service at full load.

When the overload comes on, the increasing temperature of the coil is communicated to the hollow metal disc and to the ether contained in it. The disc consequently bulges out and lifts a small

ELECTRIC WINCHES.

An excellent new list of electric winches, capstans, [illegible] gear, &c., is issued by Messrs. Clarke, Chapman & Co., Gateshead-on-Tyne, in attractive form, containing illustrations of a number of fine examples of these machines. Winches for various classes of work are shown, and include single-speed and two-speed machines, those for shipyard work being especially noticeable. The semi-portable single-speed ship-yard winch illustrated below is one of many included in the list. It is driven by a 13 B.H.P. series-wound continuous current motor, and is controlled by a tramway type reversing and speed-regulating controller with cast-iron grid resistance. A central barrel and two warping drums are driven by the motor through three pairs of spur wheels, and the winch is designed to lift a load of 5 tons at a speed of 90ft. per minute. Lighter loads are lifted at higher speeds without change of gearing, as the motor speed runs up as the load decreases. The main lifting pinion is of cast steel and the motor pinion of raw hide, the remaining wheels being of cast iron with machine-moulded teeth. All the shaft bearings are adjustable and, with the exception of the barrel shaft, are fitted with brass sleeves. The side frames carrying the shafts are mounted on a steel channel frame, which is arranged so that travelling wheels can be easily fitted. The motor is of the four-pole enclosed type with slotted drum armature fitted with carbon brushes, and will run for one hour on full load with a temperature rise of 100°F. above the surrounding air. The controller and resistances are watertight, and are mounted on an extension of the bed, so that the winch, with its electrical equipment, is self-contained and makes a compact design. Two brakes are fitted to the winch, one on the motor shaft and one on the drum, and a clutch is fitted to allow the barrel to be lowered quickly on the brake.

The list contains the most complete set of illustrations of electric winches that has come to our notice. Both single-speed and two-speed capstans are listed, as well as double track winding gear, for working a double track with one cage ascending and one descending.



ELECTRICALLY-DRIVEN WINCH BY CLARKE, CHAPMAN & CO.

piece of metal, which, in rising, first closes a bell circuit or a lamp circuit, and then, if the overload continues, actuates the trip gear of the main switch (see Figs. 1 and 2). By means of the screw adjustments indicated in the illustrations, the time element may be varied within wide limits. It will be noticed that the main switch cannot be closed again, after being tripped, until the resistance coil and ether disc have cooled down sufficiently. The device does not act, of course, instantly on a short circuit, the shortest time being about some 10 seconds. Fig. 2 shows this thermal safety device applied to a motor circuit. It is fitted with a carbon break. The same device is made so that it may be placed directly below the ordinary tumbler switch and lift the lever of the switch when an overload occurs.

RECENT DEVELOPMENTS IN ELECTRIC SMELTING IN CONNECTION WITH IRON AND STEEL.*

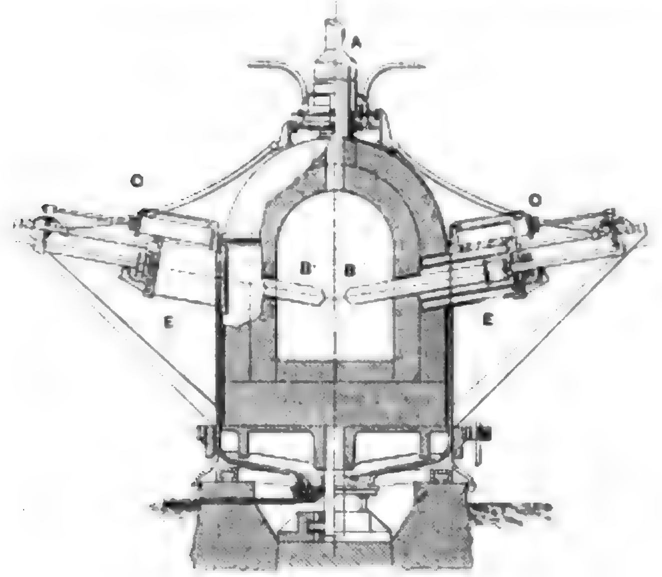
BY. F. W. HARBORD.

(Concluded from page 964).

THE ARC FURNACE.

In this type of furnace the necessary heat is obtained by direct radiation from the arc and by reflection from the roof and sides of the furnace. As far back as 1879 the late Sir William Siemens designed a small crucible furnace capable of melting a few pounds of steel on this principle, and the Stassano furnace is the best-known furnace of this type used for the smelting of iron and steel. It is shown in Figs. 5, 6 and 7, with a description attached. The furnace rotates round an axis inclined about 7deg. to the vertical. There are three electrodes, which nearly meet in the centre of the furnace, their distance being regulated by a hydraulic ram. A three-phase alternating current is used and distributed between the three electrodes. In the latest type two pairs or four electrodes are used, and the following details of a 4 to 5-ton furnace were supplied by Capt. Stassano to Dr. Haanel, the commissioner* sent over by the Canadian Government to report on electric smelting. The furnace is capable of producing 4 or 5 tons of steel per day, a current of 4,900 amperes at 160 volts being distributed to four electrodes supplying two arcs with 2,450 amperes for each arc. The electrodes are cylindrical in shape, about 6in. in diameter, from 50in. to 60in. long, and weigh about 182lb. The furnace is lined with magnesite blocks made specially to the shape of the furnace; even under unfavourable conditions these blocks will last 40 days with slight repairs to the parts in contact with the slag.

The process differs from the Héroult and Keller processes, in so far that steel is produced direct from the ore in one furnace, instead of from pig iron or scrap. The ores used are the very purest hematites, and these, after most careful analysis, are ground very fine and mixed with just sufficient fluxes to form a fusible slag, and with sufficient carbon to effect the reduction, and are then moulded into briquettes. The arc takes no part in the reduction, but simply supplies the heat, the reduction being effected entirely by the solid carbon. As there is no combustion of the carbon by oxygen, the reduction cannot be effected by carbonic oxide, but by the carbon; and hence it is necessary to have all the materials of the charge finely ground and briquetted, so that the oxides and the carbon may be in very intimate contact. The rotation of the furnace also assists in maintaining this contact after the bath is molten. By very carefully adjusting the amount of carbon so that it is present in a just sufficient quantity to reduce the oxide, extremely soft pure iron, practically free from carbon, is obtained, which is stated to give exceptionally good results for dynamo purposes. By increasing the amount of carbon in the briquettes it is claimed that any product varying from dead soft steel to pig iron can be obtained. There is no doubt that the process has been worked out most scientifically; and, under the special conditions as to very pure ores and cheap electric energy which exist in Northern Italy, may give good commercial results. In cases where comparatively impure ores have to be treated the problem would, from a practical standpoint, be much more difficult, as not only would a greater amount of energy be absorbed in melting the slag produced, but the bulk of materials in the furnace would greatly restrict the output.



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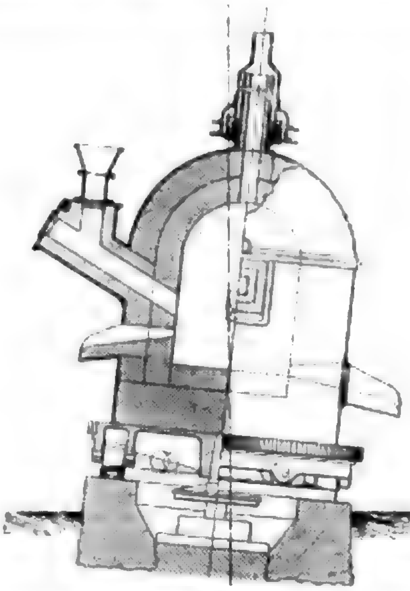

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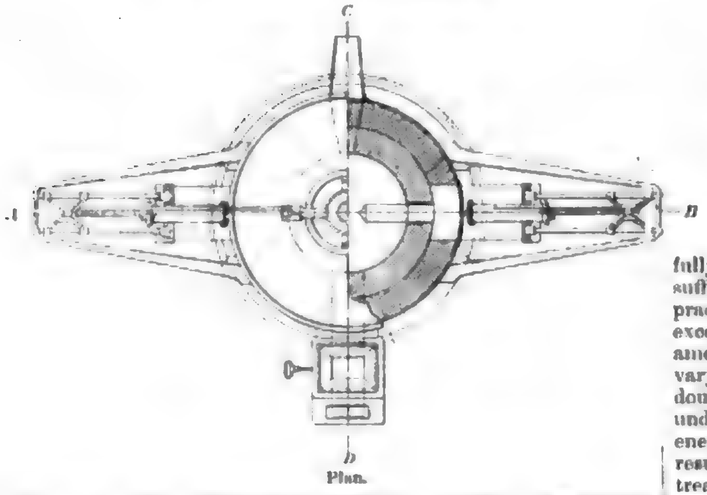

Plan.

FIGS. 5, 6 and 7.—SECTIONAL ELEVATION OF STASSANO ELECTRIC FURNACE. Furnace lined with Magnesia Bricks. The Furnace is slightly inclined to the vertical, and rotated by mechanism shown in the bottom of the furnace.

Volatile products are led off through tube A. BB, electrodes; CC, hydraulic cylinders for regulating electrodes; EE, water-jacket for electrodes. There is a tap-hole for metal at bottom of furnace, and a slag-hole at somewhat higher level. The charge is fed through a hopper and inclined shoot to deliver below the electrodes.

The furnace can equally well be employed for scrap melting and purifying, and at the Government works at Turin is almost entirely charged either with scrap or a mixture of scrap and pig iron. In a recent letter, dated January 15, 1905, Capt. Stassano sends me the following particulars: "The furnace at Turin has been working regularly since March last, producing normally the grade of steel required by the Government for the manufacture of artillery projectiles. The furnace is standing at present, in consequence of the transformer having been damaged, but a new one is being installed which will reduce the current from 8,000 to 80 volts; the furnace is expected to be ready to commence work again in March. The usual charge consists of 350kg. to 400kg. of pig iron, 200kg. to 250kg. of scrap, the necessary amount of ore being added to oxidise the impurities, and sufficient lime to form a basic slag to protect the lining of the furnace, and remove the phosphorus and sulphur in the materials employed. During the last year's working the following data have been obtained:—Loss on weight of materials charged, 1·5 to 2·01 as a maximum; consumption of electrodes, 5kg. per ton of steel produced; mean consumption of current, 1·2kw. per kg. of steel produced, equal to ·186 E.H.P.-year per ton of steel; six men, an electrical mechanic, melter, and four labourers are more than sufficient for one furnace."

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* Paper read before the Faraday Society on March 6.

* Report of Canadian Commission on Electric Smelting, 1905, p. 11.

Captain Stassano considers there is every reason to anticipate a reduction in the consumption of electric energy when the workmen have acquired greater experience, and when furnaces of larger size are installed, and there seems little doubt that this will be the case. The average mechanical results are as follows:—

Max. stress, per sq. in.	Elastic limit, per sq. in.	Elong to elastic limit.	Total elongation.
11·3 to 45·7 tons.	19 to 20·3 tons.	1·5 to 1·8 per cent.	16 to 19 per cent.

The length on which elongation is taken is not stated. Unfortunately, when the Commission visited Turin, this furnace was not at work, so that the author did not see it in actual operation, but both as a steel melter and for the direct smelting of the ore, it certainly offers considerable possibilities. The details of the design have been most carefully worked out as the result of numerous experiments, and its future development will be most carefully watched by all metallurgists interested in electrical smelting. Various other processes both for the manufacture of steel and the direct smelting of ores have been proposed; but so far as the author is aware, although of considerable theoretical interest, none of them have been experimented with on a commercial scale.

M. Harmet, the well-known French metallurgist, has patented one or two processes of smelting which deserve consideration. In one form of furnace he proposes to melt oxides of iron and reduce them by solid carbon, and in another form he proceeds on ordinary blast-furnace lines, relying upon carbonic oxide as his chief reducing agent. The first form of furnace consists of a vertical shaft, in which the oxide of iron is melted by producer gas, the molten oxides being allowed to flow into a reducing chamber containing incandescent carbon, through which they percolate, and are reduced before being tapped off to the refining furnace for conversion into steel of the grade required. Theoretically, this furnace should give good results, but in the author's opinion there are many practical difficulties which would largely interfere with the success of the operation. This is a mere opinion, however, and he would be very sorry to condemn the process without further information, and especially without discussing the details fully with M. Harmet. In the melting and reducing chamber electrodes are provided to supplement the heat developed by the combustion of the gas when necessary, and the finishing or regulating chamber is practically an open-hearth furnace electrically heated by electrodes passing through the roof, as in the Héroult and Keller furnaces. One disadvantage of any process of this kind is that the steel furnace is not independent of the reducing furnace, or what corresponds to the blast furnace in an ordinary iron and steel works, and consequently irregularity in the working of this portion of the plant interferes with and retards the steel manufacture. There appears no reason why, with slight modifications, the steel furnace could not be separated, a mixer being used to receive the metal from the reducing furnace, from which it could be transferred to the steel furnaces as required. The advantages claimed are that the process enables a much cheaper fuel to be employed than is used in the blast furnace, and that the ore being in contact with the fuel during a short period only, does not take up impurities from the fuel to the same extent.

The other process suggested by M. Harmet depends upon the reduction of solid oxides of iron by carburised gases. The materials, previously calcined and preheated to a temperature of 500deg. by waste gases, are charged with preheated coke into the top of a shaft furnace, similar to an ordinary blast furnace, electrodes being arranged in the crucible of the furnace to furnish the necessary heat units for the fusion of the reduced metal; a portion of the gases taken from the furnace top are forced into the bottom of the furnace by a blowing engine, and these serve the double purpose of carrying some of the heat units generated electrically and distributing them through the charge, and of acting as reducing agents. The composition of the gases leaving the furnace top will vary with the system of working, and provided a rapid circulation of the gases is maintained, so that the temperature at the top is about 500 C., they will consist largely of carbon monoxide with a little carbonic dioxide; if the circulation of the gases is slower, the temperature at the top of the furnace will be lower, and the proportion of carbon dioxide will be much greater, as the temperature will not be sufficiently high for the carbon dioxide to combine with carbon to form carbon monoxide. Whichever method of working is adopted, the carbon dioxide injected with the furnace gases at the bottom coming into contact with the incandescent carbon in the charge, is converted into carbon monoxide, which acts as a reducing agent to the oxide of iron, being again converted into carbon dioxide, and again reduced to carbon monoxide so long as the temperature is sufficiently high for the reactions to take place. These reactions are identical with those taking place in the blast furnace above the fusion zone, except that we should anticipate that the reducing action of the gases would be more energetic, as they are not diluted by any inert nitrogen. M. Harmet claims that this furnace forms the most perfect gas producer invented, as, working under conditions of rapid circulation, he is able to produce a combustible gas consisting almost entirely of carbon monoxide, and that the reducing conditions are far superior to the blast furnace. From a series of calculations as to the heat units required for the production of 1 ton of steel, including the reduction and final finishing in the steel furnace, on the basis of coke at 25fr. per ton and electric energy at the price usually allowed in the French Alps (0·01fr. per 1,000 electric calories), M. Harmet estimates there is a balance in favour of electric smelting of from 21fr. to 16fr. per ton of steel. This process is extremely ingenious, and the details, both as to plant and method of working, have been most carefully thought out; it is a very fascinating process, theoretically perfect, and is one which one would very much like to see tried under favourable conditions as to cost of electric energy. The plant, as designed by M. Harmet, would probably have to be considerably modified, as one can foresee considerable practical difficulties in carrying out all the operations in the manner suggested; but this could probably be done without interfering with the fundamental principle of reducing the ore by practically pure carbon monoxide, which is an entirely new departure so far as the *commercial* production of iron is concerned.

The Gin Furnace.

There is one other electric furnace which calls for a short description, as it is different in principle and design to those already described. The Gin furnace was designed to avoid the disadvantages attending the use of carbon electrodes, and it is also claimed by its author to have considerable advantages over the induction furnace. The furnace hearth consists of a trough or channel of considerable length and small cross-section; this channel is filled with molten pig iron, and terminal water-cooled blocks are provided for connecting to the electric circuit. For convenience, the channel which holds the metal is doubled upon itself several times, so that in plan it has the form of a huge filament of an incandescent lamp. By varying the current passing into the fused metal any required temperature can be obtained. It is stated that by having the terminal blocks of very large section in comparison with the section of the channel carrying the molten metal, and by internal water-cooling, they are prevented from attaining a very high temperature. The furnace is basic-lined, and can be used as a crucible or melting furnace for the production of steel, by melting selected pure materials to give the composition of steel required, or it can be used with pig and scrap, additions of ore, lime, &c., being made in the usual way to effect the oxidation and removal of impurities. The author is not aware if this furnace has actually yet been tried on a commercial scale, and cannot express any opinion as to the advantages it may offer from an electrical standpoint; but he thinks that any practical metallurgists present who have had experience with Siemens furnaces, will agree with him that from a metallurgical point of view this is not a furnace likely to give satisfactory results. The difficulty of charging the pig iron, scrap, ore, &c., into such a furnace during the working of the charge, and the maintaining of the hearth or channel in fair repair, seems to rule out a furnace of this design for the manufacture of steel on anything like a commercial scale. The maintenance of the terminal blocks, notwithstanding water-cooling, would also probably be attended with considerable difficulty.

General Conclusions.

The following, given in the Canadian Report, were the general conclusions arrived at by the author as the result of his investigations, and of the information he was able to obtain from various sources. They represent what are, in his opinion, the possibilities of electric smelting in the present state of the art; but, no doubt, future developments and improvements will necessitate that these conclusions be greatly modified in the near future.

1. Steel, equal in all respects to the best Sheffield crucible steel, can be produced, either by the Kjellin or Héroult or Keller processes, at a cost considerably less than the cost of producing a high-class crucible steel.

2. At present, structural steel, to compete with Siemens or Bessemer steel, cannot be economically produced in the electric furnaces, and such furnaces can be used commercially for the production of only very high-class steel for special purposes.

3. Speaking generally, the reactions in the electric smelting furnace as regards the reduction and combination of iron with silicon, sulphur, phosphorus and manganese, are similar to those taking place in the blast furnace. By altering the burden and regulating the temperature by varying the electric current, any grade of iron, grey or white, can be obtained, and the change from one grade to another is effected more rapidly than in the blast furnace.

4. Grey pig iron, suitable in all respects for acid steel manufacture, either by Bessemer or Siemens processes, can be produced in the electric furnace.

5. Grey pig iron, suitable for foundry purposes can be readily produced.

6. Pig iron low in silicon and sulphur, suitable either for the basic Bessemer or the basic Siemens process, can be produced, provided that the ore mixture contains oxide of manganese, and that a basic slag is maintained by suitable additions of lime.

7. It has not been experimentally demonstrated, but from general considerations there is every reason to believe, that pig iron low in silicon and sulphur can be produced even in the absence of manganese oxide in the iron mixture, provided a fluid and basic slag be maintained.

8. Pig iron can be produced on a commercial scale at a price to compete with the blast furnace only when electric energy is very cheap and fuel very dear. On the basis taken in this report, with electric energy at $10 (41s. 8d.) per electrical horse-power-year, and coke at $7 (29s. 2d.) per ton, the cost of production is approximately the same as the cost of producing pig iron in a modern blast furnace.

9. Under ordinary conditions, where blast furnaces are an established industry, electric smelting cannot compete; but in special cases, where ample water power is available, and blast-furnace coke is not readily obtainable, electric smelting may be commercially successful.

It is impossible to define the exact conditions under which electric smelting can be successfully carried on. Each case must be considered independently after a most careful investigation into local conditions, and it is only when these are fully known that a definite opinion as to the commercial possibilities of any project can be given.

The illustrations in this Paper have been reproduced from the Canadian Report by permission of Dr. Haanel. In all cases the horse-power-year is taken for 365 days of 24 hours.

DISCUSSION.

M. ADOLPHE MINET communicated some further particulars of the Héroult process, giving a sketch of its development. About 8,000 tons of steel have up to the present been made. The process was an advance upon others and upon the crucible furnace, because it allowed of a complete elimination of sulphur and phosphorus, and common raw materials, costing 70fr. a ton, could be used. The current consumption at present was 120kw.-hours per ton of steel. M. Minet also gave some tables of tensile strengths and summed up the special advantages of this process, and he exhibited some specimens of steel and ferro-alloys made in the Héroult furnace.

Mr. H. THWAITE (*communicated*) described a scheme for the production of high-quality ingot steel in Canada, suggested by him in 1903. The anthracite had to be imported from the United States, and it was proposed to briquette the raw materials to effect the reduction in a particular design of arc furnace. The gases evolved were to heat an open-hearth furnace in which the steel was to be made, additional electric heating also being available. He considered that both the Keller and Héroult processes were available for the useful employment of the power-producing resources of the blast furnace, now mostly going to waste.

Mr. BERTRAM BLOUNT (*communicated*) insisted that now is the time for steel makers in this country to adopt electrical methods of working for making the special steels used in the construction of such articles as guns, safes, motor-cars, cutting tools, &c., which have individual properties easily obtained when those methods are employed.

Mr. W. MURRAY MORRISON agreed that the Keller and Héroult seemed at present the only practicable furnaces as far as this country was concerned. M. Héroult had recently reduced his energy figure to 0·15 E.H.P. years per ton of steel, starting with scrap, and to the remarkable figure of 0·0114 E.H.P. years (equivalent to 2s. 4d. a ton), starting with molten metal; he was now constructing a 300-ton mixer and a 50-ton furnace, in which still better results were to be hoped for.

Mr. R. S. HUTTON pointed out that electric heating was only economical when very high temperatures were desired, and that it was not, therefore, desirable to use electric furnaces for melting. One of the advantages of the Héroult furnace arose from the fact that it was an arc as well as a resistance furnace. The two sources of intense heat caused convection currents in, and hence intimate mixture of, the molten charge.

Mr. R. L. GAMLEN, speaking as one interested in the production of cheap power, was of the opinion that the limiting figure of £10 per electrical horse-power year mentioned by the author could be considerably lessened by the producers of power on a large scale. In considering this question of cheap power too much stress was usually laid on fuel costs; capital costs were an even more important item. These were very large in the huge gas engines required by low thermal value gases, such as blast furnace gases, and steam power was therefore more economical even if gas cost nothing.

Dr. O. J. STEINHART drew attention to the difficulties of making low carbon ferro-chromes, especially in arc furnaces. The value of these was very high compared with those of higher carbon content.

Mr. T. V. HUGHES said that a sober presentment of the possibilities of electric smelting, such as Mr. Harbord had given, was of great value as not tending to inflate the public mind.

Prof. E. WILSON thought that the figure of £10 per electrical horse-power-year could be diminished for large supplies of power.

The CHAIRMAN, in moving a vote of thanks to Mr. Harbord, remarked on the enterprise of the Canadian Government in appointing a Commission to study this very important question. He wished that some of our manufacturers would see the desirability of becoming alive to the possible future of electric smelting, and making experiments on the subject.

SUCTION-GAS PLANTS.*

BY F. H. BOWMAN.

Apart from use with small-power gas engines, illuminating gas, as derived from distillation in closed retorts, cannot be used in central lighting stations on account of its cost, except under special conditions, and where the by-products and coke can be utilised close at hand. In this case the gas itself may then be considered as a by-product, and in the author's own experience in one large chemical works the net cost of 14 c.p. gas with a calorific value of between 500 and 600 B.Th.U. did not exceed 1d. per 1,000 cubic ft. This, however, is altogether exceptional The same holds good with coke-oven gas, which is a by-product, and is now being used as a source of power; it has a calorific value, on the average, of about 600 B.Th.U. The utilisation of blast-furnace gas is also now becoming the rule rather than the exception, and in place of being burned under boilers for the purpose of generating steam power, is being used in large gas engines after proper cooling and purification so as to remove all dust. It is gratifying to note that the very earliest suggestions for the utilisation of blast-furnace gas as a source of power in gas engines were made in this country by Mr. B. H. Thwaite, of London.

In determining the nature of the plant to be used, several particulars have to be taken into consideration. The size of the plant is important, because it will determine whether it will pay best to use bituminous or non-bituminous fuel. For small plant non-bituminous fuel, such as anthracite coal or coke, is much the best. It may be used either with pressure or suction plant, whereas bituminous fuel, such as ordinary coal, or lignite, or peat, can only be used in pressure plant. Presuming that the generative plant is in units of not less than 500 B.H.P. each, it will pay to use either; but the plant for non-bituminous fuel is so much simpler and requires so much less attention that it often is much better to use such fuel, even when costing more per ton, than to use the bituminous fuel.

When the works are apart from dwelling-houses or large residential districts, and when they are amidst large manufacturing premises, where smoke and fumes are so prevalent that a small increase in quantity will make no difference, bituminous plant may be employed. When, however, it is desirable to avoid even the appearance of a nuisance, then anthracite or coke, and preferably the former, must be employed.

Bituminous plant always requires more space than non-bituminous, because it is necessary to have a large space occupied by the condensing and purifying plant, and in case of the recovery of residuals a more complicated plant still, which not only requires a large area, but cannot be confined within an enclosed building. In addition also, as all bituminous plants are pressure plants, there is the necessity for large gas-holders, unless the gas is consumed as rapidly as generated. Even in this case there is usually a small gas-holder required to equalise the composition of the gas, which varies considerably from time to time, and also to give a more constant pressure. Non-bituminous plant occupy much less space and need little purifying arrangements. But, of course, when it is of the pressure form, there is the necessity for a small gas-holder, as although the production of the gas can be regulated just as it may be required, in a manner which is impossible in a bituminous plant, still there must be some storage provided or gas would have from time to time to be turned out into the air, thus causing a loss in economy.

One pound of coal when consumed in the most economical manner liberates about 14,500 B.Th.U., and this quantity of heat if entirely employed in evaporating water would evaporate about 13lb. of water from 62°F., or 15lb. of water from 212°F. But the coal is never perfectly pure and free from ash, and commercially it would only generate on combustion 13,500 B.Th.U., and not, as above, 14,500 B.Th.U. Other losses are:—(1) Loss in heat carried away in the ashes, 135 B.Th.U.; (2) radiation loss from the boiler surface, 675 B.Th.U.; (3) carried away as waste heat up the chimney, 2,970 B.Th.U.; total loss, 3,780 B.Th.U. Compared with the 13,500 B.Th.U. per pound of coal in the furnace this represents a loss of 28 per cent. before one single pound of steam can be delivered to the engine.

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* Abstract of a Paper read before the Leeds Local Section of the Institution of Electrical Engineers on March 16th.

In a well-constructed producer the loss of heat in changing the solid fuel into gas is considerably less than in the raising of steam, and does not exceed 13 per cent. of the total heat units which would be given out by the complete combustion of the coal. Again, taking the heat units in 1lb. of coal at 13,500 B.Th.U. we have a loss of 1,755 B.Th.U. It is not so easy to determine the proportion of this loss, which is due to any particular cause, as in the case of a steam boiler, but these causes may be summarised as follows: (1) Heat carried away in the escaping gases, 8 per cent.; (2) heat absorbed by the dissociation of the solid fuel and the water vapour in the air, 2 per cent.; (3) heat lost by radiation, 1 per cent.; (4) undecomposed carbon-dioxide, 2 per cent. These figures are only approximate, as they will differ with the form and size of the producer.

The largest portion of the loss is the heat in the gas generated, which has to be cooled down to the temperature of the air before it can be available for a gas engine. This probably accounts for two-thirds of the total loss. A considerable portion of this heat may be recovered by making the producer regenerative and heating by this waste gas the incoming air required for combustion, and, where a suction plant is used, by raising the steam necessary to mix with the air, thus keeping down the temperature of the combustion, and, by the decomposition of the steam in the producer, enriching the gas by the liberation of hydrogen and the production of carbon-monoxide without any admixture of nitrogen. By this means, from 1lb. of coal 11,745 B.Th.U. can be delivered to the gas engine, as against 9,720 B.Th.U. in the steam to a steam engine, and, what is equally important, the cooled gas is far more fixed and stable than the steam, which, from its easy condensibility, can rapidly lose a further quantity of its heat units. This gives us the first cause why the use of a gas-driven plant is more economical than a steam plant.

There are two principal forms of producers:—

I. *Pressure Plant.*—Where the air and steam is forced into the producer by means of a blowing engine, a fan or other form of blower or a steam jet. Pressure plant may be either—(*a*) For use with bituminous fuel, or (*b*) for use with anthracite or other non-bituminous fuel, such as coke.

II. *Suction Plant.*—Which can only use non-bituminous fuel, such as anthracite or coke.

Pressure plant with bituminous fuel may be used for large units, say, of 1,000 H.P., because they will generally be placed where there is sufficient space and where bituminous fuel is cheap. It will pay also in this case to use recovery plant, and the sale of the residuals will in this country, probably for some time, go a long way in the reduction of the price of the gas and diminish the greater expense arising from the outlay of capital and expense of working. They are not, however, advisable for intermediate-sized plant, and ought not to be put down for any size under 1,000 B.H.P. It must be remembered that in all these cases it is not every kind of bituminous slack which can be used. Only free burning non-caking coal, such as that which pertains in the northern part of the Nottingham coalfield, centred round Linby, is suitable for use in producers. Most of both the Lancashire and Yorkshire coal is unsuitable. With a good bituminous plant and recovery of residuals and a modern gas engine developing 1,000 B.H.P. on a full load, a brake-horse-power can be produced at a cost of under 0·2d. per hour, including everything, and a kilowatt hour for 0·25d. per hour at the pole of the dynamo. With a pressure plant such as a Dowson, using anthracite or coke, a brake-horse-power may be obtained, including everything, for about 0·45d. per hour, and a kilowatt-hour for 0·6d. per hour.

Besides Dowson there are many makers of these non-bituminous pressure plants, such as Crossleys, Tangyes, Fielding & Platt, Paisley & Welsh, Daniels and the Dynamic Gas Co. Anthracite and coke may be mixed, or the latter used separately as the fuel, but in this case the producer must be of greater capacity and provision made in the cooling and purifying of the gas to arrest the sulphur which is always present in the coke, and extra cleaning is required. All pressure plants, however, have one disadvantage—they require power to produce the blast necessary to force the air and steam through the system, and they require storage for the gas unless the requirements are perfectly uniform, which is never the case when the gas is used for power purposes. They require also a separate steam supply, and experiments have proved that when the best results are attained about 16 per cent. of the total fuel used is consumed to generate this steam. Another disadvantage of this form of producer is that the gas being under pressure there is a liability to leakage, and as the gas has no smell and is of a highly poisonous character, serious accidents have happened, and pressure plants are quite unsuited to confined spaces. Whatever form of producer is used, as the gas is of less calorific power than town gas, a larger engine is required for the same power. The difference ought not to be taken at less than 20 to 25 per cent., but better results are frequently obtained.

In 1888, M. Bénier, a Frenchman, conceived the idea that these disadvantages might be overcome by arranging a closed producer in such a manner that the air might be sucked through the producer by a suitable pump, instead of being forced into it by means of the steam jet, and that the gas thus aspirated might be delivered stroke by stroke to the engine as and when generated, and thus do away with the necessity for a gas-holder. Also that the aspiration of the pump would produce a slight vacuum in the producer and scrubber, and thus the waste heat could be utilised in an open boiler to generate the steam necessary to be mixed with the incoming air so as to enrich the gas with the necessary hydrogen. In continuing his experiments, Bénier himself found that a separate pump was unnecessary, as the suction of the piston of the engine in its outward stroke was sufficient to draw the gas through the system. Up to 1901 this form of producer was scarcely used in this country, partly on account of the general cheapness of gas, but principally in consequence of certain defects which were common to all the existing forms. The correct regulation of the steam to the air supply and the control of the fire while the producer was in operation was not provided for; while the exact proportions between the area of the fire and the heating surface of the boiler, the relations of these to each other, the temperature of the furnace, and the relation of the whole to the size and speed of the engine were not understood. Now, however, these difficulties have been overcome, and a large unit has been run for weeks continuously night and day with a regularity quite equal to the very best steam plant.

The dynamic gas producer is the most perfect of its type, and when suitable fuel is employed and the engine properly constructed in regard to the proportions of its valves and the compression of the gas before ignition, it is at present the most economical source of power which can be obtained. The composition of the gas is practically the same as produced in a pressure plant using non-bituminous fuel, but it is much more regular, and the calorific value can go as high as 155 B.Th.U.; but its average value is about 150 B.Th.U., being a mixture of producer and water-gas. The engine and producer, however, in this suction plant being exactly suitable to each other, the engine has absolute control, not only of the quantity, but also the quality of the gas, and the regularity in the composition much exceeds that from any pressure plant. Analysis of the gas taken from a dynamic gas producer, even when running on an irregular load, showed no variation exceeding from 148 to 155 B.Th.U., and samples taken at regular intervals during many hours showed a regular average of about 42 per cent. of combustible matter. The first suction plant put down in this country to drive a public electric lighting plant was at the Suffolk Electricity Supply Co.'s station at Stowmarket, and the following analysis of gas was taken from the producer at this station:—

	Per cent.
Carbonic oxide (CO)	21·8
Hydrogen (H)	20·3
Oxygen (O)	0·2
Total combustible gas	42·3
Carbonic dioxide (CO_2)	7·8
Nitrogen (N)	49·9
	100·0

The results have been most satisfactory, and a second order has been executed for the Felixstowe electric light station, belonging to the same company.

The advantages of these producers may be summarised as follows: Reasonable in cost, cheap and regular gas, perfectly safe from explosion, occupy small space (a 500 B.H.P. plant will stand in a space 6ft. by 10ft.), simple in design, and when in operation no moving parts, not liable to get out of order and simple to repair, easily put into operation and entirely automatic in action, require little attention, can be attended by unskilled labour, create no nuisance even in confined spaces, no escape of poisonous gas possible, gas production stops the instant the engine stops, always ready for starting, as the fire may be kept without re-lighting for six months at a time, requires no gas holder, applicable to all forms of gas engine, can be made regenerative when necessary.

The author has installed several plants in which two engines are running from the same producer with great success, even though there is a great disparity between the two in size. The one disadvantage of a suction gas producer is that it cannot be worked on an absolutely light load for any length of time, because when no air or an insufficient quantity of air is drawn into the producer the temperature of the fuel falls, and so at last it is reduced to the point that good gas is not produced. This is specially the case in small plants where the volume of incandescent fuel is small. The limit of satisfactory working on light load seems to be about one fifth of the total load. A 50 B.H.P. engine will not work for long under 10 B.H.P. In large units where there is a greater reserve of heat the elasticity is greater.

A plant recently put down in Yorkshire at the works of the Weldrivet Boiler and Motor Co., Halifax, supplies gas to a 60 B.H.P. Campbell gas engine, and the power, which is, on the average, about 30 B.H.P. to 40 B.H.P., is distributed electrically. The cost per week of 54 hours with town's gas at 2s. 6d. per 1,000 cubic ft. was about £3. 18s. per week. Since the suction plant has been put in the cost of the anthracite coal has not exceeded 14s. per week, or rather less

Test of Dynamic Gas Producer, carried out by J. Whitworth, Engineer.

Name, size and speed of engine, and description of brake.	Condition of producer before and after test.	Starting up producer. Time.	Coal Consumption. Best Welsh anthracite nuts used.
Crossley Bros. "Otto." 8½in. cylinder. 15in. stroke 250 revs. per min. Brake, 44in. diameter to centre of rope. Weight of cast-iron pan ...... 101¾lb. Weight in pan .... 42 143¾ Spring balance showed........ 8 (W − w) = 135¾ Explosions counted every 30 minutes. Varied from 106 to 110 out of poss. 125. Brake horse-power .... 11·5 Indicated ,, ... 12·5	Producer working the day before shut down at 5 p.m. Producer half full of fuel. Ashpit cleaned out before starting test. *After Test.* After test contents of ashpit were riddled out through a ¼in. mesh riddle. Unconsumed large coal .. 13lb. ,, small coal .. 10 Ash, 4 per cent. .... 3 Fuel in producer left at same level as before the test.	Started to blow up producer with hand fan .. 11:0 a.m. Got gas .... 11:5 ,, Engine started .... 11:6 ,, Fan stopped ...... 11:6 ,, Load on brake .... 11:7 ,, Engine up to speed. 11:11 ,, Put in first charge of fuel .... 11:11 ,, Put in last charge . 3:35 p.m. Engine shut down . 4:10 ,, Total time of test.. 5 hours.	Total coal put into producer 74lb. Ash, 4 per cent. .... 3 —71lb. Unconsumed large coal.... 13 ,, small coal.... 10 —23lb. Total coal used .... 48lb. $\frac{48}{5}$=9·6lb. coal per hour. $\frac{9·6}{11·6}$=0·835lb. per B.H.P. *Cost of Running.* Coal 32s. per ton. One-seventh of a penny per B.H.P. hour. This is for fuel only.

than one-tenth of a penny per brake-horse-power. The above table gives the results of a trial of a small plant used at the experimental station of the Dynamic Gas Co. in Manchester.

It may be interesting to note that since the test was made, by the use of a special mixture of fuel, the cost of fuel per indicated horse-power has been reduced to less than one-thirteenth of a penny on a two days' test. Looking at the inclusive cost of a brake horse-power we may take the value of the plant as follows:—Producer, £110; engine, £105; sum, £215. Cost of running per hour, based on 300 days per annum of 10 hours each=3,000 hours: quarter time of attendant, based on wage of 25s. per week, £18; 14 tons of coal at 26s., £18; oil, waste, water, &c., £10; rent, rates and taxes, £10; depreciation and interest 10 per cent., £21; total £77 or 0·51d. per brake horse-power-hour, or 0·704d. per Board of Trade unit. The following is the cost given to me for a similar sized steam plant:—Coal per unit, 0·572d.; attendance, 0·395d.; oil, 0·056d.; water, 0·050d.; waste, cleaning, &c., 0·082d.; interest and depreciation on £280, 0·210d.; therefore, cost per unit per hour, 1·415d.

The steam plant was a self-contained upright engine and boiler, working at 120lb., and driving by a belt on to the dynamo. The capital outlay on the steam plant was £280, and the gas plant £295, or £15 dearer than the steam plant, but it is twice as efficient.

The cost per unit for a 270kw. steam-driven plant, working on an average at 80 per cent. load, came to 0·51d. The large steam plant is, therefore, more economical than the small one in the ratio of 0·51 to 1·4. Tested on full load this steam plant gave 0·41d. per kilowatt-hour.

Comparing a similar sized gas plant on the same basis we get 0·44d. per kilowatt-hour, including everything.

From this it will be seen that the large gas plant is more efficient than the small one by 0·7—0·44, or 0·26d. per unit, which is practically ¼d. On full load this plant would give 0·32d. per kilowatt-hour.

With continuous running, of course, better results can be obtained, even with smaller gas plant, and the following may be taken as an example, being run continuously for weeks together at the works of the British Westinghouse Company, Trafford Park, Manchester:—

130 B.H.P. dynamic gas producer, £250; cost of vertical three-cylinder gas engine and 75kw. direct-coupled dynamo, with switchboard, £1,600; cost of gas plant, &c., £1,850.

Three men, 28s. each per week, three shifts of eight hours, £219; oil, waste, cleaning, &c., £80; water, £100; coal, 320 tons at 26s. (anthracite nuts), £416; sundries, £50; cost of running, say, 8,700 hours per annum on 80 per cent. load, £1,050; or 0·45d. per kilowatt-hour; if there had been a free water supply, 0·41d. per kilowatt-hour; if on full load, 0·31d. per kilowatt hour.

The efficiency of a gas engine does not fall off in the same ratio as that of a steam engine with a decreasing load, and where multi-cylinder vertical engines—which occupy much less space than horizontal—are employed, the steadiness of running is equal to that of the best steam engines. With suction-producer plants, which need no tall chimneys and large reservoirs, and where the products of combustion are perfectly colourless, they can be placed in positions where steam engines or pressure bituminous plant could not be used, and for all units up to, at any rate, 1,000 B.H.P., they are to-day the most economical and up-to-date plant.

DISCUSSION.

Mr. G. **WILKINSON** mentioned that he had had some experience in the last 2½ years with the Diesel oil engine, and in Harrogate he was obtaining in everyday work 1 B.H.P.-hour on a 40 H.P. Diesel engine for ⅛d. The reason he could not come down to $\frac{1}{10}$d. was because he was very much handicapped by the cost of the carriage of oil. Suction-gas plant certainly gave an economy which compared favourably with the Diesel engine. It was very much simpler, lower in first cost and in cost of upkeep and repairs. Dr. Bowman had referred to the necessity for extreme regularity in the turning moment required in the lace industry, and he should like to ask him if in the case mentioned in his Paper the engine was a single-cylinder engine or whether it had several cylinders working on the main crankshaft. He had heard of two tests, which confirmed Dr. Bowman's remarks regarding the economy of suction-gas plants. One referred to a Fielding & Platt engine which produced a horse-power-hour for 0·1d. from small anthracite coal at 20s. per ton, and a Tangye engine which consumed 0·8lb. of coal per brake horse-power-hour, which was equivalent to an output of 11 H.P.-hours for 1d. Messrs. Crompton & Co., when testing an 80 H.P. Crossley gas engine with coke as fuel, obtained a kw.-hour at the switchboard with a consumption of 1·35lb. of fuel. In Yorkshire a fair amount of suction-gas plant had been turned out, and he thought Messrs. Robson & Co., of Shipley, had made something like 80 or 90 such plants. Another practical point mentioned in the Paper was that suction-gas plant could not be worked on light load for any length of time. That was a very material point under certain conditions, and the same difficulty occurred with Diesel engines. A Diesel engine could not be on light load because the oil was injected into the cylinder by means of compressed air. It naturally followed that the lower the load the smaller would be the necessary amount of oil to be injected into the power cylinder, and as the area of the spray nozzle was a fixed one, less oil meant a larger amount of air through the nozzle, and this waste of compressed air rapidly lowered the pressure in the air reservoirs until it became too low for effective injection when the engine stopped. When a Diesel engine or a suction-gas plant was required to run with a light load it was necessary to put a brake on the rim of the flywheel. Mr. Robson had informed him that his engine ran for two hours on no-load before showing any signs of the gas becoming weaker.

Mr. **ROSLING** had used gas engines for 15 years, and in 1893 with a 30 H.P. engine he could produce 1 kw.-hour for 26 cubic ft. of town gas, whilst this year he had a guarantee of 25 cubic ft. from another maker for a plant twice the size. That was an improvement of only 1 cubic ft. per kilowatt-hour in 12 years. In criticising the conclusions drawn by Dr. Bowman in connection with the 12 H.P. producer plant in the Paper, he mentioned that if 17½ per cent. be allowed for capital charges and attendance the price came out to 1·06d. per brake horse-power-hour, and with a generator of 85 per cent. efficiency the price per kilowatt-hour came to 1·67d. per B.O.T. unit, running for 60 hours per week with 9½ H.P. average load. He thought these figures were nearer the commercial costs than those given in the Paper.

Mr. **BENTON** mentioned a report by Mr. Michael Longridge on a very ordinary compound steam engine, which consumed 1·9lb. of coal per indicated horse-power-hour when indicating 395 H.P. With coal at 6s. 10d. per ton 14 I.H.P.-hours were thus obtained for 1d.

Mr. A. B. **MOUNTAIN** said that in Dr. Bowman's example of the 12 H.P. producer-gas plant the item of repairs had been altogether omitted. His experience was that with a gas engine the cost of repairs was three times higher than with a steam engine. He did not think it was reasonable to put down the ashes at 1 per cent. in the case of a producer. From actual experience he had noticed that when the ashes were taken from the producer a very large quantity of combustible matter was also drawn out, and it appeared as if the figure should really be nearer 10 than 1 per cent. He noticed that Dr. Bowman had taken his tests practically at full-load, but at low loads gas engines were most inefficient.

Mr. J. H. **WILKINSON** said that at the central station with which he was connected all the generators were run solely from gas engines. One 300 H.P. set had run every day during the whole of this winter, and the reliability, governing and running of that set had been very good. The author had stated that two engines could be worked from one producer. He would like to know what would be the effect upon the producer and one engine if the other engine was suddenly shut down, and whether there would be any trouble from back firing.

Mr. **PULLAN** asked what was the largest engine actually at work with suction gas, and what time it had been at work. There was not much doubt that the engine referred to as driving the lace machinery so well had got an enormous flywheel to ensure steadiness of motion.

Dr. **BOWMAN**, in his reply, stated that he was only aware of one instance where polyphase working had been tried with gas engines in this country, and believed it answered very well. The engine in the lace factory, mentioned in the Paper, had a single cylinder and the angular variation of velocity was very small indeed. He always preferred electrical ignition; pre-ignition, as with gas jets, was impossible. He was very much in favour of small cylinders, and in gas engines he did not think it advisable to get even 1,000 H.P. out of one cylinder. He would rather have four cylinders of 250 H.P. each. He also preferred governing by throttling the mixture. Referring to the question of improvements in gas engines, he remembered distinctly testing one of the early gas engines which he found used 36 cubic ft. of gas per brake horse power-hour. He had now a gas engine which produced 1 B.H.P.-hour for only 14 cubic ft. Tests were made with a certain engine to determine the consumption of gas at various loads. At full load (21 B.H.P.) and at 10 per cent. overload the consumption of gas was the same—viz., 20 cubic ft. per brake horse-power-hour. At three-quarter load (16 H.P.) 21½ cubic ft. were consumed per brake horse power-hour, and at quarter load the corresponding figure was 24. Steam engine efficiencies fell off quicker than that. The ashes taken out of these suction producers were small in weight. They did not amount to 4 per cent. of the weight of the coal in a particular case of a 12 H.P. engine. With regard to a question by Mr. Pullan, the largest suction-gas engine actually working was of 500 H.P. and had been running satisfactorily for several years.

ELECTRICALLY-DRIVEN LIFTS.*

BY F. O. HUNT.

The question of the most suitable type of lift motor is a matter upon which considerable difference of opinion still exists. In some few cases series-wound motors have been used, but the practice can only be condemned as hopelessly bad. The choice lies, therefore, between shunt and compound winding. The reasons given by the advocates of shunt winding are mainly greater simplicity of only one magnet winding, less space taken by insulation, and greater simplicity of the controller. Where, however, shunt winding is used, it is usually designed as if for a lower voltage than that on which the machine is to be used, and a resistance is placed in series with it. During the process of starting this resistance is short-circuited, thus making the machine take an abnormally large shunt current and producing the required extra torque to accelerate the load. Alteration of grouping of the shunt coils on a multipolar motor is also adopted by some firms, but in either case the net result is to obtain the required increase of ampere-turns by an addition to the shunt current taken by the motor. Seeing, however, that the greatest trouble with lifts supplied from public lighting mains is their tendency to cause fluctuation of voltage by their demand on the mains at the instant of starting, it is difficult to see how the shunt winding can be really as satisfactory as a properly-designed compound-wound motor arranged to have its compound coils cut out after the process of accelerating is accomplished. The compounding merely takes the place of the last section of the starting resistance, so the complication of the controller is more imaginary than real. In this case the increase in ampere-turns is obtained by an alteration of the number of active turns, while the current value remains unchanged. In whichever way the increased excitation is obtained, it is essential that the magnetic density in the field magnet should be kept low, so that the temporary increase in excitation shall be as effective as possible in augmenting the field strength, and consequently the starting torque, of the motor.

Where cheapness is an essential, hand-rope gear is at present the commonest method of operating the reversing and circuit-breaking switches. It usually consists of a more or less direct mechanical connection between what is virtually the handle of the switch and a rope. In many cases the reversing and circuit-breaking functions are both performed by the same switch, but there appears to be a tendency to separate the two operations. Probably this arises from the fact that with this arrangement it is possible to adopt more effective measures for magnetically blowing out the inevitable arc at the contacts. When speeds of more than 160ft. per minute are required it is now becoming usual to supersede the mechanical hand-rope transmission by an electrical method, in which the attendant merely moves a switch in the cage. Where the cage-switch method is used, the general practice is to avoid taking the actual power circuit to the cage, owing to the probabilities of trouble where heavy flexible cable is required. An independent circuit carrying a comparatively small current is led into the cage, this current being used to energise the operating solenoids of the power switches.

Formerly the American method of causing the motor to provide mechanically the motion necessary to cut out its own starting resistance was very much in favour, and it is still retained by some makers, owing to its inherent properties of preventing the motor being started against an overload, and also the certainty of a definite time being taken to cut out the starting resistance. It has, however, the serious drawback that, unless further auxiliary apparatus is employed, it is necessary that sufficient current to start the motor shall pass through it on the first contact stud. General practice now appears to tend in the direction of obtaining this motion electrically even when hand-rope control is in use. The time element during the process of acceleration is usually obtained by means of an air or oil dash-pot. To avoid the use of a dash-pot, some makers adopt an air-vane geared up to run at a very high speed. There appears, however, to be still room for improvement, as all methods of slowly-moving contact makers over studs are more destructive than intelligent hand working. What is wanted is a quick movement from one stud to the next and a prolonged pause on each stud, but an intermittent motion such as this is always difficult to obtain by mechanism that is at once cheap and reliable.

In the early days of electrically-driven lifts brakes were exclusively a mechanical matter, and are so still in many cases where hand-rope control is adopted. When electrical control is used, it becomes necessary to lift off the mechanical brake magnetically, thus ensuring that when current is "off" the brake is "on," and vice versa. In the design of magnetically-lifted brakes there appears to be still room for improvement in the direction of arranging the link-work so that the solenoid has a considerably greater mechanical advantage at the beginning of its travel than at the end, thus compensating for the inherent property of the solenoid that its pull is weakest where it is desirable that the greatest force should be available.

The supplementing or replacement of the mechanical brake by a retarding device depending on electromagnetic action, due to the motor being used as a dynamo, is a development which is growing in favour, and undoubtedly further changes in the same direction may be expected in the near future. The facts that such a device can be made much more even in its action and is capable of much finer adjustment than any brake depending on an erratic coefficient of solid friction are strong points in its favour. Where only mechanical braking has been used, the writer has seen the end of the motor shaft twisted off by the action of the momentum of the armature combined with an excessively severe application of the brake. This latter circumstance is always liable to occur owing to the anxiety of the maker of the hoisting gear to reduce the error in stopping at floors to a minimum. The ideal brake evidently should be such that the armature will be caused to dissipate the whole of its own kinetic energy in the same time that the mechanical brake is performing a similar office for the mechanical parts of the system, thus relieving the motor shaft from all twisting stresses no matter how quickly the stopping may be done. Where push-button systems are in use the range of error in the stopping point becomes rather an important matter. Some makers provide two additional buttons in the cage to enable the user to adjust its position with regard to the floor. What really is required in such a case is a method of varying the braking effect according to the load in the cage.

DISCUSSION.

Mr. **CROSS** said he failed to see how shunt motors were more simple than compound motors. The difficulty of the lift attendant not knowing the exact position of the switch contacts was due to design, and could be remedied by making the distance between the stops greater. This would allow the attendant more play when stopping. The relay currents were very small, and ½ ampere on a 200-volt circuit was all that was needed, and this current could be easily dealt with by push contacts. There was no need to reverse to bring the cage level with any floor; it should be quite easy for the lift to be made to stop accurately enough for most purposes.

Mr. **SNELL** asked Mr. Hunt if he had had any experience with three-phase and single-phase lift working. Three-phase induction motors were being largely used, and he would like to hear of their possibilities.

Mr. **CLATWORTHY** asked Mr. Hunt how to arrange limit switches when the clearance between the bottom of the cage and the floor was only about ½in. How was a lift started again after the limit switch had been knocked out?

Mr. **HIRST** mentioned that automatic lifts did not usually exceed 120ft. per minute, and at this speed would have only a small stopping error of about an inch each way. Limit knock-out switches were often in inconvenient places, and were, in consequence, ignored and not kept in proper working order.

Mr. **HANKS** desired to know if any difficulty was experienced with the insulation and the conductors of the flexible cables owing to the wires becoming brittle and breaking and piercing the insulation.

Mr. **FALCONAR** asked whether there was more wear on the winding cable when driven by a sleeve than when wound on a drum. The stretching of the cable would not affect a sleeve-driven lift.

Mr. **EUGENE BROWN** did not like the idea of series motors, as they were so liable to run away.

Mr. **HUNT**, in reply, agreed with Mr. Cross that the switch trouble would be avoided if more travel were allowed between the contacts. In some cases less than ¼ ampere at 200 volts was used in the relay circuits, and he had heard from American sources that as small a current as [illegible] ampere was used. He had not much experience in three phase lift working. There need be no regulation of speed other than at starting. With small clearance at the bottom of a lift well the only limiting device was buffer stops. A wire was carried to the limit switches from the reversing switch, and by this means the limit switches could be closed inside the cage. Sleeve driving wore the winding cable much more rapidly than drum winding. There was not much trouble with the flexible cable. Hard drawn flexible cables would be an advantage, but insulated steel wires would be the best if they could be had.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

N-rays.—O. Rosenbach writes a "critique of the N-ray problem," in which he takes the view that the N ray phenomena are actually seen by the normal observer (though this has been denied), but are due to an unconscious visualisation of muscular processes. He describes an experiment in this connection which, he maintains, everyone can perform with ease. In a perfectly dark room the hand is held before the eyes. The fingers will then be seen black on a background filled with vague luminous impressions such as are always present. On moving the fingers, their motions are seen. The vision is, of course, not real, but due to an association of ideas which has by habit become irresistible.

(O. Rosenbach, *Physikalische Zeitschrift*, March 16, 1905.)

Electromagnetic Inertia.—P. Langevin enters deeper than usual into the connection between electric charge and inertia. He proceeds from the basis of Kaufmann's observation that the mass of the electron is purely electromagnetic—*i.e.*, that its inertia is due to the fact that a change in its motion modifies the energy in the surrounding ether, and therefore either absorbs or emits energy. At a distance from its source an electromagnetic wave contains strictly equal amounts of electric and magnetic energy. This equilibrium can only be disturbed by matter, which acts somewhat like a catalyser in chemistry. Matter alone can give rise to radiation. The author shows mathematically that the acceleration or retardation of an electron gives rise to a wave which has all the characteristics of an electromagnetic wave, including the quality of electric and magnetic energy. Conversely, all radiation implies change of velocity of electrons. When in steady motion, the electron is accompanied by a "wake" of electromagnetic energy, but this energy does not radiate into infinite space. It is constant, and moves with the electron. Hence Newton's first law of motion, if all matter consists of electrons. The constancy of the inertia of matter enunciated by that law is, however, not universal. It fails when the velocity begins to approach that of light. At that very high velocity, the inertia increases rapidly with the velocity, so that the kinetic energy becomes infinite when the electron moves with the velocity of light. This contingency, however, can only happen once, since P. Hertz has proved that such a velocity must have existed for infinite time if it exists at all. Ordinarily, the energy required to change the "wake" of a slowly moving electron into that of a swiftly moving one is very large compared with the energy radiated at the instant during which the change takes place. Hence the energy radiated can be neglected in ordinary mechanics. But in any system of mechanics based upon electromagnetic theory, the velocity of light must constantly intervene.

[P. Langevin, *Journal de Physique*, March, 1905.]

Radium as a Curative Agent.—A. Béclère has tested the therapeutic value of radium salts applied externally. He finds that the rays have exactly the same effect as those of a "soft" Rontgen ray tube, and are of little use for deep seated affections. Their chief advantage lies in the smallness of the apparatus required. A radium preparation is a kind of "pocket edition" of an X-ray tube, and can be applied in places where the latter could not find room.

[A. Béclère, *Archives d'Electricité Medicale*, March 25, 1905.]

Variation of Dielectric Constant of Glass.—A. Broca and Turchini have found a slight variation of the specific inductive capacity of glass at high frequencies. They found a slight decrease with increasing frequency, but were unable to measure it. They went up to three million periods per second, and used Leyden jars. Consistent results were obtained on putting into the formulæ a capacity amounting to about 0·07 times the capacity of the condenser for ordinary alternating currents.

[Broca and Turchini, *Comptes Rendus*, March 20, 1905.]

Transmission of Electric Waves through Liquids.—V. Buscemi has, with the help of a modification of Fleming's detector, determined the transparencies of a number of liquids for electromagnetic waves. He finds that acid solutions strongly absorb the waves. If the strength of the penetrating waves is 21 for air, it is 16 for petroleum, 17 for benzine, 12 for ether, 7 for distilled water, 1·5 for a 0·5 per cent. salt solution, and inappreciable for concentrated acids or sea water.

[V. Buscemi, *Nuovo Cimento*, February, 1905.]

Atmospheric Electricity.—G. C. Simpson gives the results of measurements made in the Lapp village of Karasjok, 200 miles south of the North Cape. He got daily curves of the potential gradient extending over a year, and also measured the dissipation, ionisation and amount of emanation. He could not trace the slightest influence of the aurora. The potential gradient had a maximum at 9 p.m. The dissipation was highest at midday in the summer and autumn. For any given wind strength the dissipation is a linear function of the ionisation. Both become less in the cold. With rising humidity, the dissipation falls rapidly, and the ratio of negative to positive dissipation increases.

[G. C. Simpson, *Royal Society*, March 2, 1905.]

Electron Theory of Metallic Conduction.—H. A. Lorentz continues his theoretical investigations of metallic conduction, with special reference to thermo-electric effects. He calculates the heat developed in a circuit in which there is an electric current i, or rather, supposing each element of the wire to be kept at a constant temperature by means of an external reservoir of heat, the amount of heat that is transferred to such a reservoir per unit time. He considers the part of the circuit lying between the sections whose positions are determined by x and $x+dx$. The work done during the time dt, by the forces acting on the electrons in this element, is $w\,dt$. $W\Sigma$ being the quantity of heat traversing a section per unit time, $d/dx(W\Sigma)dx$ is the difference between the quantities of heat leaving the element at one end and entering it at the other, and the production of heat is given by

$$q = w - \frac{d}{dx}(W\Sigma)dx.$$

This expression may be divided into three parts. The first of these,

$$w_2 = \frac{i^2}{\sigma\Sigma}dx,$$

is the Joulean heat. The second,

$$-\frac{d}{dx}(W_1\Sigma)dx,$$

is entirely independent of the current, and represents the ordinary conduction of heat. The third portion,

$$q^1 = \frac{mi}{2eh}\frac{d\log A}{dx}dx.$$

which is proportional to the current and changes its sign if the latter is reversed, leads to formulæ for the Peltier effect and the Thomson effect. For the former, the temperature must be supposed to be uniform, but the metal to vary. The Peltier effect is then given by

$$\frac{2aT}{3e}\log\left(\frac{N_1}{N_2}\right),$$

where N is the density of free electrons. The author next assumes a homogeneous metal and a gradient of temperature, and thus obtains for Kelvin's "specific heat of electricity" the expression

$$\mu = -\frac{2aT}{3e}\frac{d\log A}{dT}$$

At ordinary temperatures the expression aT/e is 38×10^5. This enables the author to determine the relative number of free electrons in various metals from their thermo-electric force, by means of the equation

$$\log\frac{N_2}{N_1} = 0{\cdot}00011F_1$$

F_1 being the thermo E.M.F. for 1 degree difference of temperature. For bismuth and antimony the ratio comes out as 3·7.

[H. A. Lorentz, *Proceedings* Amsterdam Academy, February 25, 1905.]

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THE ELECTRIC MOTOR CAR.

An interesting Paper on "The Future of the Electric Automobile" was recently read by Mr. T. G. CHAMBERS before the Automobile Club of Great Britain and Ireland. In spite of the title of his Paper, the author did not, however, confine his remarks to the future but gave a brief historical sketch of the electrically-propelled vehicle and also summarised its present status. It appears that the backward position of the electric motor-car industry is due largely to ill-timed and badly-financed ventures, and that these mistakes have not been peculiar to London, but have occurred almost simultaneously in Paris and New York. Unfortunately, too much was expected—and demanded—of motor cars driven by electricity, it having been proposed to employ them for all sorts of purposes for which they were not in the least suited. So many wonderful things had been performed through the agency of electricity that statements as to its possibilities, as far as traction was concerned, were readily swallowed by a gullible public. The result was that companies were floated, expensive patents purchased, and attempts made to establish an industry, with an entire absence of data and long before the time was ripe. Small wonder is it, then, that matters have come to their present pass. However, it would seem that order is gradually being evolved out of chaos, and that, given proper management, there is every prospect of a bright future.

Allegations have frequently been made that the electric car are not reliable, but statistics prove that quite the reverse is the case. Mr. CHAMBERS said that the total number of involuntary stops of carriages dealt with during six months at a West-end garage was only 61, the total number of carriage-miles run being practically 160,000. This is, of course, an exceedingly good record, but it does not include the stops caused by power exhaustion; it is asserted, however, that little or no difficulty at all arises from this cause, especially when the limitations of the battery are well understood. The author said very little indeed about technical details, but he rightly advocated the standardisation of accumulator plates.

Perhaps he might also have urged the standardisation of the number of cells in each battery, so that charging stations may be provided with standard apparatus as far as possible.

With regard to the future of the electromobile, there is little to be said except that, unless some wonderful new battery is discovered, it can never be a touring car, and that until then town work will be its only sphere. For this latter purpose it is, however, eminently desirable, and has undoubtedly come to stay. In certain circumstances electrically-propelled delivery vans are possible and even economical, but we scarcely think that very serious attention will be given to them. For certain special uses, such as in connection with ambulance vans, electricity is an ideal motive power.

As far as the greater part of Mr. Chambers' Paper is concerned, we are in agreement with him, but there seems to be something unsatisfactory in his estimate of the cost of keeping an electric motor car. He considers the case of an automobile such as might be suitable for replacing a single horse brougham of the type used by medical practitioners, and says that he does not think any automobile of to-day could be let out to such a customer at £250 to £300 a year. However, he foresees the time, "when the cost of production is lowered by building in large quantities, and when standing costs are reduced by the number of carriages garaged," and it will then be possible to let out a brougham at £250 a year without a driver. Assuming that an efficient driver may in time be procurable at £75 a year, he arrives at £325 a year as the lowest inclusive cost which would be remunerative to the company supplying the carriages. He then asks if this figure is prohibitive, considering all the advantages to be derived by a business or professional man; we are inclined to think that it is. Mr. Chambers considers the matter entirely from the point of view of the company which desires to let carriages out on hire—in fact, of the job-master—and he neglects to take into account the possibility of a person wishing to possess a carriage of his own. For this reason the Paper is misleading, for it might be imagined therefrom that it is impossible to have the use of an electric carriage for less than about £320 a year. Happily this is by no means the case. Major Edward F. Gosset, an enthusiast for the electrically-driven car, has shown us his electric phaeton, which he keeps in first-class repair, and runs at a cost far below this figure. Major Gosset's vehicle was built by the London Electro-Mobile Syndicate, and is equipped with Hart cells. Its owner estimates a year's expenses as follows:—Re-plating battery, £20; renewing bearings, £5; re painting, £10; renewing tyres, £20; insurance, £8; and cost of running (say) 20 miles per day—roughly 7,000 miles—on the basis of 4 miles per unit, 1,750 units at 3d. per unit, £22; total, £85. As a matter of fact, Major Gosset has been using his car for nearly a year, but the battery does not need re-plating, the bearings are quite good, very little painting is needed, the tyres have not so far cost more than about £5, and the total cost of repairs of all sorts was amply covered by £10. No driver is required; a boy is employed to keep the carriage clean, and Major Gosset affirms that it causes a minimum of trouble and is entirely satisfactory in every respect. Another point worthy of attention is that Mr. Chambers estimates the cost of electrical energy at 1½d. per unit, whereas Major Gosset puts it at 3d.

It may be admitted that a carriage which is on hire has to do much more work than that quoted above, but the fact remains that an electromobile can be maintained in good condition so as to give excellent service for a much smaller sum than that mentioned by Mr. Chambers. Of course it may be argued that the vehicle which is entitled to garage privileges and is supplied with a regular driver, can hardly be compared with the private car such as that owned by Major Gosset, but this is not the point that we have endeavoured to emphasise. The business or professional man does not want the use of a garage, and, in many cases, not even of a driver: for him, then, the electric vehicle is admirable, and we trust that Mr. Chambers' figures will not have a deterrent effect upon any who may be thinking of purchasing electromobiles.

OBITUARY.

CHARLES ALEXANDER GERHARDI.

We regret to record the death of Mr. Charles Alexander Gerhardi, M.I.E.E., which took place at his house in London on Sunday. Mr. Gerhardi was born in 1837, and has been connected with telegraphy since 1853, when he entered the Belgian Telegraph Service. In 1856 he resigned this appointment to enter the service of the Electric & International Telegraph Co., which he left in 1857 to join the Atlantic Telegraph Co. He was present on board the United States steam frigate "Niagara" at the attempts to lay the first Atlantic cable in 1857 and 1858, and also at the final laying of that cable in 1858, when he was attached to the Newfoundland station of the company till 1859, the cable being then abandoned as unworkable. In 1860 Mr. Gerhardi was appointed by the Submarine Telegraph Co. as superintendent of their Channel Islands cable, and later on was put in charge, at London, of the Belgian, Dutch and German cables. He left the Submarine Telegraph Co. in 1872, being appointed in the same year manager of the Direct Spanish Telegraph Co., which had just then been formed, and he continued to manage this company until his retirement from active service, with a pension, in 1902.

Mr. Gerhardi represented his company at the International Telegraph Conferences of London, 1879; Berlin, 1885; Paris, 1890; and Budapest, 1896. He became a Member of the Society of Telegraph Engineers (now the Institution of Electrical Engineers) in 1874. In October, 1898, Her Majesty the Queen-Regent of Spain conferred on Mr. Gerhardi the Commandership of the Order of Isabel la Catolica.

The funeral took place on Wednesday at New Southgate Cemetery, and was attended by many friends and representatives of the Post Office, the Cable Companies with which the late Mr. Gerhardi was associated for so many years, and the Telegraph Cable Lodge. He leaves a widow and one son, who is already well known in the electrical profession.

JOHN BAILEY.

We have also to announce the death of Mr. John Bailey, which occurred on March 30th, after a comparatively short illness. By the decease of Mr. Bailey another link with the earliest days of submarine telegraphy is broken. Mr. Bailey was born in London on July 24th, 1830, and was thus, at the time of his death, in his 74th year. At the age of 18 he entered the service of Messrs. S. W. Silver & Co., of Cornhill, where he remained until 1857, when he was appointed to the post of resident manager of the works at Silvertown, which were then in an embryo condition. From that date until his transfer to the headquarters in Cannon street, in October, 1900, he remained at Silvertown. The growth of the India Rubber, Gutta Percha and Telegraph Works was, to a great extent, due to the tireless energy and organising ability which Mr. Bailey possessed.

In the year 1875 Mr. Bailey was elected as an Associate Member of the Council of the Society of Telegraph Engineers, in the progress of which he took a great interest. By the retirement and death of Mr. Bailey, the Silvertown Company have lost an able and zealous member of their staff, who will long be kindly remembered by all those who were associated with him. His unfailing cheeriness and good nature, which were unaffected by stress of work, together with the intimate knowledge which he possessed of all the details and difficulties which must necessarily arise in connection with a large establishment, made it easy and pleasant to work with him. Mr. Bailey only survived the loss of his wife by a few weeks and leaves a family of four sons and five daughters.

SOME NOTES ON A PRIVATE LIGHTING AND POWER PLANT.*

BY P. T. BLISSET.

This Paper is devoted to a description of the electrical driving and lighting of a large number of plants, formerly entirely steam-driven and gas-lighted, nearly all working in wet and steamy situations, and scattered over about 50 acres. As the conditions were exceedingly adverse to the successful working of the ordinary electrical gear to be obtained 10 years ago, it is very satisfactory to know that most of the original motors and starting gears are still in use and doing good work. The change over from steam and gas to electricity has been going on gradually, the old engines and gas lighting coming in useful as "spares" until sufficient confidence was gained to dispense with their services and depend entirely on electricity. Recently, however, in some large extensions that have been made, electricity is in use exclusively.

A battery of 10 cylindrical multitubular boilers supplies steam to the generating station, each boiler generating steam at 150lb. pressure per square inch. Induced draught is used, the ingoing air being heated by passing through tubes in the uptake. Sturtevant fans, driven by 11 H.P. or 15 H.P. motors, draw the gases from the smokebox and discharge them through cyclones to take out any dust. These cyclones absorb a large portion of the power of the fan motors, but are necessary, as dust could not be allowed to blow about where there are many open tanks containing water and other liquids. Feed water is pumped by three-throw pumps driven by a 5 H.P. motor through a Royle heater into each boiler; an injector is also provided as a spare. This range of boilers is fired by three men, and as the load-factor of the battery is about 73 per cent., the three men are kept fairly busy. A Vicars stoker is now being used on one boiler, and gives still better results than firing by hand. The steam is generated at a cost of 12·64d. per 1,000lb., slack coal being used. The generating station at present contains two Willans compound engines coupled to 120kw. generators, two Willans of 60kw. each, two old-type Parsons turbo sets of 60kw. and one Parsons turbo of 250kw. capacity. All the generating sets exhaust into a condenser, the atmosphere, or into a main carrying from 10lb. to 15lb. pressure per square inch, the steam being carried round the works and used for heating purposes. As the demand for heating steam varies very considerably, some of the engines are made to exhaust into the condenser, if cooling water is available, or, failing this, into the atmosphere—*i.e.*, when there is more steam going into the back-pressure main than is required. As there is considerable waste at times, due to exhausting into the atmosphere, a new Parsons 250kw. set is being installed to work at from 10lb. to 15lb. pressure per square inch, exhausting into a separate surface condenser. Under these circumstances, economy of steam is not of the first importance, as the heat wasted by the engines is made use of afterwards.

Fig. 1 represents comparative tests between the new Parsons 250kw. set and a 120kw. Willans-Mather & Platt set. A comparison was also made from an actual run of both types, extending over several days, the steam consumption per kilowatt-hour ranging from 50lb. to 65lb. There is a marked difference between a test made with the best load for a machine and one made on an actual run where the load is constantly changing; the steam consumption at its lowest, when the Willans sets only were working (with exhaust to atmosphere), was about 50lb. of steam per kilowatt-hour.

The kind of load that the engines were dealing with is shown by Fig. 2. The published coal consumption figure for the City and South London station—9·95lb. per kilowatt-hour—does not compare well with the 5·9lb. of coal consumed in the present case. It is possible that the conditions of working in the two cases may be very different. Still, it is satisfactory to know that, with regard to coal consumption, this small plant can compare very favourably with some of the larger ones.

Perhaps the question of actual efficiency of the machines is not so important within the scope of this Paper as their running. The Willans engines have proved rather troublesome and require a lot of attention, the maintenance charges coming out very high. They frequently required taking down and putting together again, which would take a fitter and his helper two weeks to do, costing about £5. 10s. per engine. Occasionally knocking in the engines occurs, but on being taken down nothing wrong is discovered, and when put together again the engines work perfectly well. The oil consumption is also rather a large item compared with that of some other types of engines, three-quarters of a pint of cylinder oil being used every eight hours in each of the 120kw. tests, and every month or so about 6 or 8 gallons of crank-chamber oil on account of water from the cylinders coming down and floating off the crank-chamber oil if not noticed. The Parsons turbines give very little trouble, in the later type the oil being circulated through the bearings by means of a pump. Considering that the speed of the 250kw. machine is 8,050 revs. per min., the system of floating the bearing is remarkably successful, and a great improvement on the older types, in which the apparatus consisted of a worm on the spindle engaging in a wormwheel with 41 to 1 reduction, which drove the air-pump, the working of which caused a considerable knock at each revolution of the wheel. On one occasion, the blades having become jammed, a coupling between the turbo and generator, consisting only of a 1in. square spigot working in a square hole, was sheared off. With Parsons sets the wear of the commutator is very considerable, due to the great speed, and sparking is almost inevitable, due to the changes of the load, although the brushes are adjusted to the load as much as possible. As the sparking is due to the distortion of the field by currents flowing in the armature, an arrangement is being fitted for preventing this distortion by taking the current of the machine round a coil inside the pole-faces, so that the current flowing in it will be in the opposite direction to that in the armature, the current in the coil neutralising the action of the armature on the field.

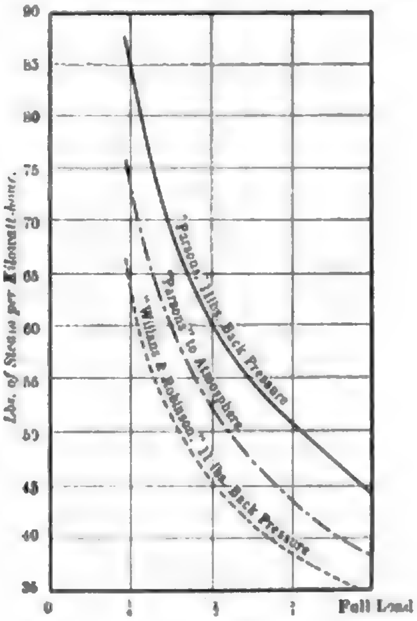

FIG. 1.

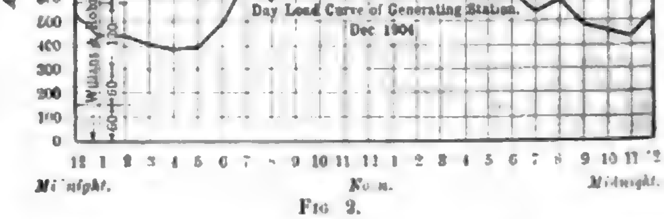

FIG. 2.

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* Abstract of a Paper entitled "Some Notes on the Running of a Private Lighting and Power Plant," read before the Dublin Local Section of the Institution of Electrical Engineers on February 9th.

The generators are all coupled on to the two 'bus bars of a Ferranti low-tension switchboard, this switchboard having been recently installed at the back of an old Mather & Platt board, which it has replaced. The Mather & Platt board, which was designed about 1889, was rather a dangerous arrangement, the feeders being plugged on to the 'bus bars and the cables at the back crossing each other in a very risky manner. Some of the terminals were very near the supporting frames, and arced across on one occasion, causing the cables at the back to catch fire. To make matters worse, some energetic fireman turned the hose on instead of using the sand buckets provided.

The engines in the station are governed by two types of governors, the Willans having "centrifugal" and the old type of Parsons "solenoid." As the solenoid governors were much more sensitive than the centrifugal, the Parsons machines took up practically all the variation in the load of the station. This caused overloading frequently, and consequently the sensitiveness of the governors had to be reduced by shifting the point of suspension of a spring, which resists a core being drawn into the solenoid part of the governor. There is no difficulty in running the two types of engines in parallel providing that the governing is of the same type. The governor of the 250kw. Parsons is of the pendulum type. There is also another one running with it, which acts on a trip gear and closes the stop valve in case of the turbo running away. At first the trip gear came out occasionally, but this never happens now, and it runs on continuously, requiring no overhauling. Perhaps a good thing in the new types would be to have a second oil-pump, so that if one pump failed the lubrication would still go on. The cost of maintenance for turbo sets should be very little, the biggest item, perhaps, being new brushes and the renewal of the commutator, say, every four years. It may be safely said that the cost of repairs and oil together for them is not one-sixth of that for the Willans engines. Any comments on the running of Mather and Platt generators are not necessary, as no complaint is ever heard concerning them.

The power wiring has been done chiefly by the staff on the works, and some time ago was carried out with lead-covered and armoured cables fixed by means of teak cleats. Although this style of wiring gave comparative safety, it was impossible to pull the cables quite straight, and it was difficult to bend them neatly round sharp corners. Much of the armoured cable was afterwards put into wood troughs and covered with a teak capping, the smaller cables being put into specially heavy pitch-pine casings. For the heavier cables, say 37/16, the wood troughing with cleats every 2ft. makes a very good job, and if the troughing is well coated with shellac inside to keep moisture from coming through, the arrangement has been found to stand well under very trying conditions, braided cables only being used. Braided cables have been drawn into galvanised iron screwed tubes, but the drawing-in part is very difficult with cables of over 7/16. There is a great temptation to thread the pipe fittings over the cables and then screw them up, resulting in the cables being twisted and badly damaged.

When cables come to a distribution or fuse box, they should preferably be brought into it direct on to front-connected switches or fuses, or, if back connected, should be brought in at the side of a frame on which is mounted a door, hinged horizontally, and carrying the fuse or switch gear, so that the back connections are accessible, and the cables coming in and going out near the axis of the hinges need have no slack in them. Cables sweated into cable eyes (sometimes badly) have been known to fall out from the melting or softening of the solder. No weight of cable should, therefore, be allowed to hang on a cable eye into which it is only sweated. In a running plant, where so much depends on the distributing system, these small details are of more importance than is thought by those who design small electrical gear. Small gear as supplied in the ordinary way by manufacturers is usually too light for the usage it has to put up with. Screws, &c., are generally put where they cannot be tightened up without taking off much covering. Highly-polished hexagon nuts, etc., are fixed where a spanner cannot be got on them, and pliers are used instead. Brassfinishers' nuts, being of various sizes, do not usually fit ordinary Whitworth spanners.

Of the various types of fuses tried, the switch type with the porcelain handle appears to be the best. The hollow handles should, however, be lined with plaster or asbestos; porcelain handles with no lining are extremely dangerous to anyone putting in a fuse with "a short" on the line, as the arc inside the handle may cause it to burst suddenly. The damper type of fuse cannot be seen when blown, and in the larger sizes the holders are burst. Copper wire appears to be the best to use for fuses except for very small currents. In the majority of switch fuses the spring contacts are easily bent, and no provision is made to prevent the fuseholder from falling out when the contact springs are bent.

It is not much good to arrange the top half of a motor to lift off in a few seconds and find that it takes 10 minutes to disconnect the shunt. There is no reason why the shunt connections should not be made automatically when the top is put on, as is done in some motors. There is a great difference in the winding of armatures, some being very much more difficult to get a coil out of than others. Certainly the best kind is the "former" wound type for repairing, the individual coils being bound together very hard. Some makers of armatures use very soft coils, and not only does the insulation get rubbed off the wires, but the coils are very difficult to get into the slots. A great many breakdowns of armatures are due to the wires flying out at the commutator end, where they are sweated into the bars. They should always be bound down with piano wire binding, or some better connection provided. Some breakdowns are due to careless handling in putting the armatures into the carcases, but this can only be expected when it is such a difficult job in some cases. As sometimes the spindles of motors get bent or damaged, it is a great advantage to have the coil mounted on a sleeve which can be drawn off the spindle. A weak point in the insulation of armatures is at the outer end of the commutators, as there is generally a thickness of mica only between the end of the commutator and the spindle. As there are 204 motors in use, varying from ¼ H.P. to 15 H.P., with a total horse-power of 1,863, it speaks well for electrical driving when it can be said that under the worst conditions there are rarely more than two or three armatures under repair. Spare armatures are kept for all motors, and a breakdown causes little delay. The majority of the motors being well above their work, breakdowns from overloading rarely occur. There is no serious loss in efficiency when working under full load, and with small motors particularly it pays to put in a much larger motor than actually required, as this is about the only way of preventing breakdowns on small motors.

The best form of brush gear is found to be the parallel frame arrangement with a spring across the diagonal, which is certainly better than the gear provided with a rectangular slot hole in which the carbon slides. Unless considerable pressure is put on the brushes, they are liable to stick, and too much pressure causes great wear of the commutator. Motor-starting gear is, perhaps, one of the most troublesome arrangements—far more so than are the motors. The makers of this kind of gear have not brought their branch up to the same standard as the motor builders. Resistances are seldom properly divided. Insulation from the frames is often not good, and generally the resistance coils are not heavy enough to stand the starting current long enough. The starters adopted are made to stand the starting current for about a minute without injury, so that if the circuit-breaker or fuse goes whilst starting, the motor can be started again without waiting for the resistance to cool down. The ordinary man does not think of waiting for cooling, and this often results in the burning out of small resistances. The asbestos tubes used for winding the coils on are liable to get moist, and when wet there are leakages to the frame, from which bad shocks are to be had. Many of the handles for switches and starting levers are ridiculously small, and, as they have fairly rough work to do, should be made much heavier. The card-wound type of resistances used were very unfortunate in breakdowns, and have nearly all had to be replaced by other types. The insulating material being porous absorbed moisture, which caused much of the trouble. Some of the resistances supplied were insulated with a kind of paper tarred over, which ignited when the resistance warmed up.

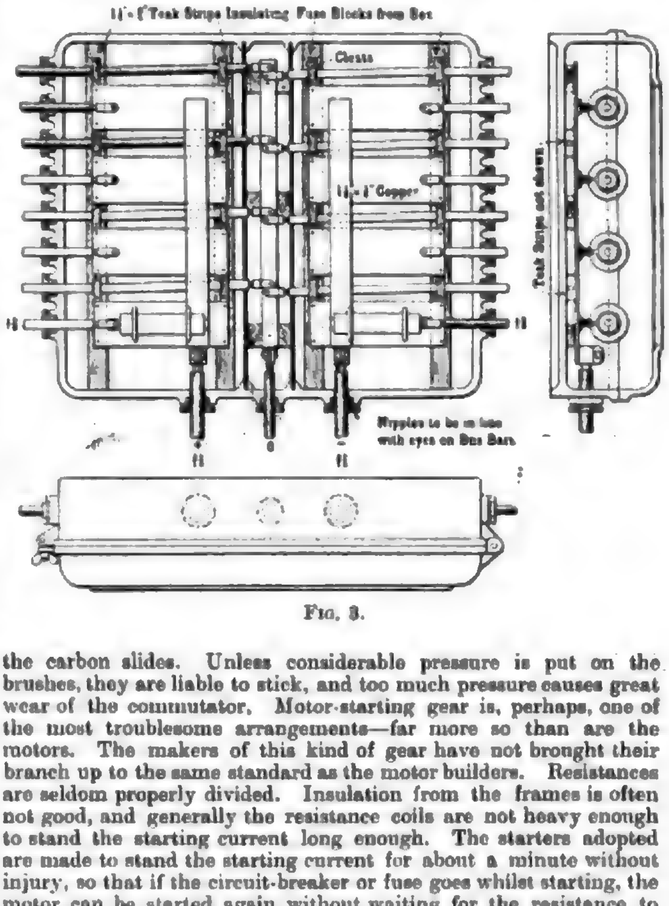

1½″ × ½″ Teak Strips Insulating Fuse Blocks from Box
Cleats
1½″ × ¼″ Copper
Teak Strips not shown.
H
H
+
0
−
H
H
Nipples to be in line with eyes on Bus Bars.

FIG. 3.

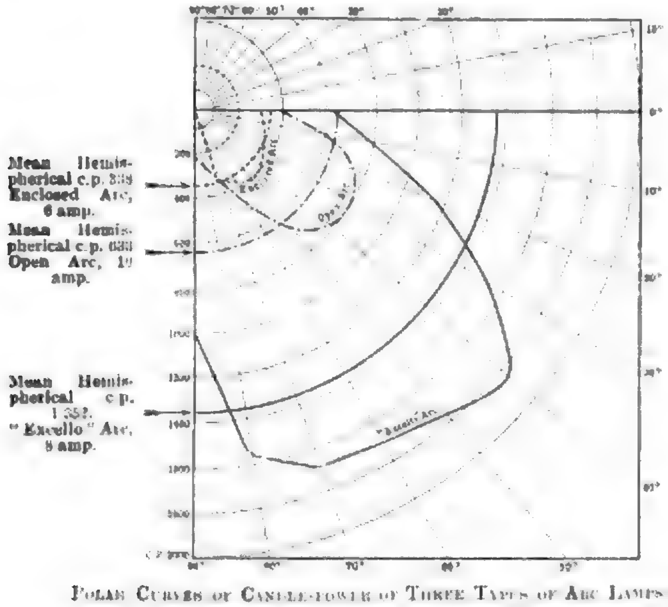
All motor panels are provided with double-pole switches, fuses, and an ammeter with a full-load mark on it. The ammeter should be of the dead-beat type, and is a great advantage at starting, showing if anything is wrong with the motor or the gear driven. It is important that all connections to starting gear should be accessible from the front, and that the starters may be changed quickly. The complete panels should be enclosed in a case to keep all contacts clean, especially the starting contacts, which, when dirty, sometimes cut the greater part of the resistance out at one jump. Coal dust on the slates has sometimes caused an arc between two terminals.

The cleat system of wiring for light has been tried with success, and although this form of wiring is not looked upon favourably by insurance companies, it has proved itself up to now to be as safe as the other systems, and has certainly many advantages. It can be done very neatly, and in much less time. Unfortunately, porcelain fittings for this kind of work have not been obtained, and various makeshifts have been used in consequence. Junction and cross-over boxes could be made, but the prices are prohibitive for small quantities. There appears to be a good opening for manufacturers to take this matter up, and an extensive use of wiring on porcelain cleats would be likely to be made, especially for factories. The accompanying diagram (Fig. 3) of a fuse box for cleat wiring gives an idea of how such a system as this could be made very reliable for wet situations.

The result of experience with lighting of large areas broken up with columns, joists, &c., has led to the conclusion that groups of incandescent lamps are more economical to run and require less attention than enclosed arc lamp lighting, arc lamps being always a source of more or less trouble, especially in steamy places. Perhaps arc lamps of the open type may be successful for street lighting, but for interior lighting on 210-volt circuits the losses in the lamp are so great that probably a new three-watt incandescent lamp can show as good an efficiency as a small arc lamp. If the cost of trimming and maintenance are considered, the cost of arc lamp lighting may come out to more than that of the incandescent.

THE "EXCELLO" FLAME ARC LAMP.

In view of the attention which is now being attracted by the "flame" type of arc lamp, a report issued from the Westminster Electrical Testing Laboratory is of considerable interest.



POLAR CURVES OF CANDLE-POWER OF THREE TYPES OF ARC LAMPS TESTED AT WESTMINSTER ELECTRICAL TESTING LABORATORIES.

With current at 4d. per unit the cost of 1,000 c.p. of light per hour is:—With enclosed arc lamp, 5½d.; open arc lamp, 2½d.; "Excello" arc lamp, 1½d.

Comparative tests for candle-power and efficiency were made on three different types of arc lamps on behalf of the Union Electric Co. One was an ordinary open type lamp, rated at 10 amperes and fitted with a positive cored carbon and a negative solid carbon. The second was an enclosed lamp, rated at 6 amperes, both carbons being solid. The third lamp was an "Excello" flame lamp made by the Union Company, rated at 8 amperes, with the arc burning horizontally, and fitted with Noris-Excello carbons, Nos. 101-105. All three lamps were provided with Alabastrine globes, and the amount of light obscured by the globes appeared to be the same in all cases. The same photometer, light standard and instruments were used throughout and the conditions were, therefore, about as fair as could be obtained. In the following tables details of the tests are given.

Electrical Details.

—	Open arc.	Enclosed arc.	Excello arc.
Positive carbon	18mm. cored	13mm. solid	9mm. flame
Negative carbon	12mm. solid	13 " "	8 " "
Mean current in amperes	10·8	6·25	8·7
Mean pressure in arc volts ..	44·0	77·6	44·0
Mean consumption in watts (shunt included)	476·0	485·0	382·0

Candle-power Details.

Angle below horizontal.	Candle-power.		
	Open arc.	Enclosed arc.	Excello arc.
0 degrees	363	290	600
10 "	390	308	760
20 "	735	330	1,120
30 "	800	350	1,520
40 "	790	382	1,630
50 "	690	410	1,750
60 "	490	360	1,700
70 "	330	345	1,680
80 "	250	75	1,560
90 "	210	80	1,000
Mean hemispherical C.P.	633	388	1,352
Watts per M.H.C.P.	0·753	1·435	0·299

Continuing, the report says that from the above it appears that the watts per mean hemispherical candle power is, in the case of the "Excello" arc lamp, only 37·5 per cent. of that obtained with the open arc and 19·65 per cent. of that obtained with the enclosed arc. Both the open and enclosed arcs were considered as representatives of their class. It was not possible to test the "Excello" lamp without globes, as its candle-power was then higher than any that could be measured in the photometer room, but on the assumption that the globe absorbs the same amount of light as that fitted to the open arc, the mean hemispherical candle-power without globe should work out at about 2,800 c.p.

PROPOSED MODIFICATION OF THE WRIGHT TARIFF SYSTEM IN DUNDEE.

We have received from Mr. H. Richardson, City electrical engineer of Dundee, a description of a new system of charging for electrical energy which he proposes to introduce in that city. Mr. Richardson says:—

£5. 8s. having been found to be the average standing charges per kilowatt maximum demand in Dundee, and the average maximum demand per consumer being 1·5kw., then it may be assumed that the true standing charge for a maximum demand of 1·5kw. is £5. 8s. per kilowatt. But the standing charge per kilowatt of maximum demand increases with a less and decreases with a greater demand. Now, if a = standing charges per kilowatt in £'s., and b = maximum demand in kilowatts, a curve may be drawn showing the connection between a and b. This curve is found to follow the law

$$(a-5)(b+1)=1, \text{ or } a-5=\left(\frac{1}{b+1}\right), \text{ or } a=5+\left(\frac{1}{b+1}\right) \quad . \quad . \quad . \quad (1)$$

Then again, let c = total units consumed per quarter, d = load factor, e = running costs per unit in pence, and x = price per unit in pence. (Profit has not been considered, as it may be added to x).

Now, $c=2{,}190b\times d$, there being 2,190 hours per quarter, and d being equal to $c/2{,}190b$ (2), or $c=d\times 2{,}190b$. The standing charges charged to any particular demand would be £ab, and to this must be added the running costs and profit per unit to make up the cost (total) of c units. The price of a unit is, therefore, $\frac{60}{c}ab+e$, which gives x, the price in pence.

Now, assigning to c its value as given in equation (2), we have

$$x=\frac{60ab}{2{,}190bd}+e \quad (3), \text{ or } \frac{60a}{2{,}190d}+e.$$

From (1) the value of a may be got for any value of b, and then the cost per unit for any maximum demand and load-factor may be got at from (3).

Again, if the equation $x=\frac{60ab}{c}+e$ be multiplied by c, then $cx=60ab+ec$, or $c(x-e)=60ab$, and $c=60ab/(x-e)$. Now, by giving x a certain value, an immediate relation is obtained between c and b.

For example, if the price be fixed at 2d. per unit, then $c=60ab/(2-0{\cdot}7)=60/1{\cdot}3ab$, and a is got from (1), so that c is easily determined for any value of b.

Mr. Richardson reports to his Committee that as it is impracticable and unsatisfactory to put any formula before the general public, he has gone further into the matter and has worked out a set of tables, made up in little pamphlets, "which can let any consumer instantly find out the correct charge per unit which he will have to pay. All he has to do is to take his known maximum demand and read from his meter his total consumption in units. With these two facts before him he refers to the table which is simplicity itself and looks up the particular line which deals with his special maximum demand and then looks down the column until he comes to a figure representing his consumption in units and at this point in the margin of the table he will find the price he has to pay per unit. The tables have been worked out for different maximum demands from 1kw. to 50kw., and also to include even a consumer who might possibly be so situated as to use his meter up to 50 per cent. of its possible consumption."

CORRESPONDENCE.

THE LONDON COUNTY COUNCIL TRAMWAYS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been called to a circular letter which has been issued by Messrs. Thomas Tilling (Ltd.), omnibus proprietors, with the intention of exciting opposition to the proposal contained in the Council's Tramways Bill of the present Session for the construction of tramways over Westminster Bridge, along the Victoria Embankment and over Blackfriars Bridge, to connect the existing tramway termini in Westminster Bridge-road and Blackfriars-road. The letter contains the following paragraph:—"You can safely affirm that these tramways are not self-paying, and that a better service can be given to the travelling public with motor omnibuses by private enterprise, and without being a burden to the rates."

This statement is to my mind likely to so seriously mislead the House of Commons in its consideration of the Council's proposals, that I desire to trespass shortly upon your space to indicate what are the facts concerning the working of the Council's tramways. The Council's tramways have from the first year that it acquired control of any lines in London been entirely self-supporting, and they will continue to be so. Even during the years when the bulk of the tramways south of the Thames were being reconstructed for electrical traction, entirely disorganising the ordinary traffic (some of the lines being closed altogether), the tramways account has never been a charge to the extent of a single penny upon the rates. On the contrary, the tramways have already, during the past eight years, paid from surplus revenue in reduction of rates, after the provision of interest and sinking fund charges, a sum of over £293,000, divided between the northern and southern systems.

The following details as to the application of the moneys received from the tramways account during the past eight years, in respect of the Council's systems north and south of the Thames, indicate the absolute inaccuracy of Messrs. Tilling's statement:—

Applied in reduction of rates, over	£293,000
Amount paid for sinking fund charges in reduction of debt during the same period (northern system, which has been in Council's hands for eight years, £117,044; southern system, which has been in Council's hands six years, £210,195; and general, £6,997)	385,286
Amount paid for interest on capital	414,000
Amount set aside as a reconstruction, renewals, reserve fund for the southern system	66,000
Amount paid in rates and taxes in respect of the southern system during the past six years	90,000
Amount paid in reduction of debt from proceeds of sale of horses, rolling stock, surplus property, &c.	126,220

During the four years from 1889 to 1903 the 48 miles of tramways north of the river, which are leased by the Council, earned as profit, after paying interest and sinking fund charges, £153,700; while the 24 miles on the south side of the Thames, worked by the Council itself, during the same period provided, after paying corresponding charges, the sum of £72,900.

The following facts are of importance in any institution of a comparison between the results from the system north of the Thames, leased to a company, and the lines south of the river, worked by the Council itself. These illustrate the advantages that have been secured to the travelling public, and the amelioration of the conditions of labour of the tramways employes, obtained from the Council's immediate control:—

1. 200,000,000 passengers were carried at half-penny fares, as compared with a penny, the minimum fare on the north. This represents a very considerable money value to the travelling public on the south side of the river.

2. Workmen's cars, running up to 8 a.m., have been instituted with a fare of 1d. for any distance for a single journey on the existing lines, and 2d. for a return journey, which means a very valuable boon to workers using the southern lines. In addition, all-night car services have been established.

3. The Council has conceded to its employés a six-days' week and a 10-hours' day, which, with certain other improvements in the conditions of labour, represent an expenditure beyond that involved under this head when the tramways were acquired of over £30,000 a year. This ensured the granting of conditions of labour which were considered necessary to secure efficient service.

During the period of reconstruction there was a deficiency in the southern tramways accounts of £2,250 in 1902-3 and of £8,284 in 1903-4. This result was brought about by the Council paying interest and sinking fund charges of £12,300 on expenditure incurred for reconstruction before a single electric car was run on the lines creating those charges. Moreover, during the first-named year a sum of £11,000 was set aside out of revenue for the renewals fund for the horse lines, which were, at the time, entirely disappearing. The result of this was to give to the Council as an asset in the way of a renewals reserve fund a sum of £30,750 at the commencement of electrical working, before any wear and tear had begun, and the "account deficiency" is thus amply covered by assets more than corresponding thereto.

The facts, therefore, only serve to illustrate the soundness of the Council's tramways finance policy. In regarding this aspect of the matter I should like to point out that, contrary to company practice, the capital expenditure, a term by no means elastically interpreted by the Council, is being steadily paid off, and the tramways are being put in a better financial position every year, a constantly-increasing sum being available by way of surplus receipts. In other words, a leasehold property is being rapidly converted into a freehold one, while a company undertaking remains a perpetual leasehold. The importance of this point cannot be over-estimated.

As the period of reconstruction passes away the "account deficiencies" will entirely disappear and it is important to note that the accounts for the present year show a very substantial surplus, after the payment of the very heavy capital charges upon the lines that have been reconstructed. To the impartial expert, it would appear that the Council has surmounted the difficulties of traffic maintenance and organisation during the trying period that comes in the history of every horse-propelled tramways undertaking when improved methods of traction have to be applied to the lines, with remarkable success.

In criticising Messrs. Tilling's letter in the light of the actual facts I can only think that they are not prepared to rely upon the efficiency of the motor omnibus service as a means of locomotion in fair and open competition with the tramways service. I cannot otherwise account for the methods adopted by them in their endeavour to defeat the Council's efforts to improve the locomotion system of London in the best interests of the travelling public.—Yours, &c.,

J. ALLEN BAKER,
Chairman of the Highways Committee.
County Hall, Spring Gardens, S.W., March 31.

LIGHTNING DISCHARGE EFFECTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As you publish, from time to time, particulars of the surprising effects of lightning discharge, the performance of such a discharge in Bournemouth on March 15th last may be of interest to some of your readers. At 4:30 p.m. on this date a flash of lightning struck a chimney of a house in the Richmond-park-road, shattered the chimney stack and got on to the wires of the electric lighting installation. This installation is connected to the Electricity Supply Company's distributing mains, which are triple-concentric lead-sheathed cables drawn into stoneware ducts. The cables are arranged as usual with the outer conductor neutral, and with 400 volts between the "inner" and "intermediate," the supply to consumers being at 200 volts. The neutral conductor is dead earthed at the transformer chamber, 780yds. from the house struck, and the lead sheathing of the cables is dead-earthed in each draw box. The installation struck is connected between the inner and neutral conductors.

The discharge appears to have found its way to earth through the neutral earth at the transformer chamber, in its course blowing all the distributing and main fuses of the installation struck, shattering the porcelain covers with such violence that one piece of porcelain broke a window some yards away, and blowing the cast-iron service fuse box to pieces. The meter, connected on the pressure or inner main, was burnt out, and the metal cover twisted out of shape, while the incandescent lamps were curiously affected. In one case a 16 c.p. lamp, hanging by a length of silk "flex." from the ceiling, had three small holes about ¼in. diameter burnt through the glass close to the collar, the lamp globe not being burst, but the glass being very much blackened all over the inside. In three lamps of this installation the filaments were broken into short lengths and projected against the glass with such force that many of the pieces adhered to the glass and cannot be shaken off. All other installations within a radius of 430yds. both on the inner and intermediate sides of the distribution system had one or more lamps affected in the same way, but in no case were all the lamps of an installation damaged. In one house, 95yds. away, connected on the opposite side of the three-wire system to the one struck, a porcelain fuse fitting was broken.

There is no sign of the lightning having pierced the insulation between the conductors of the triple-concentric cable or of having jumped across in any joint box, and the insulation remains high. Nor was there any interruption of the supply by the blowing of transformer or distributing cable fuses. No shunt windings of meters were damaged except that in the house struck. There were no lamps switched on at the time in any of the installations affected.

The chief interest in these occurrences appears to me to lie in the curious way in which the lamp filaments behaved.—Yours, &c.,

EDGAR LL. INGRAM.

The Bournemouth & Poole Electricity Supply Co.,
Bournemouth, April 5.

PARLIAMENTARY INTELLIGENCE.

LONDON ELECTRIC POWER BILLS.

Friday, March 31.

The hearing of the Administrative County of London and District Electric Power Bill was resumed.

Mr. C. H. WORDINGHAM, one of the Borough Council's witnesses, was further cross-examined by the Hon. Evan Charteris, on behalf of the promoters. In his opinion turbines were a passing fashion, and would very likely be superseded by gas engines for driving electric generators. He did not think that cables were less liable to depreciation than machinery, for in his own experience he had had to replace in five years the whole of a most expensive system of rubber cables, which were considered the most up-to-date at the time they were laid.

Would you say it is impossible to purchase mains that will be guaranteed by the makers for 20 years?—I do not know.

The CHAIRMAN: Guaranteed does not mean that the cables will last for 20 years.

Under further cross-examination on the question of capital cost per kilowatt, he agreed that by increasing the size of the units the capital cost was decreased, but this only applied up to a certain point. As a matter of fact, he had designed a 400kw. station, which cost £8 per kilowatt for the generating station, excluding mains. His views were adverse to the use of very large generating stations under the conditions prevailing in London.

Re-examined: Since the promoters had stated it was their intention to supply the electrical energy transformed, he had examined Mr. Merz's estimates to ascertain what capital cost had been allowed for the transforming machinery, and could only find a sum which he considered totally inadequate for the supply intended.

In answer to the Committee, Mr. WORDINGHAM said that his fear of danger from the large ring mains was danger to the public from explosions. For instance, some years ago a very violent explosion occurred in Manchester on a comparatively small main. A fault occurred which set fire to the cable covering, and this gave off a highly inflammable gas. This gas found its way through the ground into a cellar, and being ignited caused an explosion which moved a very heavy stone staircase, and did other damage. The main in question was carrying only 3,000 H.P., or 1,000 H.P. The work had been carried out according to the Board of Trade regulations. On the question of the crowded condition of the streets as to mains, he thought it would be extremely inconvenient to have any further breaking up of the streets. At the same time it was not impossible.

Mr. G. G. BELL, electrical engineer to the Hammersmith Borough Council, explained some of the figures of Mr. Dawson's table. The Hammersmith works were carried on at a profit. The average price for power was 1·54d. per unit, and the works costs last year were 1·0d. The capital cost per kilowatt was £40.

Mr. S. BAYNES, electrical engineer to the St. Pancras Borough Council said that the amount set aside to the relief of the rates out of the profits of the electrical undertaking at St. Pancras was £10,000. They also had a reserve fund of £30,000. The revenue last year from power consumers was £4,666. He handed in a table showing how the costs and prices at St. Pancras had decreased. For instance, the power charge had decreased from 3d. per unit to 1d. per unit. The demand for power had increased by 100 per cent. since the price had been decreased from 2d. per unit to 1d. per unit. The congestion of the streets in St. Pancras, as far as underground pipes and mains were concerned, was very great.

Mr. P. V. McMAHON, engineer to the City & South London Railway Co., said that company generated its own electricity at a total cost of 0·675d. per unit, and when the Euston extension was opened he anticipated this would be reduced to 0·611d. He failed to see any advantage in a railway company taking a supply from an outside company, as all control would be lost over the generating station, which was the heart of the system. This was the opinion of most other railway companies. The actual works costs were 0·433d.

Mr. FREEMAN, K.C., addressing the Committee on behalf of the 16 local authorities already mentioned, said that very much the same arguments as had been used on behalf of the electric supply companies would apply as regard the local authorities, with the exception that the companies were liable to be purchased and the local authorities were not. The local authorities regarded the bill as very important from the fact that Parliament had given them the authority to invest the ratepayers' money to the extent of 5½ millions. First as to competition, he pointed out that in no single instance had a company been allowed by the Board of Trade to compete with a local authority for the supply of electrical energy under a subsequent provisional order, nor had any power company been allowed to supply in competition with a borough council. Further, it had been the general rule in past years to exclude from power acts local authorities who were doing their duty, and only to give the power company a wayleave to lay mains in order to supply someone on the other side of the town. In adopting most of the arguments put forward by Mr. Neville on behalf of the companies, counsel also gave an illustration of what might take place were the promoters' bill to be passed. The St. Marylebone Borough Council had been authorised to spend nearly £2,000,000 upon their electricity supply undertaking, and the Council had also bound itself not to take electricity in bulk, should such a supply be needed, from anyone but the Metropolitan Electric Supply Co. Now, should the new company manage to kill the Metropolitan Co. the Marylebone Borough Council would be at their mercy. What had to be considered was, that any loss which was likely to be incurred by the local authorities through the operations of the new company would have to be borne by all the ratepayers, and not only by those who were consumers of electricity. Dealing with the case for the bill, Mr. Freeman pointed to the possibility of applications by the company in future sessions (if the bill were passed) for an extension of the industrial area when large factories were erected in the non-industrial area. He maintained that there was no evidence that the present electric supply authorities were unable to give a supply on reasonable terms; neither did the promoters produce any witnesses who had definitely pledged themselves to take a supply. Further, as to the supply of electrical energy to railway companies, which the promoters anticipated, he maintained that the trend of modern policy of all railway companies was to manufacture everything their undertaking required, including even rolling stock, &c., and in the generation of electricity the same thing applied. In fact, all railway companies in England which had gone in for electric traction, had erected their own generating stations, except the North Eastern Railway Co., and where, then, was the business of the promoters in this direction to come from? With regard to the financial side of the bill, he did not dispute for one moment this aspect of the scheme, but it was, on the one hand, a source of strength to the promoters, and, on the other, a menace to the borough councils, for the strong financial position of the company would enable it to supply at a loss for a certain period in order to kill competition. The borough councils without generating stations at present were largely interested in the prosperity of the companies in their districts, and the effect of any ruinous competition upon the business of the companies would be felt by the councils when the period for purchase was arrived at. Therefore, on all these grounds he argued that the passing of the company's bill would be prejudicial to the public interest generally in London.

Mr. BLENNERHASSETT, K.C., who addressed the Committee on behalf of the Westminster City Council, laid stress upon the question of the purchase of the existing companies and the breaking up of streets. With regard to the latter, he was willing to have the matter referred to the arbitration of the Board of Trade or some other authority, but he was of the opinion that no such powers as those sought should be granted until the report of the Royal Commission on London Traffic, which had been specially considering this matter, had been issued. No great case of public necessity had been made out with regard to the supply of energy direct to power consumers, although, as regards the supply in bulk to authorised distributors, the Westminster Council had no objection.

Mr. JOHN HUNT, Town Clerk to the Westminster City Council, and Mr. J. BRADLEY, the engineer, gave evidence to this effect.

Mr. LEWIS COWARD, K.C., for the London County Council, drew attention to the prejudicial effect which the passing of the bill would have upon the security of the vast sums of money which the County Council has loaned to the borough councils. A matter of special importance to the London County Council was the question of purchase. As soon as the recommendations of Lord Cross's Committee with regard to bulk supply companies were known, a conference was held of all the borough councils and the County Council with regard to this matter. Subsequently a bill was introduced by the London County Council to provide for the purchase of bulk supply companies' generating stations where they affected the County of London, but owing to a little want of unanimity amongst the borough councils the bill did not pass. Subsequently another conference was held, and in 1903 a new bill was introduced by the County Council dealing with the same subject, but the Government intervened and asked the County Council to withhold its hand until a new bill dealing with the matter had been introduced by the Government itself. In the sessions of 1903 and 1904 the Supply of Electricity Bill was introduced by the Government, but in both cases it was abandoned before the close of the session. On the last occasion, before Lord Wolverton's Committee, the London County Council had succeeded in obtaining substantially what it asked for, and at any rate a clause was inserted which showed a desire on the part of the Government to help the local authorities with regard to this matter. In the circumstances, therefore, it appeared to the London County Council that the proposals in the promoters' bill were premature, having regard to the existing condition of the legislature, and he urged the Committee to reject the bill on these grounds until the whole matter had been finally settled by the Government.

Mr. WILLIAMS, on behalf of the Stepney Borough Council, detailed the history of the electric supply undertaking in the hands of that body, and stated that their charges were the lowest in London for power purposes and compared very favourably with any other charges for electric lighting. With regard to the promoters' evidence, he stated that it was a curious fact that no witnesses had been called on their behalf from the big London dock companies, in view of the fact that an essential part of their scheme was a potential supply to docks, canals, &c. He thought he could give a very good reason for this—namely, that most of the dock companies had their own installations, and therefore did not want any assistance from the company. In any case, those docks that were in the Stepney area, he maintained, were the legitimate customers of the Council, and the unrestricted competition with regard to power consumers asked for by the bill would have a most serious effect upon the Borough Council's undertaking. This borough council had incurred great expense in buying out a company which had a provisional order but had not exercised it, and the Council had brought the undertaking to a flourishing condition.

Mr. W. C. P. TAPPER, electrical engineer to the Stepney Borough Council, stated that up to date £200,000 had been expended upon their works, and that both in regard to buildings and plant theirs was more than sufficient to supply the requirements of the borough for some years to come. Witness handed in a table showing how the prices in Stepney had decreased. The charge for power was a flat rate of 1d. per unit.

Monday, April 3.

At the commencement of proceedings on Monday, Counsel explained to the Committee two tables which had been prepared at the request of the chairman, one by the promoters and one by the opposition. The object of the tables was to show the date of the passing of the various power company's acts, the area of each company, the list of companies or local authorities supplying at the time of the passing of the Companies Acts, and the effect upon the business of such authorities.

Mr. TAPPER was then further cross-examined by the Hon. J. D. Fitzgerald. He said he could not explain why, in so many of the London boroughs, the charge for public lighting was higher than that for private supply. In his own borough, however, this was not the case. He did not know how the price charged by the companies in London compared with those charged in other great cities, but he would agree with counsel that those in Edinburgh and Brighton were lower than in London. Stepney was proposing to erect a new generating station which would cost about £250,000 which would be borrowed from the London County Council. In the existing station there were 2,700kw. of plant and another 1,000kw. on order.

The case for the West Ham Corporation was then taken.

Mr. W. J. W. BULLOCK, chief engineer to the West Ham Corporation, said their generating station was on the river, and all the coal was at present sea borne. The Corporation also worked a system of municipal tramways. There had been a large increase in the demand for power in the borough during the past 12 months, and a new generating station had been erected in consequence. The capacity of this station was 18,200kw. normal, and the capital cost of the generating station per kilowatt up to date was £20·5, but when the station was completed this figure would be reduced to £12, comparing with the £8·5 per kilowatt estimated by Mr. Merz. In three years the output of electricity for power purposes had doubled itself, and the estimated sales this year for power purposes were considerably over 3,000,000 units. The total sales this year were estimated at 6,168,000 units. The total works costs during the present year were 0·96d. per unit, the total cost per unit sold 1·03d., and works costs per unit generated 0·59d. The load-factor at present was 16·8 per cent., but if the output were increased to his estimates the load-factor would be 25 per cent. He did not think that by 1910 any power company would be able to generate cheaper than the West Ham Corporation. The lowest charge for power purposes was 0·98d. per unit. Several of the signatories to the petition in favour of the bill resided in West Ham, and to many of them offers of 1d. per unit and under had been made, but in some cases the firms had preferred to put down their own plant, or did not care to take out their existing steam plant.

Cross-examined by Mr. LLOYD, K.C.: There were steel chimneys at the new station, but he had not gone into the question of how much less than £12 per kilowatt the station would have cost if the London Building Acts did not apply. He did not know of any station in London which was so cheap as this, and agreed that even if the promoters could erect a station on these terms they would have done much better than anything hitherto accomplished in London. With regard to the price charged for tramway purposes, this had not yet been arrived at, because up to the present merely an experimental figure of 1·6d. per unit had been adopted.

Mr. H. E. BLAIN, manager of the West Ham Corporation Tramways, said it was estimated that when the whole system was completed the traffic would be 26,000,000 passengers. On the general question of the breaking up of streets, there was the possibility of great inconvenience to the tramway traffic.

Mr. MORTEN, addressing the committee for the West Ham Corporation, contended that there was no economy in increasing the size of an undertaking beyond a certain limit. It could not be expected that the Corporation of West Ham or any municipality would give their consent to the promoters supplying in their district to individual power consumers. There would thus be hundreds of applications to the Board of Trade by the promoters to say that the Corporation was unreasonably withholding its consent. The Corporation must oppose them, because, once the consent was given, it was given for all time. The company would, at the time of the applications, say to the Board of Trade that they were willing to supply at a price which might be below cost price, and the Board of Trade would have no possible means of finding out whether this was so or not. The company then having once got into the district could immediately increase the price. Moreover the Corporations would be liable to their costs in these inquiries.

The CHAIRMAN asked if the consent given was for all time.

Mr. FITZGERALD said that a consent would mean a consent to supply in West Ham for all time, even if the application was only for one customer.

Mr. MORTEN said the Board of Trade could not bind the company to supply at any particular price.

Mr. FITZGERALD replied that the Board of Trade could grant a consent to the company conditionally on its not raising the price above a price fixed by the Board.

Mr. MORTEN said that even supposing the Board of Trade had power under the bill to impose conditions, which he maintained it had not, there was also no possibility of any such condition being enforced.

The CHAIRMAN asked if the promoters wanted the Board of Trade to fix terms.

Mr. FITZGERALD: Certainly.

The CHAIRMAN: Then you will assent to any amendment of the bill that will make that clear?

Mr. FITZGERALD: Certainly.

Mr. MORTEN continuing, said that the West Ham Corporation strongly objected to the promoters being exempted from the building bye-laws as they were the authority which framed the bye-laws in West Ham. If the promoters were not liable they would be able to create a nuisance by the emission of smoke, &c., and in fact they would be able to come into the borough and do just what they pleased in any way. As to the breaking up of streets, the West Ham Corporation had a tramway system and once the promoters obtained consent to supply there, they would have to lay their mains underneath the tramway track owing to their consumers possibly being on different sides of the road. For the inconvenience to the tramway traffic thus caused there would be no compensation; all the company would have to do would be to reinstate the road. On all these special grounds, in addition to those put forward by other opponents, he asked the Committee not to allow the bill to go forward.

Tuesday, April 8.

Mr. FORBES LANKESTER addressed the Committee for the Borough of East Ham. He pointed out that not one single local authority throughout the area of the bill had come forward to support it. So far as East Ham was concerned there were only two large works—viz., the Gas Light & Coke Co. and the London Docks Co.—both of whom generated their own current. The district was largely a working class residential one, with very little demand for power, the bulk of the supply being for lighting and tramways. But if at any time there should arise a large demand for power purposes East Ham only being partly built upon—the present generating station of the Corporation was amply sufficient to meet it for many years. Counsel then discussed at some length the question of picking and choosing customers on the part of the promoters, and the fact that there was no obligation to supply any consumer.

The Hon. EVAN CHARTERIS said the promoters were very far from admitting this, because the Electric Lighting Acts, which were incorporated in the bill, imposed an obligation. It was the intention of the promoters to argue that they were bound by sec. 19 of the Electric Lighting Act of 1882 to give a supply.

Mr. FORBES LANKESTER pointed out that sec. 19 of the Electric Lighting Act of 1882 referred to preferential charging, and not to compulsory supply. Sec. 27 of the Electric Lighting Clauses Act which dealt with compulsory supply had been cut out of the bill.

Mr. CHARTERIS said clause 30 of the Act of 1899 was another clause upon which he would rely, and this was embodied in the bill.

The CHAIRMAN: Very well, we will leave it at that for the present.

Mr. CLEASE pointed out that the provisions of clause 30 would not, as embodied in the bill, compel the promoters to supply authorised distributors.

Mr. W. C. ULLMANN, electrical engineer to the East Ham Corporation, said the average price received per unit sold was 2·5d., including tramways. The generating cost was 0·9d. per unit., total costs 2·12d. per unit, and the capital cost per kilowatt was £32. Last year an absolute profit of £1,144 was made.

Cross-examined by Mr. CHARTERIS: The total revenue last year was £18,249, and the revenue from tramways was £6,873. The price per unit for tramways was 1½d. and for public lighting 2·13d. per unit.

Mr. MORESBY WHITE, on behalf of the Hackney Borough Council, addressed the Committee prior to calling evidence, and made substantially the same points as previous counsel.

Mr. SPENCER HAWES, of the firm of Messrs. Robert Hammond & Son, said he was responsible, on behalf of his firm, for the "Electrical Times" Tables and Records. His firm had designed the Hackney works, and there were 8 acres of land upon which 100,000kw. could be installed

At present, however, only 3,752kw. were installed, although the buildings were capable of holding 6,332kw. The capital cost of the station so far was £129,816, or £38 per kilowatt. When the buildings were filled up it was anticipated that this would be reduced to £28. The total cost per unit sold at Hackney was the lowest in London—viz., 1·04d. He estimated that if they bought current from the promoters in bulk on the terms of the estimates in the bill, it would have cost the Borough Council £1,000 more to have bought the same quantity as was generated last year than it actually cost the Council. On the other hand, if Mr. Merz carried out his offer to supply Hackney with low-pressure energy on the terms of his estimates, he had calculated that the price which the promoters would receive, after paying the cost of transformation, would only be 0·102d. per unit, or less than his coal bill. Following Mr. Merz's example, he had prepared an estimate of what he thought could be done in 1910, and the charges were as follows:—Lighting, 1¼d. per unit; public lighting, 1d. per unit; and power, 0·710d. per unit.

Cross-examined by Mr. PAGET: He could justify a higher price being charged for public lighting by the three following reasons: (1) There was no diversity factor, (2) a large proportion of the engineer and assistant engineer's time was taken up, (3) there was a separate system of mains from which no other supply was given. Charges for electrical energy in London were somewhat higher than in the provinces, owing to the higher price of coal and higher cost of labour.

Mr. GRUBB, on behalf of the Essex County Council, opposed the bill on general grounds, and particularly as a road authority.

Mr. COURTHORPE MUNRO, for the Urban District Councils of Woodford, Leyton and Hampton, said that the method of the promoters in defining the area of the bill had been apparently to take a pencil and draw on a map a line to show what could be accomplished from an engineering point of view from one generating station. Leyton was on a different footing, he believed, to any other local authority opposing the bill. In a bill which the Leyton Urban District Council promoted last year, the gas companies, in order to prevent rate-aided competition, secured the insertion of the Bermondsey clause, which, in effect, bound the local authority each year to so adjust its charges that the expenditure would not exceed the revenue for that period, and it was in connection with the clause in the present bill that a power user might apply 20 per cent. of his total supply from the new company for the purpose of lighting that the effect of the Bermondsey clause would be felt. All prospect of further increasing the lighting undertaking of the Leyton Council would disappear so far as large power consumers were concerned, and the methods by which these large power consumers would be secured to the new company would be as follows. Knowing that the local authority was burdened with the Bermondsey clause the new company would institute a rate-cutting war and, by quoting a little bit below the price which they knew the local authority generated, would be absolutly certain of securing the consumer, because once the local authority supplied at a price which was less than their expenses they could be restrained by injunction under the Bermondsey clause. Thus it was quite within the reasonable bound of commercial possibility that the electrical undertaking in Leyton would be weakened to such an extent that under clause 69 of their bill the promoters could come along and say: "How much do you want for your undertaking," knowing that the Council would be practically bound to sell. Then, having secured the undertaking, the prices would be immediately raised, according to clause 69, to the prices named in the Leyton Electric Lighting Provisional Order.

Mr. VESEY KNOX, for the Southwark Borough Council, made a similar application. The Southwark undertaking, he said, had not been a particularly successful one in spite of there having been competition, which, according to the promoters, was good for the electrical industry. As a matter of fact, two companies supplied over part of their area and one company supplied over the whole of the area, while the Borough Council also had power over another portion of the area. So far as the municipal undertaking was concerned, they had just turned the corner and were now making a slight profit, and it did seem particularly hard that now that they had succeeded in placing their undertaking on a somewhat sound financial basis a new company should be allowed to come in with competitive powers. Apart from the question of competition there was another aspect of the case which must be taken into account. The Committee had heard much about a possible acquisition of the London Electric Supply Corpn. by the promoters, who by this means would gain the right to distribute in the borough as well as supply in bulk. What he wished to point out was that by no possible means could the Committee prevent such an acquisition taking place by a clause in the bill. As an instance of this, he pointed to the tube railways of London, which had been amalgamated by Mr. Yerkes. Each one of these companies, he said, was a separate Parliamentary company, and as such could not amalgamate, but Mr. Yerkes had got over the difficulty by forming a limited liability company, which acquired the shares of the tube railway companies, and, by building a huge generating station at Lot's-road, to supply them all, had succeeded in amalgamating them without any consent from Parliament. Another aspect of the competition point of view was that, in view of the new company securing any consumers in Southwark, the Corporation would be bound under its provisional order to maintain a sufficient quantity of plant in the station to give a stand-by supply to such consumers in the event of a breakdown of the big generating station, and could only demand in revenue 13s. 4d. per quarter.

Wednesday, April 5.

Mr. BALFOUR BROWNE, on behalf of nine electric supply companies in London, asked that a definite statement should be given by the promoters as to the scope of their bill. Since the bill was first introduced so many modifications had been suggested and promised that at present it was really difficult to know what were the intentions of the measure. The proposal to supply public lighting had been practically dropped, then a certain modification as to the supply of light to power users had been made, and from what had recently been said it appeared that the primary object of the promoters was to supply authorised distributors in bulk, and that it was only failing success in this direction that a supply would be given to individual power consumers. The question of the obligation to supply had also been discussed. If the promoters would state that they only wished to supply authorised distributors he did not think the Bill would be worth taking, and many local authorities, at any rate, would probably withdraw their opposition. He would also like to know something definite about the application of the scale of charges, as such information would materially assist him in conducting his opposition.

The CHAIRMAN thought that all these matters could best be discussed on clauses, if the Bill should reach that stage. He could assure the opposition that it was the intention to consider very carefully the clauses, but in the meantime they must take the bill as it stood. The promoters had really stated that if any part of the bill was not clear, they would do anything to make it clear.

Mr. VESEY KNOX, who spoke yesterday for the Southwark Borough Council, also represented eight other local authorities, and called witnesses from each in support of his case.

Mr. A. H. SHAW, electrical engineer to the Ilford Urban District Council, handed in a table showing the condition of that Council's electrical undertaking. The works costs were 1·3d. per unit and were steadily decreasing. Supply was given to the Tramways committee at cost price. The power demand was very small, there being only 50 such consumers on his mains, representing a total connection of 300 H.P. Throughout the district there was only 600 H.P. of machinery in private works, and half of it was driven electrically.

Mr C. F. McINNES, electrical engineer to Gravesend Corporation, Mr. J. D. PEMBER, electrical engineer to the Dartford Urban District Council, and Mr. J. TOMLINSON LEE, electrical engineer to the Wimbledon Urban District Council, also gave evidence with regard to their respective undertakings.

Mr. PHILIP DAWSON gave evidence as to the cost to the local authorities of Gravesend and Dartford if the company were to lay a main to supply in those two places. The cost of a duplicate main from the Greenwich power station to Gravesend would be £38,000 and the transforming sub-station £4,000, making a total of £42,000. Upon this the Gravesend Corporation would have to guarantee 20 per cent., or £8,456, which was more than the total cost of generation last year. At Dartford the amount to be guaranteed would be £5,000, which was about the same as the total generating costs last year.

Cross-examined: He had assumed 18 miles of mains for Gravesend, which was the shortest route. If both Dartford and Gravesend took a supply, two sets of mains would not be necessary, but the guarantee on one set would be more than the actual cost of generation of the two authorities combined.

Mr. VESEY KNOX, in addressing the Committee on behalf of a number of authorities outside the County of London, asked that in the event of the bill passing, which he hoped would not be the case, all its powers should be limited to the County of London, as in the interests of local government it was not desirable that another situation like that created through the authorisation of the water companies should be brought into existence.

Mr. CLEASE, for the Barking Urban District Council, after setting forth the circumstances of that district, said that if the bill passed the promoters should be debarred from supplying lighting under any circumstances, should be placed in the same conditions as the existing companies as regards purchase, and the veto clause which was in the Yorkshire Power Bill with regard to so many towns should be included.

Mr. SANDERS, for the Islington Borough Council, argued that no public case had been made out for the inclusion of Islington, and that it was idle to speculate as to what might have been done if the bulk company had been in existence many years ago.

Mr. J. D. WILLIAMS, on behalf of the Croydon Corporation next asked for the exclusion of that borough.

Thursday, April 6.

Mr. JEEVES, for the Kingston Corporation, asked for the exclusion of that area from the bill.

Mr. READER HARRIS, K.C., for the districts of Ealing and Barnes, made a similar application on the ground that they were not essential to the scheme, there being no possible consumer in these areas except the local authorities, and these having their own electricity works did not want any other supply.

Mr. SIDNEY MORSE, on behalf of the Richmond (Surrey) Electric Light & Power Co. and the South Metropolitan Electric Lighting & Tramways Co., also asked for exclusion.

This concluded the case for the local authority opposition.

Sir GEORGE LIVESEY, chairman of the South Metropolitan Gas Co., gave evidence in opposition to the proposal in the bill to take certain lands belonging to the gas company at Greenwich.

A similar application was made on behalf of some land belonging to the Gas Light and Coke Co. at Fulham.

Mr. J. DEVONSHIRE, a director of the North Metropolitan Electric Power Supply Co., examined by Mr. Balfour Browne, K.C., gave particulars of the progress which that company has made with regard to the erection of generating stations at Brimsdown and Hertford, and the purchase of the Willesden Urban District Council's Electricity Works. At present, portions of Stoke Newington were now in the North Metropolitan Power Co.'s area, and the remainder was scheduled in a bill which would come before this Committee later on. The whole of Stoke Newington was now included in the Administrative Co.'s Bill, but a contract had been entered into with the Stoke Newington Council for a supply to be given in bulk by the North Metropolitan Co. for a long term of years. If the promoters struck out Stoke Newington from their bill his opposition would be withdrawn.

Cross-examined: The average price of current paid by the Willesden Council to the power company last year was 1·29d., or a saving of 2d. per unit over the cost of generation by the Council before the power company came on the scene. It was undoubtedly the fact that it paid a local authority to take a supply from a power company. Wood Green Council applied for a loan for erecting works, but it was refused, largely on the ground that the North Metropolitan Power Co. had made a very cheap offer of a supply of current.

Mr. MOON, K.C., objected to this line of cross examination, as Mr. FitzGerald was converting Mr. Devonshire into a witness for the promoters, and was discussing points upon which the other side could not cross-examine.

The CHAIRMAN said that as he wished to get all the information possible with respect to these bills, he did not see his way to stop Mr. FitzGerald.

In further answer to Mr. FitzGerald, Mr. DEVONSHIRE said that as a local authority which took a supply from a power company did its own distribution, it did not have to scrap its plant.

Mr. BALFOUR BROWNE (in re-examination): But you have never yet supplied any local authority which had its own generating plant?—No.

So there was nothing to scrap?—No; but at Barnet we supplied the local company with a supplementary supply in bulk

But at Willesden you bought the whole of the works of the Council?—Yes.

Mr. ROGER WALLACE, K.C., addressing the Committee for the Kensington and Notting Hill Electric Lighting Co.s, which have a bulk supply station at Wood Lane, Shepherd's Bush, asked for the exclusion of the districts served from this station from the bill. He employed very much the same arguments as Mr. Neville had done at the opening of the opposition to the bill.

Mr H. W. BOWDEN, managing director and engineer in chief of the South Metropolitan Electric Light & Power Co., said his company canvassed every power user in his area twice a year, and supplied motors on the hire-purchase system at 5 per cent. Over 50 miles of high-tension mains had been laid especially for power purposes. With the energy his company generated it was only necessary to have static transformers with a consequent reduction in transformer losses, compared with rotary converters, which would be necessary under the scheme of the promoters. The lowest price for power was 1d. per unit. The consumption of energy for power purposes was about 40 per cent. of the total sales of the company.

Major P. CARDEW gave corroborative evidence. Two-phase current, as supplied by the South Metropolitan Co., was more suitable for a combined lighting and power supply than three-phase. The site of the company was a most suitable one for extensive and cheap production.

Mr. E. MOON, for the South Metropolitan Electric Light and Power Co., maintained that if the primary object of the Bill was to supply in bulk to authorised distributors, why was not the Bill confined to this? If they had formed a combination with the companies to supply them in bulk at a lower price than they could generate, the companies would take it and the bill would be comparatively harmless.

Mr. C. P. SPARKS, chief engineer of the County of London Electric Supply Co., said his company had nine Provisional Orders, and supplied about 23 square miles in the Metropolis, including Wandsworth, Camberwell, Finsbury and Holborn. The total number of horse-power in motors connected to the mains of the company at the end of last year was 6,055 H.P. and orders for 2,000 H.P. had been received this year. In the area of his company which was in the industrial area of the promoters there were 4,821 H.P. There were in all 571 power consumers, and the units sold last year were 2,300,000. In his company's area North of the Thames, the horse power connected per 1,000 head of the population was 37·2, and it was 15·7 H.P. in the southern area. With regard to possible large power consumers in London, witness said that the tendency nowadays was for such works to remove from London, owing primarily to the high price of labour in London, and also to the cost of land and high rates and taxes. The County of London Co. had laid 500 miles of mains.

The Committee adjourned until to-day (Friday).

TRAMWAYS ON THE THAMES EMBANKMENT.

LONDON COUNTY COUNCIL TRAMWAYS BILL.

In the House of Commons on Monday,

Mr. WHITMORE moved that it be an instruction to the Committee to which the London County Council Tramways Bill is committed to omit tramways Nos. 1, 1A, 2 and 2A. These lines, he said, would run across Westminster Bridge, along the Victoria Embankment and join up with the Council's tramways on the south side of Blackfriars Bridge, and with the line running through the new subway under Kingsway to the north of London. In referring to previous bills asking for similar tramways, he maintained that no new facts had arisen to cause an alteration in the previous decisions of the House of Commons. At the moment there was approaching completion the Baker Street and Waterloo Railway, which started at the Elephant and Castle and ran to Charing Cross and Baker Street, which would provide a much more direct means of communication between north and south of the Thames than a tramway running across the bridges. He argued that until the Royal Commission on London Traffic had reported, no new tramways should be sanctioned. He appealed to the artistic sense of the House of Commons against the line at Westminster Bridge, and to those who wished to preserve the dignity of Central London, and asked for support to the instruction in the absence of proof of any overmastering necessity for bringing this alien traffic to the Embankment.

Sir F. BANBURY supported the instruction on the ground that there was no demand for these tramways, and that tramways tended to congest traffic.

Mr. CAUSTON hoped that the House would pass the bill and reject the amendment. The Embankment had not been built by private individuals for their special luxury, but out of the ratepayers' money, and surely the ratepayers were entitled to look upon the Embankment as a route to be used for their benefit. The need for some further means of communication between Westminster and Blackfriars bridges was shown by the fact that 30,000 persons crossed these bridges in four hours.

Mr. B. L. COHEN, who last year voted for a similar instruction on the grounds that the Traffic Commission had not yet reported, said he would now vote against the instruction, as he would not be influenced any longer by the fact that the long-promised report of the Traffic Commission had not been presented.

Mr. JOHN BURNS opposed the instruction. Tube railways were not so popular as they had been expected to be, and neither were they so healthy. As the cars would be on the conduit system, their appearance would not be offensive and advertisements would altogether be dispensed with. All sections of the London County Council were in favour of the scheme. The City Corporation had only rejected it by one vote, and 110,000 signatures had been obtained to a petition in favour of it. If the scheme were passed it would prevent the crushing that now went on at the Surrey side of Westminster Bridge.

Mr. BURDETT COUTTS said that the Council of the City of Westminster, which was the only district distinctly affected by the tramways, was unanimously opposed to it.

Other members having spoken, the House divided, the result being a tie, 171 voting each way.

The SPEAKER said that in order that the matter might be discussed in Committee, and to give the House another opportunity of dealing with it in a more decisive manner, he gave his casting vote against the instruction.

The proposal to construct tramways along the Embankment therefore will come before the Committee to which the bill is set.

TRAMWAY INTERCOMMUNICATION IN YORKSHIRE.

HALIFAX CORPORATION BILL.

The Halifax Corporation Bill came before the Police and Sanitary Committee (Section A), of which Mr. J. W. Wilson is the chairman, on Wednesday. The bill which is an omnibus bill, proposes to construct 1¼ miles of double and about 6 miles of single track to form part of the Corporation's tramway undertaking. To this part of the bill there was no opposition.

Mr. JEEVES, for the Corporation, said that Clause 31 of the bill empowered the Corporation to form junctions with tramways or light railways outside the borough, to be worked in conjunction with the Corporation tramways, and Clause 34 provided for agreements being entered into for working and running any such tramways with which junctions might be made. The Lancashire & Yorkshire Railway Co. opposed a general power of this description, and the Corporation, therefore, was willing to limit it to those lines which were or might be constructed between Halifax and Huddersfield, Halifax and Keighley, Halifax and Bradford and Halifax and Todmorden; in fact, all the surrounding districts. As a matter of fact, the Halifax lines were already connected with the Bradford lines in two places. They would also be willing to limit the powers to tramways actually existing to-day in the adjoining districts, or which were about to be authorised, or with which there was connection to-day.

Evidence was called in support of the Corporation's proposals.

Sir RALPH LITTLER, K.C., for the Lancashire and Yorkshire Railway, opposed the proposals on the ground of competition, and on the general ground of their resulting in too large an extension of municipal trading. The majority of the lines with which it was suggested connection might be made were not even authorised.

The CHAIRMAN, after consultation, said that although they were not unanimous, the decision of the committee was that Clauses 31 and 34 should be struck out of the bill.

WORKMEN'S COMPENSATION BILL.

In the House of Lords on Tuesday Lord Belper moved the second reading of the Workmen's Compensation Bill, the object of which is to amend and extend the Workmen's Compensation Act of 1897. By the present Bill, the alternative was still offered to the workman of proceeding against his employer either under the Workmen's Compensation Act or the Employer's Liability Act of 1880, but where compensation was sought under the Employer's Liability Act, and the employer admitted liability, the subsequent procedure would be under the arbitration clauses of the Compensation Act of 1897. This would cheapen procedure and would also give a stimulus to the principle of arbitration. The Bill also provided that where medical referees were appointed as assessors, they should be called at an earlier period than hitherto. In addition, the Bill proposes to extend the operation of the Act by doing away with the existing limitation as to the height of the structure, in the case of persons employed on buildings, and to extend it to people engaged on railways and tramways.

Some discussion followed Lord Belper's statement, several speakers complaining that the clauses of the Bill were to a large extent unintelligible.

LORD JAMES OF HEREFORD urged the Government, in view of the complexity of the measure, to give ample time before its consideration in Committee.

THE MARQUIS OF LANSDOWNE promised that the Committee stage would not be taken until after Easter.

The Bill was then read a second time.

ELECTRICITY SUPPLY ACTS AMENDMENT BILL.

In the House of Commons yesterday (Thursday) afternoon Mr. Bonar Law, M.P., introduced a bill to amend the Acts relating to electric lighting.

OTHER ELECTRICAL BILLS.

The *Aberdare Tramways Bill* came before a Committee of the House of Commons, of which Sir Lewis McIver is chairman, on Thursday last week. Mr. Wedderburn, K.C., for the bill, said that it was a proposal to authorise the Aberdare Urban District Council to construct tramways and make street improvements. The tramways consisted of five comparatively short lengths of single track with passing places, three of which ran parallel with the Taff Vale Railway Co.'s lines, which company opposed the bill. The total length of tramways was 4 miles 25 chains of single and 42 chains of double track. Several local witnesses were called and supported the bill. Mr. Owen Williams, engineer and surveyor to the Aberdare Urban District Council, said the gauge would be 3ft. 6in. and that a separate generating station combined with the refuse destructor would be erected. The total amount of money which it was sought to borrow was £66,880 for the tramways, and £12,396 for the street widenings. The refuse in Aberdare, he said, had a very high calorific value, as coal was purchasable at 5s. per ton, and consequently much waste took place. He estimated the traffic on the tramways at 8,600,000 passengers per annum. On Monday, Mr. Stephen Sellon, the consulting engineer to the Council, was called, and said that his estimate of the cost of the construction, including the generating station and equipment of the tramways, would be £62,000. If there were a 10-minute service of 10 cars for 15 hours a day the revenue would be 10d. per car-mile, or an annual income of £55,000, of which 66 per cent. would be working expenses. Mr. Alfred Baker, general manager of the Birmingham Corporation tramways, stated that he had examined the estimates and agreed with them. The total working expenses should not be more than 6d. per car-mile. Mr. Ram, K.C., then addressed the Committee on behalf of some frontagers. Yesterday, the Committee refused to pass the tramways, but allowed the remainder of the bill as regards the electricity works and dust destructor.

The *Southend & Colchester Light Railways Bill* came before a House of Lords Committee on Wednesday. The proposal is to empower the Southend & Colchester Light Railways Co. to construct piers in the rivers Crouch and Blackwater, and to work ferries across the same; to acquire Creeksea Ferry; to provide steamers; to raise additional capital; and to make provision as to the electrical working of the company's undertaking. The company already owns light railways sanctioned by the Board of Trade under the Light Railways Act, having a total length of 27 miles, running from Southend to Rochford, Burnham, Southminster, Bradwell-on-Sea, West Mersea and Colchester. The proposal is to make a direct means of communication between Southend and Colchester, by linking up the lines where they are intersected by the rivers Blackwater and Crouch by working ferries across these two rivers. The Board of Trade has limited the capital powers of the company to £300,000, but authorisation is now sought to increase this by £114,000 and £38,000 loans. On Friday the Committee passed the preamble of the bill.

The *Metropolitan Electric Tramways Bill* was read a second time in the House of Lords on Tuesday.

The *Great Western Railway Bill*, which was before Sir H. Kimber's Committee of the House of Commons last week, proposed, among other things, to build a new line, 4½ miles long, from Ealing to Shepherds Bush, at a cost of £430,000, where an exchange station would be built with the Central London Railway. The proposal was opposed by the London United Tramways Co., the Metropolitan Railway Co. and the Great Northern, Piccadilly & Brompton Railway Co. on the ground of competition, but the Committee eventually passed the line. It is not proposed, at present, to construct the new line for electric traction.

Before the Court of Referees on Friday last week, applications were heard by the Croydon Rural District Council and the Penge Urban District Council for a locus to be heard against the *Croydon Corporation Bill* in respect of clause 21, which gives the Corporation the power to run motor omnibuses within 1 mile beyond the borough. In both cases it was argued that the consent of the outside authorities should be obtained to the running of such omnibuses outside Croydon, but this was not proposed by the promoters. The court allowed a locus in each case.

The *Birmingham Corporation Bill* was before the Unopposed Committee of the House of Commons last week and was ordered to be reported for third reading. The bill proposes the construction of some 20 miles of electric tramways and the reconstruction of existing lines for electrical working. The borrowing powers are £295,530 for the construction of the new tramways, repayable in 30 years; £554,820 for the reconstruction of existing tramways, construction of generating stations, &c., repayable in 25 years; and £202,200 for land, tramway depots, street improvements, &c.

The *Ealing Corporation Bill*, which came before the Police and Sanitary Committee on Monday, related to several matters concerning the supply of electricity, most of which, however, were unopposed. It gives the Ealing Corporation, inter alia, authority to attach brackets to buildings for overhead mains for lighting purposes, to supply electrical energy for traction purposes and to supply energy beyond its boundary to authorised distributors. Power is also taken to supply electrical fittings through a contractor, but not otherwise, and a postponement of two years from the date of the commencement of the repayment of loans was asked for. So far as these portions of the bill were concerned there was little opposition, and the promoters have inserted the Bermondsey clause in respect thereof. Regarding a clause which the promoters asked for to enable them to deal with persons who took a supply of electrical energy ostensibly for power purposes at a cheap rate and then used it for lighting, it was explained that this was frequently done in Ealing, and that there was no means of checking it or inflicting a penalty. It was held that such a proceeding was unfair to those consumers who took energy for lighting. As a precedent the Chesterfield Act of last year was quoted, in which authority was given to the Corporation to inflict a penalty upon any customer found so acting, but in this case it was merely asked to have the power to charge the consumer at the higher price when it was discovered that he was using his current in the manner recorded. The Chairman, however, after consultation with the Committee, came to the conclusion that the clause was unnecessary, as so far as it went the Corporation already had the power under the general law.

The *Metropolitan Railway Bill* was read a third time in the House of Lords on Tuesday.

The *West Cumberland Tramways Bill* was read a third time in the House of Lords on Tuesday.

The *Shepton Mallet (Gas & Electric Lighting) Bill*, which originates in the House of Lords, is now proceeding unopposed.

The *Cork Junction Railways Bill* was read a second time in the House of Commons on Tuesday.

The *London Southern Tramways Bill* was read a second time in the House of Commons on Friday last week.

The *Mexborough & Swinton Tramways Bill* was ordered for third reading by the Unopposed Committee of the House of Commons on Tuesday. It asks for an extension of time for the compulsory purchase of the land and for the construction of the tramways authorised by its Act of 1902. The bill also seeks to defer the commencement of the electric supply works in Rawmarsh and Swinton, the Provisional Orders for which the company have acquired.

The *South Lancashire Tramways Bill* was read a second time in the House of Lords on Thursday last week.

THE EXPLOSION ON THE MANCHESTER MAINS.

In the House of Commons on Tuesday,

Sir THOMAS DEWAR asked the Secretary to the Board of Trade, whether his attention had been called to a recent action against the Corporation of Manchester in which the plaintiffs succeeded in recovering damages for losses sustained through a fire caused by an explosion in one of the Corporation's electrical mains; and, seeing that the plaintiffs based their claim on the ground that the linking-up system laid down in the streets of Manchester caused a difficulty in localising leakage and constituted a public danger, would he state whether this system was generally adopted in London, and whether any improved system had received the consideration of the Board of Trade.

Mr. BONAR LAW, in a printed reply, said that the attention of the Board of Trade had been called to the action referred to. An improved system, in which the mains were separated into sections connected by suitable fuses, and whereby the difficulty in localising leakage and consequent risk were much reduced, had received the consideration of the Board of Trade, and had been adopted in all undertakings established during the last two years in London and elsewhere. He also understood that the improved system had been applied voluntarily to many existing undertakings in London.

[The action in question, Midwood *v.* the Manchester Corporation, was reported in our issue of March 24, p. 937.]

EXPLOSIONS IN TELEPHONE INSPECTION CHAMBERS.

In the House of Commons on Friday,

Sir THOMAS DEWAR asked the Postmaster-General whether his attention had been called to a recent action to recover damages for personal injuries sustained through the explosion of gas in a telephone inspection chamber fixed in the footway in Regent-street. Seeing that both judge and jury expressed the opinion that, in the interests of public safety, the accumulation of gas in these telephone inspection chambers should be prevented by a system of ventilation, would he state whether he proposed to adopt the suggestion.

Lord STANLEY, in a printed reply, said the case had been carefully considered. He feared that ventilation of the inspection chambers was not practicable, as he did not think the local authorities would consent to the fixing of ventilation pillars in the footways, and the owners of private houses would not allow pipes to be carried up the walls. Ventilating covers were not practicable, as they would not keep out mud and water. He did not think any precautions would have prevented the accident in question, but he proposed to lay down certain rules to be followed when the presence of gas was suspected.

TELEPHONE PURCHASE.

In the House of Commons on Wednesday,

The POSTMASTER-GENERAL, in reply to a question by Lord Bingham, stated that he was aware of the existence of some anxiety among the staff of the National Telephone Co. with regard to their position on the transfer of the company's service to the Post Office in 1911, and he had received two memorials from different classes of the staff on the subject. Without in any way pledging his successor, he might say that in view of the extent and nature of the business it was only reasonable to suppose that it might probably be found necessary to transfer to the Post Office service all efficient members of the present executive staff. Those who were appointed to the established staff of the Post Office would at once benefit by the conditions as to pension which applied to the staff, but he could hold out no hope that operators in other classes, who were not entitled to pensions under the conditions of their present employment, would have the period of their previous service taken into account in reckoning their Post Office pensions. In the case of those members of the staff who contributed to the present pension fund, it was expressly stipulated in the agreement that any obligation arising in this respect would have to be met by the company. It would be open to the Committee, which he hoped would soon be appointed to consider the agreement, to receive representations from the company's staff if they thought it desirable to do so. The agreement had been signed, however, and could not now be modified in any respect.

MINISTER OF COMMERCE AND INDUSTRY BILL.

A bill has been presented in the House of Commons by Mr. Louis Sinclair to establish a Bureau for a Minister of Commerce and Industry, and has been read a first time. The members who have supported the bill are Sir Albert Rollit, Sir Joseph Lawrence, Sir Christopher Furness, Sir Fortescue Flannery, Sir William Tomlinson, and Mr. Randles. The object of the bill is to establish a Bureau of Commerce and Industry, under the control of a Minister of Commerce and Industry. The Ministry is to consist of a permanent Council of experts representing various trades and industries, and elected for a definite period of five years. The salary of the Minister of Commerce is to be £5,000 per year, and the salaries to the secretary, staff, &c., to be such as the Treasury shall from time to time determine. The duties of the new department will be to administer a large number of the powers, duties and liabilities already exercised under various acts of Parliament by the Board of Trade, the Local Government Board, the Home Office and the Board of Agriculture. The powers transferred from the Board of Trade relate, among many others, to the Patent Acts, the Light Railways Act of 1896, the Tramways Act of 1870, and the Railways (Electrical Power) Act, 1903. From the Home Office the Factory Acts will be transferred.

COMMUNICATION WITH TORY ISLAND.

In the House of Commons on Tuesday, Mr. HUGH LAW asked the Secretary to the Board of Trade, whether he is aware that the telegraphic cable connecting Tory Island with the mainland of county Donegal was broken or injured during the past winter, and whether he could promise that the cable would be repaired at an early date.

Lord STANLEY in a printed answer said he was sorry that it had not been possible to undertake the repair of the cable to Tory Island during the winter months. In the meantime a suggestion had been made that communication should be established by means of wireless telegraphy, and be hoped to arrive at a decision at an early date.

LONDON AND PARIS TELEPHONES.

In reply to a question asked by Mr. Henniker Heaton in the House of Commons on Wednesday,

The POSTMASTER GENERAL said that the charges for telephonic conversation between London and Paris were fixed by international agreement, and he did not feel able to propose any reduction. The lines were at present fully employed during business hours, and if the charge for three minutes' conversation was reduced from 8s. to 2s. 6d., as suggested by Mr. Henniker Heaton, there would therefore be a proportionate reduction of revenue. At night six-minute conversations were charged at 8s., and as this might work out at less than ½d. per word it had been found useful to journalists on both sides.

THE PACIFIC CABLE.

In the House of Commons on Tuesday Mr. ASHTON asked the Secretary to the Treasury, for what term annuities created for the purpose of repayment of the Pacific Cable Loan, under the Act of 1901, existed; and whether any annuities for repayment of advances under the Public Buildings Expenses Act of 1903 had been created; and if so, for what term.

Mr. VICTOR CAVENDISH, in a printed reply stated that the annuity under the Pacific Cable Act was for a term of 50 years. Two annuities had been created under the Public Buildings Expenses Act, 1903, each being for a term of 20 years.

LEGAL INTELLIGENCE.

Sudbury Corporation v. Empire Electric Light & Power Co. (Ltd.)

This case came before Mr. Justice Warrington, in the Chancery Division, yesterday.

Mr. HEWITT, for plaintiffs, said the action was brought by the Corporation of Sudbury for a declaration that an agreement of May 30, 1904, between the Corporation and defendant company had been validly determined by plaintiffs by reason of the default of the defendants, and the plaintiffs also claimed payment of £2,000, the sum named in the agreement, as liquidated damages, to be paid in the events which had happened, and, alternatively, there was a claim for general damages. In 1900 the Corporation obtained a provisional electric lighting order which was confirmed by an Act and came into force on June 20, 1900. Plaintiffs were unable to obtain a loan from the Local Government Board to enable them to work the order themselves, and by June 25, 1902, the time limited for carrying out the works expired. The town clerk wrote to the Board of Trade saying that they were making arrangements for carrying out the order, and subsequently the Board were informed that the Corporation were desirous of entering into an agreement with a company to carry out the order. The terms offered to the Council were considered to be very favourable, and the Corporation asked the Board to sanction their entering into such an agreement, but the Board wrote on October 23, 1902, that they had no authority to sanction such an arrangement. That letter from the Board of Trade was understood by the Corporation (and properly understood, he submitted) to mean that the Corporation could do it without the sanction. He said that by Sec. 11 of the Electric Lighting Act, 1882, it was provided that any local authority who had obtained a licence or order might contract with a company for the execution or maintenance of any works for the supply of electricity in the area mentioned or any part of such area; but no local authority should by any contract or assignment transfer to any other company or person, or divest themselves of any legal powers given to them, without the consent of the Board of Trade. On Sept. 17, 1903, on the advice of the managing director of the company (Mr. Slatter), the town clerk wrote to the Board of Trade that negotiations were still in progress, that the Corporation were then in negotiation with the company on the matter, and that the Corporation had every reason to believe that the matter would very shortly be completed satisfactorily. Thereupon the Board agreed to an extension of six months. On March 1 Mr. Slatter wrote that, owing to the large amount of work the company had in hand and to the fact that the financial market was exceedingly bad at the moment, the matter had better be postponed for two or three months. The town clerk forwarded a copy of this letter, which was regarded as a cancellation by the company of an agreement, to the Board of Trade asking for a further extension, which was granted until December. They added that if the undertakers had not then taken definite steps to carry out their obligations under the order, the Board, as then advised, would not allow the order to remain longer in force. In May the agreement on which the plaintiffs sued, was entered into, and it was suggested now for the first time in the defence, that the agreement was invalid, and, therefore, that they could not recover under it. The agreement was not a transfer or a divesting of any legal rights or liabilities, but it left the Corporation the undertakers, with all the obligations of undertakers, as regarded third persons, which they had before the agreement was entered into. The agreement, however, provided for an indemnity to the extent of £2,000 in the event of default by the company. The defendants denied breach, and denied that the agreement was validly determined, and said alternatively that the £2,000 was a penalty only, and was not recoverable as liquidated damages. In December, after the action was commenced, the Corporation endeavoured to obtain a further extension of time, but they were unsuccessful, and the order was revoked on Jan. 30.

Without calling on the other side, His LORDSHIP gave judgment. He said the Electric Lighting Act of 1882 provided that a corporation might contract with any person or company for the execution of works to enable them (the corporation) to carry out the undertaking of supplying electricity, and they must buy current from any outside person or company, but it prohibited the undertakers by any contract or assignment from transferring to another company or person or divesting themselves of any legal powers given them or liabilities imposed upon them without the consent of the Board of Trade. That meant that the power which the provisional order gave to the local authority of itself supplying the district or not without the consent of the Board of Trade could be put into the hands of any other person. The agreement, however, contained a clause to the effect that the company should "manufacture, distribute and supply electricity and carry out the provisional order as if the company were the undertakers, except as in this agreement otherwise provided." The company also was to fix the charges and to enforce regulations. It was clear that it was contemplated that the entire business was to be handed over to the company. The agreement, therefore, was one which was prohibited by the Act of 1882, and could not be sued upon. Judgment for defendants, with costs.

Wilkinson v. Querette (Northern Counties) (Ltd.)

At Leeds Assizes last week, the plaintiff, Mr. Geo. Wilkinson, borough electrical engineer, Harrogate, and chairman of directors of defendant company, sued to recover £124. 6s. 1d., for director's fees. The company was floated in October, 1903, to acquire certain trade secrets, by the application of which waste substances or refuse, and in particular waste leather, could be converted into marketable commodities, together with the sole and exclusive right of using the same in the six northern counties. The articles of association provided that the directors should be paid £500. Plaintiff was one of five directors. In April last year the directors met, and decided on the proportion of payment, and plaintiff had conceded to him the right to £120 of the money when it became due. Some two months later the directors agreed among themselves that they would not ask for payment for their services until a definite result had been obtained from manufacturing by their process. It was contended that a definite result from manufacture had already been obtained, and £120 was now due.

For the defence it was argued that the directors acting collectively could make a new agreement lessening the amount of their remuneration.

His LORDSHIP said that under the circumstances plaintiff had a right to the money, and before that right could be taken away from him there must be some valid contract by which that right was destroyed. In his opinion, there was no such contract. He found for plaintiff for £114.

The hearing of defendants' counterclaim for £265 was then heard. It was stated that in the manufacture of "Querette" there was a secret process. Plaintiff suggested that he could invent a machine which would work automatically, and at the same time prevent the process from being discovered by anyone in the company's employ. The machine was made, and it was agreed that plaintiff should sell it to the company for £100 cash, 400 working capital shares, and 50 per cent. of profits from sale or lease of the patent. It was now contended that the machine wholly failed to satisfy the specified conditions, by reason of which defendants lost £250, the cost of constructing the machine, and 15 guineas paid on account of the purchase price.

Plaintiff contended it was no condition of the contract that the machine when constructed in accordance with his invention, would convey the secret preparation into the tank, so as to render it impossible for defendants' workmen to discover the composition of the preparation; he also contended that the original agreement was rescinded by mutual consent on Dec. 16, 1904, and a new agreement substituted, by which the company agreed to pay him £15. 15s. in lieu of the amount originally agreed. This sum had been paid by the company shortly before the writ was issued. The machine was not completed in accordance with plaintiff's invention.

His LORDSHIP held there was no contract between the parties. Plaintiff never intended to guarantee anything, and defendants were aware of that. He then gave judgment for plaintiff on the claim without costs, plaintiff to pay costs of issue of fact raised by him. Judgment for plaintiff on counterclaim, with costs of counterclaim.

City of London Electric Lighting Co. v. Mason & Co.

In the City of London Court on Tuesday, plaintiffs sought to recover from defendants £9 12s. for electric current supplied over a period of four years. In 1900 the company increased the voltage of supply and changed the meter, but the calculation of the amount of current consumed was continued to be made on the old basis. The result was that defendants were only charged for half their actual consumption. The company now sued for the balance.

Defendants contended that if the company made a mistake in their own favour a consumer could not compel the repayment for a longer period than the previous quarter, and asked why should plaintiffs now claim arrears for four years. It was stated, however, that the company paid back £400 recently for a similar error the other way.

Judge LUMLEY SMITH gave judgment for plaintiffs, but without costs.

Mica Insulator Co. (Ltd.) v. Bruce Peebles & Co. (Ltd.).

In the Outer House of the Court of Session last week, Lord Stormonth-Darling issued judgment in this action for £500 damages in respect of alleged breach of contract, and also for interdict in respect of the infringement of certain patents for improvements in electrical insulating sheets. Defenders deny breach, and challenge the validity of the patents on the ground of anticipation and prior use. They plead that in an action tried before Mr. Justice Kekewich in London in 1898 the patents in question were found to be invalid. Pursuers reply that the patents have since been amended, and maintain their validity. His Lordship allowed a proof.

Alleged Tramcar Obstruction.

A cart driver was charged at Bradford Police Court on Monday with wilfully obstructing one of the Corporation's electric tramcars on a dangerous portion of one of the city tramway routes. On behalf of the Corporation it was stated that defendant could have got out of the way by crossing the road or by turning up a side street, and that the seriousness of such obstruction was demonstrated recently when a car ran backwards down the hill in question. The defence was that the street was narrow at the point of alleged obstruction, and if defendant had crossed he would have been on the wrong side of the road. The summons was dismissed.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Belfast Tramways and Electricity Committee invite applications for the position of station superintendent. Salary £4 per week. Applications to the city electrical engineer (Mr. Victor A. H. McCowen), by April 15. See also advertisement.

Yorkshire Electric Power Co., Central Bank-chambers, Leeds, invite applications for junior assistants. See advertisement.

Birmingham Corporation require a tramways inspector, between 25 and 45 years of age, and with knowledge of tramway-track construction. Applications by April 12.

For the position of borough electrical engineer at Bermondsey, in succession to Mr. W. H. Vincent, there were 65 candidates, and of these the following three were selected by the Lighting committee to appear before the Council:—Mr. W. E. J. Heenan (chief engineer at Southend), Mr. Neville Appelbee (chief engineer at Ashton-under-Lyne) and Mr. John B. Mitchell (of Woolwich). The first vote resulted as follows:—Heenan 31, Appelbee 26 and Mitchell 6, and the second ballot gave Mr. Heenan 25 and Mr. Appelbee 28 votes. Mr. Heenan has been for the last three years at Southend, and prior to that was with the Northampton Electric Light & Power Co. for 10 years.

Wakefield Corporation have appointed Mr. W. H. Miller, Belfast, to the position of chief assistant electrical engineer.

Amsterdam.—At the end of 1904 the considerable municipal enterprise of electric tramways was for the most part completed, and this year the enterprise enters upon full working. The undertaking started under somewhat unfavourable conditions as to capital outlay. It was necessary to redeem at a large cost the concessions which had been granted to the companies working the then existing horse tramways, and, in addition to the usual heavy costs of conversion to electric working, a number of bridges required to be reconstructed or strengthened. In 1904 there were 31,260,756 passengers carried on the lines, the receipts being £174,329.

The receipts from the electricity supply works of Amsterdam reached in 1904 £41,375, of which amount £22,083 was applied to amortisation and interest on loans.

Argentina.—The "Review of the River Plate" says the Compañia Alemana Translantica de Electricidad have given the municipal director of public lighting a seat on the board of the company.

It is stated that the concessions granted to Mr. W. B. Cassels and Mr. Juan Miegil Najan for tramways and to Mr. L. F. Negretti for a light railway at La Plata have been declared as lapsed.

The mayor of Buenos Ayres has demanded the removal of the overhead wires of La Capital Tramway Co. in Calle San Juan.

Electric traction will shortly be adopted on the Tramway del Oeste, Buenos Ayres.

Buenos Ayres municipality have declined to sanction the Buenos Ayres and Belgrano Tramway Co.'s proposed line to Chacarita and Villa Urquiza which would cover a route to be served by Messrs. Sawyer & Lacroze under a concession recently granted.

Barking.—The Light Railways committee have been authorised to apply for an order to extend the tramways.

Bermondsey (London).—The Finance committee have passed an estimate of £6,159 for extensions of distributing mains.

Birmingham and District Electric Club.—A general meeting will be held on April 8 at the Colonnade Hotel, New-street, Birmingham, at 7·30 p.m., when Mr. W. H. Moorhouse, M.I.E.E., will give a lecture entitled "Lightning Conductors." The rules of the club have now been issued.

Brighton.—The consulting electrical engineer (Mr. Arthur Wright) has submitted his report on the position of the Southwick electricity works.

Mr. Wright prefaces his report by stating (1) that there is not the least chance of the general body of ratepayers having to contribute towards the scheme, as it can always be made self-supporting, as the Brighton electricity undertaking has invariably been in the past; (2) that the cost of carrying out the scheme will be much less than was estimated in 1900; and (3) that the Southwick scheme is not only the best solution of the problem of how to furnish the additional supply required for Brighton, but that its advantages over the only other alternative are even greater than were foreshadowed in 1899.

The whole of the interest on the money already spent on the works, together with Mr. Wright's fees for superintending the work, have hitherto been provided out of the profits of the electricity undertaking, and the accumulated profits and the certain economies resulting from the use of the plant now being installed at Southwick would be much more than sufficient to meet the full interest and sinking fund charges in the future. The scheme outlined and estimated for by Mr. Wright in 1900 contemplated the building of a 10,000kw. station, the provision of the necessary trunk mains to Brighton, the laying down of 6,000kw. of new generating and converting machinery and the removal of the large engines and boilers from North-road to Southwick. The cost of carrying out the complete scheme, with the exception of the removal of the North-road plant, would be about £86,000 less than the £400,000 sanctioned by the 1900 Act, and £123,000 less than the estimates signed by Mr. May and himself on March 9, 1900. To the great advantage of a saving in capital cost must be added those of having acquired an ideal site of an enormous extent for a power station which would be capable of holding plant of 60 per cent. more generating capacity than it was originally designed for, and the certainty of having a much larger field for the sale of electricity than was contemplated in 1900, due to the neighbouring districts now requiring supply. The reason why he (Mr. Wright) recommended the committee not to carry out that part of the original scheme involved in the removal of the North-road plant to Southwick was that the accepted turbines were guaranteed to be so much more economical in fuel and other works costs than the triple-expansion engines originally intended to be installed at Southwick.

In view of the approaching completion of his 14 years' service as manager of the Brighton Corporation electricity undertaking, Mr. Wright considers that the critics of the Lighting committee should bear in mind the satisfactory results of the committee's work in conjunction with that of Mr. Christie and himself. These results Mr. Wright enumerates in his report.

Canada.—The municipality of Coaticook, Quebec, came into possession, by purchase from a private company, of the electricity supply undertaking of the town in October, 1903, at a cost of $36.000, met by an issue of 4 per cent. debentures at about par. The station is a water-power one situate on the Coaticook river, where 400 H.P. is available. The demand is slowly but surely reaching the full capacity of the plant. A severe drought immediately followed the purchase by the municipality, but this notwithstanding the first 15 months' operations under municipal guidance realised a cash surplus of $1.000 towards meeting capital charges, repairs, &c. A considerable demand for power for domestic and industrial purposes has arisen.

Chili.—The Senate has passed an Act authorising the construction of an electric railway from Valparaiso to Santiago, via Casablanca and Curacavi valleys, with a branch line to Melipilla. The main line will be about 89 miles in length. Materials, &c., imported for this undertaking will be free of customs duties.

City Telephone Fire Inquest.—An inquiry was opened on Tuesday by the City Coroner (Dr. F. J. Waldo) into the cause of the two fires which took place on Feb. 28 last on the premises of the National Telephone Co. at Mansion House Chambers, Queen Victoria-street, and Oxford-court, Cannon-street, London, E.C. The fires occurred simultaneously, although the two places are a considerable distance apart.

Mr. W. E. L. Gaine, the general manager and solicitor, represented the National Telephone Co.; Mr. W. Clode appeared for the Metropolitan District Railway Co., and the insurance companies were also legally represented.

In opening the proceedings, Dr. Waldo said that Mansion House Chambers was a huge building, and contained some 550 offices. In the upper floors of the building, which was four storeys high, the Telephone Co. had their Bank exchange. The fire, which broke out at 2 a.m. of Feb. 28, destroyed two little wooden structures on the roof which were known as the test room. In the switch room, immediately behind the test room, some 80 women telephone operators and 10 male exchange inspectors were engaged during the day. At night four male operators only were engaged there. The fire at Oxford-court broke out in the telephone distributing room on the topmost floor, where the housekeeper and his wife resided. The distributing room was closed at the time, and was seldom used except for inspection or repairs. The origin of the fire had been traced to a cause the location of which lay outside his jurisdiction. It appeared from what he had been informed that some electrical work was in the course of execution on the inner circle of the District Railway which rendered necessary some alterations in the telephone wires in the tunnels. Some tests were being conducted on the railway early on the morning in question, and the conductor rails were charged. One of the telephone cables came into contact with the live rail, an arc occurred, the lead sheathing was melted off the cable, and the wires came in contact with the rail. The telephone wires, used to carrying current at only 22 to 24 volts, received current at 600 volts from the rail. That current was carried to the test room of the Bank Exchange and the cable room, and caused fires at both places. He had investigated the case, and had come to the conclusion that no public inquiry was needed, but he hoped that an inquiry would be made by one of the electrical inspectors of the Board of Trade. Within the last week, however, several members of the City Corporation asked him to hold an inquiry. Thereupon he communicated with the Board of Trade, and had received a reply from Lord Salisbury that the fire "did not appear to be a matter in regard to which the Board of Trade had any power to order an inquiry." He had decided, therefore, to hold an inquest.

Percy Thornton, a telephone operator at the Bank exchange, stated that about five minutes to two he tried to communicate with the Fire Brigade's headquarters at Southwark, but the line was "off."

Henry John [illegible], night inspector, said that after Thornton gave him the alarm he switched off the current and turned off the gas. He then got a chemical extinguisher and threw it through an open door, but the fire was burning very fiercely, and the extinguisher did little good. Since the London Wall fire there had been half-hourly inspections of the premises during the night. The fire undoubtedly broke out in the test room.

Other evidence having been given, the inquiry was adjourned.

Croydon.—The Corporation have authorised extensions of mains for the coming winter involving an expenditure of about £4,290.

Dalkey (Ireland).—The Council last week decided, like Blackrock Council, to send a deputation to wait upon the Chief Secretary for Ireland to advocate the insertion of a clause in the Dublin United Tramways Bill authorising the company to supply current for lighting in Dalkey and Blackrock. As will be seen from our Parliamentary Intelligence the effort to insert this clause failed.

Derby.—Application has been made for sanction to a loan of £9,600 for a 500kw. turbine dynamo and condensing plant, extension of mains, &c.

Dover.—The Board of Trade have granted the Council's application for a Provisional Order for the parishes of River, Ewell, Whitfield, Guston, Westcliffe and St. Margarets, with part of Alkham.

The estimates of the revenue and expenditure of the Electricity department for the year ending March 31, 1906, show total receipts £17,568, expenditure £8,935, gross profit £8,633. Interest requires £6,750, sinking fund instalment £2,481, leaving estimated surplus £542.

Dublin.—The Lighting committee have issued a report in which it is stated that

They look forward to the completion and taking over of the various sections of Mr. R. Hammond's original electricity supply scheme before the end of May. The steady and rapid growth of the undertaking will necessitate entering upon a large amount of additional work during the summer, as they fully anticipate that next winter the present capacity of some of the substations and sections of mains, &c., will be exceeded. Much of the extension work is of such a nature as could be satisfactorily carried out by the city electrical engineer (Mr. M. Ruddle) and a local construction staff without retaining the services of a consulting engineer, and the committee therefore believe that the time has arrived when they should suggest to Council the termination of the agreement entered into with Mr. Hammond on Nov. 30, 1899. They accordingly recommend that the agreement with Mr. Hammond be determined as from June 1 next, and that the town clerk be empowered to take any steps that might be necessary in connection therewith. The committee further recommended that, in connection with any additional works which might be required to be carried out, the committee be empowered, subject to the approval of the Council, to engage the services of such expert or experts as may be required for the assistance of the city electrical engineer

Lengthy reports have been prepared by the city electrical engineer (Mr. Ruddle) and the consulting engineer Mr. R. Hammond) on the position and prospects of the electricity undertaking. Mr Ruddle states that he is of opinion that notwithstanding the amount of unproductive capital and other embarrassments, the undertaking will in time be self-supporting. He suggests various alterations in the plant at the stations. £40,000 he suggests should be expended upon the generating and distributing system by the end of 1906, not including any provision for Clontarf. Mr. Ruddle recommends the following scale of charges for power: 5d. per unit for first hour's daily demand, and 1d. after; or an alternative flat rate of 2½d.; special combined flat rate of 2d. per unit for motive power, and 3½d. for lighting of newspaper offices. Clontarf to be treated as a separate concern. Certain extensions of mains are suggested.

Mr Robert Hammond's report puts the total expenditure on the new and old undertakings at £361,391. 6s. 9d., and considers that a demand of 3,300kw. will be obtained without making it necessary to incur the whole of the expenditure on mains and extensions. The committee should foster the demand for electric motors, and should inaugurate the sale of motors on the hire system, like Bradford, Sheffield and Huddersfield Corporations. It should, too, be possible to supply Blackrock, Kingstown, &c., with electricity from the Pigeon House at a moderate price.

Electricity in Iron and Steel Works.—A valuable and instructive booklet is issued by the Electrical Co., 121-125, Charing Cross-road, London, W.C., on the subject of electrical equipment of iron and steel works. The adaptability of electric driving to the various classes of machinery employed in these works is well established, and the publication under review shows some fine examples of plant supplied for this purpose. Electricity now plays a most important part in all up-to-date Continental factories and the descriptions which are given refer to some of the installations which the Electrical Co., or their parent companies on the Continent, have put down. The several plants described differ each from the other in many respects, and show clearly the varying needs of the different factories and the methods adopted to meet them. The first illustration in the list shows the generating station at the works of the Holwell Iron Co., where Belliss engines are included in the equipment. Another illustration shows the generating station at Bolckow, Vaughan & Co.'s works, where Willans engines form a portion of the extensive plant installed. There is a large range of these illustrations shown. To engineers and contractors engaged in the installation of this class of plant and to owners and managers of large iron and steel factories the booklet will prove of real interest.

Forthcoming New Books and New Editions.—"The Electrician" Printing & Publishing Co. (Ltd.) announce the issue shortly of "Electricity Meters and Their Management," by C. H. W. Gerhardi; "The Electrician" Primers, in 3 volumes (Vol. I., Theory; Vol. II., Electric Lighting, Power and Traction; Vol. III., Telegraphy, Telephony, Electro-Chemistry, Electro-Metallurgy and Miscellaneous); "A Digest of the Law of Electric Lighting, Electric Power, Electric Traction, &c.," by A. C. Curtis-Hayward, A.I.E.E., solicitor; "The Steam Engine Indicator and Indicator Diagrams," by W. W. Beaumont; "Electric Motive Power and Gearing," (revised by Mr. G. Thomas-Davies); "Submarine Telegraph Cable Laying and Repairing," by H. D. Wilkinson; "The Electrician" Wireman's Pocket Book," by F. C. Raphael.

German Exports.—In an interesting report on the trade of Germany for 1904 Mr. Consul J. Schwabach sets out a list of the principal exports of German machinery and apparatus for that year, these including electrical machinery valued at £1,079,300 and turbines £78,700. The value of electrical machinery exported in 1904 very closely approximates to the figure for the two preceding years.

Greenock.—The Corporation and the Tramways Co. have agreed on the following revised scale of charges for supply of electricity for the next five years: First 500,000 units 1¼d. per unit, next 200,000 units 1⅛d. per unit, next 200,000 units 1d., beyond this 0·85d. per unit. The anticipated revenue is about £5,000 per annum.

Halifax.—The Corporation has been advised by the Tramways committee to purchase, as an experiment, two motor buses at an estimated cost of £90. The deputy mayor has, however, ruled that the Corporation has no powers to run motor 'buses.

Hammersmith (London).—The Council on Wednesday adopted the following suggestions of the Lighting committee:—

That, from and after the reading of the meters at the end of the next September quarter, the present method of charging for electricity for private lighting upon the maximum demand system be abolished, and that in lieu thereof a flat-rate charge of 3d. per unit be adopted. That the principle of the appointment of a canvasser and the provision of a show room be approved

The borough accountant's statement of income and expenditure (partly estimated) of the electricity undertaking for the year ended 31st ult. shows estimated profit £5,919. 10s. 2d.

Additional office accommodation and a workshop are to be provided at the generating station at an estimated cost of £1,200.

Holborn and Finsbury Electrical Exhibition.—This exhibition, which closed on Wednesday, was a great success from every point of view and the attendance has been remarkably good. The County of London Co. have received repeated congratulations from the exhibitors on this score. In a number of cases the direct business already done is considerable. From the company's point of view the exhibition has been equally promising, and there seems every prospect from the inquiries received that the 7,000 H.P. (about), which the company have already connected to their mains, will be considerably augmented in the near future. The exhibitors are organizing a dinner to celebrate the occasion to take place early next week.

Ilford.—Col. Druitt inspected the Roding Bridge tramway route on Friday.

Islington (London).—The Finance Committee has passed an estimate of £4,500 for six mechanical stokers, steel bunker, coal elevator and conveyer, &c., for the electricity works.

Keighley.—The Tramways committee have been allowed a grant of £1,200 to meet a possible deficiency on the working of the tramway undertaking for the ensuing year.

King's Norton.—The Council have decided to pay the engineer (Mr. A. W. Cross) £350, and the clerk (Mr. Edwin Docker) £100 for special and extra services rendered by them in connection with the tramway undertaking.

Lambeth (London).—Some correspondence has passed between the legal advisers of the South London Electric Supply Corpn. and the town clerk of Lambeth in regard to a suggestion by the Corporation that the Lambeth Borough Council should apply to the South Metropolitan Electric Light & Power Co. for the terms upon which they would dispose of so much of the undertaking of the late Crystal Palace & District Electric Supply Co. as is within the Borough of Lambeth, so that the same should be acquired by the Council and transferred to the South London Electric Supply Corpn. On the recommendation of the General Purposes Committee the Borough Council have decided not to give the desired notice.

Light Railway.—The Devonport Light Railway order has been submitted to the Board of Trade for confirmation. Objections by 26th inst.

Liverpool.—The salary of the city engineer (Mr. J. A. Brodie) has been advanced from £1,400 to £1,500 per annum.

The salary of the resident electrical engineer (Mr. Alfred Clough) has been increased from £800 to £900 per annum, and that of the deputy resident electrical engineer (Mr. W. H. Collis) from £500 to £550 per annum.

The salary of the tramways manager (Mr. C. R. Bellamy) has been increased from £1,200 to £1,500 per annum, and that of the traffic superintendent (Mr. Chas. W. Mallins) from £400 to £500 per annum.

London County Council.—At Tuesday's meeting it was agreed to loan £11,083 to the Hackney Council for electric lighting.

Contracts for Electric Lighting Installations.—The General Purposes committee reported on the question of the terms of payment in contracts for electric lighting installations at fire stations. The committee recommended amendments in par. 4 of the Standing Orders, so that the payments will be made as follows:—*In Contracts for Machinery*: 50 per cent. on delivery of the machinery, 25 per cent. after erection, 15 per cent. after the trial testing, balance after expiration of prescribed period of maintenance. *In Contracts for Electric Light Installations*: 80 per cent. of the contract price (less extras) on completion of work, the balance after expiration of prescribed period of maintenance.

Tramways.—Captain Swinton asked whether, in view of the uncertainty in the public mind as to whether the Council's tramways paid, the Finance committee would bring up a short report showing the relative cost and result of the northern system leased to a company, the southern system worked by the Council, and the cost of the street widenings necessitated by the tramways.

Lord Welby said he would see if this could be done.

As reported in *The Electrician* a few weeks ago, the Highways committee recommended a vote on capital account of £351,900 to cover the cost of conversion of the lines of the South London Tramways Co to electric traction and the construction of other authorised tramways, in all 17¼ miles in length. The total cost will be £443,775. The conduit system will be employed.

Sir Melville Beachcroft moved an amendment to refer the matter back for further consideration with a view to considering the advisability of having a combined system of overhead and conduit traction.

The amendment was defeated and the recommendation adopted.

Lighting of Workmen's Cottages.—It was agreed to accept the offer of the County of London Electric Supply Co. to light cottages on the Totterdown Fields Estate.

Mexico.—The imports of machinery of all kinds into Mexico in 1903 amounted to £1,992,796, compared with £2,000,155 in 1902. Electric batteries stand for £23,438, bulbs for electric lamps £15,065, electric arc lamps £5,154, scientific instruments £27,050, machinery for steam power £868,385, steam engines £515,113. The largest relative increase over 1902 is in connection with arc lamps, the figure for that year being £3,448. The greater proportion of these imports came from the United States, the United Kingdom figuring last, or nearly so, in the list of countries supplying these goods, except for steam engines, for which the United Kingdom takes second place.

N.E.R. Fatality.—In his report on the death of a young girl killed by coming in contact with the live rail on the North-Eastern Railway, Lieut.-Col. von Donop says that the accident was due to the girl crossing the line at the wrong place. Close to the point at which she was found there were two regular crossings where the live rail was guarded. Col. von Donop considers that further protection of the live rail is not called for.

New Zealand.—The "Australian Mining Standard" says the question of the utilisation of New Zealand's water-power for the generation of electricity, which was recently reported upon by Mr. Hancock, an American expert, has now been further reported upon by Mr. P. S. Hay, superintending engineer of the N.Z Government Public Works Department.

Mr. Hay says that between Tekapo and Pukaki lakes (a distance of 13 miles) there is a fall of 750ft. If the water from these two lakes were brought down to the south of Fairlie the fall would be 1,000ft., and a power station erected there would give 500,000 H.P., or 2½ times the estimated horse-power of all steam, gas and oil engines employed at present in the colony. Mr. Hay, however, thinks it preferable, on the ground of economy, to proceed at first with a scheme to utilise the water of Wanaka and Hawea lakes, which are 1½ miles apart and have a 150ft. fall.

Newcastle-on-Tyne.—The Tramways committee recommend the construction of the Scotswood-road tramways at an estimated cost of £22,727.

Newfoundland Telegraphs.—The Government paid to the Reid Syndicate on Saturday last the $1,500,000 recently awarded as compensation for the expropriation of the telegraph system.

Northfleet.—At a meeting last week the District Council sealed an agreement with Gravesend Corporation for the supply of electricity by the Corporation in Northfleet. The District Council reserve the right to purchase the undertaking within their district at 14 years at fair market value plus 20 per cent., after 21 years plus 15 per cent., after 28 years plus 10 per cent., or after 35 years plus 5 per cent.

Norwich.—An inquiry was held here on Tuesday into the application of the Corporation for permission to borrow £30,000 for electric lighting extensions.

The Town Clerk (Mr. A. H. Miller) gave a history of the undertaking, which was acquired by the Corporation in January, 1903. There were, he said, at present 3,277 customers, and 2,100,000 units were sold last year.

The city electrical engineer (Mr. F. M. Long) supplied technical details.

The inspector (Mr. H. Ross Harper, M.I.C.E.), said when the Corporation purchased, they were purchasing machinery which was out of date and machines which were not economical to work. They were out of date before they bought them. He asked to see the report of the engineer on which the Corporation bought. The undertaking was purchased at an expenditure of nearly £250,000, and included machines of no value.

The Town Clerk: Which we are going to part with and substitute others to give greater accommodation.

A long discussion took place as to the exact sum that the Corporation had paid for each machine. The inspector said the Corporation had paid something for those machines, and there must be some value in them.

The Town Clerk pointed out that the Corporation purchased the whole business as a going concern, paying so much per share. There was a depreciation fund of £14,000, which the Corporation took over from the company.

Mr. Gentry said the machinery stood in December, 1903, at £41,777, and depreciation amounting to £6,206 was struck off that amount, reducing it to £35,571, the figure that the Corporation brought into their books, and forming one item of the purchase money.

The Inspector said the figures first stood at £41,803. When they purchased, what did they purchase at?

The Town Clerk: As a going concern.

The Chairman of the Electricity committee (Mr. E. Wild) submitted that the inspector was pursuing a point that had nothing at all to do with the matter in hand.

The Inspector said the Council were applying for permission to supersede this machinery.

The Inspector: What was the total original cost of this machinery to the company? You must give me some figures. The amount you paid for the purchase of the undertaking was £209,650 in February, 1903. What is your present capital?

The City Accountant: £265,908, which includes £30,000 raised for further works after the purchase of the undertaking. Then there was £2,000 cost of transfer, £1,750 for purchase of property adjoining the works, and £19,905 expenses of issue and discount on stock.

The Inspector: The Corporation have paid £235,908 to the company for the undertaking. What proportion was paid for plant, and what for goodwill?

The Town Clerk: I can give you what we apportioned at.

The Inspector said the point was that the Corporation gave something for these machines. Now they were applying for permission to put in 1,000kw. additional, which was going to supersede some of the machinery which they bought. The point was, what did they give for those machines which were not to be superseded? He would take £5,950 as the present value of the plant which would be superseded by the proposed installation, and inquired what machinery had been sold.

Mr. Lang said one 60kw. set for £400, two 80kw. at £750, a 120kw. at £400, and a 187kw. at £750.

The City Accountant said the net balance to be carried forward, after paying all working expenses, &c., was £1,432 for the year ended March, 1904.

Mr. Lang said they had purchased four superheaters at £100 apiece. The estimated profits on the undertaking would amount to £5,500 during 1905. So far the working had proved a financial success.

The City Accountant said no depreciation fund had been started at present, but they had £4,400 surplus from last year. The committee had decided to start a depreciation fund, but they had not yet settled the basis of working. As soon as the accounts for March, 1905, had been prepared, and the committee could see the position of affairs, a depreciation fund would be started.

Provisional Orders Revocation.—The Board of Trade have revoked the Gosport and Alverstoke Electric Lighting Order, 1900, and the Tipton Electric Lighting Order, 1902.

St. Pancras (London).—The Lighting Committee have been in negotiation with the Underground Electric Railways Co. of London respecting the supply of current to the company's eight stations in St. Pancras.

The company offered 1½d. per unit for a continuous supply for 23 hours each day throughout the year, and to guarantee for 5 years a minimum consumption at each station of 5,000 units per annum. The committee had decided to accept the offer, and this decision has been approved by the Council.

Salford.—The Bury Old-road tramway route between Whitfield and Manchester will be opened on 17th inst. Through connection between Bury, Radcliffe and Manchester will then be established.

Spain.—Authority has been obtained for the substitution of electric for animal traction on the Murcia-Alcantarilla-Espinardo tramways.

Sweden.—The Swedish State Railways Department are about to submit to the Riksdag a proposal to purchase, for 4,000,000 crowns, the waterfalls near the principal railways, and to utilise the water power in the generation of electrical energy for working the trains.

Switzerland.—Amongst the electrical enterprises recently undertaken is one to construct and work an electric railway from Interlaken to Merligen, a concession for the line having been granted to M. van Erlach of Spietz.

An electric railway is to be constructed between Linthal and Braunwald, this work being in the hands of Messrs. Bebie Heft, Linthal.

An electric railway is also to be built between Muattas and Muraigl in the Upper Engadine. The engineer for the enterprise is M. Englert-Faber of Basle.

Switzerland.—A company (headed by M. Balli, mayor of Locarno) has secured a concession for the construction and working of an electric tramway between Locarno, Lake Maggiore and Minusio. The line will eventually be extended to Gordola.

Messrs. O. Birken, E. Strub and J. Wennips have received a concession for an electric funicular railway from Cassarate to the summit of Monte Bré.

Telephone Detection of Wine Adulteration.—A well-known Paris chemist (M. Maneuvrier) is credited with the discovery that the adulteration of wine with water or other liquids or solids can be detected by the aid of the telephone. Two glasses, one filled with the wine to be tested and the other with a like quantity of wine known to be pure, are placed upon an apparatus resembling a scale, and telephonic connection is made with both liquids. If both wines are pure no sound is heard in the receiver, but if one contains water sound is produced until a pointer is moved to a given place on the dial plate attached to the telephonic apparatus. The movement on the dial continues until the conductivity of the liquids is uniform. The dial index indicates the quantity of extraneous matter in the wine.

Tramway Order Transfer.—Lees District Council intend to grant a lease to Oldham Corporation of tramway No. 1, referred to in the Lees 1902 Order at an annual rental of £376. 4s. 6d. for 21 years.

Tredegar.—The engineer of the Tredegar Iron and Coal Co. is preparing a scheme for the supply of electricity in bulk to this district.

Uruguay.—The Government have decided not to sell their Monte Video electricity works, and a new board of administration has been appointed.

Venezuela.—Puerto Cabello has recently established an electricity supply, the greater portion of the plant being of American make. The engine and boiler, however, were of English manufacture.

Westminster.—Electricity v. Gas.—Yesterday Westminster City Council discussed a report of the Works committee on the subject of an offer from the St. James' & Pall Mall Electric Light Co. (whose contract for lighting certain streets in the parish of St. James' at £30 per lamp per annum for 66 street lamps will expire in November next) to continue for another five years at the reduced price of £20 per lamp.

The offer was not accepted, and a specification was prepared by the city engineer for the provision and maintenance of 66 lamps, each giving a minimum candle-power of 700. Clause 14 of this specification was as follows:—"The existing pillars and lamps are the property of the City Council, and can be used in their present position free of cost as electric lamps. Further, if they can be converted into oil or gas lamps in such manner as to have the approval of the City Council, this will be allowed. In case new pillars and lamps are required under any scheme submitted, the existing lamps must be carefully taken down and carted to the Council's depot, in order that their sites may be utilised under the scheme. The existing mains, surface boxes, &c., are not the property of the City Council. As the present contract does not expire till Nov. 9, 1905, possession of any of the existing lamps, columns, &c., cannot be given till after that date."

Tenders were invited with the following result:—Gas Light & Coke Co., per lamp, installation £10, maintenance and lighting £15. 1s., subject to an increase or decrease of 9s. 6d. for every 1d. per 1,000ft. increase or decrease in the price of gas for public lighting, which is now 2s. 2d. per 1,000 cubic ft.; Kitson Light Foreign Supply Co. (oil light), installation, not using existing pillars and lamps, £35. 10s., using existing pillars and lamps £15. 10s., maintenance and lighting £14; St. James' & Pall Mall Electric Light Co., installation nil, maintenance and lighting £17.

The committee confined their attention to the first and third tenders. Acceptance of the Gas Co.'s tender would, they observed, involve an expenditure of £10 per lamp for installation, but the company had notified that they are prepared to accept payment of this charge in five annual instalments, free of interest. The committee reported that it was advisable that the use of electric lighting in Regent-street and Piccadilly should be continued, and recommended that the tender of the St. James' & Pall Mall Co. be accepted for five years terminating Nov. 9, 1910.

Ultimately the recommendation was referred back for further consideration.

The Council yesterday, discussing a notification of a proposal of an additional system proposed to be adopted by the London Electric Supply Corpn. for the supply of energy in Westminster, decided to notify the Board of Trade that the Council objected to the adoption of any system of distribution which would involve a multiplication of street boxes.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1905 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date (to Feb. 22), and the Directorial Division of the new volume has been corrected up to February 11th, 1905. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. The number of large sheet Tables, &c., has been increased, and the 1905 Edition of this indispensable work is offered as the most complete book of the kind ever published.

Among the chief features of the Handbook Division are Notes of the Year on Electric Traction and Electric Power, Turbine Notes, Electric Lamp Notes, Wireless Telegraph Notes (very full), Parliamentary Summary, Legal Decisions, and a complete set of all the chief documents used by Government Departments affecting the Electrical Industry (including the new "Special Mining Rules," issued Feb. 22).

TENDERS INVITED.

Cardiff Corporation invite tenders for the supply and erection of extra high-tension three-phase main switchboard for power station, switchboards for sub stations, motor generators, rotary converters, &c. Specifications, &c., from the borough electrical engineer and manager (Mr. Arthur Ellis), Central Offices, the Hayes. Tenders to the town clerk (Mr. J. L. Wheatley), Town Hall, Cardiff, by April 17. See also an advertisement.

Tenders are invited for the supply of a surface condenser with electrically-driven pumps for *Devonport* electricity works. Forms of tender, &c., from the borough electrical engineer (Mr. J. W. Spark), to whom tenders (at the Electricity Works, East Stonehouse, Devon), by April 18. See also advertisement.

Stockport Gas and Electricity committee invite tenders for supply of a 500kw. steam generator. Specifications, &c., from the borough electrical engineer (Mr. A. J. H. Carter), Electricity Works, Mill Gate, Stockport. Drawings and full particulars to Mr. Carter before April 17, and tenders (addressed to chairman of committee) to the town clerk's office, Stockport, April 26. See also advertisement.

Hull Corporation invite tenders for air-space telephone cable. Specifications, &c., from the Corporation telephone engineer (Mr. A. R. Bennett), Queen Anne's-chambers, Westminster, London, S.W. Tenders to the town clerk (Mr. E. Laverack), by 10 a.m. April 17. See also an advertisement.

Woolwich Guardians invite tenders for wiring Woolwich Union Infirmary and Nurses' Home, and for supplying fittings. Plans and specification at the Steward's Office, the Infirmary, Plumstead, S.E. Tenders to the clerk (Mr. Tom Cutter), 30, Rectory-place, Woolwich, S.E., by 4 p.m. April 19. See an advertisement.

Wigan Corporation invite tenders for steam dynamo and accessories, steam and water piping, ejector condenser and motor driver, centrifugal pump; paper and lead-covered, dry-core telephone, paper and lead-covered twin-service and vulcanised-rubber cables. Specifications from the electrical engineer (Mr. James Slevin), Bradford-place, Wigan. Tenders to the town clerk (Mr. Harold Jevons), by noon 17th inst. See also an advertisement.

Wimbledon District Council invite tenders for supply and erection of a 1,000kw. steam-driven turbo-alternator, with condensing plant, high tension switchboard and pipe work, and are prepared to accept one tender for the whole of the work. Specifications, &c., from the chief electrical engineer, Mr. H. Tomlinson-Lee. Tenders (addressed chairman of Electric Lighting committee) to Mr. Tomlinson-Lee's offices, Durnsford-road, Wimbledon, before noon 28th inst. See an advertisement for further particulars.

Glasgow Corporation invite tenders for main cables, electricity meters and carbons for 12 months from 31st prox. Specifications, &c., from the chief electrical engineer (Mr. W. W. Lackie), 75, Waterloo-street, Glasgow. Tenders to Mr. John Bowers, town clerk, by 17th inst. See advertisement.

Luton Town Council invite tenders for supplying and erecting certain plant and machinery at the electricity works, Luton, in accordance with plan and specifications of the electrical engineer (Mr. W. H. Cooke, M.I.E.E.), Town Hall, Luton, from whom further particulars after April 15. Tenders to the town clerk (Mr. Geo. Sell), Town Hall, Luton, by 4 p.m. May 19.

Great Western Railway Co. invite tenders for erecting electricity sub stations at Old Oak Common (near Acton), at Shepherd's Bush and Royal Oak. Tenders by 10 a.m. of 12th inst. to Mr. G. K. Mills, secretary, Paddington Station, London, W.

Batley Corporation invite tenders for permanent way construction and paving of Bradford-road tramway route, overhead equipment, steel poles, &c., feeder cables, conduits and accessories. Tenders to the town clerk (Mr. Jos. Hanson Craik) by April 17.

Tenders are wanted by 4 p.m. April 12 for electrical engineers' work at the Union of London & Smith's Banking Co.'s new bank at *Batley*. Plans, &c., of Walter Hanstock & Son, Branch-road, Batley.

The Clyde Navigation Trustees require tenders by April 10 for electric power generating and lighting plant for *Clydebank Dock*. Particulars from Mr. G. H. Baxter, 16, Robertson-street, Glasgow.

Aberdeen Corporation invite tenders for one surface condenser with air pump, oil separator, &c. Tenders to the city electrical engineer (Mr. J. Alex. Bell) before noon April 19.

Swindon Corporation require tenders by 10 a.m., 17th inst., for three years' supply of electric motors.

Johannesburg Municipal Council invite tenders for supply and erection of switchboards and accessories for their new direct and alternating-current power station. Specifications from and tenders to the consulting engineers (Messrs. Mordey & Dawbarn), 82, Victoria-street, Westminster, S.W., by noon April 27.

The Municipal Council of George Town, *Penang*, invite tenders for supply and delivery, f.o.b., of a 300kw. steam dynamo, motor generator, balancer, switchboards, &c. Specifications, &c., from the consulting engineers (Messrs. Preece and Cardew), 8, Queen Anne's-gate, Westminster, S.W. Tenders to Mr. R. M. Christie, 4, East India-avenue, London, E.C., by noon April 18th.

Debreczen City (Hungary) invite tenders to erect a central station for lighting and power. The city has 70,000 inhabitants. All information can be had from the chief engineer of the Municipal Council.

Dax (France) Municipality invite tenders by May 14 for a concession for the electric lighting of the town for 35 years. Particulars from and tenders to La Mairie de Dax (Landes).

Tenders will be opened on the 12th inst. by the Administration des Chemins de Fer de l'Etat (43, Rue de Louvain, *Brussels*) for supply of electric lighting materials. Plans, samples, &c., are deposited at the Bureau des Adjudications, Musée Commercial, 15, Rue des Augustins, Brussels. The general and special conditions of contract may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Ilford District Council have accepted the following tenders for ensuing year :—

British Thomson-Houston Co., electricity meters and demand indicators at schedule prices; W. T. Henley's Co., cables and house service boxes at schedule prices; Sunbeam Lamp Co., incandescent lamps, at schedule prices; Cwmaman Coal Co., Welsh coal, at 19s. 7d. per ton.

Gloucester Corporation have accepted the following tenders :

H. & T. Danks (boilers), £1,731. 10s.
Phœnix Dynamo Mfg. Co. (generating plant), £3,093.
Mirrlees Watson Co. (condensing plant), £1,669
Edward Le Bas & Co. (pipework), £1,545.
British Electric Plant Co. (feed pump), £238. 10s.

Southwark (London) Council have accepted the tender of W. Winn for electric lighting at the new museum at £52. 10s., and for ventilating at £92. For the lighting contract there were nine tenders (£52. 16s. to £175) and for ventilating six tenders (£87 to £115. 10s.)

The following contracts have recently been placed with Raworth's Patents (Ltd.) for tramcars with regenerative control :—

6 new cars for Plymouth Corporation tramways.
4 additional cars (making 7 in all) for Scarborough Tramways Co.
26 cars for the Yardley route of Birmingham Tramways.

Shoreditch (London) Council have accepted the following tenders for annual supplies :—Cables and sundries, Johnson & Phillips, Western Electric Co., and Siemens Bros. & Co. ; engineers' stores, Jas. Gibb & Co. and Middleton Bros.

Islington Lighting committee has provisionally accepted the following tenders for annual supplies :—British Thomson-Houston Co., meters ; General Electric Co., switches ; Sloan Electrical Co., carbons ; H. G. Mayer & Co., incandescent lamps, &c.

Sunderland Tramways committee have accepted the tender of White Bros. for installing intercommunication telephones of English make at the new tramway offices.

Sunderland Electricity and Lighting committee have accepted the tender of the Electrical Co. for a steam alternator, and that of the Phœnix Dynamo Mfg. Co. for four three-phase motor generators.

Southend-on-Sea Corporation have placed an order with the Hart Accumulator Co. for renewing the storage battery at the electricity works with 132 of their standard lighting type cells.

South Shields Tramways committee have accepted the tender of Wm. Underwood & Bros. at £42,903 for the construction of tramway permanent way and track and for landing at £770.

South Shields Electrical committee have accepted the tender of Dick, Kerr & Co. for generators at £2,695, and of J. & H. McLaren for engines at £8,400.

Stoke Newington (London) Council have placed an order with Bruce Peebles & Co. for two 120kw. motor-driven balancers, with 50kw. transformers, switch gear, &c.

Stockport Gas and Electricity committee have accepted the tender of Johnson & Phillips for supplying and laying feeder and test cables in connection with their tramway extension.

Bolton Corporation have placed an order amounting to £466. 10s. with the Key Engineering Co. for Cowan-Andrews remote control switch gear for their high-tension 3-phase extensions.

Rochdale Corporation have accepted the tender of Bruce Peebles & Co. for three 120kw. motor converters.

Barking Council have accepted the tender of Babcock & Wilcox for a boiler, feed pump, water softener and storage battery at £1,6

Croydon Corporation have accepted the tender of Callender's Co. for the supply of cables for the next 12 months.

BUSINESS NOTICES.

Edwd. Bakewell and Henry Nelson Bundy, electrical engineers, 59, Narrow Wine-street, Peterborough, have dissolved partnership. Debts by Mr. Bakewell.

Geo. Chas. Ching, Hy. Geo. Kettle and Chas. John Edwards, electrical engineers, &c., Ipswich, have dissolved partnership.

Mr. R. H. Schofield has been appointed by Ferranti Limited to represent them in the southern half of Great Britain.

LIQUIDATIONS, &c.

Claims against Hugh Evans Arkwright & Rosina Maria Collins, electricians, 35, Electric-parade, London, S.E., and against the separate estate of Mr. Arkwright, must be sent by 21st inst. to Mr. A. C. Culley, 24, Railway-approach, London Bridge, S.E.

The Lodge Electric Light & Power Co. (Ltd.) is to be wound up voluntarily. Mr. W. E. Mounsey, 3, Lord-street, Liverpool, is liquidator.

The liquidator in the winding up of Harry South & Co. (Ltd.) has been released.

Claims against the Electric Tramways Construction & Maintenance Co. (Ltd.) (in liquidation) must be sent by May 9 to Messrs. Leslie Morse & A. J. Paine, 79, Queen-street, Cheapside, London, E.C.

Sale by Auction.—Messrs. Percy Huddleston & Co. have been instructed by the liquidator of Walker & Hodgetts (Ltd. to sell by public auction at St. Simon's Electrical Works, St. Simon-street, Blackfriars-road, Salford, on Thursday and Friday, April 13 and 14, stock and plant of a dynamo and motor manufacturer, including gas engines, motors and dynamos, lathes, drilling, milling, &c., machines, and a large quantity of electrical apparatus, &c. Catalogues from the liquidator (Mr. E. A. Radford), 86, King-street, Manchester; of the auctioneers, 72, Finsbury-pavement, London, E.C.; or on the premises. Further particulars are given in an advertisement.

Electric Lamps for Sale.—In the liquidation of the Sir Hiram Maxim Electrical & Engineering Co. (Ltd.), 44, Gillingham-street, Pimlico, London, S.W., tenders are invited (by order of the Court) for purchase of about 500,000 high-class incandescent lamps, for voltages ranging from 80 to 280 and from 2½ c.p. to 32 c.p. Catalogues and forms of tender may be obtained from Messrs. W. H. Smith & Son, solicitors, Gresham House, London, E.C., Messrs. Lumley & Lumley, solicitors, 15, Old Jewry-chambers, London, E.C., or the auctioneers, Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., and Albert-square, Manchester. Tenders must be in by April 14. See also an advertisement.

Plant for Sale.—Messrs. Kynoch (Ltd.), Witton, Birmingham, have for sale some electric lighting plant, including three electric generating sets. See an advertisement.

A 25 H.P. Crossley gas engine, suitable for electric lighting, is advertised for sale by Leo Sunderland & Co., 39, Victoria-street, London, S.W.

British Electric Transformer Co., Hayes, Middlesex, have for disposal wire-covering (cotton) machinery.

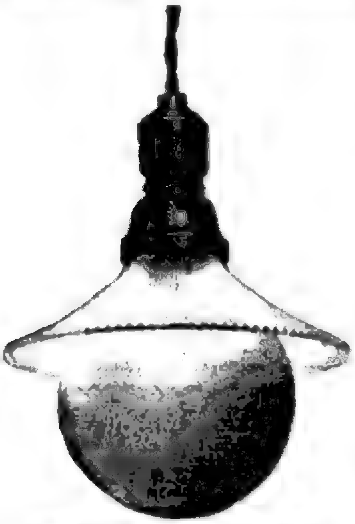
A 65 B.H.P. National gas engine (for electric driving) is advertised for sale by the British Electric Transformer Co., Hayes, Middlesex.

Mr. James R. Cull, Newton Abbot, Devon, has for sale some electric lighting plant, including Crompton dynamo, horizontal engine, arc and hand lamps, pendants, switch and distributing boards, cable, &c. See also advertisement.

Factory Sites for Sale.—Messrs. Woodhouse & Davidson, 10 and 11, Lime-street, London, E.C., have some conveniently-situated freehold factory sites for sale within 11 miles of London. See an advertisement.

A freehold factory recently completed, with all the L.C.C. requirements, fireproof construction, electric lift, &c., and with buildings covering an area of about 15,700ft., is advertised for sale in another column.

John W. Collis & Co., 143 and 144, Holborn Bars, London, E.C., have for sale some conveniently situated and well appointed freehold factory premises at Belvedere, Kent. See an advertisement.



THE B.T.-H. "MERIDIAN" LAMP.

The "Meridian" Lamp.—In this lamp (which is placed upon the market by the British Thomson-Houston Co.) the shape of the filament, its location in the bulb, and the exact shape of the reflector have been adopted after careful study, and it is claimed that it affords the best distribution of light possible. The special type of prismatic glass shade is accurately and rigidly fixed to the lamp fitting, so that the lamp may be burned in any position and the same distribution of light obtained as when arranged vertically. The employment of "Meridian" lamps affords opportunity for the most artistic lighting effects to be obtained, as they can be made to harmonise with interior decorative schemes either by making them part of the ceiling decoration or by building them into the ceiling to conceal the outlines of the lamps without reducing their illuminating power. They can also be arranged in clusters or groups and fixed to electroliers, side brackets, &c. Hitherto these lamps have only been made for use on 100-125-volt circuits, but we learn that the British Thomson-Houston Co. have, after a series of exhaustive experiments, developed a 120-watt "Meridian" lamp for burning in multiple on circuits of from 200 to 250 volts, and are prepared to fill orders for these lamps immediately from stock.

Temperature Experiments with Insulating Materials and Field Coils.—Messrs. George Schultz and Co., Laurence Pountney-lane, London, E.C., as agents for Messrs. Meirowsky & Co., manufacturers of the Excelsior paper, which was one of the materials experimented upon, write us that the reference to "Berrite varnish" on line 10, column 1, p. 885 of our issue of March 17 is liable to misconstruction, and they point out that the Excelsior paper No. 3, to which the paragraph refers, was impregnated with "Excelsior" varnish.

Catalogues, &c.—J. H. Holmes & Co., have prepared a list of installations, giving particulars of generators and motors supplied by the company to newspapers, printers and paper mills. The list gives a good indication of the extent to which electric power is being applied in these branches of industry.

A further batch of recent publications issued by Siemens Bros. & Co. is to hand. These include specifications of plain, open and engine base types of G machines; a leaflet giving outputs, weights and dimensions of F and FA type motors, ranging from 2½ B.H.P. to 58 B.H.P., open, protected, ventilated and fully enclosed types; a leaflet giving particulars of SK maximum and reverse automatic cut-outs for from 50 amperes to 2,400 amperes; and a leaflet describing patent transport cells.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from March 28 to April 4, with the ports of destination:—

Africa—Alexandria, £265; Cape Town, £827 (including £73 telegraph material); Delagoa Bay, £164; Durban, £2,977 (including £2,040 telegraph material); East London, £268; Port Elizabeth, £47. *Argentina*—Bahia Blanca, £15; Rosario, £130 (including £100 telegraph material). *Australasia*—Adelaide, £17; Auckland, £101 (including £55 telegraph material); Fremantle, £62; Launceston, £302; Lyttelton, £335; Melbourne, £2,575 (and 79 cwt. telegraph wire); Napier, £31; Sydney, £2,901; Wellington, £857. *Azores*, £16. *Belgium*—Ostend, £140. *British Guiana*—Demerara, £170. *Burma*—Rangoon, £488. *Canada*—Toronto, £32. *Ceylon*—Colombo, £921. *China*—Shanghai, £142; Tientsin, £712. *France*—Paris, £900. *Germany*—Hamburg, £60 (telegraph material). *Gibraltar*, £576 (including £326 telegraph material). *Greece*—Piræus, £250. *Holland*—Amsterdam, £135 (including £55 telegraph material); Rotterdam, £49. *Hong Kong*, £110. *India*—Bombay, £569 (including £23 telegraph material); Calcutta, £2,214; Madras, £546. *Italy*—Spezia, £23 (telegraph material). *Japan*—Kobe, £166; Nagasaki, £564; Yokohama, £944. *Norway*—Christiania, £44. *Russia*—Batoum, £55; Odessa, £201; Reval, £1,350; St. Petersburg, £130 (telegraph material). *Siam*—Bangkok, £98. *Spain*—Bilbao, £85. *Straits Settlements*—Singapore, £218 (including £10 telegraph material). *U.S.A.*—Philadelphia, £268. *West Indies*—Trinidad, £91. Total £23,824 against £7,942 for two days last year (March 30 and 31).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

January 19, 1905.

1,073 B.T.-H. Co. (G.E. Co., U.S.) Prepayment mechanisms.
1,079 Allgemeine Elektricitats-Gesellschaft. Electric distribution systems especially for train lighting. (Date applied for, Jan. 20, 1904, date of application in Germany.)*
1,090 A. C. Baronio. Stenographic recording and stenotelegraphic transmitting and recording systems.

January 20, 1905.

1,136 J. Rymer-Jones. Electrical condensers.
1,153 O. H. Baldwin. Current-collecting devices.
1,154 O. H. Baldwin. Devices for supplying current to vehicles.

January 21, 1905.

1,169 W. Simm and J. S. Sellers. Liverpool. Magnetic separators.
1,173 F. H. Loring. A system of electric generation.
1,190 F. G. Carter. Brighton. Electric igniter for motor gas lamps.
1,221 C. W. Atkinson. Electricity meters.
1,224 C. J. Earll. Trolley retrievers.*
1,231 J. G. Lorrain (Société Anonyme des Allumeurs extincteurs automatiques, Switzerland). Electrically igniting gas.*

January 23, 1905.

1,243 J. Parry. Worcestershire. Clip for electric lamp shades.
1,247 D. Maxwell. Dundee. Conduits for protection of conductors.
1,249 J. Ferguson & Kelvin & James White. Glasgow. Electric relay with time control for closing circuits of electro-magnets.

1,281 Siemens Bros. & Co. & H. Berry. Controlling polyphase and alternate-current motors.
1,299 H. Starcke. Apparatus for recording telephonic messages.*
1,300 A. B. Soar and H. F. Joel, jun. Switches, controllers and the like.
1,308 H. C. Jenkins. Magnetic ore separators.
1,313 B. T.-H. Co. (Ltd.) (G.E. Co., U.S.) Electricity meters.
1,321 S. W. Huff. Railway electric signals.*
1,324 F. R. Simms and R. Bosch. Terminal rods for internal combustion engines.*

January 24, 1905.

1,335 W. T. Thorley. Staffordshire. Brush holders for dynamos or motors.
1,360 W. Champ. Electric bleaching apparatus.
1,369 A. C. Cossor. A new electro-therapeutic ray tube.
1,380 W. D. Watkins, J. W. Bolster and W. E. Goodsell. Telephone selecting mechanism.*
1,384 T. O. Wilson. Electric apparatus for felling trees or sawing wood (Date applied for, Jan. 30, 1904, date of application in U.S.)*
1,391 R. P. Jackson. Systems of electrical distribution. (Date applied for, June 6, 1904, date of application in U.S.)*
1,399 J. R. F. Smith. Electric governor.
1,400 B.T.-H. Co. (G.E. Co., U.S.). Incandescent lamp sockets.
1,406 and 1,407 L. N. J. Roselle. Plates for secondary batteries.
1,413 L. A. Timmis, E. W. Timmis and J. R. Cook. Electric and magnetic appliances.
1,421 V. B. Lewis. Manufacture of carbons for arc lamps.
1,430 Sautter, Harlé & Cie. Compounding alternators. (Date applied for Feb., 1904, date of application in France.)*
1,432 C. A. Pomeroy. Telephone directories.*

January 25, 1905.

1,482 P. W. Noble. Coventry. Contact makers and breakers.
1,493 J. J. Coachman. Electric time switches.
1,507 H. H. Lake (Compagnie Générale d'Electricité, France.) Electrodes for arc lamps.*
1,518 C. W. Maunsell, F. R. Butt and H. W. Cox (Ltd.) Binding screws and terminals.*
1,522 F. H. Headley. Distributing boards for electric installations.
1,526 A. F. Berry. Coils or windings for electrical apparatus.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1904.

1,494 Latour. Alternating-current dynamo-electric machines. (Date applied for, Jan. 21, 1903.)
3,337 Lapeyrade. Dynamos. (Date applied for, Feb. 10, 1903.)
3,356 Chandoir. Electric lifts and hoists.
3,523 Friedlaender. Hand telephones.
3,613 Taylor and Ratcliffe. Bracket for carrying electric lamps and for displaying goods.
3,826 Pontite Limited and de Pont. Insulating materials.
3,885 Wright and Nicholls. Electrical switching systems. (Date applied for, Feb. 16, 1903.)
3,925 Hocken and Hocken. Attaching battens to cable drums.
4,110 Martin and Lowson. Electrical connectors.
4,116 Chandoir. Electrically-controlled lifts and hoists.
4,943 Cleveland Bridge & Engineering Co. and Hills. Electric controllers for use with cranes, winches, transporters, &c.
5,104 Thompson (Ges. für drahtlose Telegraphie m.b.H.). Increasing the discharge energy of electrical vibration systems.
5,926 Mavor & Coulson and Mavor. Electric motors.
6,040, 6,041 and 6,042 Levis (G.E. Co.). Arc lamps.
6,617 Marples. Controlling devices for electric motors.
7,662 Carolan (G.E. Co., U.S.) Arc lamps.
7,985 D'Olier, Jun. Attachments for incandescent lamps.
8,077 Thomson. Trolley heads.
8,096 Denton, Ingham and Jones. Catching and supporting broken overhead wires.
8,399 and 8,402 B.T.-H. Co. (G.E. Co., U.S.). Alternating-current motors.
8,401 and 8,404 B.T.-H. Co. (G.E. Co., U.S.) Alternating-current motors.
8,477 Rees. Incandescent lampholders.
8,590 B.T.-H. Co. (G.E. Co., U.S.). Brush holders.
8,686 Delafon. Primary galvanic battery.
8,699 B.T.-H. Co. (G.E. Co., U.S.). Windings for dynamo-electric machines and methods and apparatus for forming same.
8,777 Williams Thomas and Northwood. Attachment of globes or shades.
8,984 Delafon. Positive electrodes for galvanic batteries.
9,117 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.
9,372 Hills, Urquhart and Honey. Armatures for dynamo-electric machinery.
9,373 Hills, Urquhart and Honey. Brushes for dynamo-electric machinery.
9,427 Crosbie and Ward. Automatic electromagnetic sanding gear.
9,565 Raworth. Electric tramway or railway vehicles.
10,356 Phillips and Parkin. Construction of trolley arms.
11,262 Tardian. Transmission of sound and telephonic apparatus therefor.
11,777 Lawton and Whatson. Tumbler and like switches.
13,169 Lea. Electric light fittings.
13,928 Jones (Long Arm System Co.). Automatic cutout mechanism.
15,322 Chevallier and Cadet. Switches particularly adapted for use with targets. (Date applied for, Aug. 14, 1903.)
17,939 Lauvergnier. Trolleys for electric traction.
19,126 Foot. Dynamo-electric machines. (Date applied for, Sept. 16, 1903.)
19,242 Lea and Mitchell. Electric light fittings.
20,963 Candi and Candi. Electrically igniting and extinguishing gas burners.
21,464 Broomhead (American Bank Protection Co.). Burglar alarms.
21,601 Williams. Trolley sheaves.
22,326 A. Justice (Voltage Controller Co.). Controllers for electric current. (Date applied for, Oct. 17, 1904.)
22,342 Körting and Mathiesen Akt.-Ges. Arc lamp electrodes. (Date applied for, Oct. 31, 1903.)

COMPANIES' MEETINGS AND REPORTS.

Willans & Robinson (Ltd.).

The general meeting was held on Wednesday, Mr. Mark Robinson, M.Inst.C.E., presiding.

The SECRETARY (Mr. C. S. Essex) read the notice calling the meeting.

The CHAIRMAN said: Gentlemen, I have to bring before you worse figures than any which the history of our company records, but I have also to ask you to analyse them with some care, so that while, on the one hand, we may be urged to new efforts by the undoubted gravity of the position, we may not, on the other hand, have those efforts weakened by undue discouragement. While the books show a loss for the half-year of no less than £42,771, the real money loss is considerably smaller—in fact, under £19,000—and this amount might be further reduced if the explanation were extended. In some companies it might be held that in such times the writing down of premises and plant and stocks might be suspended, or carried on less vigorously. But when the corner is turned our position will be all the sounder, and the recovery all the quicker, through our not having shirked duty on the way. We ought, perhaps, to set before you all the causes of our misfortunes, which are many, and by no means all upon the surface, or touched upon in any recent discussions. We ought to explain just what are the strong points of the new work we have taken up, and why we believe it will be profitable. But much of all this cannot be spoken without injury to the company. Looking at the report, the division of certain expenses between Rugby and Queen's Ferry, so strongly desired by some of the shareholders at the last meeting, has been tried. But the whole question of apportionment of such charges is very difficult, and the directors have not been able to gain much enlightenment from the authorities they have consulted. We have spoken before of "extremely unfavourable trade conditions," and I am afraid some of my hearers have thought that overmuch was being made of this point, but the present figures should dispel that opinion. Even two years ago, when the bad times had begun, the gross profit for the half-year, made wholly in Rugby, stood at £39,797: this time it stands for Rugby at £5,366, or nearly £20,000 too little to balance the necessary general charges of the Rugby business. This fall is due in part to dullness of trade, implying enlarged shops only partially filled with work, but in very large part it is accounted for by the fact that the selling price per horse-power has fallen by some 25 per cent. in the period—a fall in itself sufficient to wipe out even a very high rate of profit and turn it into a loss. But if in the Rugby business this change of trade conditions could turn old-established prosperity into positive loss, it affects a new undertaking like Queen's Ferry most seriously. But in regard to Rugby I am glad to say there are prospects of improvement in the engine business, and of some return towards remunerative prices, and we hold very hopeful views of our new steam turbine business. The success of the earlier turbines, already at work, has been remarkable. There have been a few troubles in the first machines, but we know the causes and the remedies. As stated in the report we have made arrangements with the Hon. C. A. Parsons, which removes all fears of litigation, and places that gentleman's unrivalled experience at our service without burdening our manufacture to a serious extent. We are also fortunate in having control over other valuable patents for improvements in turbines, one of which is Capt. Sankey's improvement in the method of fixing the blades, which has already attracted the attention and received the approval of many engineers. Of course the turbine is too new a development to make a profit for us already, and I will venture no predictions. But everything about it has so far gone with a success fully up to our expectations. The gas engine is a new departure of more doubtful value. Three or four years ago the steam engine was so seriously threatened by the large gas engine that it would have been a dereliction of duty not to begin studying and at least experimenting with the latter. We took the best steps open to us, but the first engines have cost us more than we received for them. This we have treated as loss, and have written it off directly, with the exception of the cost of the very earliest experimenting. But while we have been studying the gas engine the situation has changed. The employment of large steam engines of the old forms is now threatened, and still more dangerously, by another rival—the steam turbine. There are thus two rising suns to worship, and the steam turbine is the more important of the two. We, therefore, do not look upon success with the large gas engine as so vital to our interests, and we mean to judge it by its profitableness alone, and this we shall soon be able to judge. With regard to Queen's Ferry, Mr Anderson, who has studied the situation there, recommended that the steel works should be re-opened. This was done at the beginning of the current year, and work was re-started with the same staff, the same processes and the same products as before. During the time the furnace was shut down, the wide interest felt in our steel had opportunity to develop, so that we have been able to re-start with a market in large part ready made. Both the Admiralty and the War Office show interest in our speciality, and all the auguries are favourable. As regards boiler making there have been repeat orders enough to justify working in preference to closing. The exceedingly low prices of all types of boilers at present, and the fact that financial reasons preclude the usual course of taking a few orders at a known loss for the sake of developing trade prevent us from going on in other than a very restricted and tentative way.

When depreciation is allowed for, and the effect of some exceptional writings-down of stocks and minor tools, and when allowance is made for the new method of dividing certain general charges, the real loss upon working (perhaps I should say upon *not* working) is less for the past half-year than for the half-year before, not by £3,026, as the accounts appear to show, but by £8,674. Put in another way the loss in the first half of 1904 amounted to 42 per cent. of the money actually spent in salaries, wages, rents, material, &c., but in the second half of the year the percentage was reduced to about 25, though the total volume of expenditure was smaller. Further than this, the loss now shown is in no small part due to a disastrous breakdown of one of the large hydraulic pumping engines in October, which almost entirely stopped work in the tube works, and indirectly in the machine shop, for nearly half the period covered by the accounts. I now move the adoption of the report and accounts.

Mr F. W CLARKE seconded the motion.

Several shareholders expressed their anxiety with regard to the company's future.

Mr. ANDERSON, one of the new directors, spoke of the work being done at Queen's Ferry, and said that since the beginning of the year they had made 1,743 tons of steel and sold 1,543 tons. There was every prospect of the steel manufacture becoming a valuable part of their business.

The report was then adopted.

ALLIANCE ELECTRICAL CO. (LTD.)—For the 23 months ended Dec. 31 the profit was £11,941, after deducting all expenses, making provision for depreciation and adding £259 brought forward. It is proposed to place £500 to ledger reserve, write £500 off extension of business account and to declare a dividend at the rate of 4 per cent. per annum on the ordinary shares, carrying forward £303. The directors announce that they have started a new department for dealing with the constantly-growing demand for electric power in factories, mines, &c., with headquarters in London and branch depots at Manchester, Newcastle and Glasgow.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.)—The report for 1904 states that the gross receipts amounted to £418,093 and working expenses to £227,528. Deducting debenture interest and sinking fund, the net profit was £174,003. After paying preference and interim ordinary dividends, putting £10,000 to reserve, there is available £48,422. The directors recommend a final ordinary dividend of 5s. per share, absorbing £42,500, making 8 per cent. for the year. The working expenses amount to 54·42 per cent., compared with 53·02 per cent. in 1903. The gross receipts, compared with 1903, show an increase of £89,069, and expenses an increase of £53,102. The company took over the City of Buenos Ayres Tramways Co.'s system on Jan. 1 last. The electrical conversion of those lines is in active progress and will, it is expected, be completed within the next 18 months.

BABCOCK & WILCOX (LTD.)—The report for 1904 states that the net profit, after deducting depreciation on plant, &c., was £289,748. 17s. Adding balance from last account (£26,820. 16s. 10d., less £1,050 voted to directors as bonus in April), the balance was £315,519. 13s. 10d. Interim dividends absorbed £45,400. Out of the balance (£270,119. 13s. 10d.) the directors recommend the following dividends for the half-year ended Dec. 31: 3 per cent. on preference shares (less tax), absorbing £3,000, 8 per cent. on ordinary shares (tax free), absorbing £42,400, and bonus of 4 per cent. on ordinary shares (tax free), taking £21,200. £175,000 is to be placed to reserve, leaving £28,519. 13s. 10d. to be carried forward.

BRUCE PEEBLES & CO. (LTD.)—At the meeting on Friday Mr. W. C. Peebles congratulated the shareholders on the past year's work, and said they had several large contracts in hand on favourable terms, and the outlook for the present year was considerably brighter than last year.

BUENOS AYRES & BELGRANO ELECTRIC TRAMWAYS CO. (LTD).—At the meeting yesterday (Thursday) Mr. J. B. Concanon said the receipts had shown an increase of £6,568 over the previous year. The board regarded that as satisfactory, bearing in mind the loss caused by the strike in November, and also remembering the fact that 1903 showed a very considerable increase over 1902. The increase in expenditure had only amounted to £1,083. The capital account showed an increase of £17,111, due to some extent to the purchase of 15 new cars.

CALCUTTA TRAMWAYS CO. (LTD.)—During 1904 the traffic receipts were £127,780, expenditure £64,553, leaving £63,513. Debenture interest absorbed £14,255 and interim dividend £15,340, leaving, with £2,351 from 1903, £36,268. Premium on shares (£6,557) has been credited to depreciation. The directors propose to allocate £8,442 further to depreciation, and from the balance (£27,826) it is recommended that a final dividend of 5s. per share, absorbing £26,250, be paid, making 8 per cent. for year, tax free, leaving £1,576. 1s. 5d. to carry forward. During the year large sums have been expended in consolidating and improving the system and in preparing for the requirements of the extensions shortly to come into operation, as well as those which are rendered necessary by the expansion now taking place on the existing system. Negotiations for various extensions have made considerable progress.

CHISWICK ELECTRICITY SUPPLY CORPN. (LTD.)—At the meeting last week it was stated that during 1904 £10,937. 10s 9d. was expended on capital account for new machinery, mains, &c. At Chiswick the equivalent of 29,658 8 c.p. lamps was wired, compared with 25,159 at end of 1903; and at Aberystwyth the equivalent of 11,902 lamps, compared with 11,286. Chiswick station plant, to which has been added a new 500 H.P. generating set, can now supply 50,000 lamps connected to the mains. The total profit made during the year was £4,370. 19s. 8d. Interest has required £1,513. 8s. 2d., and £184. 11s. 6d. has been carried to depreciation reserve, leaving £2,673 profit. The directors propose a dividend on the ordinary shares of 1½ per cent. for the year.

ELECTRIC TRAMWAYS IN THE FAR EAST.—At a meeting of the Mines & General Trust (Ltd.) last week, it was stated that the Hong Kong electric tramways, in which the company were interested, had been running since August last, and, though not yet fully equipped (only 26 cars out of 36 were in operation), the company was earning profits sufficient to meet all charges, including debenture interest. The Singapore tramways should be in operation early this month, and the directors had every reason to anticipate that the undertaking would be a most successful one.

GATESHEAD & DISTRICT TRAMWAY CO.—At the meeting on Friday Mr. C. R. Greene said that from January next the company were to get their current at a reduced rate, which he expected would result in a saving of from £1,500 to £2,000 a year, and that, with the reduction in rating assessment they had succeeded in obtaining, would put the company in a very satisfactory position.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—The directors have determined, subject to final audit, to recommend a dividend for the 6 months ended Dec. 31 of 17s. 6d. per share (making with interim 6 per cent. for the year) and a bonus of 20s. per share, both tax free. They also recommend a special distribution of 15s. per share (tax free) out of interest accrued during year upon reserve fund investments. The dividend, bonus and special distribution will be payable May 1. The transfer books will be closed from 12th to 25th inst. inclusive.

KIDDERMINSTER & DISTRICT ELECTRIC LIGHTING & TRACTION CO. (LTD.)—The directors' report states that the gross receipts (including amount receivable from Kidderminster & Stourport Electric Tramway Co. as dividend) amount to £6,346, which, with £555 brought forward, makes £6,902. Deducting expenses, including interest, £4,648, there remains £2,253. The directors propose that £500 be applied to depreciation and reserve, £1,500 as dividend on preference shares, £253 carried forward. The tramways profit was £2,476. To depreciation and reserve £500 is placed; to dividend of 5¼ per cent. £2,002.

MERTHYR ELECTRIC TRACTION & LIGHTING CO. (LTD.)—The gross receipts of the light railways for 1904 were £10,631, and of electricity supply £3,773. Deducting expenses (£12,345), &c., there remains £2,301. £500 is placed to reserve and depreciation, and £1,500 to dividend on preference shares, and £301 carried forward.

POTTERIES ELECTRIC TRACTION CO. (LTD.)—The gross receipts for 1904 amounted to £103,294. 12s. 6d. After deducting all expenses, the profit was £26,705. 3s. 1d. Adding £766. 6s. 6d. from previous account, the available balance is £27,471. 9s. 7d. The directors recommend that £2,500 be transferred to depreciation and reserve fund, that £12,250 be appropriated to preference dividend, and £12,249. 10s. for dividend on ordinary shares of 5 per cent., leaving £471. 19s. 7d. to be carried forward. The capital expended during year was £16,780. 7s. 4d. It has been decided to test the traffic possibilities of routes beyond the existing tramways and light railways by means of motor omnibuses. It is proposed to commence at once a service between Newcastle and Trentham, and it is probable that other routes will be tested in due course with a view to feeding the existing lines. The parcels traffic continues to show satisfactory increase.

RHODES ELECTRICAL MFG. CO.—The annual general meeting was held at the London offices, 70-71, Bishopsgate street Within, E.C., on Thursday last week, Mr A. L. Rhodes presiding. The directors' report stated that, providing for all managerial and other expenses, including bad debts and 10 per cent. depreciation on plant and machinery, and after putting 20 per cent. to reserve for goods out on approval and depreciation of patents, &c., the net profit for the year was £3,714. 2s. 11d. £800 is placed to reserve, £200 written off preliminary expenses. The interim final dividends absorb £2,463, leaving £391. 2s. 11d. to be carried forward. In moving the adoption of the report and accounts, the chairman said they had reason to congratulate themselves upon the year's trading. Considerable progress in the development of alternating-current motors had been made, particularly of the single-phase type, and everything pointed to this departure being a profitable one, since the company were at the present time the only makers of this particular type of motor in England. Several of the new machines had been tested and found highly satisfactory by eminent engineers. They had made considerable additions to their up-to-date tools for the works, all tending to reduce manufacturing cost, and their testing department had been re-equipped on most modern principles. There had been a large increase in sales for the first three months of the current financial year over that of the corresponding period last year. They had opened up branch offices in various large centres, including Manchester, Newcastle-on-Tyne and South Wales, and negotiations were in progress at Glasgow. A dividend (including the interim) of 6 per cent. for the year, less tax, was approved.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—At the meeting on Saturday Mr. B. Forrest said the company's works had been delayed owing to great and ever-recurring difficulties in obtaining delivery of plant. That trouble was now at an end and the stations were all at work. A further delay arose from the difficulty their consumers had experienced in getting their plant delivered. Customers were now rapidly increasing in number, after having satisfied themselves of the great benefits of a cheap supply of power always on tap and ready for use as and when required. Although the company had been running the stations and incurring a loss, yet the period had been an educational one, in which many of their customers had been so satisfied with the results that they had gone in for large extensions of plant, and the neighbouring collieries and works, appreciating the benefits accruing to other companies using electrical power, had been rapidly coming on to the company's mains and had placed and were placing large orders for plant, of which the company would very soon reap the benefit. Large orders for power were now constantly coming in, so much so, in fact, that extensions had been necessitated and were in hand at the Cwmbran and Pontypridd generating stations. Last year the United National Collieries (Ltd.) put down underground at their Wattstown Colliery 750 H.P. of electric pumps and haulage gears. They were so satisfied with their experience of the use of electricity that last week they placed an order for an additional 480 H.P. to do their general surface work, and had since asked for a further 500 H.P. to 600 H.P. for another of their collieries. The Cambrian Collieries at Clydach Vale last year installed 233 H.P. to drive some of their surface machinery. This proved so successful and economical that the colliery company were able to shut down three large Lancashire boilers. The Cambrian Colliery Co. had now under serious consideration the question of electrifying the whole of their haulage gears underground, which amounted to some 1,950 H.P.

THAMES IRONWORKS, SHIPBUILDING & ENGINEERING CO. (LTD.)—The report for 1904 states that the directors consider the past year's record the most satisfactory since its incorporation in 1890. The general depression had fallen comparatively lightly upon the company, owing to the large contracts with which they had been occupied during the last few years. The electrical engineering department had been fully employed on Admiralty orders and the results warranted the considerable extensions which are now in progress. An arrangement has been made with West Ham Corporation for a cheap supply of electric power current. After paying preference dividend, the directors recommend a dividend of 5 per cent. (less tax) for the year upon the ordinary shares.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

ACCESSORIES MFG. CO. (LTD.)—(84,107). Reg. March 31, capital £10,000 in £1 shares, to carry on business of electricians, manufacturers of and dealers in electrical accessories, electrical fittings, goods and supplies, electrical, mechanical and lighting engineers, &c., and to adopt an agreement with R. and A. K. Ball. First directors R. Ball, A. K. Ball and A. J. L. Ball.

HAYWARD TYLER & CO. (LTD.) (84,098.)—Reg. March 30, capital £100,000 in £1 shares (97,600 4 per cent. preference), to carry on the business of ironfounders, mechanical, hydraulic, electrical and general engineers, manufacturers of and dealers in steam fittings, water meters, &c. First directors, R. L. Howard, E. Howard, R. S. Lloyd, H. F. Howard and F. E. Howard. Reg. office, 99, Queen Victoria-street, London, E.C.

RAYMOND-PHILLIPS ELECTRIC RAILWAY & TRAMWAY EQUIPMENT CO. (LTD.) (84,128.)—Reg. April 1, capital £10,000 in £1 shares, to acquire any patents and rights relating to improvements in connection with overhead electric wires for railways, tramways, &c., in particular to acquire certain existing inventions from T. E. R. Phillips, and to develop and turn to account the same. T. E. Raymond Phillips is first director.

SINGAPORE ELECTRIC TRAMWAYS (LTD.) (84,088.)—Reg. March 29, capital £400,000 in £1 shares, to acquire business of Singapore Tramways Ltd., to adopt agreement with East India Construction Synd., to construct or acquire, equip, maintain and work (either by electrical or other power) tramways, railways and other means of communication in Singapore and other parts of the Straits Settlements, or elsewhere, and to carry on the business of generators, distributors, &c., of electric energy, electricians, manufacturers of electric cables, wires, motors, generators, dynamos, accumulators, transformers, lamps and machinery, &c.

STATUTORY RETURNS.

I. FRANKENBURG & SONS (LTD.)—The return to Feb. 22 gives capital as £250,000 in £10 shares (12,500 ordinary and 12,500 preference), of which 10,003 ordinary and 10,010 preference have been taken up. £10 per share has been called up on 593 ordinary and 10 preference shares, and £6,030 has been received. 9,500 ordinary and 10,000 preference shares are considered as fully paid. Mortgages and charges, nil.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—The return to March 4 (filed March 13) gives capital as £100,000 in 10 "A" and 99,990 "B" shares of £1 each, of which 10 "A" and 60,284 "B" have been taken up. £1 per share has been called up and £59,060 has been received, leaving £1,234 in arrears. Mortgages and charges, £41,800.

NORTHWICH ELECTRIC SUPPLY CO. (LTD.)—Return to March 13 gives capital as £25,000 in 5,000 shares of £5 each, of which 3,629 have been taken up. £5 per share has been called up and £18,145 has been received. Mortgages and charges, £11,000.

HART ACCUMULATOR CO. (LTD.)—The return to March 15 shows capital is £60,000 in £ shares (20,000 preference), of which 40,000 ordinary and 4,315 preference have been taken up. £1 per share has been called up on 17,500 ordinary and 4,315 preference and £21,815 has received. 22,500 ordinary shares are considered as fully paid. No mortgages or charges.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—Return to March 20 gives capital as £400,000 in 40,000 ordinary and 40,000 preference shares of £5 each, all of which have been taken up. £5 per share has been called up on 34,000 ordinary and 40,000 preference and £370,000 has been received. £30,000 is considered as paid on 6,000 ordinary shares. Mortgages and charges, £44,800.

SCARBOROUGH ELECTRIC SUPPLY CO. (LTD.)—The return to March 20 gives capital as £100,000 in 10,000 shares of £10 each, all of which have been taken up. £10 per share has been called up on 9,000 and £2 per share on 1,000 shares and £92,000 has been received. No mortgages or charges.

MORTGAGES AND CHARGES.

AUTO ELECTRIC RIFLE & TARGET CO. (LTD.)—Issue on March 22 of £2,650 debentures, part of series created Dec. 5, 1904, to secure £6,000, charged on company's property, present and future. No trustees. Previously issued of same series, £1,150.

TYPEWRITING TELEGRAPH CORPN. (LTD.)—Issue on March 22 of £100 debentures, part of series created Nov. 14, 1904, to secure £3,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £640.

CITY NOTES.

MEMORANDA (April 6).—Bank rate 2½ per cent. (since March 9, 1905). Price of silver 25$\frac{7}{16}$d. per oz. Consols 90⅞—91$\frac{1}{16}$ for money, 91$\frac{1}{16}$—91$\frac{3}{16}$ for account; 2½ per cent. annuities 90—90½. Consols Pay Day, May 4. Stocks and Shares Continuation Days, April 11 and 26; Ticket Days, April 12 and 27; Pay Days, April 13 and 28; Mining Share Carry-over Days, April 10 and 25.

BELFAST TRAMWAYS AWARD.—In the matter of the arbitration between Belfast Corporation and Belfast Street Tramways Co. in connection with the acquisition by the Corporation of the company's undertaking Mr. L. L. Macassey (the arbitrator) has delivered his award. Mr. Macassey decides that the total amount to be paid by the Corporation to the company is £296,948. 14s. 6d., in addition to the Corporation taking upon themselves the liability for the company's debentures, which amount to £60,000. This is equivalent to an award of £356,948. 14s. 6d. The directors, we are informed, estimate that this will enable them, after paying off preference shares at par, to make a distribution of about £10. 15s. per ordinary share, and they propose to take the necessary steps to distribute £10 per share as soon as they receive the money from the Corporation. The arbitrator further awards that the Corporation shall pay the company's costs. When these have been taxed and various other outstanding matters have been settled and adjusted, the balance will be distributed.

The following are the principal items in the award:—Value of undertaking £258,436; Ligoniel and Sydenham tramways £21,296; three years' profits, £74,216; compensation to directors and officers, £7,500. The total award is £307,493, or £84,851 less than the amount claimed, £392,345. The Corporation's rough estimate was £250,000.

COUNTY OF DURHAM ELECTRIC POWER DISTRIBUTION CO. (LTD.)—On another page will be found the prospectus of the above company, inviting applications for an issue at par of 30,000 preference and 40,000 ordinary shares of £5 each, the balance of the company's authorised share capital. The total share capital is £500,000, divided equally in preference and ordinary shares of £5 each. Of these 20,000 preference and 10,000 ordinary shares have been purchased at a premium by the Newcastle-upon-Tyne Electric Supply Co. (Ltd.). The balance is now offered to the public. The company was incorporated in 1899, and has for four years past been engaged in generating and supplying electric energy both for power and lighting in the large and important area covered by the Parliamentary powers granted to this company and to the County of Durham Electric Power Supply Co., whose shares are practically entirely held by this company, making the interests of both the Distribution Company and the Power Company identical. The Distribution Company has hitherto been controlled from London by the British Electric Traction Co., but it has now been decided that the undertaking shall be placed under local management, and the board of directors has, therefore, been reconstructed and includes four of the directors together with the manager of the Newcastle-upon-Tyne Electric Supply Co. The Newcastle Co., which was the first of the power companies to work on a commercial scale in this country, has increased its output of electrical energy from less than 1,000,000 units in 1899 to over 17,000,000 units in 1904, and has for the past seven years regularly paid dividends of 8 per cent. on its ordinary shares. Both the ordinary and preference shares of the Newcastle Co. stand at a high premium, and are considered in the district of the company's operations a sound investment. The County of Durham Electrical Power Distribution Co. (Ltd.), which now offers the balance of its share capital for subscription, controls (in conjunction with the County of Durham Electric Power Supply Co.) three power stations (at Gateshead, Jarrow and Durham City respectively), upon which the capital expenditure has been £195,533. The capacity of these stations is 4,050kw installed, and 50 miles of cables have been put down in the immediate vicinity of the River Tyne. Plant and cables, involving a further expenditure of £50,000, have been provided for, and the work of installing this plant and laying these cables is now being carried out. The units of electrical energy sold within the Distribution Co.'s area in 1904 were nearly 4,500,000, and the engineer's estimate for 1905 is 6,500,000, increasing to 27,000,000 units in 1908. The area over which the company owns powers to distribute electric energy is one of the most important in the country, being the centre of immense industrial operations, to which electric power can be applied with great economy and facility of working. The prospectus gives full information as to the agreements and contracts entered into by the company, and relating to the disposition of the capital for which subscriptions are now invited. The company is fortunate in obtaining the services of Mr. Charles H. Merz and Mr. William McLellan as engineers, these gentlemen having been responsible for designing and carrying out the Newcastle Co.'s powersupply system. There have also been favourable arrangements entered into for securing the services of the experienced staff of the Newcastle Co. In this way the future success of the Distribution Co., so far as technical help is concerned, is assured. No part of the present issue of capital has been underwritten, and the directors will not proceed to allotment unless £250,000 of the

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 1	1,110	− 56	44	58,501	+ 5,628
Airdrie	Mar. 24	194	+ 6	12	2,320	+ 8
Ayr Corporation	April 1	198	+ 9	46	13,155	+ 678
Barnsley	Mar. 24	164	+ 4	12	1,964	+ 58
Barrow	" 24	212	+ 60	12	2,195	+ 378
Bath Electric Trams, Ltd.	" 29	674	+ 63	13	7,061	+ 662
Birkenhead	April 2	1,924	+ 156	...	...	...
Birmingham Corporation	" 1	869	...	13	4,396	...
*Birmingham & Mid.	Mar. 24	1,670	+ 600	12	19,916	+ 2,625
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	" 30	414	+ 77	52	47,731	+ 6,488
Blackpool and Fleetwood	April 1	270	− 169	13	2,546	− 228
Blackp'l, St. Anne's & Lytham	Mar. 30	191	− 18	22	2,962	...
Bolton Corporation	April 2	1,863	− 179	1	704	− 471
Bournemouth Corporation	Mar. 29	992	+ 113	‡52	54,956	+ 4,598
Bradford Corporation	April 1	3,074	+ 179	51	245,526	+ 31,212
Brighton Corporation	" 2	849	− 74	52	50,105	+ 4,065
Brisbane Tramways	...	...	...	...	...	...
Bristol Trams & Carriage	Mar. 31	4,524	− 64	8	35,919	+ 415
Buenos Ayres & Belgrano	...		...	...		...
Buenos Ayres Elec. Trams	" 4	1,119	...	9	9,684	...
Burnley Corporation	April 1	1,069	− 134	26	13,260	+ 3,740
Burton Corporation	" 2	306	− 34	¶52	17,420	...
Calcutta Tramways Co.	" 1	a58,794	+ a5,602	13	a527,460	+ 59,686
Camborne-Redruth	" 3	161	− 16	23	2,196	− 176
Cardiff Corporation	...	...	...	...	...	...
Carlisle Tramways Co.	" 1	151	− 43	13	1,865	− 217
Central London Railway	" 1	7,664	+ 757	13	93,207	+ 1,675
Chatham & Dist. Lt. Rys.	Mar. 30	640	+ 97	13	7,426	+ 507
*City of Birm'gh'm Tram Co.	" 24	5,733	+ 893	12	63,629	+ 3,766
City & South London Rly.	April 2	2,697	− 15	11	41,598	− 3,519
Colchester Corporation	Mar. 30	173	...	9	7,789	...
Cork Electric Trams Co.	" 30	419	+ 30	13	5,363	+ 225
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	" 24	476	+ 29	12	5,072	− 140
Dover Corporation	" 31	132	37	52	11,220	− 15
Dublin & Lucan Railway	" 31	101	...	13	1,389	+ 82
Dublin Southern District	" 31	773	+ 97	13	56,842	+ 1,010
Dublin United	" 31	3,604	+ 110			
Dudley—Stourbridge	" 24	653	+ 98	12	8,568	+ 373
Dundee Corporation	" 29	725	+ 26	¶34	37,640	+ 419
East Ham Council	April 1	745	+ 27	52	36,904	+ 2,296
Gateshead & Dist. Trams	Mar. 24	497	+ 39	11	10,163	+ 344
Glasgow Corporation	April 1	14,092	+ 1,270	†35	625,896	+ 22,947
Glossop	" 1	126	+ 17	13	1,410	+ 133
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	Mar. 24	210	− 7	12	2,222	− 211
Gt. Northern & City Rly.	April 1	1,613	+ 680	13	20,969	...
Greenock & Port Glasgow	Mar. 24	632	+ 101	12	6,183	+ 796
**Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	" 24	250	+ 16	12	2,661	+ 34
Huddersfield	...	...	...	...	...	...
Hull Corporation	April 1	3,211	+ 67	52	113,408	+ 11,789
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	Mar. 29	116	− 16	16	2,530	− 451
Ipswich Corporation	April 1	372	− 68	52	23,411	...
Isle of Thanet Co.	" 1	316	− 116	26	9,740	+ 17
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	Mar. 24	104	+ 6	12	1,077	− 20
Kilmarnock	...	...	...	...	...	...
Kirkcaldy Corporation	" 30	190	+ 5	4	799	+ 56
Lanarkshire Trams Co.	" 30	609	+ 56	13	8,150	− 746
Leeds Corporation	April 1	5,471	+ 158	1	5,471	+ 153
Leicester Corporation	" 1	1,964	—	13	23,451	
Liverpool Corporation	Mar. 25	10,200	+ 224	12	118,100	+ 4,914
Liverpool Overhead Rly.	April 2	1,459	− 58	14	20,585	− 752
*London County Council	Mar. 25	18,912	+ 3,460	§51	651,957	+ 145,871
Lowestoft	April 1	121	− 13	13	1,579	...
Maidstone Corporation	Mar. 30	101	...	37	4,787	...
Manchester Corporation	April 1	11,929	+ 260	52	631,762	+ 31,100
Mersey Railway	" 1	1,550	+ 78	13	20,635	+ 1,208
Merthyr	Mar. 24	169	+ 10	12	2,058	− 111
*Metropolitan Elec. Trams	" 24	2,850	+ 1,219	12	22,747	+ 9,936
Middleton	" 24	387	+ 89	12	3,124	+ 218
Musselburgh	" 30	145	...	13	2,061	
Nelson Corporation	April 1	112	...	1	112	
Newcastle-on-Tyne Corp.	" 1	3,567	− 49	13	46,060	+ 883
Newport (Mon.)	" 1	541	+ 53	26	13,174	+ 810
Northampton Corporation	Mar. 31	369	+ 225	41	13,969	+ 7,159
Oldham, Ashton & Hyde	" 24	562	+ 65	12	6,790	+ 164
Oldham Corporation	April 2	1,553	+ 418	11	2,102	+ 438
Perth (W.A.) Elec. Trams	Mar. 31	1,326	+ 50	13	18,693	+ 1,317
‡Peterborough	" 24	123	+ 9	11	1,310	− 54
Poole and District	" 24	260	+ 43	12	2,109	− 34
Portsmouth Corporation	April 1	1,626	− 60	51	95,026	+ 6,794
Potteries	Mar. 24	1,649	− 87	12	19,215	+ 413
Reading Corporation	" 31	563	− 7	...	...	...
Rochdale Corporation	April 1	473	+ 212	52	14,698	+ 8,089
Rotherham Corporation	Mar. 30	401	− 21	52	23,465	+ 2,407
Rothesay	" 24	48	− 2	12	528	+ 35
Salford Corporation	April 2	4,050	+ 327	52	209,414	+ 11,043
Sheerness	Mar 22	64	+ 19	12	642	+ 124
Sheffield Corporation	April 2	4,668	+ 312	1	4,668	+ 312
Southampton Corporation	Mar. 29	848	− 11	52	49,103	− 2,637
Southend Corporation	" 19	267	+ 46	51	17,348	+ 1,711
Southport Tramways	" 24	262	+ 25	12	2,709	− 15
S. Staffordshire Trams.	" 24	719	+ 31	12	7,671	− 402
Stockport Corporation	" 31	467	− 26	51	27,794	+ 5,514
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	" 24	499	+ 49	12	5,482	+ 225
Swindon	...	...	...	...	...	...
Taunton Trams	" 24	43	+ 1	12	474	− 55
Tynemouth and District	" 24	195	− 11	12	2,036	− 321
Tyneside Trams Co.	" 23	354	+ 57	13	4,252	+ 617
Wallasey District Council	April 5	699	+ 46	52	32,038	+ 2,826
Walsall	" 1	464	...	13	5,767	...
Warrington Corporation	Mar. 30	316	+ 10	52	16,660	+ 656
West Ham Corporation	" 30	1,167	...	...	56,170	...
Weston-super-Mare	" 22	40	+ 12	12	325	+ 31
Wigan Corporation	...	...	...	...	...	...
Wolverhampton Corpn.	" 29	710	+ 245	52	36,209	...
Wolverhampton District	" 24	371	+ 14	12	4,063	+ 191
Worcester	" 21	293	+ 65	13	3,005	+ 250
Wrexham	" 21	103	+ 6	12	1,108	− 19
Yorkshire Woollen District	" 24	674	+ 110	12	6,648	+ 275

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 6 days. ** Fortnight. * Partly electrical.

issue is subscribed. The list of applications opens to-day (Friday), and will be closed on or before Wednesday next, April 12, at 3 p.m., for both town and country. It is notified that requests have already been received for shares to the amount of £150,000. It will be seen from the prospectus that the preference shares will, in addition to the dividend of 5 per cent., rank for a share of surplus profits in any year after 8 per cent. has been paid on the ordinary shares.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The directors recommend a dividend at the rate of 5 per cent. per annum for the past half-year on the ordinary shares, tax free.

DIRECT UNITED STATES CABLE CO. (LTD.)—The directors have resolved upon the payment of an interim dividend of 3s. per share, tax free (at the rate of 3 per cent. per annum), for the quarter ended March 31, payable 26th inst.

DUNDERLAND IRON ORE CO. (LTD.)—This company is making an issue of £250,000 6 per cent. first-charge debenture stock.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The directors have declared a dividend for the quarter ended Dec. 31 last of 2s 6d. per share (or 2 per cent.), making a total distribution of 7 per cent. for the year 1904, payable May 4. The share register will be closed from 26th inst. to May 3 inclusive.

LANARKSHIRE TRAMWAYS CO.—The British Thomson-Houston Co. are offering for sale 15,000 shares of £10 each of this company.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—The directors recommend, subject to final audit, dividends at rate of 6 per cent. on preference shares for half-year ended Dec. 31 (less tax), and a final dividend of 3½ per cent. on the ordinary shares (tax free), making 6½ per cent. for the year.

RAND CENTRAL ELECTRIC WORKS (LTD.).—864,000kw. hours were generated in March, yielding gross revenue of £8,050, compared with 883,520kw. hours generated and a gross revenue of £7,750 for corresponding period of 1904.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed April 13 a special settling day in Speyer Bros'. fully and partly-paid scrip certificates to bearer for £500,000 4 per cent. perpetual debenture stock of the *Baker Street & Waterloo Railway Co.*, and have granted quotations to a further issue of 4,500 £10 fully-paid ordinary shares and £80,000 4½ per cent. debenture stock of the *Bournemouth & Poole Electricity Supply Co. (Ltd.)* a further issue of 2,000 £5 fully-paid ordinary shares of the *Oxford Electric Co. (Ltd.)*, and a further issue of £44,435 4 per cent. debenture stock of the *Western Telegraph Co. (Ltd.)*. The Committee have been asked to allow 75,000 £5 ordinary shares and 75,000 £5 preference shares of the *Newcastle-upon-Tyne Electric Supply Co. (Ltd.)* to be quoted.

SUBMARINE CABLES TRUST.—The coupon due on April 15th will be paid by Messrs. Glyn, Mills and Co., 67, Lombard-street, London, E.C.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., April 5.	Rate per cent. yielded.* £	s.	d.	Dividend Due.	Business, Week to April 5. Highest.	Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.							
5	3/0	Anglo-Argentine Ord. Shares	5½–5¾	5	9	6	Ap, Oc	5⅝	5½
5	2/6	Do. 5% Cum. Pref.	5½–5¾	4	5	1	—	5⅝	5⅝
St.	6%	Do. Permanent 6% Deb. Stock	140 –143	4	3	11	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	106 –107	4	14	4	—	106¾	106½
10	6%	Barcelona Tramways Ord.	12 –12½	2	8	2	—	12½	..
10	5/0	Do. 5% Cum. Pref.	9½–10	5	0	0	—	9¾	..
St.	4½%	Do. 4½% Deb. Stock (red.)	98 –100	4	10	0	—	..	..
100	5%	Do. 5 per Cent. Debs.	99 –102	4	18	1	—	..	..
1	..	Brisbane Electric Trams. Invest Ord.	1 –1¼		..		..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾–4¼	5	17	8	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	94 –98	4	11	10	..	..	..
St.	6%	British Columbia Elec. Rlwy Def. Ord.	104 –107	5	12	2	—	..	..
St.	5%	Do. Pref. Ord. Stock	100 –103	4	17	2	—	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 –10½	4	10	11	—	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	105%–107%	4	5	9	..	105½	..
100	4½%	Do. Vancouver Power Debs.	99 –102	4	8	3	..	..	..
5	1/6	Buenos Ayres and Belgrano Ord.	3½–4	5	12	6	—	3¾	3⅝
5	3/0	Do. 6 per Cent. "A" Cm. Pref	5½–5¾	5	2	2	—	5½	..
5	3/0	Do. "B"	5½–5¾	5	6	5	—	5⅝	5½
St.	5%	Do. 5 per Cent. Debs.	107 –109	4	11	8	—	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	103 –106	4	15	3	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	97 –99	5	1	0	..	..	..
5	3/0	Calcutta Tramways	8½–9	3	12	3	—	8¾	8½
100	4½%	Do 4½% 1st Deb. Stock (red.)	106 –108	4	3	4	—	..	..
1	0/6	Cape Electric Tram Shares	1⅛–1¼	4	12	4	—	..	—
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	103 –105	4	17	2	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	101 –103	4	17	3	Ja, Jul	..	..
100	5%	Montreal St. Ry. St'g 5% Mort. Debs. (1908)	101 –104	4	16	3	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 –105	4	5	9	..	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	105 –108	4	12	6	..	..	..
		ELECTRICITY SUPPLY.							
5	3/0	Calcutta Electric Supply Ord.	9 –9½	3	13	8	—	9¼	9⅛
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	7½–8½		..		..	..	..
St.	5%	Do. 5% Debs.	89 –91	5	9	11	..	..	..
10	..	Havana Electricity Co. Shares	9½ –10½		—		—	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	⅛–¼		..		—	⅛	..
1	..	Rand Electric	1 –1⅛		..		—	..	..
100	4½%	*†Royal Elec., Montreal 4½% 1st Mort. Deb	98 –100	4	10	0	Ap, Oct	..	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., April 5.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business, Week to April 5. High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
1	..	Bath Elec. Trams Pref. Ord.	½–¾	..	..	..	..
1	1½d.	Do. 5% Cum. Pref.	¾–1⅟₁₆	4 14 1	—	..	..
St.	4½%	† Do. 4½ 1st Mort. Deb. Stock (red.)	102–104	..	..	..	..
St.	4½%	B'ham & Midland Tram 4½ 1st Db. Stk.	99–101	..	..	99½	..
10	9%	Bristol Tramways and Carriage Ord.	17½–18½	4 17 6	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10–10½	3 16 2	—	..	..
St.	4%	Do. 4 per Cent. Debs.	105–107	3 14 10	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	9–9½	6 6 3	..	9½	9¼
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾–11¼	5 6 8	Feb, Aug	11	10¾
St.	5%	† Do. 5 per Cent. Perpetual Debs	121–123	4 1 4	—	121½	121
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	98–100	4 10 0	..	98½	98¼
St.	4%	Central London Ordinary Stock	92–94	4 5 1	June, Dec	93½	93
St.	4%	Do. 4 per Cent. Pref. Stock	101–103	3 17 8	—	..	..
St.	4%	Do. Deferred Stock	88–90	4 13 1	—	..	..
100	4%	Do. 4 per Cent. Debs.	111–113	4 10 9	—	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4¾–5¼	4 17 6	—	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	101–104	3 17 3	..	..	..
St.	1½%	City and South London Rly. Con. Ord.	44–46	5 0 0	Feb, Aug	45	44½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120–123	4 1 4	Feb, Aug	..	..
St.	5%	Do. (1896)	118–121	4 2 8	..	120½	..
St.	5%	Do. (1901)	115–118	4 4 9	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109–111	3 12 1	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½–14½	4 2 8	..	13½	..
10	6/0	Do. 6 per Cent. Pref.	15¾–16¾	3 12 9	—	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	6–6½	3 13 0	—	6¼	6⅛
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9½–9¾	4 4 2	..	..	..
10	9%	‡ Imperial Tramways Ord	17½–18	5 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½–14¾	4 0 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	107–109	4 2 7	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3–3½	7 2 11	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	80–82	4 7 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	8¼–8¾	3 18 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10–10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99–101	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	10–10½	4 15 3	..	10½	10¼
St.	4%	Do. 4% 1st Mort. Deb. Stock	99–102	3 19 2	—	..	..
St.	..	Mersey Con. Ord. Stock	4–7	..	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	10–13	..	—	..	..
1	..	Metropolitan Electric Trams Def	½–⅝	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	1–1⅛	4 14 1	—	..	..
St.	4½%	Do. 4½% Deb. Stock	105–107	4 5 6	..	106½	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	¾–1½	..	May	1½	..
10	10/0	Potteries Electric Traction Ord.	9½–10½	4 17 6	..	9½	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9½–10	5 0 0	Feb, Aug	10	10
St.	4½%	Do. 4½ per Cent. Deb. Stock	103–107	4 4 11	—	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	—	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
	5%	Underground Elec. Rys. Co. of London	99½–100½	4 19 6	..	100½	99½
St.	3½%	Waterloo and City Ord.	92–94	3 6 5	June, Dec	..	—
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	99–102	4 0 0	Jan, July	101½	..
10	..	Amazon Telegraph	2½–3½	..	Jn, Dec ..	..	..
100	..	Do. 5% Debs. (red.)	72–77	..	..	..	..
St.	17/6	Anglo-American	61–63	4 7 3	F, My, Ag, N	62	..
St.	35/0	Do. Preferred	107½–108½	5 1 5	F, My, Ag, N	108½	107½
St.	2/0	Do. Deferred	16½–16¾	..	F, My, Ag, N	..	16¼
St.	4%	† Commercial Cable 4 per Cent. Deb. Stk	97–99	4 1 8	Ja, Ap, Jy, O	98½	..
10	5/0	Cuba Submarine Ord.	8½–8¾	5 8 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	17–18	5 11 1	Feb, Aug	..	—
5	2/0	† Direct Spanish Ord.	3½–3¾	5 11 9	April, Oct	..	..
5	5/0	† Do. 10 per Cent. Cum. Pref.	8½–9	5 11 2	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	101%–103%	4 7 10	Jan, July	..	..
20	3/0	Direct United States Cable	11½–11¾	5 2 6	Ja, Ap, Jy, O	..	11½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100–102	4 7 7	Jn, Dec ..	..	..
St.	22/0	Eastern Ordinary	143–146	4 15 [illegible]	Ja, Ap, Jy, O	146	143½
St.	17/6	Do. 3½ per Cent. Pref. Stock	92–94	3 14 5	Ja, Ap, Jy, O	93½	92½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	108–110	3 12 9	May, Nov	109½	..
10	2/6	Eastern Extension	14½–14¾	5 1 8	Ja, Ap, Jy, O	..	14½
St.	4%	Do. 4 per Cent. Deb. Stock	105–107	3 14 9	Feb, Aug	105½	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	100–102	3 18 5	Feb, Aug	100	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%–103%	3 17 9	May, Nov	..	..
10	5/0	Great Northern (of Copenhagen)	39½–40½	3 14 1	Jan, July	39½	39
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100–102	4 8 3	June, Dec	..	..
25	12/6	Indo-European	49–51	4 18 1	May, Nov	49½	..
100	$1	Mackay Companies Common	41	2 8 9	Jan, July	..	..
100	$1	† Do. Preference	76⅟₁₆	5 5 3	Ja, Ap, Jy, O	..	..
100	4%	Pacific & European Tel. 4% Guar. Dbs. (rd.)	99–102	3 18 5	June, Dec	..	—
10	4/0	West African Telegraph Shares	8–8½	5 17 8	—	..	..
2½	..	West Coast of America	⅝–¾	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	100–102	3 18 5	Jan, July	..	..
10	—	West India and Panama	1½–1¾	..	May, Nov	1½	..
10	7/0	Do. 6 1st Pref.	8½–9	7 4 5	May, Nov	8¾	8½
10	—	Do. 6 per Cent. 2nd Pref.	8–8½	..	May, Nov	8¼	8
100	5%	* Do. 5 per Cent. Debs.	103–105	4 15 3	Jan, July	..	..
10	2/0	† Western Telegraph	13½–14½	4 18 7	Mr, Jn, O, D	13¾	13½
100	5%	* Do. 5% Debs. (2nd Series, 1900)	101–103	4 17 1	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	103–105	3 16 11	—	..	..
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	5½–6½	5 1 9	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	1⅛–1¼	2 11 9	—	..	..
St.	6%	National Co. Pref. Stock	109–110	5 9 1	—	110	109
St.	6%	Do. Def. Stock	102–106	4 16 3	..	104	103
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11¼–11¾	4 8 11	Feb, Aug	11½	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11¼–12¼	4 16 0	Feb, Aug	12	11¾
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½–6½	4 13 0	Feb, Aug	..	5¼
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	100–102	3 8 7	June, Dec	..	..
St.	4%	Do 4 per Cent. Deb. Stock (red.)	102½–105½	3 15 10	..	104	103½
1	0/7½	Oriental	1⅛–1¼	4 4 2	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛–1¼	4 11 5	..	..	..
St.	30/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	103–105	..	..	..	—
5	3/0	United River Plate	7–7½	6 6 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5–5½	4 17 9	June, Dec	..	—
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	107–109	4 11 9	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	2/3	Elec. & Gen. Investment 5% Cum. Pref.	4¾–5¼	5 14 4	—	..	..
10	2/3	Globe Telegraph and Trust	10½–11	5 0 0	Ja, Ap, Jy, O	10¾	10½
10	3/0	Do. 6 per Cent. Pref.	14½–15½	4 0 0	Ja, Ap, Jy, O	15	14¾
100	6%	Submarine Cables Trust (Cert.)	120–125	4 13 9	April, Oct	..	..

Share.	Last Dividend.	Name.	Price Wed., April 5.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to April 5.
		ELECTRICITY SUPPLY.				
10	15/0	† Bournemouth & Poole Elec. Sup. Ord.	11½–12	6 13 4	..	
10	4/6	Do. 4½ per Cent. Cum. Pref	9½–10½	4 7 10	—	
10	6/0	Do. 6% Cum. Second Pref.	11–12	5 0 0	—	
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	105–107	4 4 1	—	
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5½–5¾	3 9 7	—	
St.	4½%	Do. Do. 1st Debs	103–105	4 4 10	—	
5	5/6	† Brompton & Kensington Elec. Sup. Ord.	9½–10½	4 15 9	..	
5	3/6	Do. 7 per Cent. Pref.	9½–10½	3 0 6	Mar, Sept	
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105–106	3 16 1	—	
5	4/0	Charing Cross (W. End & City) El. Sup. Co.	7½–8½	4 16 2	Feb, Aug	
5	2/3	Do. 4½ per Cent. Pref.	5½–5¾	4 0 0	Feb, Aug	
St.	4%	Do. 4% Deb. Stock (red.)	106–107	3 14 9	..	
5	2/3	Do. City Undertaking 4½% Cm. Pref.	5–5¼	4 4 9	—	
5	2/3	Do. Do. (1903)	5–5¼	4 7 10	..	
5	2/9	Chelsea Electric Supply Ord.	6½–7	4 5 5	March ..	
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109–111	4 1 1	Jn, Dec ..	
10	7/0	City of London Electric Lighting Ord.	11–12	5 0 0	Feb, Aug	
10	6/0	Do. 6 per Cent. Cum. Pref.	15½–16	4 5 9	Jan, July	
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	125–127	3 18 8	Jn, Dec ..	
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	103–105	4 5 9	..	
10	8/0	† County of London Elec. Supply Ord.	9½–10	4 0 0	..	
10	6/0	† Do. 6 per Cent. Cum. Pref.	12–12½	4 16 0	Mar, Sept	
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	110–113	4 0 2	..	
St.	4½%	Do. Second Deb. Stock Prov. Certs.	104–106	4 6 7	..	
5	2/0	Folkestone Electricity Supply Co. Ord.	5½–6	4 11 9	—	
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101–104	4 6 7	—	
5	2/6	Hove Electric Lighting Ord.	7½–8½	5 8 0	..	
St.	4½%	I. of W. Elec Lt. & Power 4½% Db. St (red.)	101–103	4 9 1	..	
5	7/0	† Kensingtn. & Kngtsbdg. Ord	12–13	4 13 4	..	
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101–103	3 18 5	—	
3	1/7½	London Electric Supply Ord.	2½–3	3 0 0	—	
5	5/0	Do. 6 per Cent. Pref.	5½–6	5 0 0	..	
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	99–101	3 19 3	Mr, Jn, S, D	
10	11/0	Metropolitan Electric Sup. Ord.	17½–18½	5 0 0	April, Oct	
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½–6½	3 16 5	Jan, July	
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109–114	3 18 11	Jn, Dec ..	
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97–99	3 10 8	..	
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	99–101	4 9 1	..	
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	11½–12	5 6 5	Feb, Aug	
5	8%	† Newcastle Elec. Supply Ord.	7½–7¾	5 2 7	Feb, Aug	
5	5%	† Do. 5 per Cent. Non. Cum. Pref.	6–6½	4 2 5	Feb, Aug	
1	8%	† Northern Counties Elec. Sup. 17/- paid	16/3–16/9	8 2 2	Mar, Sep	
10	8/0	Notting Hill Electric Ord.	14½–15½	4 0 0	March...	
100	4%	† Do. 4 per Cent. 1st Mt. Debs.	100–102	3 14 5	..	
5	4/6	Oxford Electric Ord.	6½–6¾	3 16 0	March ..	
St.	4%	Do. 4% Deb. Stock	95–100	4 0 0	..	
5	6/6	St. James' & Pall Mall Elec. Ord.	13½–14½	5 0 0	Feb, Aug	
5	3/6	Do. 7 per Cent. Pref.	8½–8¾	4 0 0	Feb, Aug	
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98–100	3 10 0	—	
5	4/0	Smithfield Markets Electric Sup. Ord.	2½–3½	6 19 7	—	
St.	4%	Do. 4 per Cent. Deb. Stock	79–83	4 16 5	..	
5	4/0	South London Electric Supply Ord.	3½–4½	4 11 3	—	
1	..	South Metrop'n Elec. Lt. & Power Ord.	½–1	..	—	
1	0/8½	Do. 7% Cum. Pref.	1½–1⁵⁄₁₆	4 17 0	—	
St.	4½%	† Do. 4½ 1st Db. Stk. Prv. Cts. (rd. Soon.)	105–108	4 4 0	—	
5	2/0	† Urban Electric Supply Ord.	4½–5⅟₁₆	4 19 0	..	
5	2/6	† Do. 6% Cum. Pref.	5–5½	4 15 3	..	
St.	4½%	† Do. 4½ 1st Mort. Deb.	104–106	—		
5	7/0	Westminster Electric Supply Ord.	12–13	5 7 8	Mar, Sept	
5	3/0	Do. 6 per Cent. Cum. Pref.	6½–6¾	3 14 0	—	
		ELECTRIC MANUFACTURING, &c.				
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	¾–1	5 6 6	..	
1	6d.	Aron Elec. Meter 6% Cum. Pref.	¾–⅞	..	..	
5	6/0	† British Insulated & Helsby Cables Ord.	5½–6	6 13 4	July, Feb	
5	3/0	Do. 6 per Cent. Pref	5½–6	5 0 0	Jan, July	
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101–104	4 6 6	—	
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	99–101	4 9 1	—	
5	3/0	British Westinghouse 6% Pref.	3¼–3½	9 12 0	—	
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	91–93	4 6 0	..	
2	..	British Electrical Engineering	½–1	..	March ..	
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½–2	6 0 0	Mar, Sept	
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	92–96	4 14 9	Mar, Sept	
St.	4½%	Do. Perpetual 2nd Deb. Stock	79–83	5 9 9	Jan, July	
5	5/0	Callender's Cable Con. Ord.	11–11½	5 8 8	Jan, July	
5	2/6	Do. 5 per Cent. Cum. Pref.	5½–6¼	4 7 0	Jan, July	
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	107–109	4 2 6	Nov, May	
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	¾–1	4 9 5	—	
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	91–96	4 13 9	..	
1	0/5¼	Chadburn's (Ship) Telegraph Ord.	1–1¼	3 17 6	..	
1	7½d.	† Do. 6% Cum. Pref.	1–1¼	5 6 8		
2	1/6	Crompton and Co. (Nos. 1 to 54,000)	2½–3½	3 3 4	Jan, July	
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	93–95	5 2 9	Jan, July	
5	10/0	Dick, Kerr & Co. Ord.	8–8½	5 17 8	Sept ..	
5	3/0	† Do. 6% Cum. Pref.	5½–6	5 0 0	Sept ..	
St.	4½%	Do. 4½% Deb. Stock	105–107	4 4 1	..	
5	—	Edison & Swan United ("A" Sh.) (£3 pd.)	1–1½	..	Feb, Aug	
5	..	Do. (£5 paid)	1½–2½	..	Feb, Aug	
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	80–85	4 14 2	June, Dec	
St.	5%	† Do. 5 per Cent. 2nd Deb. Stock	85–90	5 11 2	..	
5	2/6	Edmundson's Elec. Corp. Ord.	6–6½	3 12 0	H'lf-yearly	
5	3/0	Do. 6 per Cent. Cum. Pref.	6¼–6¾	4 16 5	—	
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106–108	4 3 3	..	
2	1/7½	Electric Construction Co.	1½–1¾	6 8 0	July ..	
2	2/9½	Do. 7 per Cent. Cum. Pref.	2½–2¾	5 12 9	July ...	
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97–99	4 0 10	Jan, July	
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90–95	5 5 3	—	
10	5/0	General Electric (1900) 5% Cum. Pref.	9½–10	5 0 0	—	
St.	4%	† Do. 4 per Cent. 1st Mort. Debs.	97–101	3 19 2	..	
5	10/0	Henley's Telegraph Works Ord.	11¾–12¾	5 17 8	Feb, Aug	
5	2/3	Do. 4½ per Cent. Pref.	5¼–5½	4 3 11	Feb, Aug	
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	109–111	4 1 1	Feb, Aug	
10	4/0	India Rubber, Gutta Percha, &c., Wrks.	16–17	2 18 10	Feb, Aug	
100	4%	† Do. 4 per Cent. 1st Mort. Deb (red.)	103–105	3 17 5	Mar, Sept	
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11–11½	4 7 9	Mar, Sept	
12	14/0	Telegraph Construction & Mainten'ce.	36–38	4 14 8	Mar, July	
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	103–105	3 16 2	Jan, July	
5	—	Willans and Robinson Ord.	1–2	..	Apr, Oct	
5	—	Do. 6 per Cent. Cum. Pref.	2–3	—	Apr, Oct	
	6%	Do. 6 per Cent. 1st Mort. Debs.	75–80	5 0 0	May, Nov	

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote

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NOTES.

SOME very interesting information as to the tantalum lamp will be found in this issue of *The Electrician*. The most important consideration is, of course, its life. In this connection it will interest the lamp specialist to look up the early work of EDISON on platinum lamps, about 1877 to 1881. He found platinum did all sorts of queer things. Its odd behaviour seemed to be largely due to gases occluded in its body or pores. These gases came out when the metal was heated in vacuo, and, if we remember aright, left the surface pitted and the wire weak. EDISON was also much troubled by what he called "air-washing." The wire seemed to be worn away by the abrasion of the residual air in the globe and deposited on the glass. EDISON did not know about electrons then, and had he known he would not have cared. Probably the makers of the new lamp will soon find they have a more intimate personal acquaintance with electrons than they consider advisable for their peace of mind. Of course, what people want is a high-efficiency lamp which will run with variation of pressure. A high-efficiency carbon lamp is merely a lamp run more nearly at its breaking point—that is to say, it is run with a low factor of safety. The high efficiency of the tantalum lamp, on the other hand, is due to the metal standing a higher temperature, the factor of safety being, presumably, the same as in an ordinary carbon lamp. There is, however, further compensation, as the resistance rises rather rapidly over the working range, as shown in Fig. 1, p. 1057; but the resulting difference of power, as shown in the same figure, is not very great.

◆

IT is probable that the actual temperature of the tantalum wire is not very much higher than that of the carbon filament. If the total radiation varies as the fourth power of the absolute temperature, and the radiation of any particular wave-length as the fifth power, it is clear that very little rise of temperature will increase the light efficiency enormously. A very slight difference in the melting point of a metal may thus make a very large difference in its efficiency for a given life. It is probable there are many metals which have not been tried hitherto, and we may yet find one which gives much better results even than tantalum. It rather looks, however, as if the physical constitution of solids is such that even the most refractory will not stand above a certain temperature, at which it gives about a candle per watt. We may mention that the tantalum lamp is now obtainable. Specimens, at any rate, are to be had, and if they are not yet to be got in quantity, no doubt they soon will be available.

◆

THE Supply of Electricity Bill was introduced into the House of Commons on Thursday last week. This Bill, which we give in full in our Parliamentary columns, has a much greater promise of being placed upon the statute book than either of its two predecessors, having been introduced at a much earlier stage in the session, and having already been sanctioned by one House. As the Bill now stands, it is in the identical form in which it was passed by the House of Lords last year after an exhaustive inquiry by a Committee of which Lord WOLVERTON was Chairman. When the Bill left that Committee there was a provision in it that any Borough Council in London could transfer its power to purchase the electric lighting company or companies within its district to the London County Council, but on the motion for third reading in the House of Lords this was struck out on the suggestion of Lord WOLVERTON. We commented very fully upon this measure during its passage through the Upper House last year, and have now only to repeat our approval of it.

The announcement of the possibility of an amalgamation between the Society of Arts and the London Institution has been received by the public with a certain amount of surprise and a great deal of speculation as to the reason for such a step. Only at the latter end of last year an informal suggestion was made that there should be such an amalgamation, and a committee of representatives of both bodies was appointed for its consideration. In their report to the two Societies the committee expressed approval of the suggestion. One of the reasons why the Society of Arts is not averse from a change in the condition of affairs which have existed for 150 years is that it is only a tenant at will (the renewed lease having expired last year), and the buildings are becoming quite inadequate. It is said that the Society is very prosperous, and that there does not appear to be any reason to anticipate a reversal of its good fortune. No innovation involving considerable alteration in its work will be entertained, and members therefore need have no fear of drastic reforms. The *Journal* of the Society of Arts informs its members that the London Institution, founded in 1807, has been instrumental in conducting a great deal of chemical and physical research, and lectures on literature, science and art have been given within its walls by very distinguished men in days gone by.

It seems, however, that the majority of the proprietors of the London Institution—or, at any rate, those with the loudest voices, are not in favour of the amalgamation, for when the scheme, approved by the Board of Managers, was put before them at a meeting on Wednesday, it was met with shouts of dissent and derisive laughter. Major J. A. Travers, whose voice was frequently drowned in the uproar, moved the adoption of the scheme, and his proposal was duly seconded; but Dr. Edwin Freshfield proposed, as an amendment, that consideration of the scheme, should be deferred till after the Institution's annual meeting on the 28th inst. He said that the present value of the site and building of the London Institution was £200,000, while under the proposed scheme each proprietor who was willing to retire would receive only £25, and as the proprietors numbered 1,000 all they would get for their property would be £25,000. Even supposing they all became life members of the new institution free of charge, still the Society of Arts would gain enormously, as the capitalised value of such life memberships was only £40,000. This amendment was seconded and accepted with the addition of a clause appointing a committee to confer with the Board of Managers. Naturally there are many aspects which will have to be carefully considered, not the least being the suitability of the existing site of the London Institution. But, apart from the merits of the question itself, it would be distinctly wrong to decide upon the amalgamation contrary to the wishes of a large body of the members.

We report at some length the proceedings at the inquest into the cause of the recent fires at the Bank Exchange and Oxford court junction room, and, although the inquiry was adjourned, our readers will have been able to gather all the circumstances of the peculiar incident from the evidence given by Mr. C. B. Clay, who frankly confessed to the imperfections at the old Bank Exchange. It is to be regretted that the inspector of overhead wires for the Corporation of London should have considered that it was within his province to confirm the wild suggestion made in a daily paper that there was serious risk to telephone users of being killed by electric shock. This witness ought to know that there have been several cases in the United States of telephone wires being charged at 500 volts by fallen trolley wires, but the only case of shock that he was able to quote was one of lightning stroke, reported in the *Telephone Magazine*. Any one well acquainted with the arrangements of circuits in connection with a telephone exchange will know that the subscriber is absolutely protected from severe shock in the case of contact between the telephone wire and a "live" trolley wire or third-rail.

The oscillographic wave tracer of Mr. Rudolf Goldschmidt's design, an illustrated description of which appears in another column of this issue, has the merit of being simple and, presumably, cheap, and it will find a ready application for tracing simple current waves. The periodic time of $\frac{1}{3000}$ seconds claimed for the apparatus is good indeed, although still about twice as high as the limit reached in the Duddell oscillograph. It is a pity that Mr. Goldschmidt has omitted a reference to the self-induction of the instrument, as, judging by the design, this item might not be negligible.

Party-line telephone systems have considerable fascination for the inventor, but they have never found much favour with telephone engineers in this country. Although they must, it seems, be taken account of in published lists of charges, there are few districts in which they have become popular, either with the telephone manager or the general public. The party-line systems that have been used so far in this country have suffered from the disadvantage that any one of the party subscribers can listen-in, and even speak in, while one of the others is speaking. There is also the trouble that two of the subscribers can monopolise the line, as, although on the automatic calling system, the operator knows when they are talking, she has no means of disconnecting them unless, indeed, she chases them away by an application of the "busy back," or relegates them to the "howler" for a period. The new system devised by Mr. Paul Arnheim, and described in another column, removes this defect in an extremely clever manner, but in doing so it introduces, almost of necessity, another, namely, that the subscribers to the same party line are debarred from communicating one with another.

The main question in connection with party lines, however is, what is to be considered their object from the telephone manager's point of view? Are they intended to attract a permanent class of party-line subscribers, or are they merely, as it were, a bait, to attract new telephone users, who, having tasted the advantages to be gained even by this incomplete service, will be induced to have a line of their own? If party lines exist only for the latter purpose, probably the present systems are good enough. On the other hand, if the party-line subscriber is to be considered as permanent, the question of improving the system becomes a simple matter of cost, and the cost at the switchboard must be considered equally with the cost of the line and apparatus. A ten-party line will bring in more income than the same line used by one subscriber, but the outlay on the subscribers' instruments and accessories is more than 10 times as great, and the switchboard space it occupies at the exchange is also far greater. In the large exchanges in the City of London, for instance, about 140 message-rate subscribers per operator's position is probably the limit, but with "unlimited service" subscribers this figure is only about 60: party-line boards with 10 party lines would probably require an operator's position for about every 40 lines. This part of the switchboard will, therefore, be much dearer, as the number of multiples required increase with the number of operators' positions. It is also conceivable that a large addition of party-line subscribers to an exchange will have a retarding effect on junction working. Further, the question arises, will it pay to provide for the less remunerative of the subscribers' apparatus, which requires the most skill in operating and maintaining? These points will have to be decided before party-line working improves its position. If the Arnheim system proves that it can continue to work as well as in the apparatus we inspected this week, it will afford an excellent basis upon which such comparative estimates can be established.

Sheffield University.—Intimation has been received by the promoters of a university for Sheffield that the Committee of the Privy Council have decided to recommend the King to grant a Charter incorporating a University of Sheffield.

A New German Combine.—A new addition to the list of amalgamations in the German electrical industry has just been announced—namely, between Messrs. Felten & Guilleaume, of Mülheim-on-Rhine, and the Lahmeyer Co. of Frankfort-on Maine. The new company, we are informed, will bear the title of The United Felten & Guilleaume & Lahmeyer Works Co.

Technical Institute Inspectorships.—The Council of the Association of Teachers in Technical Institutes has passed a resolution that "In view of the present advertisements for various inspectors for technical institutes generally, appointments should be given to candidates who have had actual experience as teachers in the technical movement."

Wireless Telegraphy in Spain.—In a report to their Government, concerning the applications and adoption of wireless telegraphy, the Spanish Ministers for the Home, Marine and War Departments recommend that in contracting for the service no mention should be made of any particular system, and that the system offering the greatest advantages should be adopted.

Pyramid Struck by Lightning.—The second great pyramid of Ghizeh was struck by lightning slightly below its apex during a violent thunderstorm on March 31st. Several huge stones were dislodged, and were precipitated to the sands below. The storm was the most violent experienced in Egypt for 15 years. It is reported that none of the pyramids has ever been struck by lightning before.

Royal Society.—Among the Papers down for reading yesterday were the following:—"On a New Type of Electric Furnace; with a Re-determination of the Melting Point of Platinum," by Dr. J. A. Harker. Communicated by Dr. R. T. Glazebrook, F.R.S. "The Improved Electric Micrometer," by Dr. P. E. Shaw. Communicated by Prof. J. H. Poynting, F.R.S. "The Amplitude of the Minimum Audible Impulsive Sound," by Dr. P. E. Shaw. Communicated by Prof. J. H. Poynting, F.R.S.

Cable Interruptions.	Date of Interruption.
Cayenne—Pinheiros	**Aug. 18, 1902**
Beissi-Issa (Yemen)—Camaran	**Oct. 22, 1902**
Tarifa—Tangier	**Jan. 18, 1904**
Jamaica—Colon	Jan. 10, 1905
Fort de France—Paramaribo	April 2, 1905
Pernambuco—Para	April 6, 1905
Maranham—Ceara	April 6, 1905
Medan—Olehleh	April 8, 1905

The Proposed Municipal Electric Tramways at Chicago.—The Corporation of Glasgow has received a singular although complimentary request from the newly-elected Mayor of Chicago. As was announced in the columns of *The Electrician* last week, the latter city has decided to take over some thousand miles of electric tramways from the companies at present working them, and now Mr. James Dalrymple, the manager of the Glasgow Corporation tramways, has received an invitation to go over to Chicago to confer with the mayor on the subject. A communication was received by the Glasgow Corporation asking it to accord Mr. Dalrymple 30 days' leave to visit Chicago, and this was granted unanimously.

Lightning Conductors.—On Saturday Mr. W. H. Whitehouse read a Paper on "Lightning Conductors" before the Birmingham and District Electric Club. In 1872 19 per cent. of the telegraph instruments in this country were damaged by lightning, but in 1889 the number damaged was only 1·8 per cent., this decrease being due to the employment of an ordinary galvanised No. 4 iron wire running down each pole. The lecturer then proceeded to describe the phenomena of lightning discharges, including forked, sheet and globular lightning and St. Elmo's fire. Through the kindness of Mr. A. Hands, of Messrs. G. W. Grey & Sons, the Paper was illustrated with a number of lantern slides of buildings damaged by lightning.

North-East Coast Institution of Engineers and Shipbuilders.—This Institution will hold its eighth general meeting of the session in the lecture theatre of the Literary and Philosophical Society, Westgate-road, Newcastle-upon-Tyne, to-day (Friday), at 7 p.m., when the President, on behalf of the Council, will nominate the following gentlemen to be balloted for to fill vacancies:—

President: Right Hon. Lord Armstrong. *Vice-Presidents:* Messrs. J. M. Allan, W. H. Dugdale, Summers Hunter and James Marr (three to be elected). *Hon. Treasurer:* Mr. G. E. Macarthy. *Other Members of Council:* Messrs. George J. Carter, H. Reylton Dixon, David R. Macdonald, Robert Roger, Robert Wallis and George D. Weir (five to be elected).

Any member can add to the above nominations at the meeting.

Complimentary Dinner to Mr. T. C. Martin.—Mr. T. C. Martin, editor of the *Electrical World* of New York, was entertained at dinner last Saturday, at the Café Royal, London, by a number of friends, in appreciation of the cordial welcome and assistance which he had extended to the Institution of Electrical Engineers during their visit to the United States last year. The following gentlemen were present:—

Mr. G. L. Addenbrooke, Mr. H. Alabaster, Prof. W. E. Ayrton, Mr. D. Bates, Mr. C. H. W. Biggs, Mr. R. W. Blackwell, Mr. J. T. Connolly, Prof. J. D. Cormack, Col. R. E. B. Crompton, Mr. R. S. Erskine Mr. T. E. Gatehouse, Mr. J. Gavey, Mr. R. Kaye Gray, Mr. H. E. Harrison, Mr. J. S. Highfield, Mr. E. H. Johnson, Mr. J. E. Kingsbury, Mr. G. Lang, Mr. G. C. Lloyd, Mr. W. M. Madden, Mr. F. W. Martin Mr. W. M. Mordey, Mr. F. H. Nalder, Prof. J. Perry, Mr. A. H. Preece, Mr. F. C. Raphael, Mr. J. S. Raworth, Mr. A. C. Shaw, Mr. Alex. Siemens, Mr. A. C. C. Swinton, Mr. M. J. E. Tilney, Dr. R. M. Walmsley, Mr. F. Ward, Mr. H. Laws Webb, Mr. Joseph Wetzler, Mr. E. B. Woollan.

The Junior Institution of Engineers.—A large number of members of this Institution visited the Willesden power house of the North Metropolitan Electric Power Supply Co. at Taylor's-lane on Thursday, last week. In the absence of the engineer-in-chief, Mr. E. T. Ruthven-Murray, they were conducted round by the station superintendent, Mr. F. D. Napier, and his assistants. Double-current generators are employed in the works. Continuous current is generated directly at a pressure of from 490 to 540 volts suitable for the 2 × 240-volt network surrounding the works, and this fixes the average pressure of the alternating-current terminals of the same generators at 316 volts. Step-up transformers with a ratio of 1 : 9 are employed, raising the pressure to an average of about 2,850 volts, at which it is transmitted to the substation. There, variable-rate step-down transformers and rotary converters reduce the pressure down to that suitable for a 2 × 240 volt three-wire continuous-current distribution. A detailed illustrated description of the works appeared in *The Electrician*, Vol. LIII., pp. 900 and 940, and of the sub station in *The Electrician*, Vol. LIII., p. 1021.

Obituary.—We regret to record the death of Mr. John Verity, J.P., at the early age of 42. Mr. Verity's grandfather was the founder of the firm of B. Verity & Sons, to the management of which the deceased gentleman succeeded at an early age, after completing his education at University College, London, and in Germany. He took an active interest in politics, and was once selected as Parliamentary candidate by the Liberal electors of the Aston division, but ill-health compelled him to decline the nomination. About four years ago he acted as High Sheriff of the County of London. His death occurred on Thursday last week, as the result of a chill, although he had not been in good health for some time. Mr. Verity's name was a very familiar one in the electrical world, and his loss will be deeply regretted by his large circle of friends and acquaintances.

The death occurred at Sunderland on Saturday of Mr. Frank Caws, civil and electrical engineer, well known in connection with the speed-testing of vessels.

Electrically-driven Lifts.—Mr. F. O. Hunt informs us that he was incorrectly reported in our last issue with regard to his remarks in reply to the discussion on his recent Paper on "Electrically-driven Lifts." He did not agree with Mr. Cross that a long idle travel between the contacts was a remedy for switch troubles, but stated that he considered a three-point bias to be an essential feature of a good hand-rope gear. With regard to three-phase lifts, he had found no difficulty in arranging the controlling apparatus, and gave some particulars of a controller which he had designed for the General Electric Co. in 1898. His reference to buffer stops was made with respect to the special problem of a printing-office lift, where the cage had to be brought to rest within a limit of error of about $\frac{1}{16}$in. owing to its use in handling type formes. The statement attributed to him with regard to a wire between the limit switch and the reversing switch was also incorrect. Mr. Hunt informs us, in addition, that he had no figures as to the relative durability of ropes when winding with rope or V-sheaves, and that information relating to this matter had been intentionally omitted from his Paper.

"**The Central.**"—In the current issue of this successful periodical the principal article, by Mr. Ralph Freeman, is devoted to the Victoria Falls bridge, to which reference was made last week in *The Electrician*. The author proposes, in a subsequent article, to describe the methods adopted for transporting materials across the gorge during the building of the bridge. Prof. H. E. Armstrong contributes the third part of his serial on "The Mechanism of Combustion," and this is followed by an article showing how students at the Central Technical College may enter the public works department of India, or obtain commissions in the army after having completed their studies. An interesting illustrated article on the "Klingenberg" carriage switch gear is contributed by Mr. J. D. Griffin, and the number concludes with "Old Student Notes." In these latter it is announced that Dr. M. O. Forster is among those proposed for election to the Royal Society, he being the second Centralian to receive this distinction. The editorial columns contain the announcement that it is proposed to establish an employment agency for old students, in connection with the Old Students' Association.

Mishap on the Central London Railway.—On Tuesday evening, between 5 and 6 o'clock, a 300kw. air-cooled transformer caught fire in the Notting Hill Gate sub-station of the Central London Railway. The remaining two of the group were also burnt, but it is not known whether the fire was communicated to them by the third, or whether all three were ignited internally. From the transformers the flames spread to some cables, and to anyone familiar with the construction and lack of room at the Notting Hill sub-station this is not surprising. A considerable quantity of smoke was produced, and, as it was forced up the air shaft by the fans down below, a certain amount of alarm was created at the surface. The fire brigade was summoned by a passing policeman, but the outbreak was extinguished with the company's own hydrants, and no difficulty was experienced by passengers in getting out of the station. The entire line was shut down, however, and one train had to be emptied in the tunnel; but the passengers walked along the permanent way to the station, without showing any signs of panic. Full working was not resumed for about an hour, but the lighting and lifts were supplied continuously from the Bond-street sub-station.

Electricity in Mines.—In a Paper on the "Use of Electrical Energy in Mines and Collieries" read before the Manchester Local Section of the Institution of Electrical Engineers on March 28th, Mr. M. B. Mountain included a résumé of the respective advantages and disadvantages of continuous and alternating-current for mining work. He also described some of the various applications of electricity to haulage, winding and coal cutting, while the Paper concluded with a list of some of the more important collieries at home and abroad which have been equipped electrically. In the discussion, Mr. G. G. L. Preece expressed agreement with the author in advocating the use of long cleats for securing cables in the mine shaft. Messrs. R. H. Willis and J. D. Bailie favoured centrifugal pumps as against ram pumps. Mr. J. D. Bailie quoted an instance of a colliery where the works cost per unit was only 0·229d., and, allowing 10 per cent. for depreciation, 0·544d. Mr. Austin Hopkinson said that the chief objection to the disc type of coal cutter was that of the coal closing in on the disc. He had known six motor armatures to be burnt out in one month, owing to this cause. Bar cutters were best for soft work, because the coal could be wedged up close behind the cutter; the Jeffrey chain machine possessed the same advantage.

Röntgen Ray Dangers.—Dr. H. W. van Allen, in writing to the *Boston Medical and Surgical Journal*, says that in Röntgen ray workers of experience the skin and its appendages suffer first, the former assuming a yellow hue which is almost characteristic. The nails and hair turn brittle and the victim is attacked by intestinal indigestion. In certain cases there is an inability to concentrate the thoughts for any length of time, accompanied by drowsiness, although in others there is considerable insomnia. The disposition of the patient becomes somewhat irritable and an abnormal sensation of cold is experienced. To avoid these dangers, Dr. van Allen suggests that the operator should be entirely removed from the source of Röntgen rays. Excepting the tube, all the apparatus should be in one room, while the tube and couch for the patient should be in an adjoining room. The wall separating the rooms should be covered with sheet lead not less than $\frac{1}{32}$in. thick, and any observation aperture should be protected with glass containing as much as 20 per cent. of lead. The hole may, however, be protected by an arrangement of silvered mirrors which permit the operator to observe the patient, while the silver on the mirrors prevents the rays coming in contact with him. Of course, these suggestions involve the abolition of fluoroscopy, but this is not considered a great disadvantage, as radiography is far more reliable.

Electrically propelled Fire Engines at Hanover.—According to the *Elektrotechnishe Zeitschrift*, it was three years on February 19th last since the professional fire brigade of Hanover first acquired an electrically-propelled chemical fire engine and hose reel. It appears that the two vehicles have proved satisfactory, and the following table contains the maintenance and working costs (in marks) for them for the three years:—

	1902-3.	1903-4.	1904-5.
Motor repairs	15·85	18·10	362·95
Controller repairs	21·15	—	—
Indiarubber tyres	181·00	208·00	82·00
Waggon repairs	—	39·50	—
Current for regular service	684·62	615·50	520·10
Current for capacity tests, &c.	162·60	75·50	176·50
Maintenance of batteries	92·20	15·85	734·30
Lubricants	22·50	28·00	21·50
Total	1,179·92(£59)	1,000·45 (£50)	1,897·35(£95)

In the three years the combined mileage of the two vehicles amounted to 2,340, 1,930 and 2,040 miles respectively, the cost per car-mile being, therefore, 6·1d., 6·2d. and 11·1d. The waggon for the chemical fire engine, including the complete electrical equipment, but excluding the engine proper, cost

£765, and the hose reel, excluding the hose, &c., cost £530. A few armatures, which had suffered from dampness, had to be re-wound in the third year, and the negative plates of the storage battery were changed for new ones. It is stated that the positive plates are still in a good and serviceable condition.

Compressed Air Brakes for Tramways.—Brakes actuated by compressed air are in common use on Continental tramways, and it is interesting to know what additional amount of power their use entails. In the course of an article on this subject, recently communicated to *Elektrische Bahnen u. Betriebe*, Herr Ph. Scholtes, manager of the Nürnberg-Fürth electric tramway system, states that he ran an experimental electric car 24 times over a line 2·56 miles long with 5·84 stops per mile, 12 runs being undertaken with the air-compressor and air-brakes working, and the remainder with air-brakes and compressor disconnected. In the first case the consumption per car-mile was found to be 735 watt-hours, in the other case the corresponding figure was observed as 690. The difference amounts to 6·3 per cent., and the extra consumption of energy per stop due to the compressed air brakes was 7·5 watt-hours. Assuming an extra consumption of 20 watt-hours per kilometre (32·2 watt-hours per car-mile) the author has drawn up the following interesting table, which shows the surprising annual amount of energy required to operate the compressed-air system of brakes for a few prominent German tramways.

Tramways.	Car-miles run annually.	Kw.-hrs. required for compressed-air system.	Cost of extra energy in £.
Grosse Berliner Strassenbahn ..	36,600,000	1,180,000	5,900
" Leipzinger " ..	7,500,000	242,000	1,210
Munich	4,960,000	160,000	800
Hanover	4,840,000	156,000	780
Nurnberg-Fürth	2,540,000	82,000	410

The cost of current is assumed to be 10 pfennig (1·2d.) per unit. In the last case in the table it is assumed that all the cars of the system are equipped with compressed-air brakes, but this is not actually the case.

Refractory Materials for Furnace Linings.—In a Paper on this subject, recently read by Mr. E. Kilburn Scott, before the Faraday Society, the author dealt principally with silicon carbides, made in the electric furnace, such as carborundum, siloxicon, amorphous or soft silicon carbide; and crystallised magnesite, made in the electric furnace.

For ordinary furnace kilns, &c., carborundum is ground up very fine, and mixed in the proportion of three parts by weight of carborundum to one part by weight of silicate of soda (waterglass). After thoroughly brushing the freshly set firebrick to get rid of dust, &c (the mixture does not stick readily to a surface which has been already fired), the carborundum is painted on to the depth of about half a millimetre. It is then left for about 24 hours to dry, and afterwards the firing started up gradually. The result is that a layer of carborundum becomes cemented over the whole surface of the firebrick lining, cracks and all, and if properly done it adheres quite soundly. Where basic slags or basic materials have to be taken into consideration, fireclay is employed as a binder instead of the waterglass, the proportion being usually six parts by weight of carborundum to one part by weight of fireclay. Although to a certain extent self-binding when heated to a high temperature, in commercial work it is advisable to add some form of bond to siloxicon. If it is desired to make up articles which can be baked thoroughly before use, the Siloxicon Co. recommend the addition of about 2 per cent. of finely-powdered alumina, the mixture to be baked at a temperature slightly below that at which siloxicon oxidises. In certain cases 5 per cent. of finely-powdered, refractory, plastic, non-alkaline clay can be used in addition to the alumina, this giving increased strength without detracting from the refractoriness of the article as a whole. If it is desired to use siloxicon as a lining to some form of furnace, the material is tamped into place and baked in the furnace itself; for this purpose it may be mixed with either silicate of soda or coal tar. In the former case a solution of silicate of soda having a specific gravity of 1·1 should be used. This can be mixed with the siloxicon until the desired consistency is obtained, and can be made up into a thin wash and applied as a paint where it is merely desired to protect some other form of lining. As silicon carbide is a much better heat conductor than ordinary firebricks, it is best not to use it alone, otherwise there may be serious loss of heat, but it should be used as a wash over other bricks; indeed, this may be said to be true of all silicon carbides. In other words, it is best to use the material as a wash over the surface of ordinary firebricks. Although silicon carbides are fairly good electrical insulators, they are better conductors than ordinary firebricks, heated to the same temperature. Of course, the more porous they are the lower the electrical conductivity. Ordinary calcined magnesite, generally in the form of brick, is now recognised as the best material for lining *basic* open-hearth furnaces, cement kilns, &c. It may be employed to advantage wherever high temperatures and chemical reactions are usually detrimental to dolomite, chromite and silica.

American Industry.—Last Friday evening's discourse at the Royal Institution was delivered by Mr. A. Mosely, C.M.G., and the subject was "American Industry." The lecturer said that the secret of America's industrial success lay in her system of education. There it was customary to teach four "R's" instead of three as in England, the fourth signifying "Reason." Every child was taught to reason and to think for itself instead of learning by rote. Education had done more for America than all the natural resources had done for England. The industrial development of America was alarming, and it behoved Englishmen to face the question in a serious fashion. The British Empire stood at the parting of the ways: either it would cling to tradition and sink into obscurity, or it would accept modern advances and ideas so that the present would be nothing more than its birth. Scientific methods of organisation must be introduced, as they had been in Germany, which had made miraculous progress during the last 30 years. The entire system of English education was wrong, because it did not make every child self-supporting and capable of rising to almost any position in the world. He had met would-be office boys in England who had passed through Board schools and were not able to do arithmetic—they could barely write their own names. In justice, he confessed that American boys stayed longer at school, but, then, in that country all education was free, even including the universities. Mr. Mosely then launched into a somewhat lengthy advocacy of fiscal reform. Dealing next with the relations existing between employers and employed in America, he said these were most cordial. In almost every American factory there was an "idea box," into which workmen were encouraged to insert letters setting forth new ideas which might occur to them: if these ideas were valuable their originators were well rewarded. In America, the men worked longer and harder than in England, and they were usually 50 per cent. better off. Machines were run at a higher speed and the factory organisation was immeasurably superior. Piece work was almost universal and prices were not cut. The lecture concluded with a series of remarkably fine coloured lantern views showing the places visited by the British labour delegates to the United States.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, April 14th.

North-East Coast Institution of Engineers and Shipbuilders.

7 p.m. General Meeting in the Lecture Theatre of the Literary and Philosophical Society, Newcastle-upon-Tyne. Business consists of election of officers and council for ensuing year and the reading of a Paper on "Boiler Furnaces and the Effect of Oil on their Ultimate Strength," by D. B. Morison.

Institution of Mechanical Engineers.

8 p.m. Ordinary General Meeting, when the Steam Engine Research Committee's Report will be further discussed. The President will also deliver his Address.

Physical Society.

8 p.m Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "On Ellipsoidal Lenses," by R. J. Sowter; (2) "The Determination of the Moment of Inertia of the Magnets used in the Measurement of the Horizontal Component of the Earth's Field," by Dr. W. Watson; (3) Exhibition of a series of Lecture Experiments illustrating the Properties of Gaseous Ions produced by Radium and other Sources, by Dr. W. Watson.

Royal Institution.

9 p.m. Evening Discourse: "The Law of Pressure of Gases below Atmosphere," by the Right Hon. Lord Rayleigh, F.R.S.

SATURDAY, April 15th.

Royal Institution.

3 p.m. Afternoon Lecture III. "Some Controverted Questions of Optics," by the Right. Hon. Lord Rayleigh, F.R.S.

TUESDAY, April 18th.

Institution of Civil Engineers.

8 p.m. Annual General Meeting of Corporate Members only, to receive the report of the Council, and to elect the Council and Auditors for the ensuing year.

WEDNESDAY, April 19th.

Manchester and North of England Horological Society.

7 p.m. Meeting at the Municipal School of Technology, Sackville-street, Manchester. Paper to be read: "Electric Clocks," by F. Hope-Jones. Members of the Manchester Section of the Institution of Electrical Engineers are invited.

Royal Microscopical Society.

8 p.m. Meeting at 20, Hanover-square, London, W. Paper to be read: "The Application of the Undulatory Theory to Optical Problems," by A. E. Conrady.

THE WORKS OF MESSRS. ELLIOTT BROS.

The works of Messrs. Elliott Bros., makers of electrical, optical, engineering and mathematical instruments, are situated at Lewisham, and are known as the "Century" works, this name implying that the firm has been established for 100 years. From a tour of the works it is clear that Messrs. Elliott Bros. are keeping pace with modern progress in the way of labour-saving tools and methods and of works' management generally. The greatest strides in this direction have taken place quite recently, American methods and tools having been extensively adopted. The card system is employed for putting work through the shops, for calculating costs, for filing drawings, &c., while a number of regulations of a social nature tend to increase the cordial relations existing between employees and employers, thus developing the intellectual interest taken by the workmen in their work.

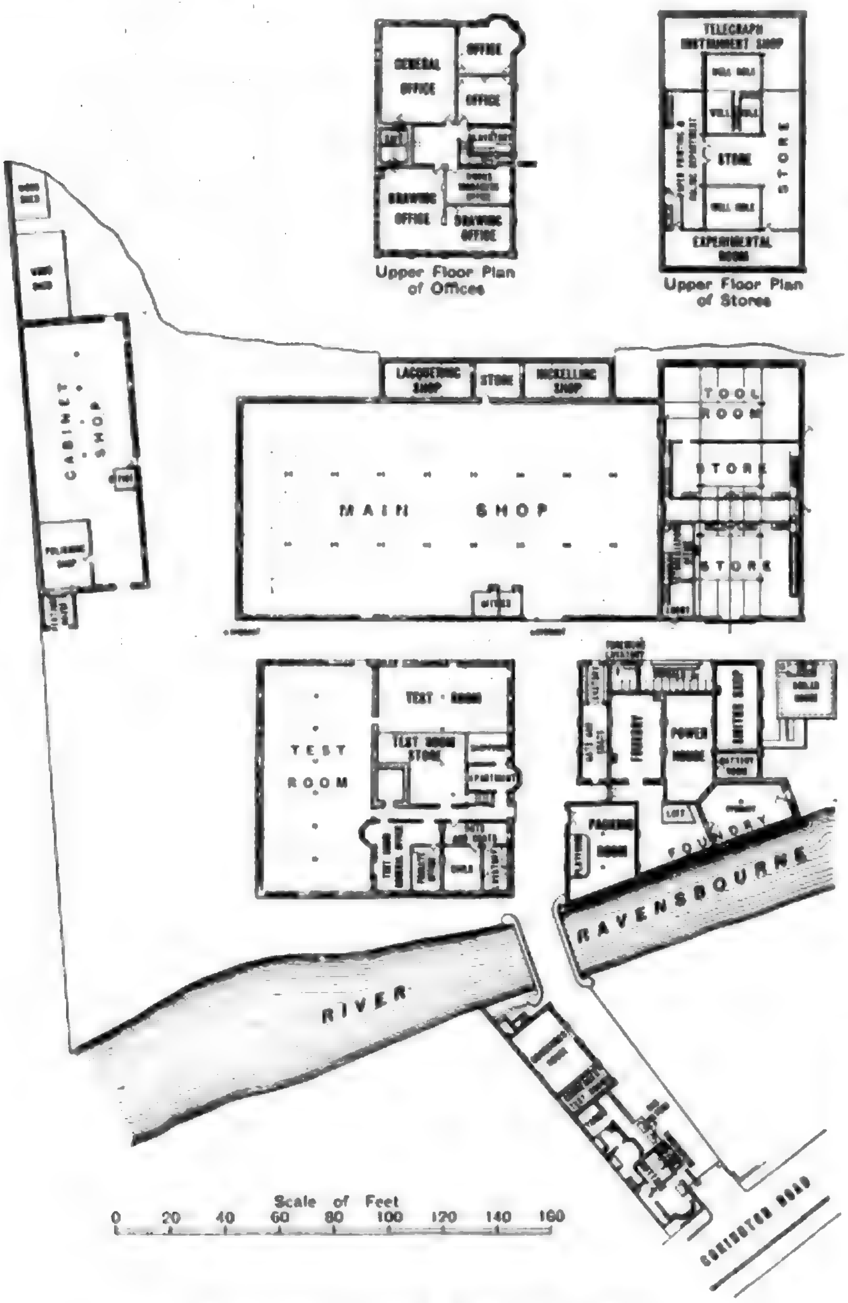

Fig. 1.—Plan of Messrs. Elliott Bros.' Works.

The founder of the firm of Messrs. Elliott Bros. was William Elliott, who started business in 1800 as a drawing instrument maker in Sash-court, Gray's Inn-lane. After a number of changes, he removed his business, in 1830, to 56, Strand, where he died in 1853, his sons succeeding him. In about 1860, the business was removed to St. Martin's-lane, and Mr. Willoughby Smith became connected with the enterprise in 1873. As the premises in St. Martin's-lane gradually proved inadequate, commodious works were erected in Conington-road, Lewisham, and the removal to them was completed in 1900. The plan of the works is given in Fig. 1; some 420 workpeople, including about 20 girls, are employed by the firm. Fig. 2 is a view of the light and airy drawing office, in which six or eight draughtsmen, including a couple of girl tracers, are employed. The 4,000 odd drawings which have so far been made are dealt with by a card system. The blue-prints are made with the aid of a cylindrical arc-lamp arrangement which takes up little room and is at one side of the drawing office. Of the other rooms on the first floor—viz., general office, private offices and works manager's office, little need be said beyond that they are bright and lofty. In the last-named office the orders are sent through to the shops, different coloured cards being used for the various shops. In order to save writing the cards are printed as fully as possible, the item concerning a particular case simply being ticked.

Formerly the factory was driven by means of a gas engine, but about two years ago it was decided to use electricity alone for driving and lighting, and to buy the current in preference to generating it. Current is obtained under a special agreement from the South Metropolitan Electric Supply Co., who have installed and maintain a small sub-station in the works. This sub-station comprises two 100kw. motor-generators, each set consisting of an induction motor which is coupled at either end to a 50kw. 200-volt continuous-current generator. The high-tension alternating current is at 2,000 volts, and no measuring instruments are connected on the high-tension side, the energy supplied being metered on the continuous-current side. In this room, called the power room, is the switchboard which controls 19 circuits and is equipped with a recording voltmeter, a recording ammeter and two integrating wattmeters, besides all the usual instruments and appliances. The current is conveyed on the two-wire system, and as an earth indicator there are two 200-volt lamps connected in series across the supply at the switchboard, the middle-point between the two lamps being earthed. If an "earth" develops on one or the other side of the system, one of the two lamps will extinguish and the other will burn with full brilliancy. Ordinarily both lamps burn dimly. The continuous-current generators work in parallel with a storage battery, and most of the energy supplied by the sub-station is used for operating the motors distributed throughout the works. There are altogether some 35 motors, all designed for 200 volts and varying in power from ½ H.P. to 10 H.P. Since the machine tools have (with the exception of the wood-planing machine) to deal with light work only, groups of machine tools are usually driven by belting from counter-shafting which is belt-driven from an electric motor. It will be noticed from the accompanying illustrations that the motors and counter-shafting are clamped to the iron I girders. No holes are bored in the girders and the motors and shafting may be shifted or removed with little trouble. There are three motors at present in various parts of the works for driving two air compressors and one vacuum pump respectively, but arrangements are now being made for driving all three machines by belt from a 10 H.P. motor in the power room. With regard to the general arrangement and equipment of the shops, it may be noted that the floors are mostly of wood blocks, and that the rooms and shops are heated by hot water, the pipes not being run along the walls, as is usually the case, but suspended well away from them above the men's heads.

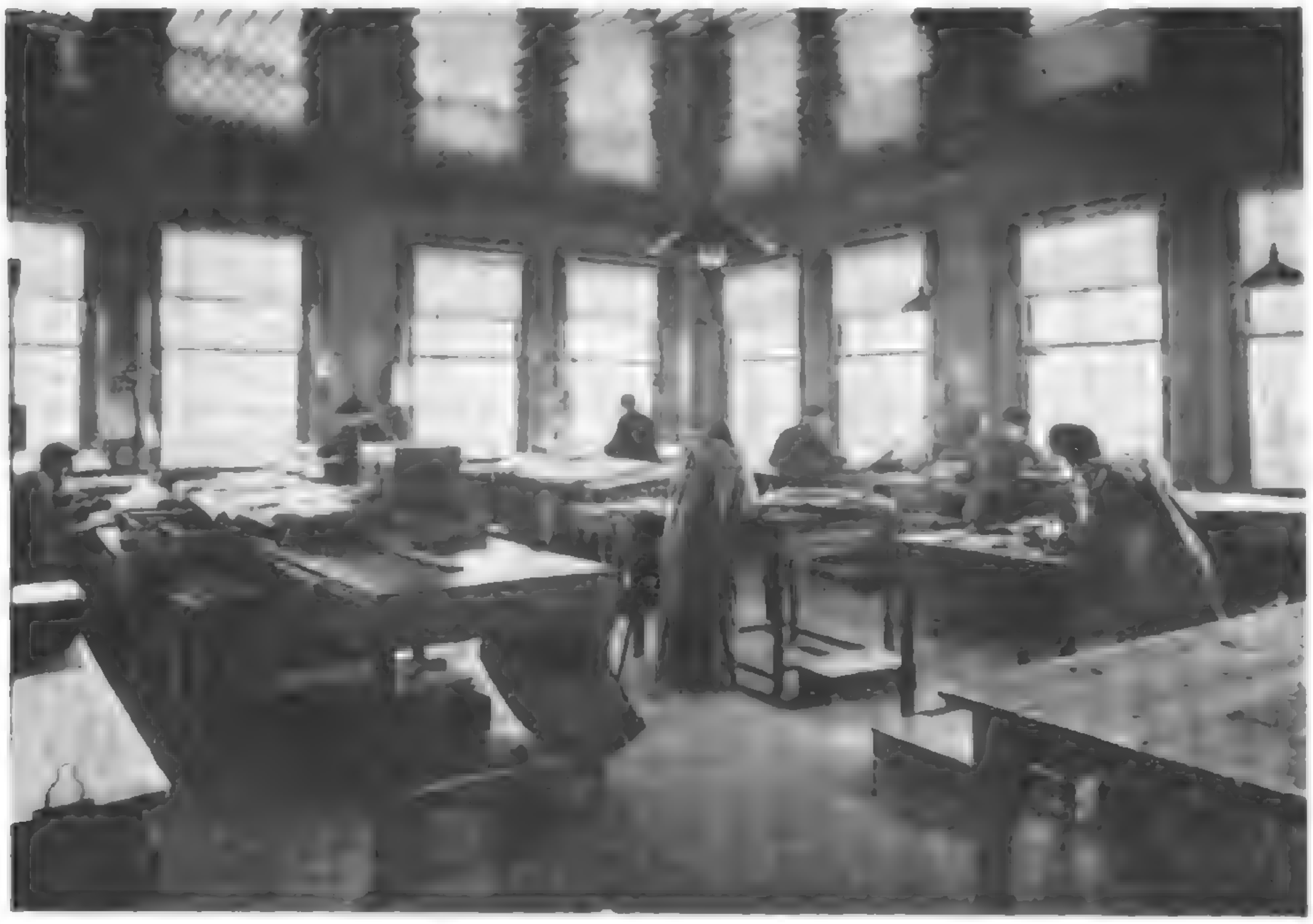
FIG. 2.—DRAWING OFFICE.

The foundry (Fig. 3) is equipped with four coke furnaces and one gas furnace. All the firm's copper, brass, gunmetal and aluminium casting is done here. Adjoining the foundry is the soldering shop, which contains a number of acid tanks for cleaning metal, a band-saw for cutting the castings, an American soldering pot heated by gas, and other appliances. Compressed air at 1½lb. is used here for soldering purposes. The smithy contains a forge, a belt-driven power hammer, a number of gas-fired ovens for hardening and tempering, &c. The temperatures in these ovens are measured by a pyrometer, while a table hung up on the wall near by gives the proper temperatures for hardening and tempering steels with various percentages of carbon. The stores are divided by a gangway into a department for raw material and a department for finished parts. It is, as far as possible, a principle of the firm to send out of the stores the material already cut to proper dimensions, and for this reason a circular metal saw and an automatic saw of the usual design form part of the equipment of the raw material stores. When a workman requires a tool it is handed to him in exchange for a small metal disc bearing his number. This metal disc is inserted into a slot which is uncovered when the tool is taken away. In order to ensure that the workman gets his metal disc back again the arrangement is such that the tool cannot be replaced before the metal disc is taken out of the slot. Next door to the stores is the tool room which is equipped with lathes made by Messrs. Brown & Sharpe, Pratt & Whitney and Ludwig Loewe, Brown & Sharpe, universal milling machines and shaping machines of American manufacture. In addition, there are a number of small bench lathes, drilling machines, &c. Some fine samples of stampings are to be seen here; for instance, the frame of a moving-coil instrument, formed out of one piece of aluminium. Another interesting sample of work is the aluminium tubing used for instrument pointers. This tubing has an outside diam. of 0·036in. and an internal diam. of 0·032in. Most of the machine work is done in the main shop (see Fig. 4), 160ft. by 80ft., which is well equipped with modern machine tools, including about 20 milling machines by Messrs. Brown & Sharpe, Alfred Herbert and others, and about 10 automatic and capstan lathes, a series of multiple spindle drilling machines, &c. The machining is done at one end, the fitting at the other end, and a small space between the two portions is taken up by the inspectors' bench, where the machined parts are tested as to accuracy. The floor is of concrete, with a 2in. layer of wood on the top. Much use is made in this shop of grinding methods for removing metal. One of the most interesting novelties in the way of machine-tool design is a magnetic-chuck, fitted to an American grinding machine. The slide rest of this tool is fitted internally with windings, which convert it into a powerful magnet ready to attract small pieces of iron or steel.

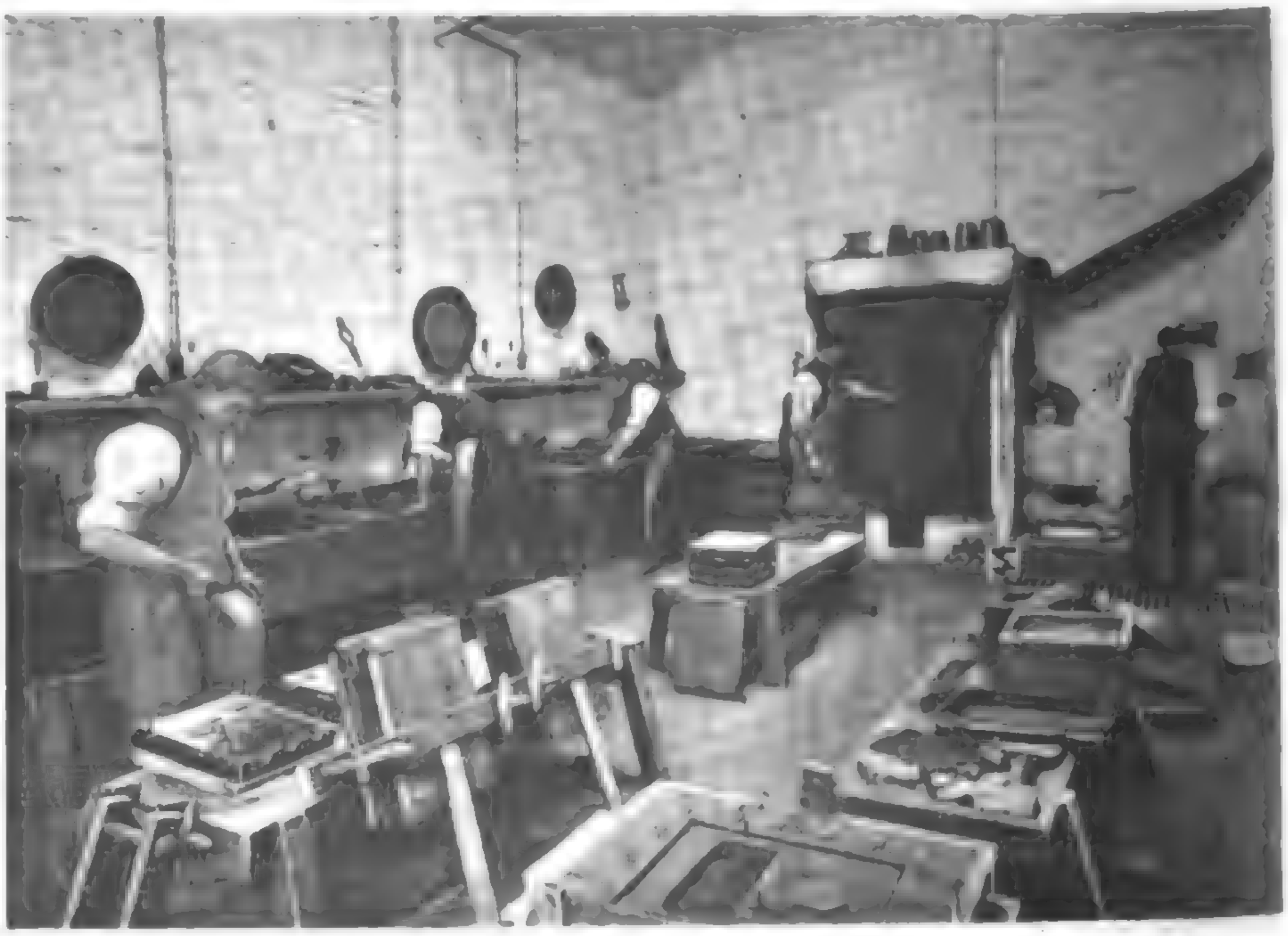
FIG. 3.—THE FOUNDRY.

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At the time we saw the machine it was grinding a considerable number of thin steel pieces down to a uniform thickness. These pieces are first arranged side by side on the slide rest, then the current is switched on and the pieces are attracted so powerfully that they cannot be removed by hand. Current is led to the slide rest—which moves forwards and backwards during the process of grinding—by a flexible conductor, and it is said that the consumption of current for this device amounts to about ½ ampere at 200 volts. Other interesting machines are the engraving machines, which work on the pantograph principle and are capable of engraving, by means of a miniature milling cutter, letters of any size and arrangement. A number of Murray type-printing telegraph instruments are at present being manufactured in this shop for some foreign countries. Certain aluminium-zinc castings for instrument parts are cast in metal moulds under pressure, the composition of alloy and method of casting producing results more accurate than with ordinary metal and methods, so that much machining is saved.

In an adjoining shop the nickel-plating and copper-plating of instrument parts is carried on, a 3kw. motor generator being employed for converting the ordinary supply voltage from 200 to 6 volts. In several small shops close by polishing, lacquering and japanning is carried on. The wood-working shop is equipped with the usual machine tools, including an over and under-type planer, which is separately driven by belts from a 3 H.P. motor. A corner of this shop is taken up by the polishing and varnishing department. In another room the paper used in recording instruments is ruled and printed, the printing machines being driven by two ¼ H.P. motors, and in the same room there is also a small printing press for printing cards, pamphlets, &c. Adjoining this room is the shop for fine work in connection with telegraph apparatus, Wheatstone receivers, &c. There are here a number of small bench lathes, each belt-driven from a ¼ H.P. motor. One of the largest rooms is the test room (Fig. 5) for testing all kinds of instruments. The equipment of this department includes a number of standard voltmeters and ammeters, standard resistances, current transformers and voltage transformers for high pressures. Continuous, single-phase, two-phase and three-phase current at all frequencies is obtained from four motor-generators in this testing room. One set gives current waves of sinusoidal form, the second set produces flat-current waves, while the third set generates current, the waves of which are peaky. As the generator of the first set is built up of two halves, it is easy to obtain any phase displacement between voltage and current by shifting the halves relatively to one another; this can be done while the machine is running. The equipment of the testing room also includes a storage battery of eight E.P.S. "K 58" cells for heavy currents and a battery of 1,000 small cells, made at Century Works, for pressures up to 2,000 volts and small currents. There are several shops grouped around this testing shop, in which coils are wound, impregnated and baked in a vacuum oven, the permanent magnets for instruments are tested as to their magnetic strength, and instruments of great precision, such as galvanometers, &c., are assembled and tested. Near the entrance, finally, are two shops where condensers are made and tested, the temperature being kept constant by a special hot-water system and a fan.

The firm have lately introduced a number of innovations of a social kind. Evening classes and lectures, for instance, have been organised for teaching the boys and enabling the men to progress in their work. Four committees, entitled respectively, the welfare committee, suggestion committee, factory committee and sales committee, have been established, and each meets once a week. The first two are composed of members

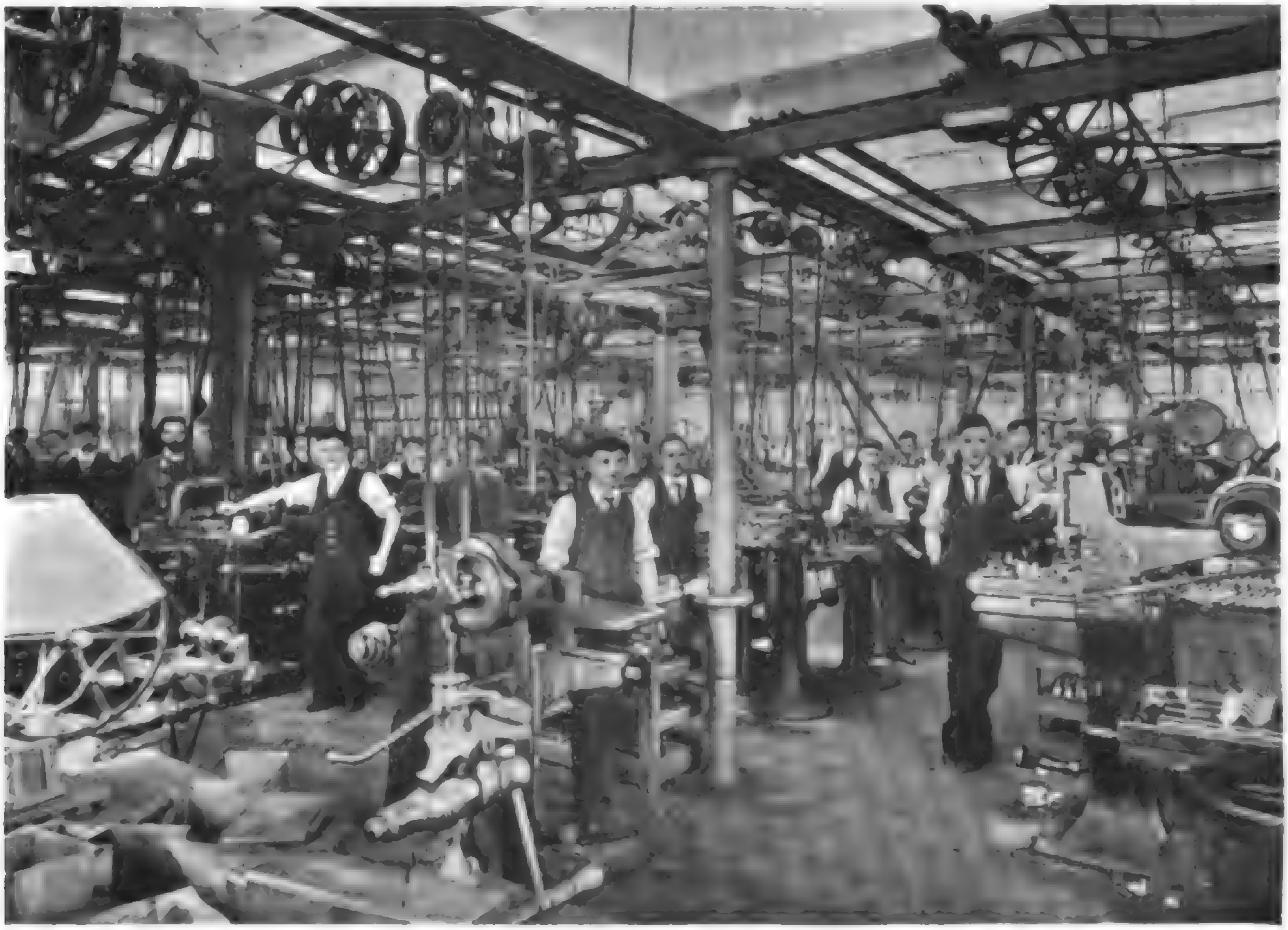

FIG. 4. MAIN MACHINE SHOP.

of the staff and a number of workmen, while the last two are composed of members of the staff only. The welfare committee concerns itself with lectures, entertainments, visitors, Papers and discussions, library, the education of the boys, &c. One of the most important committees is the suggestion committee, and we are told by Mr. G. K. B. Elphinstone, who kindly conducted us around the works, that the suggestions already made had been valuable either in reducing the cost of manufacture or increasing the efficiency or usefulness of instruments. As showing the nature and scope of the suggestions accepted, the following examples are of interest :—

Suggestion No. 14.—I suggest that in future the wages be paid in the various departments before 1 o'clock on Saturdays instead of at the gate as at present. Each man's money could be handed to him at his bench in exchange for his card, and the amount checked by him in the presence of the person in charge of the money-boxes. This would be much appreciated by everyone, would prevent a rush being made for first place, and induce orderliness when leaving off at 1 o'clock.

Suggestion No. 55.—Castings for magnetic shunts should be made thicker webbed as tightening up they more or less crack on a 12" pile of iron concerning D.A.G. and Bridge types.

Thus details of instruments are constantly being improved, and new designs are brought out from time to time. At present the switchboard for the Marylebone District Council is going through the firm's works. This switchboard is to control 14 generators and 34 feeders and is to deal with 10,000kw.

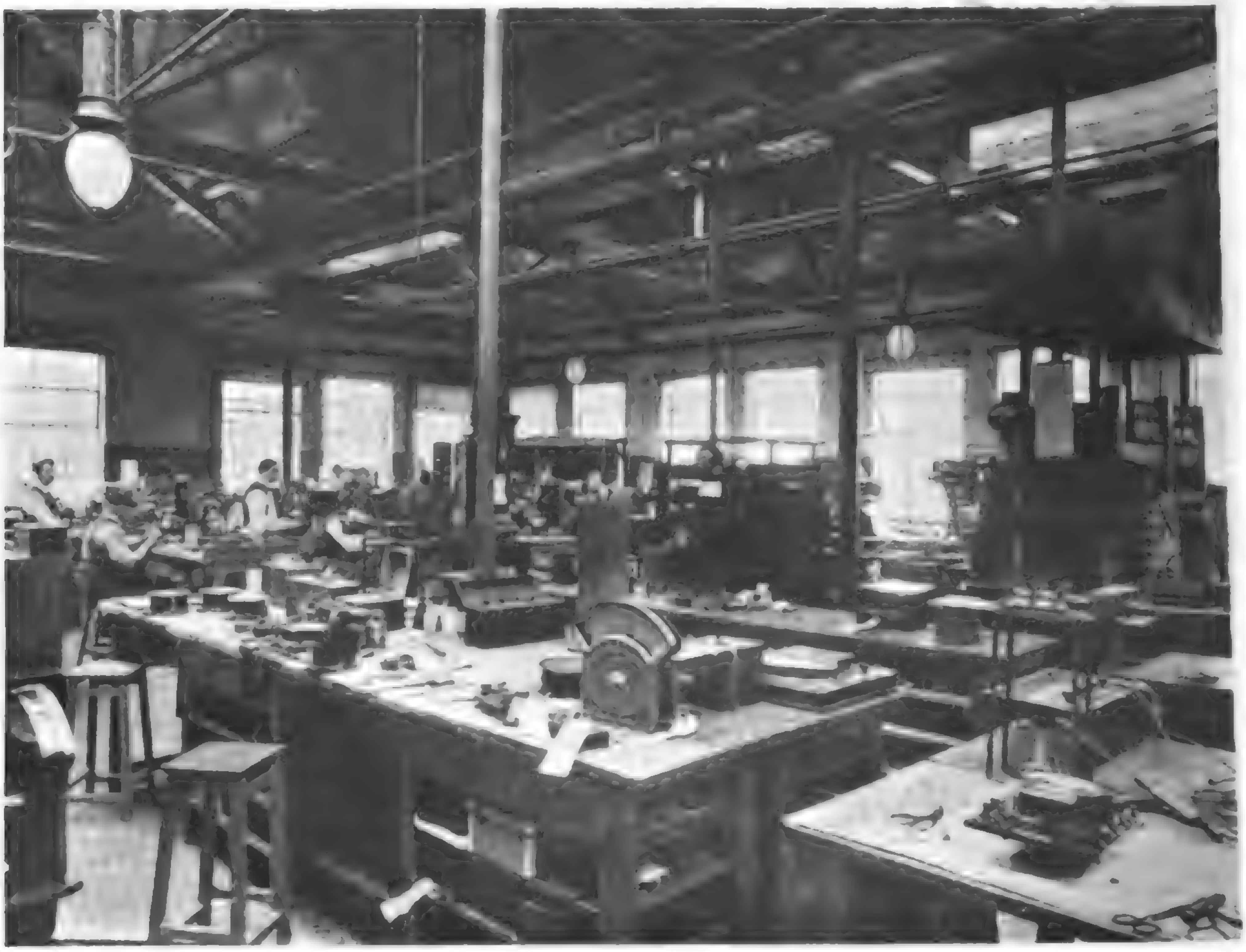

FIG. 5.—INSTRUMENT TESTING ROOM.

UNSOLVED PROBLEMS IN ELECTRICAL ENGINEERING.*

BY COL. R. E. B. CROMPTON, C.B.

In these later days of large power schemes, the importance of protecting our works against lightning stroke has become increasingly evident. For a long time we thought that the damage caused by lightning was confined to systems of overhead conductors, as its effect on these was at once evident, but during recent developments of large power schemes, employing systems of conductors to carry the energy into districts where the use of overhead conductors is inadmissible, the influence of lightning discharges, or of earth strokes connected with them, on our underground systems, has been undoubtedly the cause of many failures and interruptions to service, the investigation of which forms a problem of the first magnitude. The problem has been insufficiently investigated, but it appears probable that many of the mysterious perforations of the insulation of our underground cables are commenced by static charges due to condenser effects produced on a gigantic scale in the system. I have been slowly gathering evidence during the last few years, and find that most of the engineers who have studied this question are in agreement with me, that our present methods of detecting or guarding against the effects of frequent and hitherto unnoticed static discharges, are altogether inadequate to protect our works. During a recent conversation with Prof. Elihu Thomson he reminded me of the undoubted fact that lightning strokes very frequently follow one another over nearly if not the same identical air path. He seems to think that the dielectric strength of the air at this point is reduced or partly broken down by the passage of a powerful lightning stroke, which facilitates the passage of subsequent strokes at the same point. Are we to conclude that corresponding conditions of weakened path are set up below the earth's surface and consequently affect us by affording paths for disruptive discharge through underground mains?

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* Abstract of the "James Forrest" Lecture, delivered before the Institution of Civil Engineers on Monday.

Closely allied with the investigation of these interesting phenomena are the hitherto unexplained causes of ball lightning. We have such consistent accounts given by truthful and competent observers of balls of fire moving slowly in the air or rolling along the ground, sometimes attended with slight noise or explosion, in others by violent disruptive effects, that we cannot refuse to believe that ball lightning is a reality. As Planté in his researches has distinctly stated that he was able to reproduce ball lightning effects on a small scale when experimenting with direct currents of high E.M.F., there can be no doubt that Nature does produce these phenomena for which at present we have no explanation to offer. Those of us who were at St. Louis last summer witnessed the remarkable luminosity surrounding the electrical conductors carrying currents at the extremely high pressure of 100,000 volts. It appeared under those conditions of electrical stress as if the air itself became luminous, and I suggest that this may throw some light on the phenomena of ball lightning.

There appear to be three hypotheses of the cause of terrestrial magnetism, the first being that the crust of the earth has at some time, probably shortly after solidification, become a permanent magnet owing to the circulation of electric currents which possibly may have been produced by thermal causes; the second being that the cause was originally, and may still be, connected with the earth's rotation, which has gradually accumulated its magnetic field much as is the case with an ordinary self-exciting dynamo; the third hypothesis being that the sun itself is the power station for the whole solar system, and that each of the planets is merely a distributing station for the energy generated in the sun. It can, however, be shown that the direct magnetic effect of the external field produced by the sun must be small, although we know that changes taking place in the sun are unquestionably associated with the appearance of the magnetic storms which are of such importance to the navigator and the telegraphist.

Another problem which is only now commencing to pass outside the domain of the physicist into that of the engineer is that of the etheric transmission of power. The development of electric-wave telegraphy is an excellent instance of the various stages of the solving of an electrical problem. We may consider that the etheric transmission of signals up to a given distance, and notably for the purposes of signalling to and between ships at sea, is practically solved, although there are many secondary problems arising out of it. No doubt the first and most important of these is the production of wave trains sufficiently powerful and of the right character to yield the best results. Fleming has particularly devoted himself to this subject, and the value of his inventions has been fully acknowledged by Marconi. What we require is a better method of originating a continuous train of waves rather than intermittent ones, and here we can formulate our problem, which may be solved by the mechanical engineer, or probably by the electro-chemical engineer. None of us has as yet succeeded in constructing an alternator with a frequency approaching 1,000,000 per second; but who can say that recent developments in extremely high-speed turbo-generators of the De Laval type may not furnish us with a good start in obtaining such frequency by mechanical means? Again, turning to the possibilities within reach of the electro-chemist, very promising attempts have already been made by Lodge and others to produce electrical oscillations from condensers charged by a Cooper-Hewitt mercury vapour lamp. Duddell has shown by his investigation of the singing arc that herein lies a method of producing a continuous series of discharges, although in this case the frequency obtained is not sufficient for the purpose. One problem connected with electric wave telegraphy requires mention, although I believe it has been already nearly, if not completely solved by Fleming. I refer to the noise caused by the signalling spark used in wireless telegraphy, especially on board ship. The loud cracking discharge of this spark has the two-fold disadvantage of being a nuisance to anyone in the neighbourhood of the apparatus and of entirely defeating secrecy, as the message can be read by anyone conversant with the Morse alphabet. Fleming has caused the discharge to be produced in cast-iron vessels filled with nitrogen or carbonic acid under pressure, and by this means has practically succeeded in silencing the spark, even when large powers are employed.

It is evident that the consequences which would follow on the etheric transmission of considerable amounts of power would be so startling, from every point of view, that they would revolutionise our ideas socially and politically, and would profoundly affect all our present conditions of life.

It is 30 years ago since we were introduced to the dynamo. The progress of our design has been marked by constant alteration following on new discoveries of systems of generating and utilising electrical energy, but throughout the considerable changes of the many systems that have been tested and still survive, I find that we meet with the one mean group of problems which form the central feature of all our designs, those relating to the designs and construction of the most efficient magnetic field, which for convenience I hereafter call the problem of "core and coil." The electro-magnet bears the same relation to electrical machinery that the cylinder, piston, and crank, bear to the steam engine. Take the core first. In most cases we find it necessary that a considerable part of the path of the magnetic field should lie within the metal which possesses the highest permeability for magnetic lines of force. This, up to the present has confined us to iron in its purest form, which, when cast or produced by methods where it has been at one time in a molten condition, the engineers have preferred to call steel. When we first formulated our requirements for core material they were exceedingly simple. We only stipulated that it must be permeable, easily cast, forged or worked into the shapes in which we required to use it, of sufficient mechanical strength and easily cut or shaped up by machine tools. These requirements were easily met by the addition of small percentages of nickel and aluminium, as the use of these alloys produced cores with extreme permeability; but when it became of extreme importance to minimise eddy currents, we found it necessary to subdivide our cores mechanically, either by slotting or sawing the solid castings or by forming our magnet arms of thin wrought-iron plates, which are held in position by being cast into cast-iron or cast-steel yokes. But at this stage we encountered an annoying difficulty, which still exists and has been the cause of much disappointment and loss to steel founders and dynamo builders. I refer to the difficulty in producing steel castings for magnets, yokes and frames sufficiently free from blow holes or porosity to ensure that the magnet core portions are of equal density of mass and, therefore, of sufficiently equal magnetic moment.

This porosity of steel castings will continue to exist so long as they are poured from steel or ingot iron comparatively free from carbon, silicon and other materials which are present in cast iron, and thereby lower its melting point. The purer material is so viscous that it does not run smoothly into the moulds, and consequently entraps the gases to form the blow holes and irregularity of mass that I complain of. This difficulty is a real one, and may possibly be met by further development of Barrett's discovery that the addition of silicon in suitable proportions to cast iron renders the whole very fusible, so that complicated and difficult castings free from porosity can be made from it, but in addition he has shown that we have the great gain from it as it reduces hysteresis. It is probable that the silicon acts by reducing the combined carbon that is in the iron in the form of carbide, so that the pure iron is left with a structural formation calculated to give high permeability, as it will be in the form of a sponge or network, which will give great freedom for molecular movement; moreover, at first sight we might think that such pure iron would have the disadvantage of reducing resistivity which would facilitate the formation of eddy currents, yet in practice this is not so, as although the iron has lessened resistivity the cross-section of the filaments of the pure iron sponge are small, and therefore the mass as a whole has considerable resistance to these eddy currents. Barrett's discoveries, therefore, point in the direction from which we may hope to obtain considerable improvement in our magnet cores. We may, therefore, reformulate our requirements for these cores as follows: Maximum of homogeneity, permeability, low hysteric coefficient, high resistance as a mass to eddy currents; of course, all this combined with sufficient mechanical strength to resist the stresses due to centrifugal forces when the core forms part of the revolving mass or to the stresses set up by magnetic attraction when they form part of the frame of a stator or magnetic ring of large dimensions. In the other class of cores, particularly those subjected to alternating electrical stresses, such as the cores of transformers, we cannot hope to obtain sufficient freedom from the losses due to eddy currents by means other than minute subdivision, that is to say, by lamination, or by forming the cores of a bundle of individual wires. A great part of our constructive work lies in the organisation of the labour necessary to fit together the large number of sheets or stampings which go to form this class of cores. Where such cores are used for revolving armatures we meet with the secondary problem of securing satisfactory balance of the rotating mass, and it is not easy to obtain this, as any turning or cutting process applied to the edges of the thin sheets has a tendency to bring them into electrical conducting contact at the edges and ends; facilitating the eddy currents. The same difficulties occur in smoothing out of the tunnels or slots of our armatures, and a satisfactory means of carrying this out cheaply and efficiently has yet to be found. I cannot close this core question without referring to the interesting discoveries of Dr. Heusler of magnetic non-iron alloys. Dr. Hadfield has produced for Dr. Fleming rings formed of an alloy of aluminium, copper and manganese which is nearly as magnetic as a low grade of cast iron, although it contains no iron at all. It is possible that the whole secret of magnetism is locked up in these rings; at any rate the discovery is of extreme importance, and may have wide-reaching influences on the question of cores.

From the first we found that the most convenient method of forming our existing coil or helix was by winding up into a coil on the core itself, or on a separate frame slipped on to it, copper wire of circular cross-section and covered with a fibrous insulating material, such as cotton or silk thread. The mass of the wound coil is, however, largely made up of insulating material, as, on account of the circular section of the copper itself, there is much wasted space. Moreover, on account of the low heat conductivity of the mass of insulation and the waste spaces entrapping air, the heat-conducting properties of the coil as a whole are very low. An ideal winding of a coil consists of thin copper strip wound on its edge into correct position by suitable machinery, each turn being insulated from the adjacent turn by a thin film of insulating material applied to it at the time it is being wound. It will be seen that we gain greatly in reducing the bulk of the winding, weight and cost of copper, and as the magnet arms are shorter we gain greatly in the size and cost of the framework of the machine, but in order to apply it generally to the smaller class of apparatus we still require a combination of rolling, winding and insulating machinery which will take the rough copper strip, and at one operation reduce it to the correct cross-section, winding it into place, and apply the coating of insulating material. In order to render the coils non-hygroscopic we have already introduced vacuum machinery to remove the moisture after they are wound, and afterwards we inject our waterproofing and insulating varnishes under pressure to fill up as far as possible the interstices. Quite recently in connection with this winding question another difficulty has been observed by Highfield and others—*i.e.*, the formation of ozone, and, finally, of nitric acid inside the coils, which has in many cases destroyed the fibrous material used for insulation. This points to the desirability of dispensing with fibrous material and of replacing it by an insulating material which will have sufficient dielectric strength, will stand the action of nitric acid, and facilitate heat conductivity. A good deal has been recently done in this direction, and notable advances have been made towards increasing the temperature up to which such insulating compounds can be worked without notable decrease of their dielectric strength, so that although a few years ago we considered a temperature of 100°C. as quite the outside temperature at which coils could be satisfactorily worked for lengthened periods, we are now slowly coming to the opinion that it is desirable that we should work them at far higher temperatures, and that it is quite reasonable to hope that our chemists will furnish us with suitable insulating materials for impregnation, or coating our conductors, which will stand continuously temperatures up to at least 200°C. If we are successful in obtaining the two requirements which I have mentioned, *i.e.*, the reduction in the sizes of our coils, and the higher temperatures at which we can work them without endangering the durability of our plant, we shall benefit greatly, both constructors and users, by reducing the bulk, weight and cost of our machinery without in any way impairing its efficiency.

The recent introduction of high-speed turbo-generators has called attention to the difficulties of designing both the cores and the winding of the revolving fields so that they can successfully withstand the severe mechanical stresses to which they are exposed at these extreme speeds. Much ingenuity has already been exercised in attempting to reconcile the antagonistic requirements of great mechanical strength to resist centrifugal forces combined with minute sub-division of the core to prevent a free path for the eddy currents. It will be seen that here the difficulties of the designer are very great and the problem of overcoming them is yet in its early stages.

It may surprise many of you to hear how great have been the improvements in the lead-couple accumulator during the 15 years or so that it has been in practical use. The causes of these improvements are two-fold. Our early troubles arose partly from difficulties in the manufacture of the plates; means were adopted to hasten the formation of these plates during their manufacture, for which we paid somewhat dearly by their shortened life. Another and very important cause of our early troubles was that for a long time we continued to use the cells themselves as a means of regulating our electrical pressures. This introduced conditions extremely unfavourable to the regulating cells of our batteries of accumulators, but since, owing to the introduction of the Chamen and Highfield boosters, this difficulty has been largely removed. The value of recent improvements may be gauged by the fact that the formation of deposit in the bottom of the cells from detached active material has been reduced to one-quarter of its quantity during the last five years, and we may safely say that the cost of upkeep of these accumulators has been reduced in the same proportion. Where the demand for electrical energy is intermittent, or is confined to short hours, such as in towns or villages where the demand up to the present has been principally for domestic purposes during hours when artificial light is required, my view is that we can design far the most economical plant by combining the internal-combustion engine with a suction-gas plant worked for long hours, and thereby charging storage sufficient to deal with the bulk of the load, but supplying the short hours of peak load from steam plant specially designed to work for short hours at a maximum efficiency.

After long years of disappointing delay we now see in the streets of London and Paris a very considerable number of private carriages driven by electrical means. Here again we have been told that the lead-couple accumulator is hopeless, and that we must wait for something lighter and stronger, such as Edison has been working on for some years past, but again practice has shown that we are far from obtaining anything to take the place of the lead-couple, and it is reasonable to suppose that great progress will be made in portable accumulators, and that a few years hence we shall see great developments. It is quite certain that an enormous impulse will be given to the production of electrically-driven vehicles when the boxes of accumulators and the means of charging them are sufficiently standardised.

One solution of the railway problem seems already within our reach—namely, that of the utilisation of single-phase alternating currents for long-distance transmission. We have the choice between the type of series motors as made by Finzi in Italy, and that of the Winter and Eichberg compensated repulsion motors made by the Allgemeine Company. The difference between these two types lies principally in the size of the transforming apparatus which must be carried on the train. In the first instance, this must be equal in capacity to the total output of the motor equipment, whereas, with the repulsion motor the transformer need only have a capacity of one-tenth the rated capacity of the motors. As regards the problem of the third rail, its difficulty and dangers, and of substituting the overhead work necessary for these single-phase motors, it is a mere draughtsman's question, and is quite certain to be satisfactorily dealt with. I think we can even now answer two questions. This first is: Can electric traction supersede the existing steam haulage at the schedule speeds which are at present in use on our railways? We have no doubt whatever that we can answer the question in the affirmative. The second railway question is: Can we by the introduction of electric haulage raise to a notable degree the present schedule speeds, and from this cause alone become very formidable competitors to long-distance steam-haulage? Although there are many electrical engineers who would answer this question in the affirmative with as much confidence as they answer the first one, yet personally I am not quite so sure. I see that, spurred by our electrical competition, the designers of the steam locomotive are likely to make further efforts, and I feel sure that if we electrical men can work to schedule speeds of 100 miles an hour, the steam locomotive also can be improved so as to work at the same speed with equal safety. As to long-distance goods traffic, I do not think we are likely to attack this problem for years to come.

Our railway problems would be greatly assisted by the solution of another mechanical problem closely connected with it, or with the driving of any machinery such as rolling-mills, where the starting torque is very great and very variable, whereas the source of energy for driving is constant. I believe and hope that the solution is an electrical one.

The instruments that we have already at command for measuring direct currents, are already so accurate and so low priced that they are commencing to be used for many purposes quite outside the field of electrical engineering proper; but when we come to the measuring of alternating energy, although the instruments for measuring separately the current and pressures are satisfactory, yet no completely satisfactory method at all approaching the accuracy and simplicity of the direct-current methods for measuring power are as yet available in this case. Probably the solution of this problem lies in the further perfecting and simplification of electrostatic means of measuring alternating pressures.

More than 12 years ago Langley defined the brightness of light as the intensity of retinal absorption, and probably this is what most of us believe it to be. He pointed out that the effect of lights of different colour on the retina varied with the individuals and with the age of individuals. Now that we have at command electric lamps rich in violet or yellow rays, it will be interesting to notice how far Langley's ideas are corroborated.

A problem of real moment to both suppliers and users of electrical energy would be the discovery of a direct method of producing artificial cold by electrical means. Of course, we can now produce artificial cold by connecting an air compressor to be driven by an electric motor, and by expanding the air into the cold-storage chamber, but the method is costly and cumbrous. Probably something may be done by a well-designed high-speed air compressor, but the real solution we are looking forward to is a direct method of producing cold from the electrical energy in our supply mains, and this probably is a problem for the electro-chemist, as we may conceive the apparatus taking the form of a battery abstracting heat from the surrounding air.

Time will not permit me to speak at any length on the interesting subject of electrical heating. The importance to the mechanical engineer, chemist or physicist of being able to maintain in quite small furnaces extreme regularity of high temperature for very long periods of time cannot be over-estimated, and this problem is already satisfactorily solved; but when we deal with electrical furnaces on the larger scale I may point out that, although when Keller read his Paper on electrical metallurgy before the Iron and

Steel Institute in 1903 the possibility of electric smelting taking the place of heating direct by fuel was received with much incredulity. Since that time so much attention has been given to the matter that this problem has already been successfully grappled with, and appreciable advances have been made in the practical application of electrical smelting.

Finally, I believe the greatest problem of all, and the one which will have the most profound influence on the well-being of our fellows, is the satisfactory development of our power schemes, by which we hope to send the population back to the land. We already see that the necessity for bringing our working population into huge factories, so that they may work within the range of power allowed by revolving shafting, is already at an end; that nearly all power can be supplied through electric motors, and therefore the factory units themselves can be small, spaced more widely apart and many classes of manufacturing processes can be carried out most perfectly in the workers' own home unaided by the other members of his family.

NOTES ON SOME EFFECTS IN THREE-PHASE WORKING.*

BY W. M. THORNTON, D.SC.

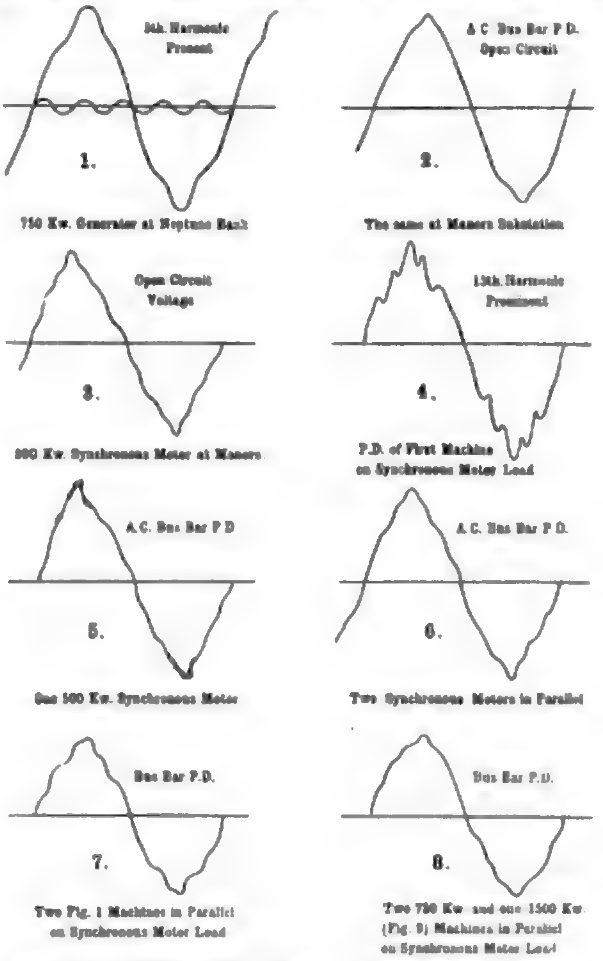
Influence of Cables on Transmitted Wave-Forms.—The behaviour of a polyphase electrical transmission system under working conditions presents many interesting problems. Through the kindness of the Newcastle-on-Tyne Electric Supply Co., I am able to give the results of some investigations with the oscillograph which were undertaken with the object of deciding, for this particular system, a few questions of importance in the regular working of the plant. The interest of the curves lies in the fact that they were taken under working conditions, in the absence of any abnormal phenomena, in the comparisons between different machines, and in the addition of a few more facts to our knowledge of polyphase working on a large scale. The tests were suggested by Mr. H. C. Leake and Mr. W. B. Woodhouse, and all the details were in their hands throughout. They were taken in three sets—in December, 1901, March, 1902, and July, 1903.

From the curves recorded I have selected those which throw light upon points of more than local interest. For example, it was desired to know whether the wave-forms at the sub-station were distorted by the mains. Fig. 1 is the voltage on open circuit of a General Electric (U.S.A.) 5,500-volt 750kw. three phase generator taken at the Neptune Bank power house. Fig. 2 is the same wave at Manors sub-station, a length of three miles of three core cable intervening. Analysis of the first curve shows that there is present a strong 5th harmonic. This machine has one slot per pole per phase, and, as is well known, six slots per period give rise to 5th and 7th harmonics in the voltage. Here the former predominates. It is clear from the second curve that there is little distortion by the capacity of the cables; the tops of the waves are slightly more pointed, but there is no fear in this case of trouble arising from resonance.

Influence of Synchronous Motor Load upon Wave-Form.—There is, however, the possibility of danger arising from the synchronous motor waves if they have strong harmonics. Fig. 3 is taken from a 500kw. motor-generator set at Manors, driven from the direct-current side as a three-phase generator on open circuit, and is typical of all the motors in the system. The machine has two slots per pole per phase, causing a well-marked 13th harmonic. The generator curve (Fig. 4) is the power-house wave of the same machine as in Fig. 1, but now running on a synchronous motor load at Manors. Although in this generator the 5th harmonic is most pronounced, the voltage appears with a 13th prominent, more marked, in fact, than on the motor, an effect possibly due to the mains, but more likely to the double-frequency phenomena explained in the next section. In Fig. 5, which is the 'bus-bar voltage at the sub-station when one synchronous motor is running light from the alternating-current side, the ripples are smoothed out. In curve 6 the superposition of the 5th and 13th is clearly seen.

Another proof that the ripples came from the reaction of the synchronous circuit is that they appeared to run up and down the curve in time with the engine driving the generator. If they had arisen from this machine they would have been fixed, but since its phase is swinging slightly, by reason of the engine irregularity, with respect to the circuit voltage, they move along the wave, the amount of movement indicating precisely the range of the relative phase swing between generator and motor. The visible motion is slight on account of the small scale of the curves, or this would be a suitable method of measuring phase displacement between machines, either motors or generators, in parallel, having somewhat different wave-forms, by observing only the 'bus-bar voltage. In Fig. 5 the tips of the curves waved to and fro in time with the engine. The relative movement of the machines in this case corresponds to 17deg. of phase, the mechanical movement depending on the diameter and number of poles on the rotor of each machine. Even when several generators are in parallel, as in Figs 7 and 8, the motor harmonic is able to make itself felt at the power house, though less so as the number of machines is increased.

A still better example is the reaction upon a Parsons turbo-generator. This machine gives a very fine curve (Fig. 9) on open circuit. It has, however, two slots per pole per phase, and the 13th harmonic is now just visible in the generator wave. On a water resistance (a circular brick tank, into which dipped three iron plates forming the inside surface of a symmetrical clover-leaf pattern, rigidly connected and raised or lowered together by a single pulley), there is some distortion, which increases with load (Figs. 10 and 11). In this case, however, it is the 11th harmonic which appears, suggesting that the occurrence of either harmonic is a question of armature reaction. Fig. 12 shows the wave-form of this machine on a synchronous motor load, and there is now a pronounced 13th harmonic. The current is full of a 23rd harmonic. This cannot readily be seen in the voltage, but a wave (Fig. 13) may be built up of a fundamental 13th and 23rd, which approximates in wave-form to that of Fig. 12. As the load increases the higher harmonics predominate (Fig. 14). That these high ripples do not entirely arise from double-frequency effect of armature current reaction, may be seen from Fig. 15, taken from a 1,500kw. Parsons turbine Brown-Boveri generator set on open circuit, the machine having four slots per pole per phase. In this curve a 23rd can be counted. When the machine is on load there is a slight change in the voltage wave, but the current shows the 23rd harmonic much more clearly (Fig. 16).



750 Kw. Generator at Neptune Bank

The same at Manors Substation

500 Kw. Synchronous Motor at Manors.

P.D. of First Machine on Synchronous Motor Load

One 500 Kw. Synchronous Motor

Two Synchronous Motors in Parallel

Two Fig. 1 Machines in Parallel on Synchronous Motor Load

Two 750 Kw. and one 1500 Kw. (Fig. 9) Machines in Parallel on Synchronous Motor Load

FIGS. 1 TO 8 — VOLTAGE WAVE FORMS OF THREE-PHASE MACHINES, R.M.S. VALUE OF EACH WAVE 5,500 VOLTS.

Presence and Origin of 23rd Harmonic.—The presence of this high harmonic of large amplitude in normal three-phase working has not, I believe, been previously observed. Since it appears in open-circuit voltage, it must arise in the movement of the magnetic lines across each slot. Every line is first retarded by the slot, then suddenly snaps across it. The voltage induced in the wires within the slot is, therefore, not sinusoidal but of the following form (Fig. 17a), the zero line being taken to cut off equal areas above and below. This wave-form can be produced by the superposition of two curves, one twice the frequency of the other, as shown at *b*; so that, since by the mechanical motion of the poles the first distorted form *a* is produced, the result on the main voltage will be two ripples, corresponding, in the case of a machine with two slots per pole per phase, to 12th and 24th disturbances, *both of which must always occur.* Their magnitude depends upon the relative reluctances of slot and air-gap, a short gap favouring the production of the higher harmonics. A low flux density in the teeth, giving them higher permeability and so causing the lines to be held by them a little longer, may also be a source of these high harmonics. Their greater prominence in the Brown-Boveri generator is probably aided by the surface winding of the magnet rotor and a low density in the armature teeth. The practical importance of this is that in a wide network of mains trouble is much more likely to arise from machines with short air-gaps or low saturation on account of this high harmonic. In addition to which, every harmonic increases the "copper" loss in the circuit.

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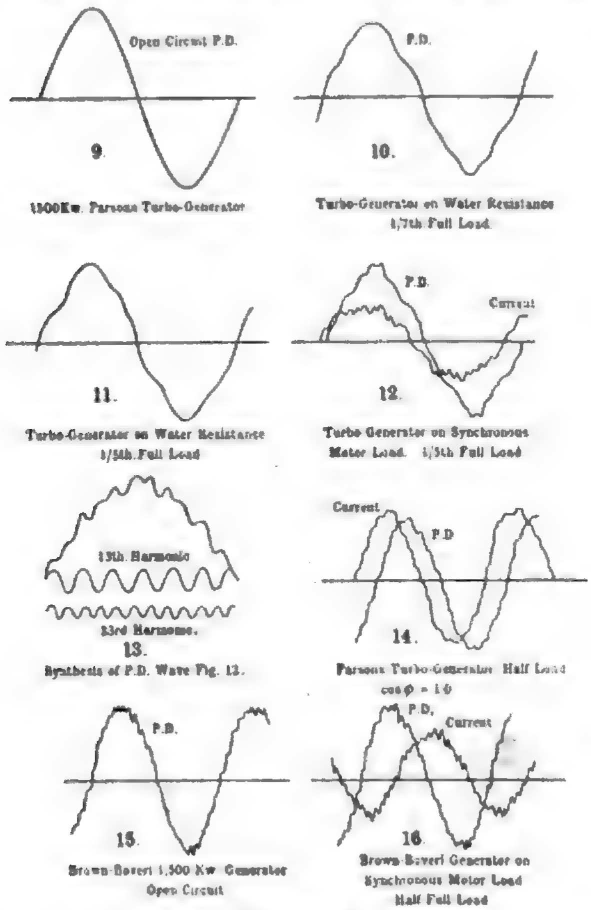
* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers on February 27th.



9. 1500 Kw. Parsons Turbo-Generator

10. Turbo-Generator on Water Resistance 1/7th Full Load

11. Turbo-Generator on Water Resistance 1/5th Full Load

12. Turbo Generator on Synchronous Motor Load. 1/5th Full Load

13. Synthesis of P.D. Wave Fig. 12.

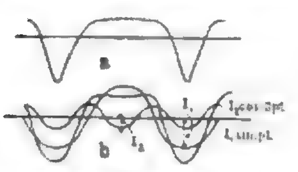
14. Parsons Turbo-Generator Half Load cos φ = 1·0

15. Brown-Boveri 1,500 Kw. Generator Open Circuit

16. Brown-Boveri Generator on Synchronous Motor Load Half Full Load

Figs. 9 to 16.

The effect of harmonics upon cable losses is a matter for further investigation. Steinmetz has found that dielectric hysteresis follows the same law as that in iron, the energy loss per second being proportional to the frequency and to the 1·6th power of the voltage Thus if there are two similar wave-forms, one having one-twentieth the amplitude of the other, but 23 times its frequency, the loss from that with the higher frequency will be as much as 20 per cent. of that from the other having 20 times its amplitude. Of course, a harmonic only causes fluctuation and not reversal of stress, but the high index 1·6 may make the former as important as reversal of the same amplitude about zero.



Synthesis of "a" from Two Waves

Fig. 17

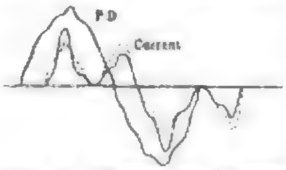
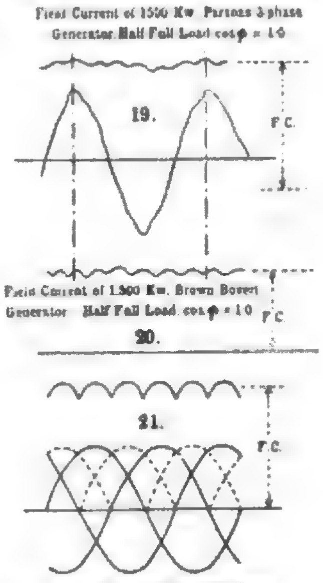


Fig. 18.—Effect of Lagging Current in Generator on Current Wave Form.

Current Wave in Under-Excited Generator.—As an example of the effect of under-excitation upon the output current of a machine running in parallel, Fig. 18 is given. This is the current in one of the windings of a turbo-generator with a light load. There are here two effects—the dip in the curve and the swing of the ordinate between the dotted limits. The curve shows a very strong 3rd harmonic in phase with the generated wave, and nearly equal to it in amplitude, added to which is a 13th. To explain the origin of the 3rd, it must be first noted that the curve is lagging with regard to the 'bus bar voltage by an angle of 58deg.—that is, 23deg. in the windings—so that the magnetising current component is 0·37 of the whole. It is well known that hysteresis in iron distorts magnetising current waves by giving rise to harmonics, of which the 3rd is the most important. In the given curve the distortion is aided by the way in which the machines were connected. When generator windings are joined "three-wire star," no 3rd harmonic can exist: but when the neutrals of generator and motor are earthed, the ordinates of the 3rd harmonic in each phase are added, and a triple-frequency current flows in each winding and to earth. Moreover, the magnetising component of the current in a motor reacts in opposite phase to that in a generator with regard to the voltage. A 3rd harmonic in the motor is, therefore, in phase with one in the generator, and a triple-frequency current circulates through the machines. As the excitation was raised, the dip in the curve disappeared at about quarter full load, and the current became approximately sinusoidal.

Periodic Variation of Exciting Current in Three-phase Machines.—The reaction of a large demagnetising component upon the field circuit must in the above case have been very marked. Unfortunately, no record of this was taken at the time, but some 15 months later I obtained Fig. 19, which is the exciting current of the same machine with a load of 160 amperes. There are here six well-defined waves per period superposed on the continuous exciting current. These arise from the double-frequency magnetising effect of the current in each phase in turn. The existence of these three-phase field disturbances has been disputed, but that they probably exist in all machines and do not depend upon a particular design is seen by their being equally pronounced in the Brown-Boveri generator (Fig. 20).



Field Current of 1500 Kw. Parsons 3-phase Generator Half Full Load cos φ = 1·0

Field Current of 1,500 Kw. Brown Boveri Generator Half Full Load cos φ = 1·0

Addition of Rectified 3-phase Waves

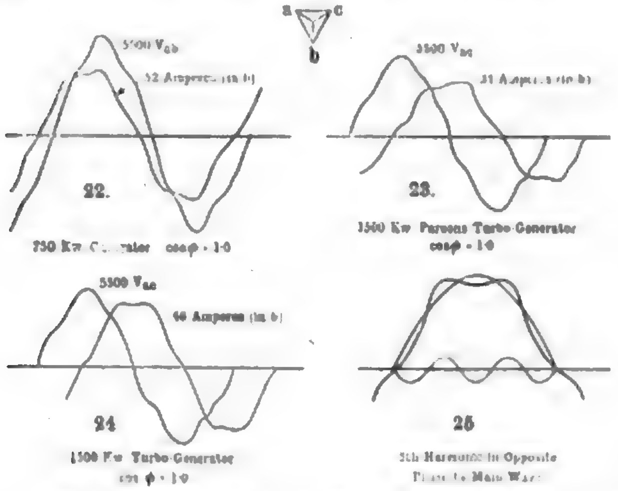
Figs. 19 to 21.—Effect of Armature Reaction on Exciting Current of Three-phase Generator on Load.

The calculation by which the back ampere-turns of armature reaction are found in theory to be perfectly steady, assumes that "the effect of a constant current in the armature coils varies as a sine curve when their position is reckoned from the centre of a pole." The influence of the breadth coefficient of the winding is also neglected. That these assumptions are only approximate, which is all they are said to be, and do not represent the true facts, is here shown to be the case. The following diagram (Fig. 21) may help to make the origin of these ripples clearer. The lower halves of the curves have been reversed to show their action, irrespective of coil position. The positive and negative maxima lie under opposite poles, and the effect on the magnetic circuit is cumulative. Note the correspondence between the general shape of this ripple and that of the actual current, and that the former are most marked in the Brown-Boveri machine. On open circuit the field current is practically straight.

Power-Factor of Large Generators on a Water Load.—There has been some discussion recently upon the fairness of testing large alternating-current generators on a water load, on account of the lead said to be produced by the capacity effect of the electrolyte. The following curves (Figs. 22, 23, 24) may therefore be of interest

By careful measurement of Fig. 22 it is found that the angle between voltage and current on the paper is 28½deg., but this is caused by the presence of a harmonic which has the effect of bringing the curves nearer on the zero line. Taking the equivalent sine wave, the angle is exactly 30deg. Again, with the Parsons turbine the angle is 90deg. at 31 and 46 amperes. The possible error in these measurements—due to the oscillograph cam—is about 3deg. Since the cosine of 87deg. is 0·998, the power-factor of large generators on a water load may, therefore, be taken as unity, with a possible error either way of ½ per cent.

The tops of the current waves are in all three cases flattened. This has nothing to do with the liquid resistance, but is caused by the 5th harmonic having changed its phase by 180deg., as may be seen by comparing Fig. 25 with Fig. 1. In the generator wave this harmonic was nearly in phase with the fundamental; now it is opposite to it at the start of the period. As a generator the machine was connected "four-wire star"—*i.e.*, with neutral point earthed—but now the water resistance forms a mesh across the line wires, and the earth connection on the generator is removed. It can be shown that the phase position of an *n*-th harmonic changes when the connections are changed from four-wire star to mesh, either by 180deg. or not at all; in this case by 180deg. But why should the Parsons machine, which has apparently only higher harmonics than the 5th, show the latter in the current? The answer is, I believe, to be found in the field ripples of the preceding section. There are six of them to a period, produced by armature reaction, and their further reaction upon the armature current is brought out in a striking manner by this shift of phase due to mesh connection. The distortion of the current wave observed in Fig. 22 is the result of having only one slot per pole per phase. It is similar to the sweeping forward of the magnetism in continuous-current generators, and with the two slots of the Parsons machine is less marked.



Figs. 22 to 25.—Wave Forms and Power-factors of Three-phase Generators on Water Load.

Phase Swinging.—The influence of unequal turning moment in generators is a subject which, in this section at least, is somewhat stale. There is, however, an interest attaching to the following curves on account of the reversal of current. Fig. 26 was taken at Manors when two 500kw. motor-generators were running light in parallel, but with no direct-current load, from a single generator at Neptune Bank driven by a marine-type triple-expansion engine. The corresponding wave-form of the generator is Fig. 1 above. The voltage shows 5th and 13th harmonics, and was practically steady except for the small sliding movement of the ripples. The current wave presented the most remarkable appearance. It seemed a living thing, swinging as it did from one position (A) to the other (B) at 100 times a minute, the tops of the waves shooting out like tentacles. It is a very suggestive example of phase swinging, the more so because there is little sign of a lateral movement. The curves collapsed on themselves and sprang out in the reverse direction. To explain this, let OE_1, OE_2 (Fig. 27) represent the voltage vectors of a generator and synchronous motor respectively, running light with a power-factor nearly unity. The resultant voltage OE is therefore small. If now, by reason of the unsteadiness of the engine speed, the vector OE_1 is set swinging, the motor vector will follow, and, if the disturbance is great, may swing past the zero line. As it approaches opposition to OE_1, OE falls to zero and increases to some opposite maximum OE^1 at the end of the swing. The steady position of OE_2 is usually above the zero line; the value OE^1 will therefore be less than OE. The current in the circuit is proportional to OE, and by inspection of the curves we see it diminish from a maximum, I_1, pass through zero, and increase to a lesser maximum, I_2. By measurement of Fig. 26 it is found that the relative angle of swing was six times the steady phase displacement between motor and generator; its absolute value cannot be determined from the curves. The power-factor of the circuit was 0·95. In the lower position (B) the 11th harmonic is prominent, and in the upper there is added to it—conspicuous at the maxima—a smaller 23rd or 25th.

Phase Displacement and Load.—There is one more effect to which I wish briefly to refer. The measurement of the steady displacement between, say, two alternators in parallel, or a synchronous motor and its generator, depending upon excitation and load, has not hitherto been experimentally possible, though the general effect is well enough known. If a small white patch is placed on the side of one of the revolving poles of a synchronous motor, and this is illuminated by an arc alternating at the frequency of the circuit, the effect is a white line, but if it is observed through a fine slit cut in the edge of a disc driven by a small synchronous motor it appears stationary. On raising the excitation of the motor it moves forwards to a new position, and backwards if it is lowered, the amount of phase displacement corresponding to a change in either of the vectors OE_1 or OE_2. The great advantage of this new method is that it gives the actual movement of the rotor, and the influence of armature reaction in alternators in lowering the *generated* voltage can now be observed. For the OE_1 and OE_2 are not the terminal but the generated volts in the respective machines, and there is no phase displacement unless these change.

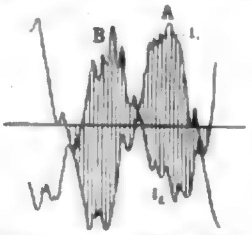


Fig. 26.—For corresponding Voltage Wave Form, see Fig. 6, in phase with A, cos φ = 0·95.

For the direct observance of phase swinging the method is very useful. When load is thrown on or off a motor or generator, the rotor appears to make torsional oscillations on the shaft, usually dying out in about half a minute. The time of oscillation at different excitations can be found, and the risk of hunting on any particular circuit determined. The fluctuation of current, and therefore of torque, by the variation of generator speed can also be readily seen. The arrangement is in effect an optical tachometer, and by the use of an enclosed revolving drum on which sensitised paper is mounted continuous photographic records could be obtained.

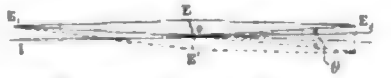


Fig. 27.—Generator Voltage steady. Motor swinging through Angle θ.

DISCUSSION.

Mr. RALPH asked Dr. Thornton if he could explain why, when an ammeter was connected between the plates of a water resistance, and another in the conductor leading to the water resistance, that in the resistance read less than the one outside, the source of electricity being a 200kw. 2,000-volt alternator.

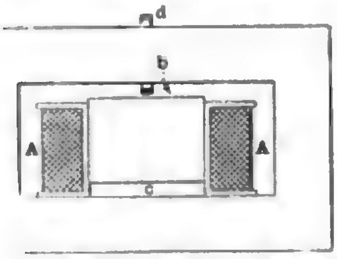
Mr. CLOTHIER said it was a common practice to use reverse-power circuit-breakers on alternating circuits. In the event of a short-circuit occurring in a feeder, it had been found in practice that a surging effect resulted which caused the reverse-power automatic devices to operate and so isolate the machine just at a time when the continuance of supply was most wanted. Curves under these conditions would be very useful to designers of protection devices.

Mr. G. STONEY considered that the wave form of the Parson's machine was smoother than that of the Brown owing to the former having closed slots or tunnels for the armature windings and the latter having large open slots.

Dr. THORNTON, in reply to the discussion, thought that leakage might account for the difference in the reading of the two ammeters mentioned by Mr. Ralph. No experimental curves had been taken when faults had been on the system, and he doubted whether he would be permitted to do such a thing. The cables would not stand a maintained resonance of enormous amplitude. He agreed with Mr. Stoney that closed and open slots would account for the difference in the wave form. The reaction on the field would increase the ohmic resistance. Mr. Turnbull had proposed to laminate the fields, but personally he (Dr. Thornton) thought that laminating would have a choking effect.

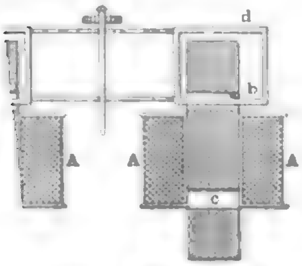
LTERNATING-CURRENT WATTMETER.

ti, of Milan, referring to Dr. Sumpner's inaugural
irmingham Local Section of the Institution of
ers on "The Use of Iron in Alternate-current



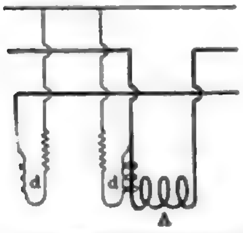
NET SYSTEM OF RECORDING WATTMETER.

lectrician of Nov. 25, Dec. 2 and Dec. 9, 1904),
owed up the same subject independently and
lternating-current wattmeters in which iron



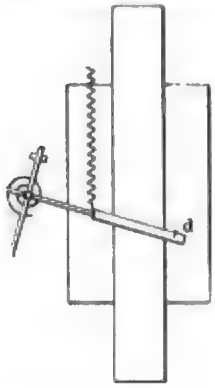
THROUGH RECORDING WATTMETER.

e instruments are said to be independent,
frequency and wave form, and nearly
isplacement.



ECTIONS FOR RECORDING WATTMETER.

shown in Figs. 1 to 4, is a recording
e-phase circuits. It is a combination
s, each electrically independent of the



G WATTMETER.

. The field magnet A of each
aminated-iron core. There are
ic path, the length of the upper gap *b* being about one-twentieth that of the entire magnetic circuit, while *b* and *c* together are about one-twelfth of the same length. These lengths of air-gap, it appears, have been found most suitable for obtaining a uniform field, an important condition in recording instruments. Coil *d* is the shunt coil, one side of which swings in the upper air-gap as shown in Figs 1 and 2. It is mechanically connected in the manner indicated in Figs 2 and 4 to another shunt coil *d* swinging in the upper air-gap of the second wattmeter. The electrical connections of the complete wattmeter are shown in Fig. 3.

DISCUSSION ON ELECTRICAL STANDARDS AND UNITS.

At the Institution of Electrical Engineers last week, a discussion was opened upon the International Electrical Congress which was held at St. Louis in September last year on Electrical Units. Mr. W. Duddell's report as honorary secretary to the British delegation to the Congress was published in the last issue of the *Journal* of the Institution (p. 171), and Mr. Duddell opened the discussion by summarising the questions that had been dealt with. Papers on "The Legalised Standard of E.M.F.," by Prof. Carhart, and "Magnetic Units and other Subjects that might Occupy Attention at the next International Electrical Congress," by Dr. A. E. Kennelly were discussed at the Congress, and have been published in *The Electrician*, Vol. LII., pp. 828 and 826 respectively. The discussion was also extended to the following other Papers read at the Congress, and these will be found in the number of the Institution *Journal* already alluded to: "On the Systems of Electric Units," by Prof. M. Ascoli; "Proposals Concerning Electrical and Physical Units," by Prof. G. Giorgi; "The Absolute Value of the E.M.F. of the Clark and the Weston Cell," by Profs. H. S. Carhart and G. W. Patterson; "The So-called International Electrical Units," by Dr. F. A. Wolff.

Mr. W. DUDDELL said he would discuss the question of units by asking a series of questions. First, What was the true value of the volt and the ampere?—It was pretty generally admitted that the true value of the volt, 10^8 C.G.S. units was such that the E.M.F. of a normal Clark cell at 15°C. was much more nearly 1·433 volts than 1·434 volts, the present legal value. In this connection it was of interest to note that during some tests made by Mr. Trotter at the Board of Trade, in which he determined the value of the normal Clark cell in terms of the standard ampere and standard ohm (the legal standards of the Board of Trade) he found that the true E.M.F. of the Clark cell was nearly $\frac{1}{10}$th per cent. lower than the present legal value—*i.e.*, there was a discrepancy amongst our three legal standards of nearly $\frac{1}{10}$th per cent. It was to be noted, however, that this error was less than the error specified in the Order of Council which governs the appointment of these standards. The volt, the ampere and the ohm were connected together by Ohm's law; therefore, if we made a concrete standard for any two of these quantities, we also determined the third. He thought no one was disposed to quarrel with the present mercury standard ohm, especially in view of the fact that the mercury standards set up by the National Physical Laboratory, and that set up by the Reichsanstalt in Germany agreed to within a few units in 100,000. Therefore, it was only necessary to set up a concrete standard for one of the other quantities. Should we set up a standard for the volt or the ampere? If the volt, it would probably take the form of some cell; should it be the Clark zinc cell or the Weston cadmium cell? If, however, the standard set up should be the ampere, was the silver voltameter the best form, or was not some form of current balance better? All the various countries which legalised definitions of the electrical units had legalised definitions which differed somewhat, although they were no doubt intended to represent the same unit. Thus, he believed, in Great Britain the law stated that each unit was the value, estimated in terms of the C.G.S. units, and was represented by a certain concrete standard, whereas under the United States law the definition of units in terms of the C.G.S. units was qualified by the words "substantially equal." It was not "accurately equal." The next question was, "Should the legal definite fundamental unit be the C.G.S. unit or that obtained by attaching values to a concrete standard"? Before leaving the question of standards he would like to say a few words on that subject, as he thought some misunderstanding had arisen as to the nature of the different standards. He thought that we needed three standards: First, the C.G.S. standard, with which, he took it, everybody would agree as our fundamental unit. That was not a concrete standard. Secondly, a concrete representation of the C.G.S. unit. Thirdly, a practical standard which could be put into everyday use in the workshop. The requirements of these standards were totally different. For the second standard—*i.e.*, a concrete representation of the C.G.S. unit, or a multiple of it—we required permanence and reproducibility. But we did not require in a very high degree that that standard should be easy to reproduce or easy to use. On the other hand, for the third standard—the practical standard to be taken into the workshop—we required that it should be easy to use, easy to set up, that it should have moderate accuracy, and should any error occur in the standard it could be referred to our standardising laboratories to be calibrated and redetermined. Therefore, the conditions governing the second and third standards were very different. The mercury ohm was an extremely good example of a secondary standard. It could be set up and gave a very high degree of permanent accuracy, but no one would suggest that it should be taken into the workshop and used. Tertiary standards fulfilled all requirements, but we required a secondary standard for potential difference or current which should have a very high permanent accuracy. Some cell in conjunction with a resistance would probably be used for workshops, and would give quite as good results as the manganin ohm was giving as our tertiary standard of resistance.

With regard to magnetic units, we required names for three magnetic quantities—viz., magnetomotive force, total magnetic flux and magnetic reluctance. There were three courses open to us by which we might choose the quantities to which the names were to be given. There were seven quantities in the volt ampere-ohm system, and we could form three more names consistent with these. The unit of total flux would be in volts per second, so that $4\pi \times$ ampere-turns would be the magnetomotive force, and the ratio would give the unit of reluctance. We could either rationalise these units by moving the 4π from the magnetomotive forces into the magnetic reluctance, or we could give names to our present C.G.S. units. It had been suggested that all the C.G.S. electrical units needed names. But did they? If so, how were these names to be formed, because a proposition had been put forward for forming them, with which he did not know whether the members would agree?

The Chamber of Delegates resolved to advise their respective Governments to appoint an International Commission to deal with the question of units and standards. It was greatly to be hoped that this excellent recommendation would be adopted, and that a permanent International Commission would be appointed. In this event his final question was—Can this Institution, which represented the great body of electrical engineers in this country who use these electrical units, help the Commission in any way by collecting data for its members, or by having apparatus made or experiments carried out, and by bringing these results before the Commission?

Mr. R. KAYE GRAY, as the leader of the delegation to America from the Institution, said a few words from him might not be amiss. He would like to mention that this country was rather indebted to the Institution for the work they had done in connection with these matters. Great Britain was hardly as prepared as it might have been to act at the time of the Congress, but the Institution stepped into the breach with the members who were out at the Exposition, owing to the intervention of Sir William Preece and Lord Rayleigh at home. Consequently Dr. Glazebrook, Prof. Perry, and Col. Crompton, were appointed to represent Great Britain, and they had represented us in a manner which everyone would have expected. One point he felt bound to refer to was the kind treatment they had received in America at the hands of the Americans. Further, they might take it from him that the opinions of the men who were representing Great Britain were received with the greatest deference, and he believed that they carried considerable weight in the decisions which the Congress arrived at.

Lord RAYLEIGH, F.R.S., said that some 20 years ago he had these matters almost at his finger ends, but since then a great deal of work had been done with which he was imperfectly acquainted. Mr. Duddell had put the questions before the meeting in a very succinct form, and one point on which he would like to make a remark or two was as to the employment of the volt or the ampere as the second principal standard. He thought the discussions which had been held on this subject given in the report seemed to take too much for granted that there was no residual uncertainty in connection with the ohm. If the ohm were given to us from heaven, then he thought there would be an immense deal to be said in favour of taking the volt as the other standard. But, as things were, the uncertainty that there might be about the ohm and the added uncertainty that there might be about the volt would become inextricably mixed. This argument weighed with him at the time he did his work in putting the ampere forward in the first instance rather than the E.M.F. of a Clark cell. From the practical point of view he could well understand that the cell was exceedingly convenient, and no doubt it would be used as a tertiary standard in the workshop, whatever might be done on the more theoretical side of the question. He did not mean to dispute that we knew the ohm more accurately than we knew the ampere or the volt; this was certainly the case. But we must look ahead. When the researches now in progress were completed that situation might no longer exist. The uncertainties which were found in the setting up of the Clark cell related principally to the mercury end of it, and in that respect there was no difference between the Clark cell and the Weston cell. He understood, however, that at the present time these uncertainties were nearly removed, and, this being so, we might then concentrate our attention on the advantage the Weston cell undoubtedly possessed at the other end, in view of the smaller temperature coefficient to which it was subject. Still, we should not be in too great a hurry, and it was well that experience should be gathered from many quarters as to the advantage of the cadmium cell if it were to be put forward as replacing the older Clark cell. On the question of magnetic units, perhaps he was too old to be impartial on the 4π question, because no doubt an innovation there would upset a good deal of his mental capital and would be decidedly inconvenient to him. But one must look in a matter of this sort rather to the interests of the rising generation, and he preferred to leave the matter in their hands. He objected, however, to the epithets which Mr. Heaviside had fixed upon the old-fashioned system. It was irrational, but it was a question of convenience; and whilst, in the abstract, the system which Mr. Heaviside preferred was the more convenient, the objection to it simply was that the other had been established. He hoped names would not be multiplied unduly. Of course, those who used them constantly found no difficulty in remembering them, but those who turned their attention to other branches for a year or two, and then came back, were apt to be at a loss to know what was meant if names were multiplied unduly, and there was a tendency to that in some of the proposals that had been put forward. Another question was as to the kind of name that should be used. He was rather horrified with the forms of some of the suggestions that had been made.

Prof. W. E. AYRTON, F.R.S., said a very important part of the St. Louis Congress was the consideration as to whether the ampere should be defined in terms of the electro-chemical equivalent of silver, or in terms of the ohm and the E.M.F. of some standard cell, and, as Lord Raleigh had most pertinently remarked, a most important point in that discussion was entirely omitted. The discussion had particular reference to what might be called over-knowledge of the vagaries of the electrolytic measurement of current and electrolytic measurement of P.D., but, practically, no reference whatever was made as to whether the ohm was known to a very high degree of accuracy. For this reason he had had put into the form of the following table the best determinations of the ohm made in this country, leaving out some of the early ones of the British Association which we knew were quite wrong.

English Determinations of the Ohm since 1882 in Centimetres of Mercury 1sq. mm. at 0°C.

1882	B.A. method spinning coil ..	Lord Rayleigh	106·27
1882	Discharge induced by coil turned through 180°	Glazebrook	106·28
1883	Lorenz method spinning disc.	Lord Rayleigh and Mr. Sedgwick	106·22
1891	Do.	V. Jones...............	106·30
1894	Do.	V. Jones...............	106·32
1897	McGill apparatus	Ayrton and Jones	106·27
		Mean............	106·28

There was a good deal of difference between them, but they might be called the best English determinations. When he read the Papers that were communicated at Chicago he felt that there must be some other determinations of the ohm, and Mr. Mather had been good enough to spend considerable time in going through a large number of Science Abstracts to seek them. But there were none, so, as a matter of fact, as regards the ohm we were not clear to a fifth place, and were not even absolutely clear about the fourth place in its value. The great advocate in America for defining the ampere by means of the ohm and the E.M.F. and some cell was Prof. Carhart, and he had looked up what had been the result of most careful work in the University of Michigan, where for some years Prof. Carhart had been the professor of physics. A Paper by Messrs. Patterson and Guthe describing "The Determination of the Electrochemical Equivalent of Silver," in 1898, gave the E.M.F. of a Clark cell at 15°C. as 1·4327 volts. In 1899 when these same authors were using other apparatus, they arrived at the conclusion that at the same temperature the E.M.F. was 1·4333 volts. It might be imagined that this was approaching considerable accuracy, but if they looked at Prof. Carhart's Paper, communicated to the St. Louis Congress, on the same subject, what he ended up by saying was this:—" When we have succeeded in reducing the effect of elastic fatigue in the suspension to smaller values, we shall hope to reach results accurate to at least one part in 5,000. For the present we are only prepared to say that the legalised value of the E.M.F. of the Clark cell (1,434 volts under standard conditions) is too high. This uncertainty was mainly, or largely, due to the form of apparatus he had used, which contained a fundamental mistake from the mechanical point of view. It seemed to him a mistake not to utilise the magnetic balance for the measurement of the force, as this instrument was made with an enormous amount of precision at the present time. Mr. Duddell had spoken in his opening remarks about the resistance of coils in this country agreeing with the resistance of coils in Germany to one part, or one or two parts, in 100,000; but that had nothing whatever to do with the ohm; it only showed that it was possible to make coils to a very high degree of similarity in resistance. It did not show that any one of them was right. The same thing happened in connection with the standard ohm in the Order in Council of the Board of Trade. This merely meant that Mr. Trotter and his staff were able to compare the resistance of some wire sent to them with the resistance of another wire in the Board of Trade laboratory with the degree of accuracy mentioned in the Order in Council, and people were misled into thinking that because coils could be compared with modern Wheatstone bridges to one part in 100,000, they could be made to remain as accurate as this. Therefore, in a sense, in dealing with this question we might put the ohm on one side. He did not say but what in a year or two we might know the ohm to a very much greater degree of accuracy than was the case at present, because it was known to some of them that one of the things that Prof. Viriamu Jones did before he died was to get the Drapers' Company to give £700 for the construction of a new Lorenz apparatus to be used in the National Physical Laboratory, and his death did not free the Company in any way from this obligation. In fact, they expressed the utmost willingness to carry out this obligation, and asked Dr. Glazebrook and himself to put the new Lorenz apparatus into material form. It was impossible, in electromagnetic measure, to make an absolute determination of the volt, although it could be done in electrostatic measure; but it was impossible to convert the result into volts unless they knew the ratio of the electromagnetic and electrostatic unit of quantity, and that was quite as difficult to obtain as a determination of the ampere or the ohm. But it was possible to determine the ampere to a very high degree of accuracy, and what was so puzzling to him was that while during the last 30 years there had been a great number of determinations of the ohm, practically nobody had redetermined the ampere. Prof. Jones had himself thought out how this could be done. In all these absolute measurements it was necessary to know the position of the wire coils that were carrying current. Therefore it was quite obvious that there must be only a single layer of wire for the stationary coil in which the metal disc rotated. Using an apparatus which he had constructed in 1898 for the determination of the ampere, he got a result which was very near, when expressed in deposit of silver, to 1·118 milligrammes per second. But the determination demonstrated that it would require a very much better apparatus made on this principle in order to get the fourth or fifth place. The next improvement made by Prof. Jones was to do away with the silk covering of the wires, but there was a difficulty then in testing the insulation between the turns. This was solved by Mr. Mather, who cut two helices in marble and wound two coils, which were joined up in series after being tested. With the apparatus he had mentioned as being in course of construction by Dr. Glazebrook and himself, he hoped to get the ampere to certainly one part in 10,000, and possibly to one part in 20,000, so that in the course of a few weeks or months he trusted that it would be possible to have the absolute ampere more accurately than the absolute value of any other of the electrical units had yet been obtained.

Mr A. P. TROTTER said: Before taking part in this discussion I wish to make it clear that my remarks are not to be understood as representing the official views of the Board of Trade. In the section of Dr. Wolff's Paper on the "Legalisation of the Electrical Units by the various Governments" he observes that "in England . . . . a distinction is made between a unit of E.M.F. and the standard of E.M.F., the latter being defined as the 100th part of the pressure producing a certain deflection of a Kelvin electrostatic voltmeter of the multicellular type . . . ." The distinction between a unit and a standard was discussed by the Electrical Standards Committee of 1890. That committee was appointed "to consider and report . . . . with a view of causing new denominations of standards for the measurement of electricity for the use of trade to be made and duly verified." The distinction is to be found in the Weights and Measures Act of 1824, which, while it declared that a certain metallic bar should be considered the standard yard of the British Empire, provided for its recovery and reproduction in case of the total destruction or loss of it and all its authentic copies and facsimiles, by a declaration that its length is 36in., such that 39·13929 of them are equal to the length of a pendulum vibrating seconds in vacuo and at the sea level in the latitude of London. When that standard was destroyed by the burning of the Houses of Parliament the new standard was constructed, not by any measurement of the length of the pendulum, but by a careful comparison of all the best scales that could be got together. The Act of 1855, which constituted the legal yard, named others as its successors in the event of destruction or loss, and omitted reference to the pendulum.* Similarly the unit of length of the metric system is the 10,000,000th part of a certain quadrant from the pole to the equator, but the standard is the platinum bar kept at Paris. Any given unit may be defined in various different ways; such definitions are descriptions. A standard is the material embodiment of a unit for practical purposes, and in this country the construction of material standards is necessitated by the Weights and Measures Act. In other countries the units are defined by law, but their embodiment in the form of measuring apparatus is left to authorised officials. The Order in Council of 1894 keeps a clear distinction between a unit and a standard. It says that "new denominations of standards are required for use in trade based on the following units of electrical measurement." Then follow three paragraphs of definitions. The primary definition of the Ohm is 10^9 C.G.S.; the secondary definition, " . . . . and is represented by the resistance" of a certain column of mercury. The primary definition of the Ampere is $\frac{1}{10}$th C.G.S.; the secondary definition, " . . . . and which is represented by the unvarying electric current which" deposits a certain amount of silver per second. The primary definition of the volt is 10^8 C.G.S.; the secondary definition, " . . . . . being the electrical pressure that, if steadily applied to a conductor whose resistance is 1 ohm, will produce a current of 1 ampere"; the third definition, " . . . . . and which is represented by" the value of the Clark cell. In these three paragraphs the word "standard" is not to be found. The Order in Council says that new denominations of standards have been made and verified, and goes on to "approve the several denominations of standards set forth in the schedule hereto as new denominations of standards for electrical measurement." The schedule "sets forth" the ohm coil, and does not mention the mercury column, it sets forth the ampere balance, and does not allude to silver deposition, and sets forth the voltmeter without mentioning the Clark cell. Unlike any other country, our Order in Council declares the limits of accuracy attainable, and this should be remembered in connection with the words "and is represented" which occur in each definition. The United States Law uses the expressions "substantially equal to" and "practically equivalent to." Germany uses the expression "practically equivalent to," and France and Belgium "sufficiently well for practical purposes," and Austria "for commercial purposes." In 1894 it was necessary to use definitions of the units, but now that so much work has been done on absolute electrical measurements, it appears to me that if we were starting afresh the C.G.S. definition would suffice for the units, and the selection of standards may be left to the officials of each country. Those officials will, naturally, be in touch with the scientific authorities, and will keep themselves informed about the values of their standards in absolute measure when important absolute re-determinations of the units are made. Mr. Duddell spoke at St. Louis of units as primary standards, and of what I call standards as "secondary standards." I quite agree with him when he says "it would be unwise to tie ourselves too tightly to these." When it is found that the standards diverge appreciably from the units, two courses are open, one is to "scrap" the standards and the other is to apply a correction. Clerk Maxwell was of opinion that the original B.A. ohm would not be altered, but that a correction would be applied, when more accurate researches had been made.* Among the many important pieces of work which have been undertaken by the National Physical Laboratory, are the absolute determination of the ampere and of the ohm. When the results are declared, the Board of Trade may or may not take official action in declaring a correction or corrections. The result will be so well known to the scientific world that anybody could apply them for himself. At present there is no reason to suppose that the standards of this country differ from the units by more than the limits of accuracy which have been laid down. It speaks volumes for the careful work of the Committee of 1890 that after 15 years so little alteration is needed. The Committee never suggested that the mercury column should be used as a standard. The mercury column is as good a definition for international purposes as could be devised. The 106·3cm. may be revised from time to time as more refined research work is carried out, and the revised figure will indicate the correction to be applied to the standard by those who are engaged in physical work involving absolute measurement. It has been suggested that the method of silver deposition described in the specification attached to the Order in Council is capable of improvement—for example, that stratification of the solution should be prevented by stirring. But the method of silver deposition is not introduced here for the purpose of defining the ampere by means of the electro-chemical equivalent of silver; it is introduced for the purpose of recording the research of Lord Rayleigh, who used that particular method. This method formed the link between Lord Rayleigh's work and the ampere standard balance of the Board of Trade. When a new determination is made other links might be devised for scientific purposes, but the precision of the silver deposition is ample for all purposes of trade. The only part of the work of the Committee of 1890 which needs revision is the definition by the Clark cell and the specification of that cell. "The Board of Trade Volt Standard" has nothing to do with the Clark cell, it was not verified with reference to that cell, and it is in good working order. Without going outside the Board of Trade Electrical Standards Laboratory, a discrepancy has been discovered between the declared value of the Clark cell and its observed value. I have taken steps to let it be known, semi-officially,† that this value appears to be 1·4329 instead of 1·434 at 15 C., or is 1·434 at 14 C. I am not convinced that this discrepancy of 0·788 in 1,000 is of appreciable importance "for use in trade." It is on the limits of practical importance in connection with lamp testing, for it is equivalent to nearly 0·4 of 1 per cent. of candle-power. The specification of the Clark cell appended to the Order in Council is now out of date. I cannot recommend that form of cell for work of the highest accuracy. I think that large cells, as suggested by Prof. Schuster, are better, and it is probable that a cadmium cell is better still. Knowing the liability of Clark cells to dry up, I should prefer a saturated cell with a higher temperature coefficient to a semi-saturated cell with an almost negligible temperature correction. Experience of the last 15 years has shown that neither the Clark cell, nor any improvement of it, is necessary in a Standards Laboratory as a standard, while, on the other hand, such cells are very valuable pieces of apparatus both for scientific and for trade purposes. I quite agree with Mr. Duddell that what he called a third set of standards seems to have been confounded with the second. Such as the cell, "an apparatus which is going to be carried about for practical purposes . . . . the practical man will take the cell as his testing standard. It can easily be carried about, and can be used with the potentiometer. The question of amending the legislation of this and of other countries has been discussed. I am not prepared to recommend the Board of Trade that any amendment of the Order in Council is necessary. But if an amendment were to be made, I should recommend that the definition of the volt should not contain reference to the Clark or to any other standard cell, but that we should fall into line with Germany, Austria, Belgium and Switzerland. I attach but little importance to our Volt standard as a legal standard. It is a useful laboratory instrument. If I want a Volt, I pass The Ampere through a copy of The Ohm, which will easily carry it. This is often done in the Board of Trade Laboratory, and is in accordance with the definition which would remain if reference to the Clark cell were omitted.

Mr. F. E. SMITH said that in looking through the report the first point with which he was struck was the unanimous approval of the mercury standard of resistance. There was no discussion whatsoever on the concrete mercury ohm. The mean value of the 10 mercury standards at the National Physical Laboratory had been compared with the Reichsanstalt standards, which were constructed on entirely different principles, and the difference was only two parts in 100,000. Therefore, he thought one was justified in saying that the mercury standard was reproducible up to two or three parts in 100,000. Another question was whether the mercury ohm was a constant one. He had found that its zero was subject to great fluctuations, and it was possible that the mercury standard was changed by about two parts in 100,000 after construction. He might say that the mercury standards of the National Physical Laboratory were not permanent, and it was not desirable that they should be. They were subject to a certain cycle of operations before erection which caused the secular change to be a minimum. Moreover, it was not desirable that mercury standards should be set up permanently, because the platinum potential leads must be included in the mercury, and no one knew to what extent the platinum would go in solution in the mercury, and what effect that would have on the resistance. He was not quite in agreement with Mr. Duddell that mercury standards would not be found in the test room in years to come. They would not be expensive, and would be a very convenient check for manufacturers.

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* "Familiar Lectures on Scientific Subjects." Sir John Herschel, p. 429.

* Electricity and Magnetism. Clerk Maxwell, Vol. I., p. 389.

† *The Electrician*, Vol. LIII., p. 916.

On the subject of the standard cell, he was in agreement in the main with the remarks made by Dr. Wolff and Prof. Carhart at St. Louis. At the National Physical Laboratory there were 200 cells constructed chiefly with the cadmium elements. However, standard cells changed so slowly in E.M.F. with time that they must be kept under observation for many years, and no cadmium cell had been kept under observation for so long. The Clark cell was a very good secondary standard if it were made according to the new specification and kept at a constant temperature. But for practical purposes anyone using both cells would prefer the cadmium cell; its temperature cofficient was only $\frac{1}{\text{[illegible]}}$th of a volt per degree C. Prof. Guthe had said he could repeat his determination of the silver voltameter to 1 part in 10,000. This, as a matter of fact, confirmed certain figures which he himself had collected. When Guthe's experiments in America had been completed, as well as some at the National Physical Laboratory, they might be able to define a particular type of silver voltameter with a higher degree of accuracy than that mentioned above.

The discussion was then adjourned, and was resumed last night.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Fluorescence and Absorption.—J. B. Burke adds further observations on the change of absorption in uranium glass in the fluorescent state. He, as well as Nichols and Merritt, found that when uranium glass is excited to fluorescence it transmits light less readily than when quiescent. The author deals with Camichel's negative result, and attributes it to his having used a fluorescent glass to cut off the more refrangible rays He maintains that the prevalent idea that the spectrum of fluorescent and phosphorescent bodies is continuous is erroneous, for whenever the luminosity was of sufficient brightness, the spectrum which, when the light was feeble, seemed continuous, was found distinctly to be made up of finer bands, whilst when the intensity was diminished the distinctly band-like spectrum was once more found to be dimmed and became continuous. Therefore if, by any means, the light of precisely the same period as the fluorescent light were sifted or removed from the spectrum of the light, transmitted through uranium glass, we should not expect to get any variations in the absorption corresponding to the changes in the body during the fluorescent state.

[J. B. BURKE, *Royal Society*, read March 30, 1905.]

Sextant Electrometer.—M. Guinchant has devised an electrometer in which the needle is charged by induction, and is suspended by an insulating fibre instead of a conducting one. The directing couple is given by a bifilar suspension or a small magnet. There are six sectors, placed in the same plane under the needle. The latter is a plate of silvered mica strengthened with strips of mica. Two of the sectors are larger than the others, and form a kind of figure of eight, filling an angle of some 80deg. on each side of the centre. The other sectors are smaller and further away. The needle in its normal position covers the whole of the central sectors and about a third of the outer ones. The theory of the instrument is the same as that of the quadrant electrometer. An outer sector, the needle and half a central sector may be considered as forming a system of two condensers in cascade. The author expects to get a deviation of 1mm. per millivolt on a scale at 1 metre.

[GUINCHANT, *Comptes Rendus*, March 27, 1905.]

Effect of Ultra-Violet Light on Glass.—F. Fischer has examined the effect produced on various glasses by ultra-violet light from a quartz-mercury arc lamp. The glass was placed very near the quartzwall. The int ervening space was sometimes filled with hydrogen, but without producing any difference. The results were not produced by Röntgen or cathode rays. Out of eight glasses examined, four showed a change of colour within a quarter of an hour, which developed into a deep violet in 12 hours. The colouration was found to be connected with the presence of manganese, as in Schott's thermometer glass and ordinary Thuringian glass. The substance producing the colour is manganous silicate. The author recalls Sir William Crookes' recent announcement that certain kinds of glass were found to acquire a violet colour on prolonged exposure to sunlight at Uyni, Bolivia, a place situated 4,000 metres above sea level. At this altitude, sunlight contains a considerable proportion of ultra-violet rays. The author suggests that the permanent colouration of tubes under the influence of Röntgen rays and radium rays may be due to a secondary generation of rays of short wave length.

[F. FISCHER, *Physikalische Zeitschrift*, April 1, 1905.]

Radium from Fango Mud.—Though the activity of fango and Capri earth is only about one-thousandth of that of pitchblende, the process by which radium is obtained from uranium ores can be successfully applied to it, owing to the insolubility of the radium-barium sulphate and its property of precipitating the radio-active earths with itself. Sixty kilogrammes of moist fango, analysed by F. Giesel, gave 0·39 gramme of barium carbonate and 0·05 gramme of an ammonia precipitate. Both preparations excited the barium platinocyanide screen, and have remained active for half a year, thus showing the presence of radium. Forty kilogrammes of Capri earth were subjected to three extractions by means of hydrochloric acid, which could be employed owing to the total absence of sulphuric acid. The third extraction, taken with excess of acid, gave 0·15 gramme barium carbonate with an initial activity of 33,000 volts, and a final activity of 192,000 volts after three weeks. The most insoluble fraction showed distinct self-luminescence. No uranium was found in either of the earths examined.

[F. GIESEL, *Physikalische Zeitschrift*, April 1, 1905.]

System of Units with Two Fundamentals.—A. E. Haas sketches a system of units which eliminates mass and contains time only in connection with velocity. The system leads to simple and rational formulæ for the chief electric and magnetic quantities. The dimensions of mass are derived from Newton's law:

$$MLT^{-2} = MML^{-2},$$

which, if the gravitational constant is unity, gives $M = L^3T^{-2}$, or LV^2 if V is velocity. Quantity of electricity and quantity of magnetism are given the same dimensions as mass. Energy has then the formula LV^4, current strength is V^3, force is V^4 and power is V^5. Resistance is V^{-1} and resistivity LV^{-1}, while capacity is simply L^{-1}. Potential, whether due to gravitational, electric or magnetic force, is simply V^4 and magnetic moment is V^2L. The mechanical units may be obtained by substituting in the usual formulæ LV^{-1} for T and LV^2 for M. No fractional indices can thus arise. The electric units above are all measured electrostatically, but if the velocity of light is taken as the unit of velocity the difference between the two electric systems disappears. One would suppose, however, that no rational system can be arrived at by making the dimensions of magnetic pole and electric quantity the same.

[A. E. HAAS, *Physikalische Zeitschrift*, April 1, 1905.]

Frictional Excitement of Vacuum Tubes.—C. Hess describes a curious phenomenon which appears to offer a method of converting friction direct into light of a very economical kind. He was experimenting with an electrodeless tube held in the hand and connected with one terminal of a Holtz machine, while the other end of the tube faced the second terminal of the machine. The tube thus represented a kind of Kleist jar, and on touching the free end with the free hand a shock was felt and a luminous discharge passed through the tube. This might have been expected, but the author also found that subsequently the tube could be brought to flash up by simply rubbing the hand over it. He then examined a number of vacuum vessels of all kinds, including glass spheres, Geissler tubes containing oxygen, hydrogen, nitrogen, carbonic oxide and acid, argon and helium, as well as glow lamps of various makes, and finally the Torricellian vacuum. In every case, the vessel could be brought to shine out by friction only, though the first incandescence was sometimes slow in coming. At lower exhaustions, the light consists of a cloud which follows the hand, while at higher vacua a ring of light adheres to the walls and moves with the finger, or a little more slowly. Hydrogen tubes are extremely sensitive, and may be brought to shine out by means of a fine brush. The author supposes that the gas is ionised by the first friction, and is thereafter capable of discharging subsequent charges, the electrons proceeding from the walls and colliding with the positive ions at distances varing with the pressure.

[C. HESS, *Physikalische Zeitschrift*, April 1, 1905.]

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UNSOLVED PROBLEMS IN ELECTRICAL ENGINEERING.

It is probable that no engineer, in delivering the "James Forrest" lecture to the Institution of Civil Engineers, has ever set himself such a difficult task as that which was undertaken by Col. CROMPTON on Monday evening. To enumerate the "unsolved problems in electrical engineering" would alone prove an impossible feat, since many of them are, of course, undreamt of; but even to classify those that are known and to hazard a guess as to the means by which they will eventually be solved would mean a labour of weeks and possibly months. With becoming wisdom and discretion, Col. CROMPTON therefore selected a few of the most prominent, and confined his attention strictly to them. He divided them mainly into two great classes: those set by Nature herself, and those which have appeared in a process of evolution due to the advances made by workers in the sciences of electricity and engineering.

Prominent in the first category comes the phenomenon of lightning discharge, and this the lecturer considered principally with reference to its effect on conductors of electrical energy for lighting and power. In countries where overhead conductors are employed this subject has been well studied and practically investigated; it is of great importance when overhead and underground mains are connected together. But we should like to know something more definite with regard to the evidence that Col. CROMPTON has collected, before we concede the likelihood of frequent cases in which the insulation of purely underground cables has been mysteriously pierced by "static charges due to condenser effects produced on a gigantic scale in the system."

With regard to terrestrial magnetism and magnetic storms, this subject has been so much discussed without having got beyond the hypothesis stage that the lecturer may be forgiven for having dealt so briefly with it. One of the hypotheses he put forward—that the earth may be compared with a self-exciting dynamo—has, at any rate, the merit of originality.

"Etheric" transmission of power is another fascinating subject, in spite of the fact that its application is at present limited to telegraphy. Col. CROMPTON seemed to hold the opinion that no great advances will be made in this direction until it is possible to construct an alternator or some similar machine with a frequency in the neighbourhood of 1,000,000 per second, so as to secure a series of continuous discharges of high power. He mentioned subsequently that Prof. FLEMING had succeeded in reducing the noise of the transmitting spark in wireless telegraphy apparatus by enclosing it in a cast-iron vessel filled with nitrogen or carbon dioxide under pressure.

Then, leaving problems which are still more in the domain of the physicist than in that of the electrical engineer, the lecturer turned his attention to that piece of apparatus which has created a new industry within the last quarter of a century the dynamo. He dealt with one feature of dynamo design only, and called it the problem of the "core and coil," otherwise the field magnet and its winding. His reference to BARRETT'S discovery that the addition of silicon, in suitable proportions, to iron, renders the latter very fusible and free from blow-holes, was put in simple language, and must have impressed the audience with the great importance of this discovery. Further details as to what has beer done towards the development of this process would have been interesting. Referring to Dr. HADFIELD'S aluminium-copper-manganese magnetic alloy, the lecturer threw out the suggestion that this may contain the whole secret of magnetism; if this be so, then no effort should be spared to prosecute research in magnetic alloys, for it is just conceivable that experiment may lead to the discovery of a material possessing a permeability higher even than iron. The result of such a discovery would naturally have very far-reaching effects; although as regards the efficiency of dynamo machines little improvement need be desired, a considerable reduction in the price of motors would have a distinctly stimulating effect on the electrical industry. The winding and insulating problem is hardly less important than that of the iron, and to obtain an impregnating material which will stand much higher temperatures than the customary limit in dynamo-electric machinery may soon no longer be among the "unsolved problems."

High-speed turbo-generators hardly received as much consideration, at the hands of the lecturer, as they deserve. There are many problems connected with them that are still lacking complete solution, and nothing was said of the sparking troubles in continuous-current generators driven at high speeds by steam turbines. The storage problem, needless to say, occupied a considerable portion of Col. CROMPTON'S lecture. He is an ardent believer in electrical storage, and did not disdain to consider how existing methods might be improved in points of detail. We support him most heartily in his condemnation of the troublesome end cells. It is doubtful, however, whether the end cell can be quite abolished. Many accumulator manufacturers with maintenance contracts greatly desire such a consummation, but it is, unfortunately, a fact that several of the smaller stations still regulate with end cells, and still have their forests of copper rod. The suggestion of a combination of the internal-combustion engine with a suction-gas plant worked for long hours, and thereby charging batteries sufficient to deal with the bulk of the load, but supplying the short hours of peak load by steam plant specially designed to work for short hours at a maximum efficiency, is an ingenious one. It is not unreasonable to suppose, however, that such an arrangement would involve rather a heavy capital outlay. On electrically-driven carriages, Col. CROMPTON is, of course, an authority, and he expressed the opinion that has frequently been put forward in these columns—viz., that as far as can be seen at present everything still depends on the lead accumulator and the improvements that can be made in it. Standardisation of batteries and the means of charging them is another point of considerable importance.

With regard to railway problems, most traction engineers will find themselves in agreement with the lecturer's remarks. It is, nevertheless, open to doubt, whether the substitution of an overhead wire for the third rail is "a mere draughtsman's question." It involves more than the supporting of a wire overhead.

Of the rest of Col. CROMPTON'S lecture there is little of great moment. He touched on measuring instruments, electric lamps, heating and cooling by electrical means, and last of all on the development of power schemes. His imaginary picture of "workers carrying on their business at home in a workshop attached to the dwelling-house, and separated from the neighbour by the garden in which the children can grow up under the best conditions of light, air and sunshine," is attractive, but such anticipations of the ultimate result of cheap power distribution are, we fear, Utopian. Decentralisation may be possible in a few particular industries in which the machinery is cheap and foremen are unnecessary. But the present tendency is towards increasing the amount of machinery per man employed, and is thus exactly in the opposite direction to that indicated by Col. CROMPTON. The problem of "sending the population back to the land" is not to be solved by electric power schemes, but by improving our methods of agriculture, and restoring this pursuit to something approximating to its former position among the industries.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign book.)

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The Letter of Petrus Peregrinus on the Magnet, A.D. 1269. Translated by Brother ARNOLD, M.Sc., with Introductory Notice by Brother POTAMIAN, D.Sc., Professor of Physics in Manhattan College, New York. (New York: McGraw Publishing Co.) 1904.

Although many writers of antiquity and in the middle ages touched on the subject of the lodestone, the first treatise devoted to the subject was the "Epistola de Magnete" of Peter Peregrinus, written in 1269 from the trenches before the town of Lucera in Apulia, then under siege. The writer was a soldier of fortune, of Maricourt, in Picardy, well versed in mathematics and scientific lore of his time, a contemporary and acquaintance of Roger Bacon. His letter, written to his patron, Sigerus of Foncaucourt, was copied by numerous hands and distributed over Europe. Some 18 or 20 manuscript versions are extant—three in the Bodleian library at Oxford, one at Trinity College, Dublin, two (one of them of date 1391) in the possession of the writer of this notice, one in the Bibliothèque National in Paris, one in the University of Leyden, and others in Germany and Italy. A version was printed at Augsburg in 1558, and is one of the rarest of early books, since only 13 copies of it are known; all of them save one are in public libraries. There is a copy in the British Museum, another in the Ronalds Library, while a third, formerly belonging to Mr. Latimer Clark, is now in the Wheeler Library of the American Institute of Electrical Engineers. This work, which is a very remarkable one for its time in its experimental knowledge of the lodestone and of the properties of magnets, was known to Gilbert and other writers who quote from it; but otherwise it was almost entirely lost sight of until the end of the eighteenth century. In 1800 Tiberius Cavallo, in the third edition of his treatise on magnetism, gave, in a supplement, a translation in English of a number of passages from the book, which, however, owing to an imperfection of the Leyden manuscript, from which he worked, he ascribed to an imaginary Peter Adsiger. In 1867 Father Timoteo Bertelli, the Barnabite monk of Florence, printed in the Bulletin of Bibliography of Prince Boncompagni a new Latin version, which he had prepared by collating together a copy of the Augsburg edition in the Prince's library with the three manuscript codices in the Vatican; and he enhanced the value of his translation by an elaborate commentary, giving various readings and innumerable references. No complete English translation appeared until in 1903 a privately-printed version by the present writer was issued to a few friends, having been produced by the Chiswick Press in their special Caxton type.

Now, in the present work, English readers are presented with an excellent version from the pen of the accomplished Brother Arnold, accompanied by an interesting introduction by Brother Potamian, otherwise known to English electricians as Dr. M. F. O'Reilly, now of Manhattan College. As the author of another translation it would ill-become the present writer to criticise the good work done by these two able collaborators. They may be congratulated upon the admirable result of their work, which, internally and externally, is most satisfactory. The printing is particularly good, and the type clear and large. The three cuts that appear in the Augsburg edition have been reproduced, and the translators have added also on p. 30 two cuts of modern origin, to show how Peregrinus proposed to pivot his compass needle. It should have been noted that these cuts date only from 1867 and show Father Bertelli's idea as to the construction intended by the description of Peregrinus. The translators have omitted one clause at the end of the fourth sentence of Chapter III. on p. 31, perhaps purposely.

The importance of this early work in its day may be better understood from an analysis of the contents of the letter, as given by Brother Potamian in his introduction. It shows that Peregrinus was the first to assign a definite position to the poles of a lodestone, and to give directions for determining which of them is the north pole. He proved like poles to repel one another, and unlike poles to attract. He showed that small fragments of a magnet are themselves magnets. He observed that a strong magnet may neutralize or even reverse the polarity of a weaker one. He was the first to pivot a magnetized needle, and to put a graduated circle around it—in fact, the first to make a real compass. He added "sights" to the compass to enable positions to be taken by magnetic bearings. Finally he proposed—and this probably made his treatise famous, more than any of his real discoveries—to construct, by the aid of the magnet, a wheel of perpetual motion. It will be noted that as he described his compass in 1269 his work disposes entirely of that fanciful legend cherished in Italy (and consecrated in the Royal Italian Navy by the name given to one of the cruisers) that the compass was "invented" in 1302 by one Flavio Gioia of Amalfi. Indeed, it is known that the name "Flavio" thus attributed to the imaginary inventor of the compass arose from a bungle about the name of the historian Flavius Blondus, who had attributed the invention of the compass to a nameless inventor in Southern Italy. That nameless inventor seems to be without doubt no other than Petrus Peregrinus.

Readers will thank Brother Potamian very warmly for his explanatory notes, of which one characteristic touch is his careful assignment to each of the various discoverers or writers who belonged to the different religious orders his precise denomination. We learn to discriminate between Roger Bacon the Franciscan, Albertus Magnus the Dominican, Cabaeus the Jesuit, Bertelli the Barnabite and Neckham the Augustinian. Such precision speaks volumes for the spirit of care with which the editors have worked. SILVANUS P. THOMPSON.

Recherches Physiques et Physico-Chimiques sur l'Acier au Carbone.

By CARL BENEDICKS. (Uppsala: University Press.)

The burden of this thesis is the existence of "ferronite," a solid solution of β-iron containing 0·27 per cent. of carbon. Ferronite has the same relation to β-iron as "ferrite" has to α-iron. Ferronite is clearly marked off from ferrite by its density, hardness, elasticity and resistivity. It is more easily attacked by micrographic reagents, and can be coloured with tincture of iodine. The author compiles a vast mass of figures to prove that the value of 0·5 per cent. of carbon is a critical value in more senses than has been suspected hitherto. The work of Le Chatelier, of Barrett, Brown, and Hadfield, of Searle, Roberts-Austen, Roozeboom, Preece, Osmond, Guillet, Mathews, Stead, and others furnishes ample material, but it can hardly be said that a comprehensive view has yet been obtained which effectively links these facts together. The author's researches seem to fill this gap in a fruitful and suggestive manner, and even if his conclusions should not all be corroborated, they will furnish a criterion by which future theories may be tested. The chief difficulty lies in the magnetic properties of steel of different compositions. If steels with less than 0·5 per cent. of carbon are made up of β-iron, it must be remembered that the transformation of α-iron into pure β-iron, taking place at the critical interval, is accompanied by the loss of the ferromagnetic properties. This would imply that β-iron is not a ferromagnetic body, and yet these low-carbon steels are strongly magnetic. Against this it is necessary to remember that the only conclusion really vouched for by experiment is that at temperatures above 770deg. β-iron is very feebly magnetic. E. E. F.

L'Année Electrique, Electrothérapique et Radiographique.

By DR. FOVEAU DE COURMELLES. (Paris: Ch. Béranger.) 1905. 3fr. 50c.

This chatty and interesting annual commences with a short description of the chief electrical features of the St. Louis Exhibition, and then the most prominent electrical inventions and discoveries of the year are passed in review. Amongst the new apparatus mentioned is an instrument for measuring the amount of ozone in a gas. It is based on the conversion of ozone to oxygen when passed over certain substances. Electricity, in its thousand-and-one applications, is referred to descriptively and statistically, and especially the medical uses of the electric current are dealt with at length.

SOME TESTS OF TANTALUM LAMPS.[*]

BY A. E. KENNELLY AND S. E. WHITING.

Since tantalum incandescent lamps have so recently been developed commercially, some tests made by the writers upon a few samples of these lamps may be of interest.

A batch of 10 tantalum lamps was received through the courtesy of Mr. Edward D. Adams, who obtained them from Messrs. Siemens & Halske, of Berlin. These lamps were all alike, and of the type shown in recent issues of the *Electrical World and Engineer* (pp. 200 and 379 of the current volume.[†]) All of them had frosted globes and were marked uniformly 110-25, which was interpreted to mean 110 volts and 25 normal horizontal hefners (22 normal horizontal British candle-power).

Figs. 1 and 2 indicate the behaviour of one of these lamps (No. 2) in respect to resistance, current, power, luminous intensity (horizontal candle-power), luminous efficiency and specific consumption (watts per candle). The corresponding data are indicated also, as dotted lines, for a particular Edison carbon filament lamp nominally of 120 volts, 16 c.p., and 3·1 watts per candle, in a frosted globe. This particular lamp was taken at random from a number of similar lamps which had been in service about 50 hours. No attempt is made, therefore, to present an accurate comparison between the tantalum and carbon types of lamps, but only their general relative behaviour. It is possible that if the carbon filament lamp had been specially selected, its behaviour would have been superior. On the other hand, if the tantalum filament lamp had been specially selected from the batch tested, its behaviour also would have been superior. The results given in the curves are to be interpreted, therefore, as showing the qualitative relative behaviour of the two general types of filament, carbon and tantalum.

Resistance.—The carbon filament (Fig. 1) had an initial resistance of about 600 ohms at the normal room temperature and lowest voltage. As the pressure at the terminals was increased this resistance fell very rapidly to a minimum of 288·2 ohms at 75 volts, this value being practically constant from 70 to 90 volts. The resistance then rose very gradually to 293 ohms at 140 volts, the highest pressure employed in the test. This curve is characteristic of the ordinary carbon-deposited filament; that is, the resistance of a carbon filament usually reaches its minimum at a voltage less than the working voltage.

The tantalum filament had an initial resistance of about 55 ohms at the normal room temperature and lowest voltage. It rose rapidly at first, and afterwards more slowly as the terminal voltage increased. The highest resistance observed was 316·8 ohms at 143·3 volts. The resistance was still rising at this point, as shown by the curve. Whereas, therefore, the carbon filament falls, under operation, to about half its cold resistance, the tantalum filament rises, under operation, to about 5¼ times its cold resistance. On this account the initial rush of energy into the tantalum filament must be about ten times as great as in the carbon filament. The time allowed for the tantalum filament to reach its working temperature is, by inference, materially less than for the carbon filament. It would be interesting to investigate, from this standpoint, the possible influence of frequent turning on and off upon the lifetime of the tantalum filament.

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[*] From the *Electrical World* of New York.

[†] See also *The Electrician* of Jan. 27, p. 589.

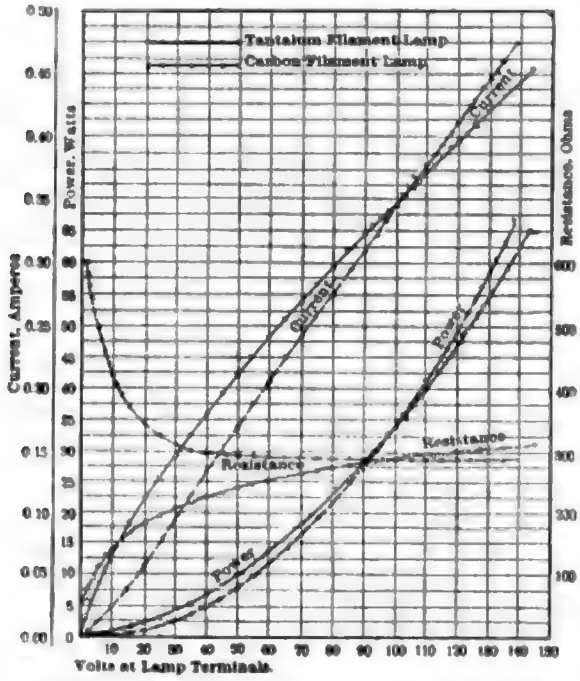

FIG. 1.—ELECTRICAL BEHAVIOUR OF CARBON AND TANTALUM FILAMENT INCANDESCENT LAMPS (FROSTED).

Under operative conditions the carbon filament has sensibly constant resistance for the working range of voltages. The tantalum filament increases in resistance about one-fifth of 1 per cent. per volt increase of terminal pressure, in the neighbourhood of its normal working voltage. On this account, a given percentage increase of voltage on the tantalum lamp will not produce the full corresponding increase in current strength. Thus, an increase of terminal voltage of 5 per cent. would increase the current only about 3¾ per cent. Such a property is valuable, since it tends to regulate automatically the current strength passing through the lamp under variations of line voltage. The effect in these tantalum filaments is not, however, very marked at their normal working point, and not so great as the curve shows it would be at a much lower pressure, say at 20 volts. Here an increase in voltage of 5 per cent. would cause an increase in current of only 2¾ per cent.

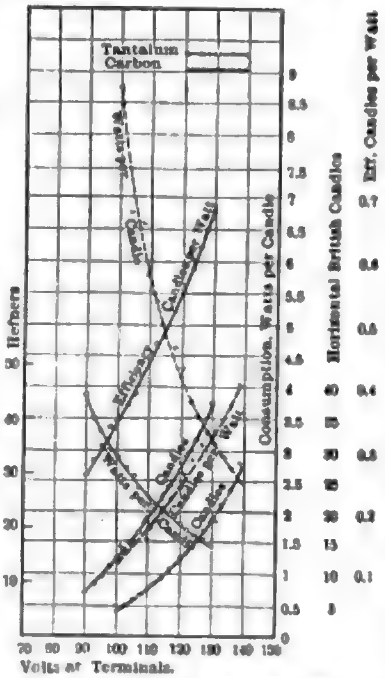

FIG. 2.—LUMINOUS BEHAVIOUR OF TANTALUM AND CARBON FILAMENT LAMPS.

Current Strength.—The curve of current strength in the carbon filament is not far from a straight line through the origin. The corresponding curve in the tantalum filament starts rapidly, but droops considerably, owing to the increase of resistance. The slope of the current is greater finally in the carbon filament than in the tantalum by about one-third. This is due to the self-regulating property referred to under resistance.

Power.—The power in the tantalum filament is decidedly greater, relatively, at low voltages, and less at high voltages, than in the carbon.

Candle-power.—The tantalum lamp became appreciably luminous at a terminal E.M.F. of 9·5 volts, or about 9 per cent. of its normal working voltage. The carbon filament became luminous at 24 volts, or about 20 per cent. of its normal voltage. Thus a tantalum filament will begin to glow at a much lower voltage than the corresponding carbon filament. This may prove a useful property in testing and the like. The curves of Fig. 2 show that the horizontal candle-power of the tantalum lamp is markedly greater than that of the carbon lamp. The luminous efficiency, or candles per watt, of the tantalum lamp is also markedly greater than that of the carbon lamp tested. (It may be noted here that the globes of both lamps were frosted.) Thus at 110 volts the tantalum lamp consumed 2·2 watts per candle, while at 120 volts, the normal for the carbon lamp, the latter consumed 4·3 watts per candle. The normal efficiency of the frosted tantalum lamp was, therefore, nearly double that of the frosted carbon lamp. We have no knowledge as to the relative duration of life for the two types at these efficiencies. A small change of voltage produced a somewhat larger change of the candle-power in the tantalum lamp than in the carbon lamp. Thus an increase of 1 per cent. in normal voltage produced 0·7 candle increase with the tantalum lamp and 0·6 candle with the carbon lamp. The lamps were, therefore, nearly alike in the increase of candle-power for a given small increase in voltage, but, as will be seen from the curves, the relative behaviour in this respect would change appreciably with a shifting of the chosen working voltages. Consequently, not much stress can be laid on this comparison. Since, however, the candle-power of the tantalum lamp was considerably greater than that of the carbon lamp, it is evident that if equal small increase in voltage produces equal increase in candle power, the percentage of increase will be markedly less in the tantalum lamp.

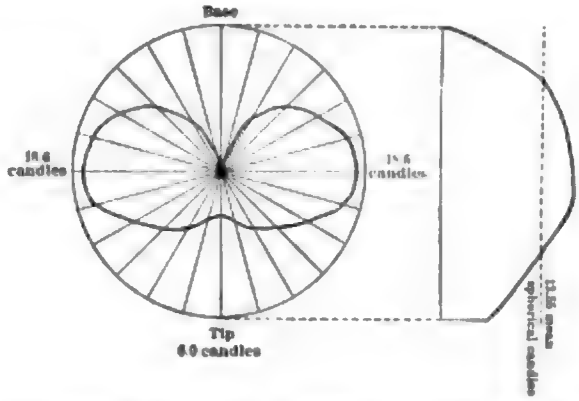

FIG. 3.—LUMINOUS INTENSITY OF TANTALUM LAMP IN VERTICAL CIRCLE AND ROUSSEAU DIAGRAM OF SAME.

Distribution of Light.—With frosted globes the change in horizontal candle-power with change of azimuth was negligible in the tantalum lamp. This would be substantially true in an unfrosted lamp, owing to the cylindrical disposition of the filament. In Fig. 3 is given the observed distribution of tantalum lamp No. 2 in a vertical plane. At the tip the candle-power falls to about 6, the horizontal value being 18·6. The mean spherical candle-power was 13·55, which gives a spherical conversion factor of 0·73. The vertical distribution of the tantalum lamp is nearly the same as that of the common type of carbon filament lamp.

The following table shows a comparison of the 10 tantalum filament lamps in regard to uniformity of candle-power and consumption at the nominal voltage, 110.

Lamp number.	Current, amperes.	Power, watts.	Horizontal candles.	Specific consumption, watts p. candle.
1	0·358	39·35	18·45	2·13
2	0·369	40·56	18·60	2·17
3	0·365	40·20	19·80	2·06
4	0·373	40·98	19·20	2·13
5	0·369	40·56	20·60	1·97
6	0·360	39·68	18·96	2·09
7	0·366	40·30	18·80	2·14
8	0·367	40·40	19·90	2·03
9	0·360	39·55	18·65	2·12
10	0·367	40·32	19·05	2·12
Mean	0·3654	40·19	19·20	2·10

THE ARNHEIM PARTY LINE TELEPHONE SYSTEM

A most ingenious development of the party line telephone system has been worked out by Herr Paul Arnheim, and is now being placed on the market in this country by the Berliner Telephone Mfg. Co. By a party line is meant a telephone line shared by several subscribers, and provision must be made for "selective ringing"—that is to say, for calling up any one of the subscribers without disturbing the others. On the Post Office and National Telephone exchanges in this country this selective ringing is provided for by connecting the subscribers' bells either between the A line and earth or the B line and earth, and by giving the bells a "bias" for positive or negative currents, so that four subscribers may be placed on a party line if necessary without the introduction of a code of ringing signals. This has the disadvantage, however, that any subscriber can cut-in and listen to or take part in the conversation of another subscriber. The main object of the Arnheim system is to remove this defect, without having recourse to the complicated "lock-out" systems which have been tried from time to time in the United States. Another object is to increase the number of instruments which can be connected to a party line.

Each party line terminates at a selector switch, to which all the subscribers' instruments are connected. When one of the subscribers wishes to use the line, he depresses a button and removes his telephone from the hook. This sets the selector switch automatically so as to connect his instrument to the line, and leaves the other subscribers disconnected, and the rising of the button shows him that he is through to the line. The subscriber then rings the exchange. Should any other subscriber try to get in while the first subscriber is still on the circuit, his button does not rise after it has been depressed, showing that the line is engaged. The automatic switch works in such a way, however, that his instrument is connected to the line as soon as the first subscriber clears by hanging up his telephone.

In connection with the instruments at each operator's position at the switchboard is a "selector disc" with a number of finger holes in it, corresponding to the number of subscribers on the party line. To ring up one of the subscribers, the operator, having plugged into the jack in the usual way, places her finger in the hole marked with the subscriber's number, and pulls the disc round. This sends a number of impulses corresponding to this number to the automatic selector switch already referred to, which connects the subscriber in question to the line.

We had an opportunity of inspecting an installation for a 10-subscriber party line this week, and were able to see these successive operations carried out. To give a more detailed account of the system, we add a diagram (Fig. 1) applying to a magneto exchange. It may be mentioned, however, that the system has also been fitted on a central-battery exchange—in fact, one is under trial by the National Telephone Co. at their Holborn exchange, the party line serving some of the offices of the heads of the engineering departments at the company's chief office.

On subscriber 2 depressing the button N (the position of this button is seen at N_1 on the instrument of subscriber 1), and removing his telephone from the hook, he places his own A line to earth through the releasing coil R. At first this coil is not energised as there is a high resistance in circuit, and the button is retained by a clutch. A circuit is formed through the spring at F corresponding to this subscriber's instrument to the bar upon which it rests and thence through the relay R_1 (which has a resistance of 1,000 ohms) to the actual A line and through a pendulum contact and battery at the exchange to earth.

The tongue of the relay oscillates backwards and forwards, and a current impulse is sent from the local battery LB through the step-by-step electromagnet H. This moves the ratchet Z, causing the arm K to travel over the spring contacts above it. As it moves along, it disconnects the subscriber's line springs one by one from the common bar, and as soon as it reaches the spring corresponding to the subscriber who is called, it breaks the coil-circuit of the relay R_1. As this relay is no longer operated, the arm cannot travel any further and stops at this position, connecting both the A and B line to the corresponding lines leading to the subscriber's instrument. The B line is connected through a condenser C. As the A line is now connected direct to the subscriber's line, instead of through the resistance of the relay R_1, sufficient current flows

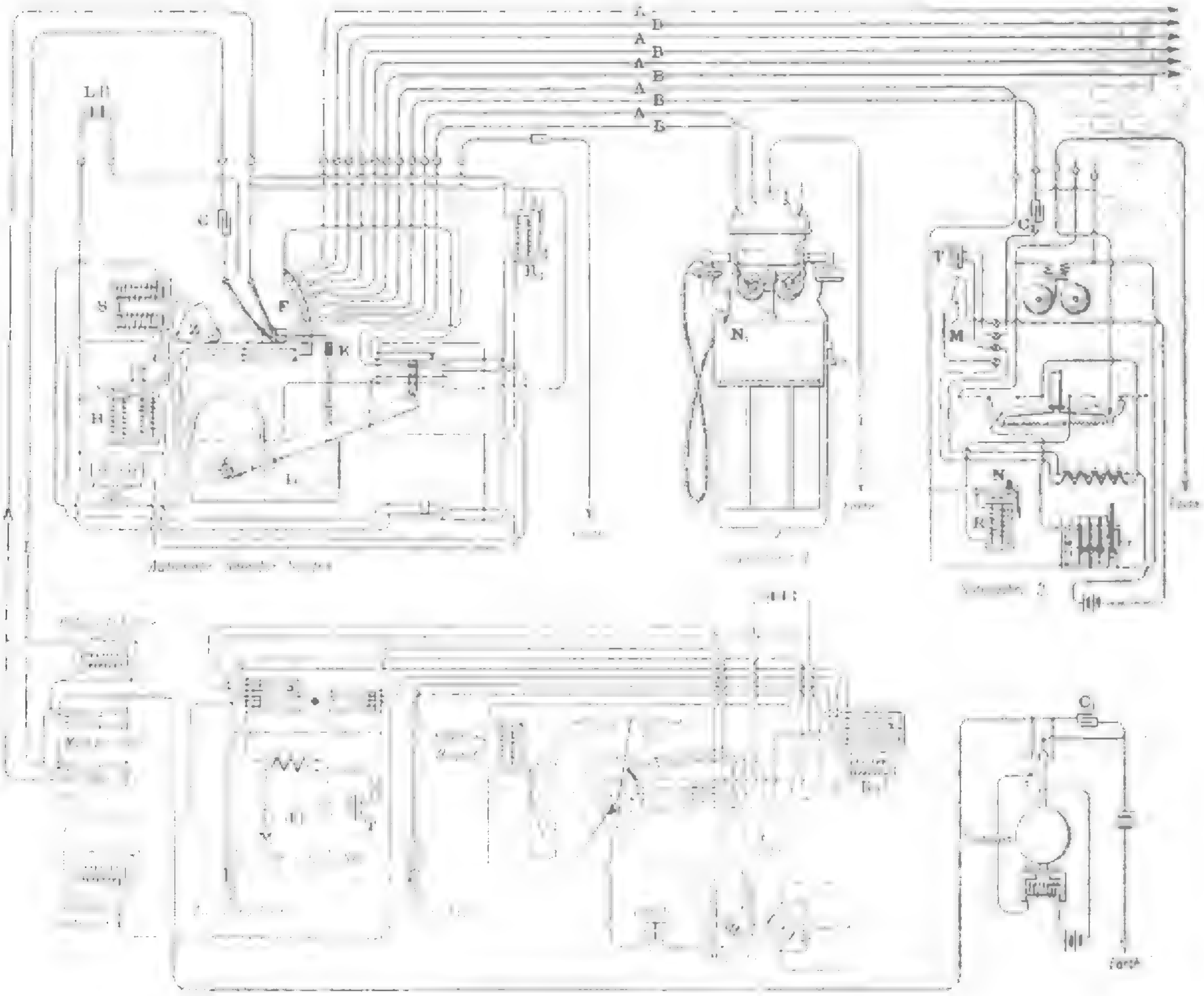

FIG. 1.—DIAGRAM OF CONNECTIONS.

through the releasing coil R in the subscriber's instrument to release the button N, and the earth connection is, at the same time, removed from the loop. The subscriber now is connected to the exchange, and his ringing current passes through the indicator which is bridged across the A and B lines. As soon as the operator plugs into the jack she cuts off, not only the calling indicator, but also the pendulum circuit.

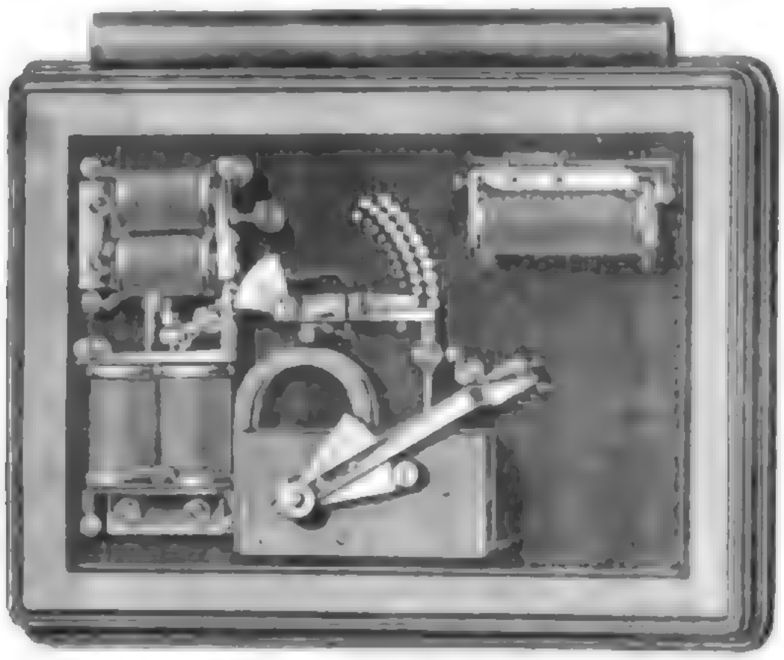

Fig. 2.—Automatic Selector Switch.

It should have been mentioned that, as soon as the lever K starts moving, the arm of a second mechanism, L, is released and drops slowly, opening the contacts seen above it, one of which is included in the circuit of the relay R_1. At the end of its travel (which occupies 50 seconds) the lever L closes the two contacts below it. If now another subscriber plugs in, nothing further happens after he presses his button N, for the circuit of the relay R_1 is open on these upper contacts. When the subscriber has finished speaking, he hangs up his receiver, and the bell coil is placed across the line. This closes the circuit through the A line to the relay R_1, and thence through the bottom contact closed by the lever L through the local battery LB and back to the B line at the selector switch. The secondary contact of this relay now closes the circuit of the releasing electromagnet S, which allows the ratchet Z to fall back to its initial position; and when the arm drops the circuit of the coil L is also closed so that the arm of this mechanism is raised to its normal position. When the arm has risen to its top position and is locked there, it opens the circuit of its own coil by means of the contact immediately above it. Everything is thus restored to its normal position.

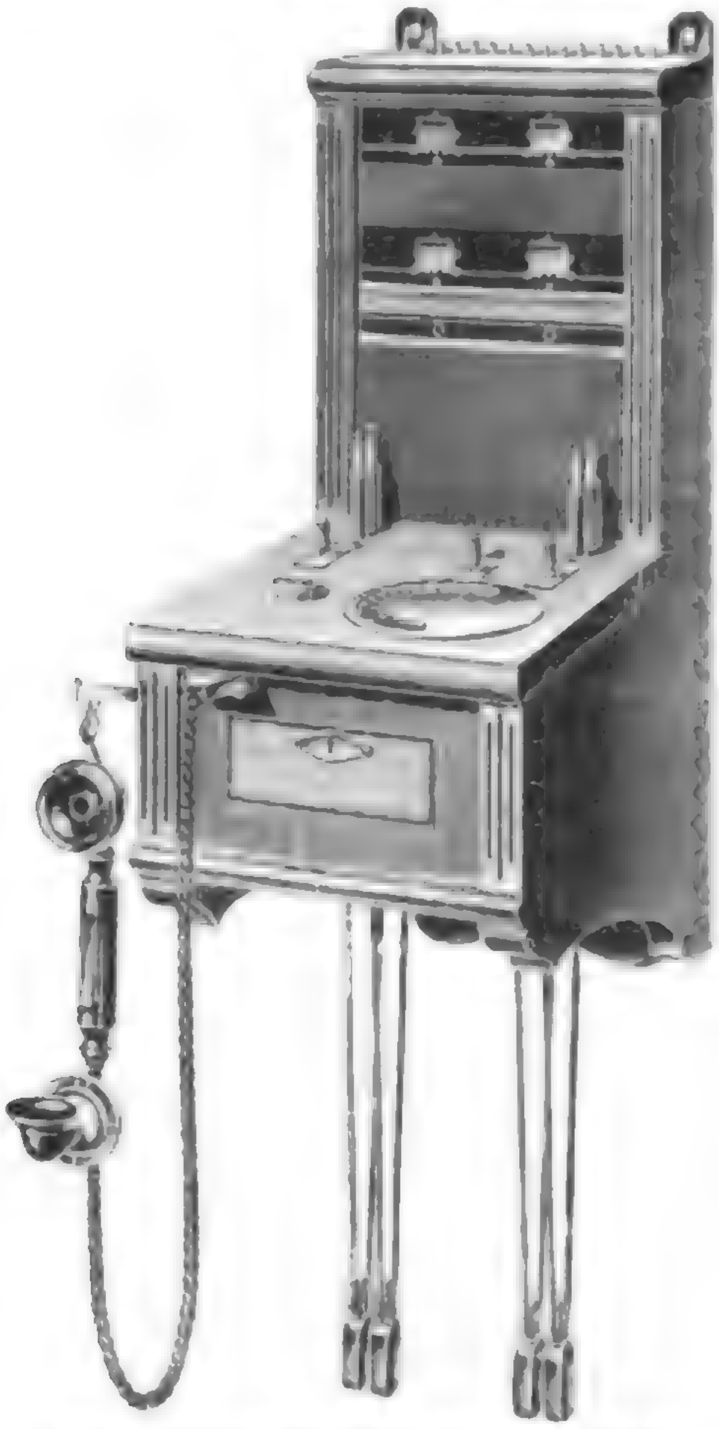

Fig. 3.—Small Exchange for Four Lines.

A point worthy of notice is the introduction of "polarised cells" with aluminium electrodes to take the induction current on breaking the inductive circuits in connection with the local battery, and so diminishing the report heard in receiver.

We have now to consider the process of calling up one of the subscribers from the exchange. The jack of the subscriber being plugged with the calling plug in the usual way, the operator pulls over the disc selector as already explained, and then momentarily presses to the left the ringing key seen above the operator's set in Fig. 1. The disc selector stays in position until the ringing key is pressed. The circuit of the retaining coil R_2 is then closed through the battery B and the releasing magnet, and as the disc flies back it closes a succession of contacts, sending impulses from the magneto over the A line through the coil R_1 controlling the automatic switch. The arm of the switch is therefore moved up to the position corresponding to the number of the subscriber wanted, and at the same time the arm of L starts travelling downwards. As soon as the selector switch makes contact with the subscriber's instrument, the disc sector, just before reaching its zero position, sends a ringing current from the magneto through the loop for a few seconds. A vibrator at the operator's position shows that the bell is ringing. If the subscriber does not answer, the operator can ring again with her ordinary ringing key. As it takes 50 seconds for the arm of the lever L to drop, after this period has expired she no longer rings the subscriber unless she turns the selector disc again. The period of 50 seconds is selected to give the subscriber time to answer the call.

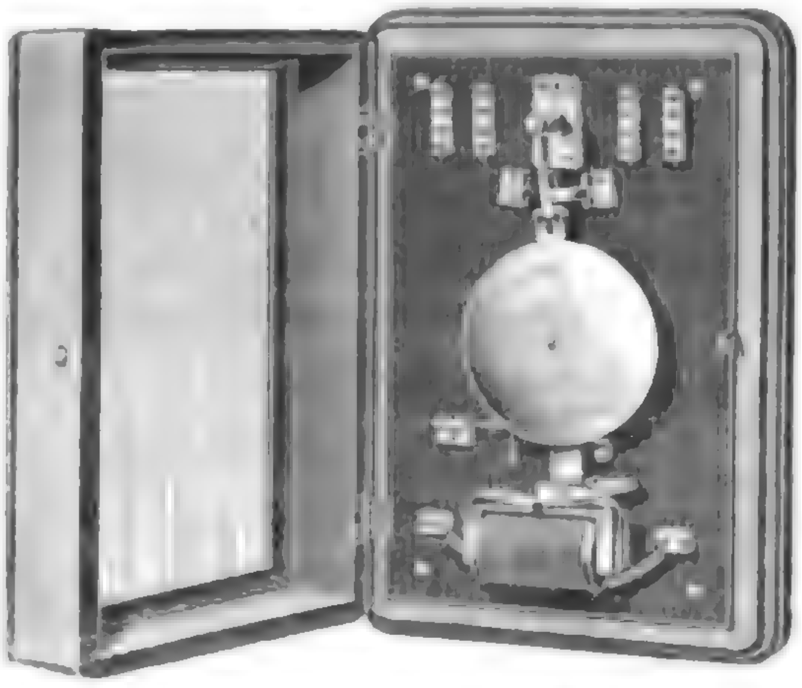

Fig. 4.—Electrically-controlled Pendulum

Fig. 2 shows the automatic selector switch, the relative positions of the various parts being the same as shown in Fig. 1. Fig. 3 is a small exchange for four lines, and shows the relative size of the selector disc, and Fig. 5 is the pendulum for sending the impulses to the selector switch when the subscriber is calling. This pendulum is electrically driven, the contacts being so arranged that the driving magnet is excited whenever the oscillations of the pendulum decrease in amplitude below a certain point.

Our thanks are due to Herr. Arnheim and the staff of the Berliner Telephone Mfg. Co. for enabling us to inspect every detail of the system, and for placing all information at our disposal in order that our description might be as complete as possible.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Experimental Researches on the Flow of Steam through Nozzles and Orifices." By A. Rateau. Translated by H. Boyd Brydon. (London: Archibald Constable & Co.) 4s. 6d.

"Modern Iron Foundry Practice." Part II. By G. R. Bale. (Manchester: Technical Publishing Co.) 3s. 6d.

"Structural Designers' Handbook." By W. F. Fry. (New York: "Engineering News" Publishing Co.) $2.

"Proceedings of the American Institute of Electrical Engineers." March, 1905. (New York: The Institute.) 50c.

"Notions d'Électricité: son Utilisation dans l'Industrie." By Jacques Guillaume. (Paris: Gauthier Villars.) 7f. 50c.

PARLIAMENTARY INTELLIGENCE.

SUPPLY OF ELECTRICITY BILL.

The following is the text of the Bill, referred to last week as being introduced into the House of Commons by Mr. Bonar Law, to amend the Acts relating to electric lighting:—

Reference is made to this Bill in our Editorial Columns.

1. *Compulsory Acquisition of Land for Generating Stations.*—(1) The Board of Trade may by provisional order authorise any local authority, company or person, who are authorised by the same or any previous provisional order or by Act of Parliament to supply electricity in any area, to acquire compulsorily or to use for the purpose of a generating station any land specified in the order, whether situated within or without the area of supply, and in the case of a local authority, whether situated within or without their district.

(2) For the purpose of the acquisition of land authorised to be taken compulsorily under any such provisional order, the provisions of the Lands Clauses Act which relate to the purchase and taking of lands otherwise than by agreement, and to the entry upon lands by the promoters of the undertaking, are, subject to the modifications set out in the schedule to this act, incorporated with the Electric Lighting Acts, as well as the provisions of those acts already so incorporated by the Electric Lighting Act, 1882.

(3) Rules made by the Board of Trade under sec. 5 of the Electric Lighting Act, 1882, shall provide for proper notice being given of an application for a provisional order by which it is proposed to acquire compulsorily, or use land for the purpose of a generating station, to owners, lessees, and occupiers of land, and also for public notice being given of the proposal by advertisement.

(4) The incorporation of the provisions contained in the schedule to the Electric Lighting (Clauses) Act, 1899, with a provisional order authorising the compulsory acquisition or use of land specified in the order for the purpose of a generating station shall not have the effect of incorporating section 81 of that schedule with so much of that order as authorises such acquisition or use.

2. *Breaking up Streets, &c., outside Area of Supply.*—For the purpose of enabling electricity to be brought into an area of supply from a generating station situated outside that area, the Board of Trade may by provisional order apply to any roads, railways or tramways situated outside that area, the provisions of the Electric Lighting Acts which authorise, or enable the Board of Trade to authorise, the breaking up of any road, railway or tramway, so far as those provisions do not already so apply.

3. *Supply in Bulk.*—The Board of Trade, unless they are of opinion that, by reason of the character or magnitude of the proposed undertaking, the matter ought to be dealt with by private bill, may, by provisional order—

(a) Authorise any company or person to supply electricity in bulk to any local authority, company or person authorised to supply electricity in any area for the purpose of distribution by that local authority, company or person within that area; and

(b) Provide for any supply so authorised being compulsory; and

(c) Define what are to be the limits of supply for the purpose of the provisions of the Gasworks Clauses Act, 1847, incorporated in the Electric Lighting Act, 1882, in the case of a company or person so supplying electricity in bulk; and

(d) Make such other provisions as appear to them necessary for adapting the Electric Lighting Acts to any case where a company or person are authorised to supply electricity in bulk in any area; and

(e) Authorise any local authority to supply electricity in bulk to any other local authority.

4. *Provisions as to Right of Local Authority to Purchase.*—(1) The Board of Trade may by a provisional order authorising a company or person to supply electricity in bulk only exclude the application of the power of purchase given by sec. 2 of the Electric Lighting Act, 1888, as respects the whole or any part of the undertaking authorised by the order, but before doing so shall cause notice to be given to any local authorities who would have the right to purchase under the said section, and shall consider any objection made by any of those authorities.

(2) Where any generating station, mains, or other works of a company used solely for supplying electricity within the district of a local authority are situated outside the district of that local authority, the generating station, mains, and other works so used shall for the purposes of the provisions of the Electric Lighting Acts and any provisional order conferring on local authorities power to purchase undertakings, be deemed to be situated within the district of that local authority, and where any generating station, mains, and other works are used solely for supplying electricity within the districts of two or more local authorities, but are not situated within any of those districts, the Board of Trade may, on the application of all or any of those authorities by provisional order make such adaptations in the provision as the circumstances of the case may require: provided that this sub-section shall not, without the consent of the company to which they belong, apply to any generating station, mains, or other works authorised by a special Act before the passing of this Act.

(3) Any local authority having power under the Electric Lighting Acts or any provisional order to purchase so much of the undertaking of a company as is within the district of that local authority may, with the consent of and upon such terms and conditions as may be approved by the Board of Trade, and with the consent of the company, transfer their rights of purchase to any other local authority having power to purchase so much of the same undertaking as is within the district of that last-mentioned local authority, and the deed of transfer may contain such consequential provisions as may be necessary for giving effect to the transfer.

5. *Exercise of Electric Lighting Powers by Authorities Jointly.*—The Board of Trade may, with the concurrence of the Local Government Board, by provisional order make such provisions as appear to them necessary or expedient, by the constitution of a joint committee or joint board or otherwise, for the joint exercise of the powers under the Electric Lighting Acts, or this act, or any provisional order, by two or more local authorities as respects any area of supply consisting of the whole or parts of the districts of those authorities, in any case where it appears to them that the joint exercise of those powers would be expedient, and any such provisional order may contain such provisions as may appear necessary or proper for adapting any of the provisions of the Electric Lighting Acts, or this act, or any such provisional order, to the case of any committee or board so constituted.

6. *Provision as to Consents of Local Authorities to Grant of Provisional Order.*—(1) The Board of Trade shall, on considering whether any provisional order should or should not be granted, take into consideration the views of the local authorities affected on the subject, but whether the consent of any local authority is or is not given, may, notwithstanding anything in section 1 of the Electric Lighting Act, 1888, grant the order or not at their discretion.

Provided that—

(a) This sub-section shall not apply to any provisional order authorising a company or person to supply electricity so far as the order relates to any district in which the local authority is authorised to supply electricity; and

(b) A provisional order authorising the breaking up of roads outside the area of supply, shall not be granted by the Board of Trade except with the consent of the local authority in whose district the road is situate, unless the Board of Trade, in any case in which the consent of any such local authority is refused, are of opinion that, having regard to all the circumstances of the case, such consent ought to be dispensed with, and in that case they shall make a special report, stating the grounds upon which they have dispensed with such consent.

(2) The notice required by sec. 4 of the Electric Lighting Act, 1882, to be given to a local authority on or before the first day of July, need not be given to the local authority of a district in which it is not intended to take power to distribute electricity.

7. *Revision of Maximum Price.*—(1) With a view to making five years the ordinary period of revision of maximum price and allowing representations as to revision to be made by consumers, sub-sec. 2 of sec. 32 of the schedule to the Electric Lighting (Clauses) Act, 1899, shall for the purpose of incorporation with any act or order passed or confirmed after the passing of this act, be read as if the words "five years" were substituted for the words "seven years," and the words "or such number of consumers not less than 20, as the Board of Trade consider sufficient, having regard to the population of the area of supply" were inserted after the words "either the local authority or the undertakers."

(2) Where any act or provisional order passed or confirmed before the commencement of this act enables the Board of Trade to revise or vary any maximum prices to be charged for electricity, that act or order shall be construed—

(a) So as to enable the revision or variation to take place at an interval of five years after the commencement of the act or order, or the last revision, in cases where a longer interval is fixed by the act or order; and

(b) So as to enable the power of revision or variation to be exercised on the representation of such number of consumers, not less than 20, as the Board of Trade consider sufficient, having regard to the population of the area of supply, in cases where the power cannot under the act or order be exercised on such a representation or the representation of a less number of consumers.

8. *Certification of Meters.*—(1) For the purpose of incorporation with any act or order passed or confirmed after the commencement of this act—

(a) Sec. 49 of the schedule to the Electric Lighting (Clauses) Act, 1899 (which relates to meters), shall be read as if the words "and fixed and connected with the service lines in some manner approved by the Board of Trade" were added at the end of the section;

(b) Sec. 50 of the same schedule (which relates to the certification of meters) shall be read as if the words "and to have been fixed and to have been connected with the service lines in some manner," and the words "or where any such meter is unfixed or disconnected from the service lines," were omitted therefrom; and

(c) The same section shall be read as if for the words "to be a correct meter" there were substituted the words "to be a meter capable of ascertaining the value of the supply within such limits of error as may, as respects meters of the class to which the meter belongs, be allowed by the Board of Trade," and

(d) Section 51 of the same schedule (which requires inspectors to certify meters) shall be read as if at the end there were added, "and the inspector shall, on the like requisition and payment, examine the manner in which any such meter has been fixed and connected with the service lines, and shall certify that it has been fixed and connected with the service lines in some manner approved by the Board of Trade, if he considers that it is entitled to be so certified."

(2) So much of any act or provisional order relating to the supply of electricity passed or confirmed before the commencement of this act as requires that in order that a meter may be considered to be duly certified it must be certified to have been fixed and to have been connected with the service lines in some manner approved by the Board of Trade, shall cease to have effect, but every duly certified meter must be fixed and connected with the service lines in some manner approved by the Board of Trade, and an electrical inspector, on being required to do so by the undertakers or by any consumer, and on payment of the prescribed fee (

the party so requiring him, shall examine the manner in which any meter has been fixed and connected with the service lines, and shall certify that the meter has been fixed and connected with the service lines in some manner approved by the Board of Trade, if he considers it to be entitled to be so certified.

(3) A meter shall be certified to be a correct meter within the meaning of any act or provisional order relating to the supply of electricity passed or confirmed before the commencement of this act if it is capable of ascertaining the value of the supply within such limits of error as may, as respects meters of the class to which the meter belongs, be allowed by the Board of Trade.

9. *Accounts of Local Authorities.* For the purposes of sec. 9 of the Electric Lighting Act, 1882, the accounts of any undertakers being a local authority shall be made up to the thirty-first day of March in each year, and accordingly as respects those accounts the thirtieth day of June shall be substituted in that section for the twenty-fifth day of March, and the thirty-first day of March for the thirty-first day of December; provided that if any such undertakers show to the Board of Trade that some other dates are, owing to special circumstances, more convenient in their case than the thirty-first day of March and the thirtieth day of June, the Board of Trade may substitute such other dates for the said thirty-first day of March and thirtieth day of June, and this section shall as respects those undertakers be construed with the substituted dates.

10. *Supply of Electricity to Premises having Separate Supply.*—Notwithstanding anything in the Electric Lighting Acts or in any Act of Parliament or provisional order authorising an undertaking, a person shall not be entitled to demand or to continue to receive from undertakers authorised to supply electricity in any area a supply of electricity for any premises having a separate supply, unless he has agreed with the undertakers to pay to them such minimum annual sum as will give them a reasonable return on the capital expenditure, and will cover other standing charges, incurred by them, in order to meet the possible maximum demand for those premises; the sum to be so paid shall be determined in default of agreement by arbitration under the Electric Lighting Act, 1882.

11. *Provisions as to Association of Undertakers.*—So much of any provisional order or special Act, or of the Schedule to the Electric Lighting Clauses Act, 1899, as incorporated with any such order or Act, as prohibits undertakers from associating themselves with any company or person for supplying energy under any licence, provisional order, or special Act unless the undertakers are authorised by Parliament to do so shall not be construed as prohibiting the undertakers from giving or taking a supply in bulk to or from any such company or person.

12. *For Protection of Gas Undertakers.*—Nothing in this Act shall enable the Board of Trade by provisional order to authorise the compulsory acquisition of any land which, at the date of the first publication of the notice for the order, belongs to any gas undertakers and is used or authorised to be used by them for the purposes of their undertaking.

13. *Definitions.*—In this act, unless the context otherwise requires—

The expression "provisional order" means a provisional order under the Electric Lighting Acts.

The expression "Electric Lighting Acts" means—

(a) As respects England and Ireland, the Electric Lighting Acts, 1882 and 1888; and

(b) As respects Scotland, the Electric Lighting Acts, 1882 and 1888, the Electric Lighting (Scotland) Act, 1890, and the Electric Lighting (Scotland) Act, 1902.

The expression "authorised" means authorised by Act of Parliament or provisional order.

The expression "area of supply" means any area within which any local authority, company or person are authorised to supply electricity under the Electric Lighting Acts.

The expression "road" includes any street as defined by the Electric Lighting Act, 1882.

The expression "generating station" includes any station or works for generating, transforming, converting, or distributing electricity, and all machinery and appliances ordinarily used in connection therewith.

14. *Application of Act to Scotland and Ireland.*—(1) In the application of this act to Scotland the Secretary for Scotland shall be substituted for the Local Government Board as respects provisional orders relating to Scottish local authorities, and the fifteenth day of May shall be substituted for the thirty-first day of March, and the first day of August shall be substituted for the thirtieth day of June.

(2) In the application of this act to Ireland the Local Government Board for Ireland shall be substituted for the Local Government Board as respects provisional orders relating to Irish local authorities.

15. *Short Title and Construction.*—(1) This act may be cited as the Electric Lighting Act, 1905.

(2) This act and the Electric Lighting Acts shall be construed together as one act and may be cited as the Electric Lighting Acts, 1882 to 1905.

SCHEDULE.

Modifications of the Lands Clauses Acts.—The following modifications shall have effect in the construction of the provisions of the Lands Clauses Acts incorporated by this act for the purposes of the Electric Lighting Acts:

(a) The expression "special act" means the Electric Lighting Acts, inclusive of any provisional order authorising the compulsory acquisition of land, except that the period of three years mentioned in sec. 123 of the Lands Clauses Consolidation Act, 1845, shall be calculated from the passing of the act confirming the provisional order; and

(b) The expressions "the promoters" and "the undertaking" mean respectively the undertakers and the undertaking under the Electric Lighting Acts; and

(c) The expression "land" includes easements in or relating to land.

LONDON ELECTRIC POWER BILLS.

Friday, April 7.

The consideration of the Administrative County of London & District Electric Power Bill was continued by Earl Camperdown's Committee.

At the commencement, the Hon. J. D. Fitzgerald, K.C., handed in a large table giving particulars of all the electrical undertakings in the area of the bill, compiled from the published accounts.

Mr. C. P. SPARKS, chief engineer to the County of London Electric Supply Co., continued his evidence in favour of that company's petition against the bill. On the question of works costs, he said that, taking the north and south stations of the company as one undertaking, the works costs in 1900 were 1·454d. per unit delivered to the mains. In 1904 this had fallen to 0·718d., for the March quarter this year it had dropped to less than 6d. and was now 0·537d. The load factor now was 13·6 per cent. The percentage of the total units sold which were used for power purposes, in 1900, was 16 per cent., in 1901 it was 20 per cent., 1902 25 per cent., 1903 30 per cent., and 1904 32 per cent. Within the next few years he anticipated that this would be 50 per cent. The County of London Co. had now some 1,500kw Curtis turbine generating sets, on order which would have an overload capacity of 50 per cent. These extensions worked out at a capital cost of between £12 and £13 per kilowatt. For the machines alone, if they were reckoned on 50 per cent overload, the capital cost would be £4 per kilowatt, and at 100 per cent. overload it would be £3. 10s. per kilowatt. Concerning the advantages claimed for the large Parsons turbines proposed, he said that Mr. Parsons had stated that with 200deg. superheat of steam it would take 13lb. of water to secure a kilowatt. The Curtis turbines above referred to would require 15lb., but owing to the greater ease of starting up and working, this advantage to the Parsons large turbine sets would disappear. By 1910 he anticipated the load factor of the County of London Co. would be 43 per cent., and that 75 per cent. of the present steam power in his area would be driven by electricity supplied from his stations.

Cross-examined by the Hon. J. D. FITZGERALD: With regard to the compulsion to supply, the facts were that any two consumers within 50dys. of a distributing main could demand a supply by paying for any connecting main over 60ft. long, and entering into a contract for two years to guarantee an annual consumption of electrical energy amounting to at least 20 per cent. of the cost of the 20yds of service line. But the company got no return for the large expenditure which was often necessary to reinforce the distributing mains up to the point where the consumer's cable connected up. This might be even £1,000. These conditions applied outside the compulsory area; inside the compulsory area, everyone could demand a supply, because the undertakers were bound to lay mains throughout the compulsory area. His total revenue last year was £122,131, and for power purposes £19,861. The average size of the power consumer was 7·5 H.P., and the average receipt per unit for power supply was 2d. A large number of the very small power consumers paid 2¼d. per unit. The scale of charges for power purposes started at 2¼d. In a small portion of the northern area there was no competition, and it was not to his knowledge that a higher price was charged in the area where there was competition, than in the area where there was no competition. The lowest actual price at which the company charged for power purposes was ¾d. for a mill which had a load-factor of between 70 and 80 per cent.

Mr. FITZGERALD said that the lowest price under this bill, under the same conditions, would be 0·367d. per unit, and that therefore that particular consumer would save about £300 per annum on these terms.

Continued cross-examination: Witness said until he heard it stated by the witnesses for the promoters, he had no knowledge that some of his consumers had left his mains to put up their own gas engines. He could not make out what the maximum charge under the bill was, because it was so hedged round with conditions.

Re-examined by Mr. BALFOUR BROWNE: The compulsory area in all Provisional Orders usually included the worst streets in the area, because the Board of Trade knew the undertakers would go to the best streets. His company had never enforced the 20 per cent. guarantee outside the compulsory area. It was the practice to forego this guarantee.

Mr. H. B. RENWICK, secretary to the County of London Electric Supply Co., said the share capital of the company was £1,100,000, and the capital expended £1,250,000. The borrowing powers were £800,000. On the question of canvassing, he believed the County of London Co. had the largest canvassing department of any electric supply authority in the country, and as a further means of inducement to possible consumers they had recently held an exhibition in Holborn.

[Counsel at this point said he would shorten this part of the evidence as much as possible.]

The CHAIRMAN: Oh, no. Mr. Merz stated very positively that the existing authorities had not pushed the business.

Mr. RENWICK having shown one of a large pile of books, containing his canvassers' reports, to the Committee,

The CHAIRMAN said it seemed to show that a great deal of canvassing had taken place.

Mr. FITZGERALD said the statement of Mr. Merz was a general one, but after Mr. Renwick's evidence he certainly did not think it applied to the County of London Co.

Mr. BALFOUR BROWNE then addressed the Committee on behalf of the County of London Co., his speech concluding the case in opposition to the bill. He said that one of the worst features of such long inquiries was that there was a strong possibility of too much detail being introduced, but he would avoid this in his remarks. This bill sinned against the whole of the past legislation regarding electric supply in London. The whole of the companies had met every possible demand, and under similar conditions, and with as good a load, the companies could do everything that the new company proposed. They were certainly in a far better position to supply for power than the promoters, because a large proportion of the expenditure to date had been for distribution mains. Competition in anything should be fair, but the proposed competition was not fair. The promoters had done their best to lead the Committee to believe that they were to be bound to supply everybody in the huge area scheduled at least at the maximum prices in the bill, but this was not the case. He was not blaming the promoters for demanding guarantees, but he did complain against the endeavour to create a false impression as to the terms of the bill. Take a consumer in the west end of the area; it would be impossible that they would lay a main there for nothing, and supply at the maximum prices in the bill. The consumer was not bound to take any particular quantity of energy, but he was bound to enter into an agreement, and any disagreement as to the terms was to go to arbitration. That was as he read the bill, but the promoters all through these proceedings had been blowing hot and cold, and pretended that they were bound to supply. Neither did the bill compel the extension of the mains to supply authorised distributors. A guarantee of seven years was wanted not merely upon the cost of the main, but also upon the cost of any new works necessitated in the generating station. The bill also sought a concession in perpetuity; therefore no sinking fund would be necessary, as was the case with the present companies. Thus, he contended, unfair competition would take place. Another point was that the existing companies were prevented from combining with one another. This had been the principle of the whole of the legislation, but the promoters were a huge combine to start with. If Parliament passed this bill it would be in breach of a Parliamentary bargain under which the London companies held their Provisional Orders to-day, a bargain solemnly entered into, carefully considered and ratified by Parliament. In 1882 the first Electric Lighting Act was passed, under which all companies were liable to purchase by the local authorities at the end of 21 years with some allowance for goodwill. This term was not sufficiently long to induce the public to invest money in electrical undertakings, and in 1888 an amended bill was introduced to extend the period of purchase to 42 years, and, in order to ensure the measure being passed, the companies agreed that the reference to compensation for goodwill should be omitted, although at least one member of the Government was of the opinion that it should not be deleted. Therefore, a Parliamentary bargain had been entered into which had been carried out ever since. Was this bargain to be broken because a number of gentlemen from the North came and said they would supply cheaper than the present companies? No. Good faith ought to be taken into account; cheapness was not everything. After the passing of the 1888 Act an inquiry was held by Major Marindin, who laid down the principle in his report that no two companies supplying the same kind of current should compete. At the time there was a great difficulty in using alternating current for power purposes, and the decision was that wherever competition was allowed it should be as between companies supplying alternating current on the one hand and continuous current on the other hand. This had been the whole principle of the competition allowed by the Board of Trade ever since, and the whole of London had been "districted" on these terms. Of course, nowadays, there was competition between two companies supplying continuous current, but this had arisen since, because the company that had originally supplied alternating had changed to continuous current. Further, what competition was allowed was between holders of Provisional Orders working under similar conditions. The clause in the Orders that there should be no combination was a suggestion of the County Council in return for an extension of the period of purchase, and there being no competition. Therefore, there was no precedent for the proposal of the promoters. The power bills outside London were in a different position altogether. Not one of them had any bearing upon companies whatever. There was no case in which a power company had obtained competitive powers against an electric lighting company. The distinction between the London companies and the local authorities was, that the latter were not liable to purchase. Further, it never was intended that a local authority should supply power; this was a matter for private enterprise, and therefore the fact that several local authorities had been included in some of the other power bills did not affect his argument. It was quite natural that traders should not wish to take power from a local authority in order to help reduce the price of the lighting. Parliament had apparently taken that view, and included some local authorities in power bills.

The CHAIRMAN: Then you do not see any objection to the promoters going into the districts of the local authorities?

Mr. BALFOUR BROWNE: The local authorities must look after themselves. They have a concession in perpetuity, whereas we have to be bought out in 42 years. The ultimate effect of the promoters' scheme would be that they would have to buy up some of the supply companies, and the result would eventually be one huge combine, having an absolute monopoly and thus crushing all possibility of competition. No case had been made of public interest or public necessity, and he asked that the bill should not be allowed to proceed.

The Hon. J. D. FITZGERALD then commenced his reply on behalf of the promoters of the bill. He said that the proposals of the bill were the only proper way of dealing with the supply of electricity to the County of London and adjoining districts. Only by some such methods as those would it be possible to ensure to the consumers of electricity in London that cheap supply of electric power which was necessary to enable manufacturers to be put on a par with their rivals, whether in the country or abroad. Notwithstanding the size of London, electricity was dearer there than in almost any large town in the United Kingdom. Dealing first with the criticism with regard to the framework of the bill, Mr. Neville he said had argued that it was wholly unreasonable and that its provisions were wholly illusory, whilst Mr. Balfour Browne did not think so; in fact, he thought they were reasonable, because he was promoting a bill with precisely the same conditions in it as were in the Administrative Bill. Mr. Neville had approached the bill as if the provisions of it were entirely novel, and that they had a total disregard of all the Parliamentary history of power bills. But the provisions of the bill had not been devised by the promoters for the purpose of putting before the Committee a "sham" case, as had been suggested. The provisions were those which had been framed with the greatest care by Sir James Kitson's Committee, which was specially appointed for the purpose, after consultation with the Board of Trade; they had been approved by the House of Lords, and had since been followed in every case in which a power bill had been passed. Sub-sec. 3, clause 48 of the bill dealt with the supply of energy within the area of an authorised undertaker. It read as follows:—

Energy shall not be supplied under this act by the company except to authorised undertakers or to the proprietors or trustees of any railway, tramway or waterworks or of any dock, canal or navigation or any Government department) in any area being at the passing of this act the area of supply of any authorised distributors, except with the consent of those distributors, but that consent shall not be unreasonably withheld. If any question arises whether that consent is unreasonably withheld, that question shall be determined by the Board of Trade. The consent shall be deemed to be unreasonably withheld if the authorised distributors are not willing and in a position to give the requisite supply upon reasonable terms and within a reasonable time, and in considering what are reasonable terms and what is a reasonable time, the Board of Trade shall, amongst other things, have regard to the terms upon which, and the time within which, the company are willing and in a position to give the supply.

The criticism which had been directed against this clause was that it was no protection to the authorised undertakers because the Board of Trade was directed to consider what the terms were upon which the company was willing to supply, and that a price of £1. might be suggested in order to get into the district. This was nothing of the sort. The Board of Trade would take into consideration all the circumstances of the case, and if the price was obviously unremunerative to the company and was only made for the purpose of getting into a district, it would be perfectly open for the Board of Trade to refuse to consent for that reason. Criticisms of this kind had been made in the Somerset Bill in connection with Bath, and after communication with the Board of Trade, the Chairman of the Committee suggested that the following clause should be inserted to meet this very point:—

"In dispensing with any consent under this section, the Board of Trade may impose upon the company such terms and conditions as they may think necessary for the protection of authorised distributors, and such terms and conditions may at any time be enforced by the authorised distributors in a Court of competent jurisdiction."

This clause was not included in the Somerset Bill, but he was willing to embody it in this bill if the Committee thought it necessary.

The CHAIRMAN, referring to the words "shall amongst other things have regard to the terms upon which and the time within which the company are willing," in clause 48, sub-sec. 3, of the present bill (quoted above), asked if a judge would not give prominence in the first instance to those two contentions.

Mr. FITZGERALD: He would have to have regard to those two contentions, but he can equally have regard to every other contention.

The CHAIRMAN: Equally?

Mr. FITZGERALD: Yes, my lord, equally.

The CHAIRMAN: Are you willing to have clause 48 end up in this way:—"The consent shall be deemed to be unreasonably withheld if the authorised distributors are not willing and in a position to give the requisite supply upon reasonable terms and within a reasonable time"?

Mr. FITZGERALD said he would like to consider the point.

Continuing, Mr. FITZGERALD dealt with clause 50. He said this provided for a supply to authorised undertakers, but it had been treated by the opposition as applying to ordinary consumers. The clause was . . . . "enter into a written contract with the company (if required by them so to do) to continue to receive and pay for a supply of energy for a period of at least seven years of such an amount that the payment to be made for the same shall not be less than £20 per centum per annum on the outlay (excluding expenditure on generating plant and any electric line then in use) incurred by the company in making provision for such supply." What that meant was that if an authorised undertaker asked to be supplied he must guarantee that he would take a supply of energy for seven years' which would be equivalent, at the maximum price, to the outlay incurred by the company excluding expenditure on generating plant and any electric line then in use. Thus the expenditure would be the cost of connecting to the ring main, and would not include any expense on that main itself. Then an agreement for seven years was necessary to prevent the authorised undertaker changing his mind, and as to the period, the Committee had heard that the Metropolitan Electric Supply Co. had asked a period of 26 years for a supply in bulk to the Marylebone Council, and the Charing Cross & Strand Co. had asked 42 years from the West Ham Corporation. The period for which a supply was being given to Willesden by the North Metropolitan Power Co. was, he believed, about 20 years. But this clause did not apply to the ordinary power consumer. With regard to these latter, the argument of the opponents as to picking and choosing fell to the ground, because the Electric Lighting Acts of 1882 and 1888 were incorporated in the bill, and under secs. 19 and 20 of the Act of 1882 the promoter would be bound to supply any consumer who asked for it. Further, under clause 52 there was an absolute obligation to supply. Clause 52 was as follows:—

The company shall give a supply of energy to any person (other than an authorised undertaker) upon that person entering into a binding contract to continue to receive and pay for a supply of energy upon such terms and conditions as, failing agreement, shall be fixed by a single arbitrator appointed by the Board of Trade, and in fixing such terms and conditions (including a minimum annual sum to be paid to the company) the arbitrator shall have regard to the following amongst other considerations :—

1. The period for which the authorised undertaker or person to whom the supply is to be given is prepared to bind himself to take energy.

2. The amount of energy required and the hours during which the company can be called upon to supply such energy.

3. The capital expenditure in connection with the supply of such energy.

4. How far capital expended in connection with such supply may become unproductive to the company upon the discontinuance of such supply.

Provided that any person so requiring a supply of energy shall give to the Company (if required by them so to do) security for the payment of all moneys which may become due to the company under such contract.

The CHAIRMAN : The impression in my mind is that there is an obligation to supply upon terms.

Mr. FITZGERALD : It is an absolute obligation to supply upon such terms as the arbitrator may determine.

Mr. BALFOUR BROWNE : We deny that there is an obligation to supply at 1½d.

Mr. FITZGERALD : But it has been denied that there is any obligation at all. Further, the minimum sum to be paid is to be taken out in electricity. In addition, the promoters were quite willing, when once they had received the consent of the Board of Trade, to supply in any district to be placed under the same conditions as the existing undertaker.

Mr. BALFOUR BROWNE : With a compulsory area ?

Mr. FITZGERALD : That has nothing to do with it. A compulsory area was originally inserted in Provisional Orders in order that electric lighting should be carried out in the principal streets. There is nothing of that sort for a power company.

Monday, April 10.

The Hon. J. D. FITZGERALD, in concluding his observations upon clauses 50 and 52, said that they were in the form as settled by Sir James Kitson's Committee, and which had been included in many, if not all, of the electric power acts. Dealing next with clause 53, the stand-by clause, of which Mr. Neville, for the electric lighting companies, had stated that it was difficult to discover the true inwardness, Mr. Fitzgerald said it was a little hard upon Mr. Neville that his clients had not informed him as to the origin of this clause. It was verbatim the clause in the Supply of Electricity Bill which was introduced into the House of Lords last year, and which was framed with the help of many of the companies who were opposing it here.

Mr. RAM remarked that, before leaving clause 50, he would like to point out that in almost every power bill there was a provision that the prices charged should be the maximum prices in the second schedule of the bill. This was the form of the clause as settled by Sir James Kitson's Committee, and Mr. Neville's argument in respect of this clause was that the omission of these words was vital.

Mr. FITZGERALD said this did not make the least difference to the clause, but if the Committee thought fit he had no objection whatever to their inclusion in the bill.

Continuing, on the general opposition to the bill, Mr. FITZGERALD next considered clause 56, dealing with the maximum prices. The maximum prices were prices that were intended to be operative, and they were of necessity prices which were framed to meet the worst case against the company. By the first schedule to the bill,* a man taking a supply for one or two hours a day would be entitled to get it at 1½d. per unit. From the evidence put before the Committee not one company was supplying at this price, although a few of the local authorities were supplying at 1d. If a consumer was taking current for only three hours a day it would be the cheapest way for him to take it under the second tariff in the schedule. In this connection there was one matter which the opponents had left out. Under clause 57 of the bill the standard price was 1d. per unit in relation to the dividend, and if the average price was raised to even 1¼d. per unit, the dividend would necessarily have to fall to 4 per cent., whilst if the average charge was 1½d. per unit, there could be no dividend at all. Therefore, in the provisions of the bill there was the most absolute security that equitable charges would be made. There was also sec. 61 of the bill, which provided for the revision of prices. The comments on clause 69, which provided for the acquisition of other undertakings, seemed to suggest that there was some deep Machiavelian design in that clause of subverting all the existing companies in London. But this very clause was to be found in one or two electric power bills, and in a similar form in five or six others. The object of the clause in this instance was that there were certain local authorities in London whose undertakings were run at a loss, and a few of the smaller companies in the outlying portions of the area which were in much the same position, and that in cases of that kind the undertakers might find it economical to transfer their undertakings to the promoters. But this could only be done by agreement, and with the consent of the Board of Trade. Therefore, he should have thought that the clause was a perfectly harmless one, but if the Committee thought that there was some hidden danger in it, it was quite open to the Committee to strike it out. Coming next to the drafting of the bill, there had been much comment upon the fact that no power of purchase was reserved to any local authority or combination of local authorities. But who was to be the purchasing authority? Lord Cross's Committee had reported that no such power of purchase should be inserted in power bills.

The CHAIRMAN : With regard to that particular point, the Committee have no intention of departing from the recommendation of Lord Cross's Committee, so you need not argue that any further.

Mr. FITZGERALD said that the question of purchase had also been argued in a different way by the local authorities and companies—viz., if the companies purchased current in bulk from the power company, that, on the one hand, the local authorities would have nothing to purchase from the companies owing to the generating stations having been scrapped, and, on the other hand, that the companies would get nothing for their stations from the local authorities. But the real question, from the company's point of view, was whether it would be most advantageous to keep their generating stations and get paid for them, or to take a supply in bulk at cheaper prices than they could generate at themselves and so increase the present dividends. From the point of view of the local authorities he maintained it would be better for them to continue to take a supply in bulk after the companies had been absorbed, than to buy stations crowded with machinery quite out of date.

The CHAIRMAN pointed out that the argument for the companies on this point was a very much stronger one than the mere scrapping of their plant. Mr. Balfour Browne had said that it was a very great hardship that having been given only 42 years, a new company should be allowed to compete under entirely different conditions.

Mr. FITZGERALD : Yes, my Lord. It was also stated that the bill was contrary to precedent and that it was contrary to all previous legislation on this subject. It had been suggested that with the exception of Bristol every local authority or company had been cut out of the areas of power companies. But this was not so. Sir James Kitson's Committee included Swansea, Cardiff, Newport and other places, but between the two Houses, a special clause was agreed and the matter was never contested in the House of Lords. In the Cleveland and Durham Bill, Committees of both Houses included Darlington, Stockton, Middlesbrough and East Hartlepool. In the Somerset bill Bath and Somerset were both included against their wish. The only bill in which a town was struck out after a fight was the Clyde bill, and Partick was struck out.

Turning next to Mr. Balfour Browne's argument that there had been a Parliamentary bargain with the existing companies, Mr. Fitzgerald said this was a most astounding one, for it was that an Act of Parliament proscribed that there should be a monopoly, when, as a fact, it stated that there should be competition.

Mr. BALFOUR BROWNE said he had argued that it was not the intention of Parliament that companies should be competed with on different terms.

Mr. FITZGERALD read Sec. 1 of the Electric Lighting Act of 1888, which stated that the grant of a Provisional Order to a company or local authority should not in any way restrict or hinder the grant of a Provisional Order to any other company. Further, Sir Francis Marindin, in his report, had stated expressly that competition was desirable ; but as continuous current was better for motors, it was desirable when competition was allowed it should be between one company supplying alternating current and one company supplying continuous current. Mr. Balfour Browne's view was that two persons supplying different articles in this way were not competing, and his answer to that, therefore, was that as his company were proposing to supply three-phase current—which not a company or a local authority supplied at the present time in the area—there would be no competition in his case either. But this was not the right view, in fact he called it a ludicrous view.

Mr. WALLACE, K.C., for the Central Electric Supply Co., and Mr. FREEMAN, K.C., for the St. Pancras Borough Council, pointed out that both these authorities supplied three-phase current.

Mr. FITZGERALD said he would withdraw the remark so far as it applied to these bodies. Continuing, he instanced the Charing Cross & Strand Co.'s Act to compete in the City of London, and also referred to the proceedings in connection with the Marylebone Provisional Order when it was stated by Sir Courtenay Boyle, the then secretary to the Board of Trade, that one of the first considerations of the Marindin report was competition. On the general question, however, there was to be no competition whatever with the authorities in the non-industrial area, and there were only four companies in the industrial area which had a motor load as large as 8 per cent. of their total load. The business which the promoters looked forward to was business which the existing authorities had not already acquired, and which they could not, on their present lines, ever possibly acquire. Referring to the question of purchase raised by the London County Council, and to Mr. Lewis Coward's argument that the London County Council had practically been prevented from bringing in a bill dealing with the subject at the request of the Government, Mr. Fitzgerald said that there was not one tittle of evidence to support this contention. What really happened was as follows. The London County Council did bring in a bill dealing with this matter, and it was rejected. They then brought in another, but were asked to withdraw it as the Government intended to deal with the matter. When the Government bill was brought in, it was to deal with the change of the electric lighting areas in London, owing to the London Government Act of 1889 coming into force, and it provided that where areas supplied by a company were in two different districts through the change of boundaries, the borough councils could, by combination, purchase that business at the end of the company's term, or, failing combination, they could transfer their powers to the London County Council. The bill was the Electric Lighting (London) Bill, and there never was any suggestion on the part of the Government to deal with the matter on the comprehensive line suggested by Mr. Coward. As a matter of fact, in the Supply of Electricity Bill last year, the power of purchase which was vested in the London County Council was struck out in the House of Lords on the motion of the chairman of the committee, Lord Wolverton. The case for the promoters' bill was that, owing to its size, London could be supplied with electricity for power purposes, and through the authorised distributors for lighting purposes, as cheaply and probably more cheaply than any other city in the United Kingdom, but that this could only be done by taking advantage of concentration in the generation of electricity, magnitude being the important factor governing economy in the production of electricity. Manufacturers in London must get a supply under some other conditions than it was possible to do to-day, where the average price was about 2d. per unit, for, as Col. Crompton had stated, under these conditions the manufacturers could generate current themselves at a less price.

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* 1. The charge to be made by the company to any consumer shall not in respect of the total units supplied, exceed the rate of 1½d. per unit.

2. The company shall, if required by the consumer, make such charge by way of a fixed sum per quarter annum, not exceeding £1 per quarter per kilowatt of the maximum power required to be supplied, and in addition, a sum not exceeding ½d. per unit for all units supplied to such consumer.

THE CHAIRMAN: But the opposition say that though they may have been supplying at 2d., they have reduced the price, and hoped to reduce it further. A great many say they can reduce it to 1d., and further than that they have facilities for increasing their generating stations.

Mr. FITZGERALD replied that the County of London Co., which was deriving a bigger proportion of income from power than any other London company, had stated that their average price was 2d. now, and that the average consumer was only 8 H.P. This showed that the large consumers had not been touched, and the present companies could never give a supply on the terms offered by the promoters. For instance, the circumstances surrounding the generating stations were all against economic production. Mr Merz's figures of works costs had not been challenged, neither had his capital costs estimates; in fact, they could not, seeing that his estimates were based on actual tenders. Another view of the matter from the local authorities' point of view, was that if it was to the power business which they looked to for the great increase in their undertakings in the future, there was the great risk that the business of the consumer would be taken away from the district, and, further, that their generating plant would become antiquated as time went on. Such considerations must be taken into account when operating with the ratepayers' money, but the power company was willing to take that risk; and, therefore, by the local authority taking the current in bulk they were relieved from these obligations. Further, he maintained that the principle of carrying on the undertakings of the local authorities was an entirely vicious principle, for they were themselves one of their largest consumers, owing to the high price which was almost invariably charged for street lighting and tramways. In fact, the high price for these two items very often accounted for the profits which were shown. With regard to the companies, six of the largest ones were in the western area, and therefore would not be competed with for the present business, and not for any business that they were likely to get. Of the remaining companies in the industrial area, he had already shown that only a very small proportion of their present business would be touched. If the contention of the companies, that they could supply as cheaply as the promoters, was to be taken seriously, no harm would come to them from the operations of the promoters; but why should the London manufacturer, who was already heavily handicapped in the matter of rates, taxes, labour, &c., as was shown by the opposition witnesses, be further handicapped by being compelled to take his electricity from one company or one local authority. With regard to the opposition of the North Metropolitan Power Co. as regards Stoke Newington, Mr. Fitzgerald stated that the fact that a contract had been entered into between that company and the Borough Council of Stoke Newington for 21 years practically safeguarded them from any competition, and he failed to see the reason for their opposition. With regard to the portion of his area which was within the area of the Kent Electric Power Co., that company, having no generating station in this portion of their area, had arranged terms with the promoters by which they would take a supply in bulk from them. The last argument which he had to meet was that the bill would create one huge monopoly, but he thought he had already met this by his previous statement as to the extent of the competition proposed. If the Committee thought there was any danger of the creation of a monopoly or a trust, the remedy was in the Committee's own hands. There were various competing bills for practically the whole area, and it was quite open to the Committee, in addition to passing his own bill, to pass one or more of the other bills.

The CHAIRMAN: But I thought you did not agree with competition between two power companies?

Mr. FITZGERALD: I did not say that. I believe Mr. Ferranti did, but only Mr. Merz, Mr. Falconer and myself have any authority to speak for the promoters.

The CHAIRMAN: Then you ask us to pass these other bills?

Mr. FITZGERALD: No; I do not ask you to pass them, but if you do I am not afraid.

In conclusion, Mr. Fitzgerald reminded the Committee that the promoters of the bill were all business gentlemen of standing, ready to carry out the obligations, and, in the public interests of London, he asked the Committee to allow the bill to proceed.

The Committee will deal with the remaining bills before giving a decision. Owing to the indisposition of Lord Romilly it has been decided not to commence the consideration of the next bill on the list until after Easter. The City of London Company's Bill and the East London and Lower Thames Bill have now been amalgamated, and will be dealt with as one bill on Tuesday, May 9th.

MOTOR OMNIBUSES AS TRAMWAY FEEDERS.

CROYDON CORPORATION BILL.

Section B of the Police and Sanitary Committee, of which Mr. Bill is chairman, considered this bill on Tuesday.

Mr. GERALD FITZGERALD, who appeared for the promoters, said the bill dealt with various matters concerning the borough. The main opposition, however, was in respect of the powers to run omnibuses. The opponents were the Croydon Rural District Council, the Penge Urban District Council and a joint petition by the British Electric Traction Co. and the South Metropolitan Electric Lighting & Tramways Co. Several tramway lines had been deleted from the bill as originally deposited, so the question of competition with the British Electric Traction Co., who were the lessees of the tramways now in Croydon, did not arise as regards tramways. The lease of the British Electric Traction Co. was terminable by the Corporation in about 12 months' time, and there was a very strong feeling that this ought to be done. Therefore, the company's interests in the borough were very slight. The interest of the South Metropolitan Electric Lighting & Tramways Co. was still slighter, for this company had recently taken over some of the tramways which the British Electric Traction Co. had been authorised to construct in the vicinity of Croydon. The proposal as regards motor 'buses was to run these vehicles over about 14 routes through the borough and to a distance of 1 mile beyond on all sides, the object being to meet a public want. They had no desire to compete with the British Electric Traction Co., and if any damage was caused to them in consequence of the construction of the proposed tramways—*i.e.*, loss of traffic through inconvenience, the Corporation was willing to compensate. Another clause in the bill to which objection was taken was that giving the Corporation powers to enter into working agreements with tramway authorities outside the borough. As regards the motor 'buses, the Corporation was willing to specify the routes proposed. The peculiarity of the case was that anyone could now obtain a licence to run motor 'buses in any of the districts proposed by the bill and he failed to see what objection could be taken to the Corporation having these powers.

Mr. LLOYD, clerk to the Croydon Corporation, was then called to prove the statutory compliance with the Borough Funds Act, &c.

Cross-examined by Mr. RAM, K.C., he said he was aware that the British Electric Traction Co. had powers to construct tramways in Penge which the Council would have the authority to purchase in seven years. It was true that under a clause in the bill agreements could be entered into with outside tramway authorities, but he did not see how the Croydon Corporation, should they arrive at an agreement with the British Electric Traction Co. in respect of the Penge lines, could do so behind the Penge Council's back, as any such agreement would have to be approved by the Board of Trade.

By Mr. VESEY KNOX, for the Croydon Rural District Council: the Croydon Corporation had not considered the specific 'bus routes now proposed.

By Mr. MOON, K.C., for the British Electric Traction Co. and the South Metropolitan Electric Lighting & Tramways Co.: He denied that there would be any competition with the tramways leased to the British Electric Traction Co. in Croydon. It was felt that the motor 'buses would act as feeders and help to develop the tramways. The Croydon Corporation did not intend to create any competition, at any rate during the currency of the lease. With regard to a precedent for the powers asked for he said he relied on the Bournemouth Act, which gave the Corporation power to run omnibuses outside its district. He agreed that in most other cases the power to run omnibuses was mainly limited to those routes where reconstruction work for tramways was being carried on.

Mr. GEORGE CARTER, borough engineer and surveyor to the Croydon Corporation, described the routes of the proposed omnibus traffic, and said he regarded them all as meeting a public want.

Cross-examined by Mr. MOON, he admitted that three of the 'bus routes were along roads where tramways were already authorised to the British Electric Traction Co. He further admitted that the British Electric Traction Co. was under an agreement to pay the Croydon Corporation as a premium 1 per cent. per annum on the total costs of the construction of these lines. With regard to these lines, the object in proposing motor 'buses over the routes was because of the delay of the tramway company in building the lines.

Mr. GERALD FITZGERALD, for the promoters, said that the Corporation would withdraw the proposal covering the three routes in question, if the tramway company gave an undertaking to complete the authorised tramways within the statutory time.

Mr. MOON said he would not agree to this at once, but the line in the Penge district had to be completed by next summer under an agreement with the Penge Council. With regard to the other lines, they were only sanctioned in 1903, but there was every possibility of their being completed within the statutory time.

Mr. CARTER, continuing his evidence, said that the bill proposed to borrow £12,000 for the provision of 12 motor 'buses.

Other evidence was called for the Corporation, and in the course of cross-examination it was elicited that the Corporation had scheduled every possible route for the running of motor omnibuses, and had not come to a decision as to which routes should be started first.

Without calling upon the opposition to speak.

The CHAIRMAN said: The Committee are now in a position to give their decision with regard to this clause, and I should say that we can only give these powers to thoroughly well-considered and thought-out schemes. We do not consider at present that the scheme which has been laid before us is a well-considered and thought-out scheme, and therefore we must strike out the clause.

In consequence of this decision, the promoters agreed to withdraw the clause giving the power to enter into agreements with other promoters for working tramways outside Croydon.

On the consideration of clauses, the South Metropolitan Electric Lighting & Tramways Co. opposed clause 23, which gives the Corporation authority to supply electrical energy in bulk in adjacent districts, but

The CHAIRMAN said the Committee would pass the clause.

The remaining clauses were not of electrical interest.

OTHER ELECTRICAL BILLS.

The *Rhondda Urban District Council Bill* has been before a Committee of the House of Commons, of which Sir Lewis M'Iver is the Chairman, during the week. The bill, which is of an omnibus character, includes an extension of time for the construction of tramways and works under the Rhondda Urban District Council's Act of 1902. The only opposition to the bill related to the tramway portion and was offered by owners of property. It appears that considerable difficulty has arisen in connection with the tramways authorised in 1902, for the Council was precluded from working the lines themselves by the decision of the Committee which considered the bill. An agreement has now been arrived at with some private individuals for the construction and working of the lines, and this agreement is before the Board of Trade for consideration. After considerable discussion the Committee granted an extension of time for one year for the compulsory acquisition of land in connection with the tramways, but refused the three years extension of time for the construction of the tramways themselves, intimating that the Committee were of the opinion that the time now at the disposal of the Council under the Act of 1902 was sufficient.

The *Birmingham Corporation Bill* was read a third time in the House of Commons on Monday.

The *Metropolitan District Railway Bill* and the *Tyneside Tramways Bill* were read a second time in the House of Commons on Monday.

The *Chelsea Electricity Supply Bill* and the *Weybridge & Walton Electricity Supply Bill* were read a second time in the House of Commons on Thursday last week.

The *Accrington Corporation Bill* was read a third time in the House of Commons last week.

The *Sheffield University Bill* was considered by the Unopposed Committee of the House of Lords on Tuesday and reported for third reading. The object of the bill is to dissolve the University College of Sheffield and transfer all the property and liabilities of that college to the University of Sheffield.

Baker Street & Waterloo Railway Bill, which was also considered by the Unopposed Committee of the House of Commons yesterday, seeks powers with regard to the purchase of additional lands, an extension of time for the compulsory purchase of lands authorised in previous Acts, and an extension of time for the construction of subways, &c. The bill was ordered to be reported for third reading.

Edgware & Hampstead Railway Bill, which asks for a three years extension of time for the completion of works under the Act of 1902, a similar extension of time for the compulsory purchase of lands under the same Act, the abandonment of certain portions of the authorised railway and further powers as to vertical and lateral deviation, was ordered to be reported for third reading by the Unopposed Committee of the House of Commons yesterday.

The *Andover Lighting & Power Bill* came before the Unopposed Committee of the House of Commons yesterday. The bill seeks to incorporate a company for the supply of electricity and gas in Andover with an original capital of £28,000, and additional capital to the extent of £35,000, with one-third borrowing powers. The gas and electrical undertakings are to be kept separate. The bill schedules land for an electric generating station.

The *Aylesbury Gas Bill* was ordered to be reported for third reading yesterday by the Unopposed Committee of the House of Commons. The proposal of the bill is to give the Aylesbury Gas Co. power to apply for Electric Lighting Provisional Orders.

The *South Wales Electrical Power Distribution Bill* was also ordered to be reported for third reading by the Unopposed Committee of the House of Commons yesterday. The objects of the bill are to transfer the undertaking of the Carmarthenshire Electric Power Co., authorised in 1903, an agreement having been entered into between the parties by which the South Wales Co. pay £1,000 in cash and £18,000 in fully paid-up shares. The Carmarthenshire Co. is then to be dissolved. The South Wales Co. also seek for the repeal of the section of their act of 1903, which prohibits them from giving a supply in Llanelly, and for authorisation to supply there. An extension of time for carrying out the powers of the Carmarthenshire Act is asked for. It is also proposed to give the company the right to take a transfer of Provisional Orders without the operation of any purchase clause which might be contained therein. The capital powers of the Carmarthenshire Co. are to be conferred upon the promoters.

The second reading of the North-East London Railway Bill in the House of Commons has been postponed until Tuesday, May 9.

In a report to the House of Commons by the Chairman of the Police and Sanitary Committee concerning the *Halifax Corporation Bill* (the proceedings in connection with which were reported in our last issue), it is stated that the borrowing powers of the bill are £24,989 for the construction of new tramways, repayable in 30 years, £8,245 for the electrical equipment in connection with the existing Corporation tramways, and such further sums as may be authorised by the Local Government Board.

ELECTRICITY IN NAVAL ESTABLISHMENTS.

In the House of Commons on Tuesday, Mr. ASHTON asked the Secretary to the Treasury, for what period annuities had been issued to pay for electric light and power in naval establishments under The Naval Works Act, 1903.

Mr. VICTOR CAVENDISH, in a printed reply, said that the Act referred to sanctions borrowing for any period up to 30 years. The annuities so far set up were 29 years. They provided for repayment of sums borrowed for the purposes of the Act generally.

WIRELESS TELEGRAPHY ON THE COAST.

In the House of Commons on Monday,

Mr. YERBURGH asked the Secretary to the Admiralty whether, in view of the importance of wireless telegraphy on the coasts of the United Kingdom in relation to national defence, any steps were being taken by the Admiralty to secure the control of all wireless telegraph stations.

Mr. PRETYMAN, in a printed answer, said the matter had been, and still was, occupying the instant and earnest attention of the Admiralty.

LEGAL INTELLIGENCE.

Patent Exploitation (Ltd.) v. American Electrical Novelty, &c., Co. (Ltd.)

This case came before the Court of Appeal (Lords Justices Vaughan Williams, Romer and Stirling) on Tuesday, on the plaintiffs' appeal from a judgment of Mr. Justice Buckley. (The case was reported in our issues of May 29, June 5, 12 and 19, and July 3, 1903.)

Mr. A. B. SHAW, for plaintiffs, said that the action related to an alleged infringement of galvanic battery patents. Mr. Justice Buckley found on both points (infringement and validity) against appellants. The case was tried in the summer of 1903, but shortly before that another action by the same plaintiffs against other defendants had been tried, and on appeal to that Court Mr. Justice Buckley's decision against plaintiffs was reversed and it was held that the patent was valid. Thereupon the present action was started, and came before Mr. Justice Buckley when defendants' appeal in the other case from the judgment of that Court to the House of Lords was pending. It was felt that a good deal would depend upon what happened in the House of Lords. About a year after the judgment of Mr. Justice Buckley the House of Lords gave their judgment affirming the decision of the Court of Appeal, and holding the patent valid for a certain construction of it. The present appeal had stood over to await the event of the appeal to the House of Lords. He understood that validity was not contested now. If that was so, it would considerably shorten the hearing. They would simply have to fight the question of infringement. The patent sued upon was No. 1,110 of 1890, granted to one Hitchcock. It was a communication from abroad. At the trial a great deal of evidence was given as to the state of knowledge at the date of the letters patent. In 1890, at the date of this patent, there had been various wet cells, in which the space between the two electrodes in this case zinc and carbon —was filled with fluid. They had got various modifications of that, and just before 1890 there was a well-known type of cell called the Leclanché, one feature of which was that the exciting substance was sal ammoniac, and the other was that, instead of having the depolarising substance a liquid, Leclanché made it a solid depolariser. That was well known before the date of plaintiffs' patent. Before Leclanché's time acids were used which would give up the oxygen so as to combine with hydrogen. Leclanché introduced powdered peroxide of manganese as a depolarising agent. Those were the two features of the Leclanché cell. Just before 1890 there were many attempts to produce a dry cell.

Lord Justice VAUGHAN WILLIAMS: I understand that the original action was against Siemens Bros. & Co., that on appeal to the House of Lords plaintiffs succeeded, and that in the present action Mr. Justice Buckley has decided against plaintiffs on both points. On what grounds did the House of Lords affirm the validity of the patent?

Mr. SHAW said the grounds were the same as were taken in the Appeal Court, with the one exception that Lord Justice Cozens-Hardy thought the direction to pulverise, which was given in the body of the specification, and was not given in terms in the claim, was not fully introduced into the claim. Mr. Justice Buckley held that he had fresh evidence as to the state of the art. Plaintiff made one pole in the form of a zinc cup, so that it acted as an outside casing as well as a pole. He had then his carbon central rod, which was the other pole, and he had nothing between these two except two layers, both being exciting layers, and the inner one must be a depolarising layer. The Appeal Court and the House of Lords had said that that was now as a combination, and that nobody before had made an effective dry battery which had this and nothing else. The line of attack was that this was all common knowledge, that there were wet batteries before, and people had stuffed sawdust in and made them into dry batteries, and that that was an anticipation, because it was only absorbing the exciting agent in some material. The plaintiffs had satisfied the Courts that no complete and sufficient cell which had these elements and nothing else had been produced, and that was why the House of Lords held that the patent was good. The patentee used a semi-solid or plastic exciting agent, and plaintiffs' evidence showed that if enough fine stuff was used it would hold up the water by capillary attraction. Even supposing the word "pulverised" meant that only fine stuff was used, if the defendant took nine-tenths fine and added a little of a slightly coarser grain he still got a semi-solid or plastic agent in the sense that the patentee meant.

Lord Justice ROMER: Does the defendant say he has not got a semi-solid or plastic exciting agent?

Mr. SHAW: Yes. He has a damp solid. He has not got enough water there to make it semi-solid or plastic, and he also says "He rams harder, and that that is too far away from packing to be plaintiffs' invention. The Judge below had held that plasticity was of no value, but he could not accept that finding. The patentee had given a prescription which produced a substance which he called semi-solid and plastic. It must be sufficiently nearly solid to stand up as a layer and it must also be plastic in order to make good contact of the other layer and with the electrodes, No one had previously made a commercially successful battery of these elements and no other. Defendants here used a little less water and a little more ramming, and some question was raised as to pulverisation. As regarded water they certainly used less than the quantity stated in the specification, but the patentee expressly said that the materials as electrodes and as exciting and depolarising agents might be varied. Ramming by itself did not produce a substance which ceased to be semi-solid or plastic. Defendants tried to say it made it an absolute solid, but a mass of fine powder and liquid did not cease to be semi-solid and plastic. There was no binding material at all, and there was nothing to make the particles adhere to one another. If, too, it was solid, it would not work as a battery. The blotting paper used in the defendants' outer layer was certainly a different substance, and the defendants had adopted an ingenious scheme to avoid similarity, but, according to the specification, the materials might be varied, and, moreover, wet blotting paper was plastic and fulfilled every function performed by the plaintiffs' material.

At the conclusion of Mr. Shaw's argument Lord Justice VAUGHAN WILLIAMS asked Mr. Walter (for respondents) if he was content to argue the appeal simply on the question of infringement.

Mr. WALTER: I say that on the true construction of the judgment in the House of Lords we are absolutely outside this patent. The House of Lords had not decided the case at the time this matter was before the learned Judge. Applying the construction of the House of Lords on the patent I am not prepared to argue for a narrower construction. I am ready to allow them to have a reversal of the judgment on validity. I say I am identical with what has been done before, and if they are going to hit me then their patent is bad.

Mr. SHAW submitted that both layers in their result might fairly be called semi-solid or plastic, and that that was the patentees' meaning.

Mr. WALTER proceeded to open the respondents' case, and said he did not propose to contest in that Court the issue of validity, but his clients said that, on the true construction of the patent, they did not infringe—the thing described in the specification was something that set. That meant that the condition of the outer layer was not hard but semi-solid. He said that the ingredients must be something which would set. That was the argument all through, until plaintiffs succeeded in establishing this patent, and then plaintiffs tried to extend the ambit of the patent. He contended that the plaintiffs' patent did not cover the use of a liquid battery, a battery in which the liquid was merely absorbed by absorbent material, and that an outer layer composed of merely absorbing materials which took away the character of spillability was not within the plaintiffs' patent. There must be liquid material, otherwise no electrical action could take place. That was common ground. The use of papier-maché and blotting paper in a battery was old. Skrivanoff's patent was one in which blotting paper was used. In Scrivanoe (No. 15,063 of 1887) filtering paper was used. Then cellulose for a different purpose was found in Germain. There cellulose was used in the same way as blotting paper as an air-absorbent.

On the resumption of the case yesterday, Lord Justice VAUGHAN WILLIAMS stated that he and his learned brothers did not wish to hear Mr. Walter further on the question of infringement. As there was no question of validity raised it was only necessary for him to state that as at present advised the Court was of opinion that the blotting paper arrangement used by defendants was not an infringement of the plaintiff's specification.

Lord Justice VAUGHAN WILLIAMS, in giving judgment, said the only question they had to decide in this case was whether the patentee had proved that the defendants had infringed upon his combination as described in the specification. His Lordship having read the material passages in the plaintiff's specifications, said the defendants had substituted blotting paper, and the suggestion was that this blotting paper sufficiently came within the description of "being a composition in a semi-solid or plastic state," and it was said that although, of course, the difference was manifest upon the mere statement of it, the difference ought not to be regarded as preventing an infringement because of the power of variation. It was said that the power of variation allowed of this substitution of blotting paper. His Lordship did not think that the judgment in the House of Lords would authorise this Court holding that this variation of the plaintiff's patent—the introduction of blotting paper—was a variation of a character which was covered by the words in the specification. Even assuming that blotting paper came within the definition of the word "plastic," yet he thought that the variation was not such as was covered by the words in the specification, because even if blotting paper came within the category of materials mentioned in the clause, yet one must look at the whole of the specification, and it was plain that you could not so deal with the blotting paper. A suggestion was made that you could tear up blotting paper and pour it in with some water. He did not think that would be sufficient to bring it within the description in the specification. In his judgment blotting paper could not possibly come within that description, or that it was in any way analagous or similar to the materials and composition used by the plaintiffs. In his opinion, therefore, the appeal must be dismissed with costs.

The other Lords Justices concurred.

Mica Insulator Co. v. Bruce Peebles & Co. (Ltd.)

Mr. E. J. Findlay, of 37, Castle-street, Edinburgh, solicitor for the defenders in this action (reported in our issue of the 7th April) considers the wording of the report of the action as published in *The Electrician* is calculated to convey the impression that pursuers had obtained judgment against defenders for £500. Mr. Findlay points out that the order is merely an interlocutory judgment finding that the pursuers have stated a case which may be permitted to go to trial. Defenders contended that pursuers' pleadings were not relevant, and it was upon this plea that judgment has been given.

Dugald Clerk v. Motor Car Co. (1905) Ltd and Moffat Ford.

In the Chancery Division on Friday last Mr. Justice Farwell had this case before him.

Mr. UPJOHN, K.C., for the plaintiff, said the action was for an injunction to restrain defendants from circulating or publishing by means of a pamphlet, entitled "Let the Judges Decide," or otherwise, any advertisement, statement, or representation that plaintiff undertook or had been engaged to act as judge of the automobiles or motor cars on behalf of or at the request of defendants, or in any manner, by advertisement or otherwise injuring the plaintiff in his profession or business. Counsel proceeded to say that in this pamphlet Mr. Dugald Clerk's name was set out among a list of other judges. His client took the strongest exception to statements in the pamphlet, and denied that the defendant, Moffat Ford, had any authority to use his name in the manner complained of. He urged that the plaintiff was entitled to stop the circulation of the pamphlet on two grounds—first, that it did or might expose him to liability, and second, that it was calculated to do him great damage in the exercise of his profession.

Mr. JENKINS, for the defendants, said it was a case in which there had been a bona fide misunderstanding. It was a case where no costs should be awarded in any event.

His LORDSHIP, in giving judgment, said he had no doubt in this case the defendants must pay the costs of the action. There was no justification for the statements in the pamphlet. He granted the injunction asked for, with costs.

CITY TELEPHONE FIRES INQUEST.

The City Coroner (Dr. F. J. Waldo) resumed on Tuesday the inquiry into the cause of two fires which occurred simultaneously on the premises of the National Telephone Co. at Mansion House-chambers, Queen Victoria-street, and Oxford-court, Cannon-street, London, E.C., on February 28th last. The proceedings at the opening sitting, held on 4th inst., were given in our last issue. Mr. W. E. L. Gaine appeared for the Telephone Company, Sir Homewood Crawford for the Corporation and Mr. W. Clode for the District Railway Co., while Mr. A. P. Trotter watched the proceedings on behalf of the Board of Trade.

Some preliminary evidence having been given by officers of the Fire Brigade, Salvage Corps, &c.,

Mr. CHAS. BUTLER CLAY, metropolitan superintendent of the National Telephone Co., said the third floor of Mansion House-chambers was formerly kept as a junction switch room, and was now kept as a test room and operators' quarters, the top floor being a subscribers' exchange as distinguished from a junction exchange. The test room consisted of two small rooms, and was of wood covered with metal on the outside. The fire originated on the District Railway near the west end of Westminster station on the south side of the line. The electrification of the railway required the alteration of the position of the National Co.'s cables, and an arrangement was made with the District Railway Co. that the latter should do this work. The cables had been taken from their former position, and were to be permanently placed on the front of the platform (under the overhang) and covered in, but the work had not been completed at the time of the fires. The cables were on the ground, and a metal cover, such as was used to cover the cables, appeared to have been left touching them and in proximity to the conductor rail. When the current at 500 volts was switched on by the Railway Co.'s staff, it reached the National Co.'s cables through the cover and burned them. Their wires were usually employed to carry a current of 24 volts, and the 500-volt current would travel along them to the test-room at Mansion House-chambers, and afterwards to Oxford-court, whence the wires were continued to the Avenue exchange. A subscriber speaking at the time would not receive the 500-volt current because the wires would be fused. As the cable was lying on the ground when it fused, the current would go to earth. Some of the current must have passed to the exchange, but he could not estimate what the pressure would be there. There was unquestionably carelessness on the part of the workmen who moved the cables, for which his company were not responsible, and the engineer of the Underground Electric Railways Co. was responsible. No injury to persons was caused, nor any fire at any other exchange than Oxford-court and Queen Victoria-street, nor at the house of any subscriber nor on the Post Office system. There was some sparking across the arresters at the Westminster exchange, but no instrument was destroyed. There were lightning arresters to each instrument, and in cases where there was any danger fuses were put in; for instance, where the wires were in proximity to trolley wires. He thought the lightning arresters, which had a sparking distance of about $\frac{1}{40}$ of an inch, would act with 500 volts. A subscriber might feel a shock, but he did not think there would be any danger, and he could not get 500 volts. Asked by the Coroner how it was the current went to earth at the company's Oxford-court and Mansion House-chambers premises, witness said the insulation must have been weaker there. The Coroner then remarked that if the insulation had been stronger the current would have gone on to private houses. Witness said it would not; the wire was fused, and the current had consequently not gone out. A few years ago nobody would have thought of taking precautions in telephone work against high-tension currents, and it was a common thing now not to take any special precautions against them, because it was thought the wires by being underground were so well protected. It would not be unsafe to have the cables in the tunnels when the electric trains were running if the cables were in their proper place and the engineers of the Railway Co. had not considered it necessary to take any further precautions. The weak portion of the insulation would be on the cable bars in the test house. The cables came in and were connected on to bars for the purpose of being connected on to other cables and other bars so that they could be manipulated and so that a wire could be put through to the east or west or whatever district they wanted to put it through to. He thought there was no doubt that the current or the wire sparked on these lightning arrester bars and lit the wires in the frame inside. After this the current would go through the bars, which were close together but separate, from bar to bar and thence up the cables leading to the derrick. The current would go along the wire to Oxford court, and act in exactly the same way as it did at the Bank exchange. There would be an arc on the lightning bars, probably in both cases. There had been no fires other than the 1902 and 1905 fires and the two now under inquiry. The only portions of the Oxford-court premises now occupied by the National Co. were the test room and the roof. The exchange there was done away with four or five years ago. The current which caused the fire there would travel to earth on the lightning arrester. He suggested this fire was also caused by the traction current at Westminster station. The railway company did not leave their current on long; if it had been there might have been danger at other exchanges, but not at all, because many were now fitted with a small fuse with a heat coil, which would prevent anything of the kind. Upon an abnormal increase of current it melted a little solder and let go a spring and opened the circuit.

In examination by Mr. GAINE, Mr. Clay said he had not heard of a single case in any country of injury to a person or to property in a subscriber's premises from fire or from any high-tension current getting on to telephone conductors. All subscribers' instruments were protected by lightning arresters. The reason that heat coils were not fitted at the City exchanges was that they were going to close them.

Mr. H. LESLIE DIXON, inspector of overhead wires for the Corporation of London, said his theory was that had the accident occurred in the day time it would have been a serious public danger. A person who had a telephone in a damp situation would have run a serious risk of a 500-volt shock to earth, and if the individual had a weak heart and made a very good contact, there would be a possibility of a fatal result.

Cross-examined by Mr. GAINE, Witness said he had heard of a case of death by lightning striking telephone wires. He had read of it in the *Telephone Magazine* of Chicago, but he could give no details. The German Post Office left off telephoning altogether during thunderstorms. Witness said lightning arresters were usually inefficient. Asked by Mr. Gaine whether, in view of the current having to pass through the test room where the fire occurred and then through the switchboard and the resistance that apparatus offered and then going on to a metallic circuit he still suggested that there was a probability of danger to subscribers if such an accident occurred in the day time, Witness replied that he did most certainly.

Mr. W. E. HANSON, constructing engineer to the Underground Electric Railways Co. of London (Ltd.) said that the current which fused the Telephone Co.'s cable was only on four or five minutes, and its strength was about 550 volts. A telephone message came (he thought from Charing Cross) that there was a defect at Westminster, and the current was immediately turned off. He afterwards found a piece of metal troughing lying across the conductor rail and in contact with the telephone cable.

Mr. S. B. FORTENBAUGH, electrical engineer to the Underground Electric Railways Co., said he was at the Mansion House sub-station during the night of February 27th, when the current was turned on. The voltage began with 60 volts and was gradually increased to about 500. On the south road (the one on which contact with the Telephone Co.'s cable took place) the maximum current was as much as 300 or 400 amperes, and when the current was turned off it was at least that. While the current was on there were occasional momentary kicks and fluctuations of the instrument needles.

In reply to Sir HOMEWOOD CRAWFORD, Witness said he thought it perfectly safe to have the National Co.'s cables in the underground railway tunnel. Witness's own company had their telephone cables there.

Examined by Mr. GAINE, Witness said when the cables were in their proper position they were perfectly safe. The cables would, when properly fixed, be underneath the overhang of the platform and would be in proper troughings.

It was then decided to adjourn the inquiry until 11 a.m. on Tuesday next.

Sir HOMEWOOD CRAWFORD offered, on behalf of the Corporation, accommodation for the resumed inquiry in the Old Council Chamber of the Guildhall. The offer was accepted. He also expressed the willingness of the Corporation to defray the expense of calling expert evidence, and this offer was accepted.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Messrs. Preece and Cardew invite applications for the appointment of chief engineer to an electricity supply undertaking in Mexico City. Applicants must have had a sound theoretical and practical engineering training, and a thorough knowledge of the supply of electricity in large towns. Experience with three-phase working is essential. Applications to Messrs. Preece & Cardew, 8, Queen Anne's-gate, Westminster, S.W., by April 27. See also an advertisement.

A draughtsman is required to assist in the design of a new engineering laboratory. Salary £3 per week. Applications to Prof. Coker, City and Guilds Technical College, Leonard-street, Finsbury, London, E.C. See advertisement.

The Electrical Co. (Ltd.), 125, Charing Cross-road, London, W.C., require an engineer with good theoretical training and wide practical experience in power-installation work for the estimating department. See an advertisement.

Two additional assistants are wanted in the department of electrical engineering of the City and Guilds Central Technical College, Exhibition-road, London, S.W., to give instruction in electric machine drawing and construction and electric machine testing. Salary £150 per annum. Applications to Prof. Ayrton. See also an advertisement.

A lecturer on electrical engineering is required at the Hull Municipal Technical School. Commencing salary £160. Applications to the director of studies (Dr. J. T. Riley), by May 4. See also advertisement.

Applications are invited for the first European Professorship (Physics) at Meerut College, Northern India. Salary, £320 per annum (£50 passage-money). Particulars from Prof. Worthington, Mohuns, Tavistock.

On Wednesday Southampton Town Council agreed to appoint Mr. H. F. Street (the borough electrical engineer) to the position of manager of the Corporation tramways, in addition to his present duties, with an increase of salary of £150 per annum. The Tramways committee had recommended the appointment of Mr. H. E. Yerbury, deputy manager of Sheffield Corporation tramways, at a commencing salary of £500, rising to £900 per annum.

Mr. W. J. Hosgood having resigned his position as resident engineer and locomotive superintendent of Port Talbot Railway & Docks Co., Mr. W. Cleaver has been appointed engineer and Mr. A. H. Hertz locomotive superintendent of the company as from April 1.

Pudsey Council received over 100 applications for the position of resident electrical engineer, and the Electricity committee has selected Mr. E. Denton, of Prescot.

Mr. J. Bryden Brown, resident engineer at Chesham for the Empire Electric Light & Power Co., has been appointed chief engineer of the Exmouth & Totnes electricity works of the Electric Supply Corpn.

Mr. H. Stanley, B.Sc. (Lond.), associate of Merchant Venturers' Technical College, has been chosen junior assistant in the Physics Department, vacant owing to the appointment of Mr. A. J. Margetson as lecturer at the Central Technical College, London, and the promotions which have resulted from this appointment.

Aberystwyth.—Chiswick Electricity Supply Corpn. have offered to dispose of their undertaking to the Council.

Andover.—The Council have decided to transfer their electric lighting order to the gas company, when the latter obtains parliamentary powers.

Argentina.—The "Review of the River Plate" says the Co-operative Telephone Co. of Rosario (of which Senhor Pedro Lopez, ex-Director-General of Telegraphs, is manager) has been formed and will shortly invite tenders for telegraph material.

Barrow-in-Furness.—At the request of the Isle of Walney Estates Co., the Council have decided to revert to the old (maximum demand) system of charging for electric current.

Bexhill.—An inquiry was held on Wednesday into the application of the Council for permission to borrow £4,000 for electric lighting extensions.

Bootle.—On the recommendation of the Electric Power and Lighting committee, it has been decided to apply £1,000 from the profits of the past year's working of the electricity undertaking in relief of the rates.

Boston.—At a special meeting of the Council last week a communication from the Local Government Board was discussed.

The board stated that they were not satisfied that the establishment of an electric lighting scheme in accordance with the plans submitted would be likely to be financially successful, and suggest that the Council should consult an electrical engineer with the view of getting out a revised scheme. The board thought the Council would be well advised to reconsider the whole matter.

Brighton.—At the meeting of the Council last week the Lighting committee's minutes contained a report by Mr. Arthur Wright (abstracted in our last issue) relating to the present position of the Southwick electricity supply scheme, and, after discussion, the minutes were adopted.

The CHAIRMAN OF THE COMMITTEE (Councillor Butt-Thompson) then moved that Mr. Arthur Wright be engaged as consulting electrical engineer to the Corporation for six years from April 19, to superintend all present and future capital expenditure in connection with the electrical undertaking, at a salary of £600 per annum, and that he be paid a further sum in any year of the said period in which a profit exceeding £5,000, after payment of all debt charges, interest and working expenses is made, equal to 5 per cent. on the amount of such profit. The proposed arrangement with Mr. Wright was a good one, and it would be nothing short of a calamity to dispense with his services.

Ald. Reeves expressed himself in favour of having a fixed salary rather than that the remuneration should be dependent upon the profits of the undertaking.

Ald. Carden said that to a large extent they were in the hands of Mr. Wright, with whom they had made a very fair and reasonable settlement.

Councillor Broadbridge said that it was the very best thing the committee could do, and also said Mr. Wright was not very particular about the work. But for his great interest in the Southwick scheme they would not be able to retain his services, which, however, he believed would have been continued on the old terms but for the animadversions made upon him in the Council.

Councillor M'Clean foresaw many great difficulties if this arrangement were entered into. It practically meant a partnership between Mr. Wright and the Corporation.

Councillor Sone thought the arrangement an absurd one, and could plainly see very great difficulties ahead.

Councillor Bryant said that Mr. Wright would complete the Southwick scheme for £86,000 below the £400,000 contemplated. Under ordinary circumstances a consulting engineer would receive 5 per cent., and that would have meant that during the last five years they would have paid Mr Wright £15,000 for his services instead of the £3,000 he had actually received.

Ald. Sendall was surprised that Mr. Wright should wish to dissolve the arrangement which he had entered into with the Council before the building, for which he was entirely responsible, was complete. He thought that if Mr. Wright used his own discretion he would feel in honour bound to carry that out and not allow anyone to interfere with that creation of his own mind.

Councillor Burt-Thomson, in reply, said most of the members who had spoken did not know Mr. Wright. He appealed to the Council to have a little faith in the Committee and pass their resolution. Mr. Wright had great faith in his child. He said he would make it pay, and he was certainly the man most likely to do so. The committee therefore thought the terms recommended were very good and economical.

The amendment having been defeated, the resolution was carried by 30 votes to 10.

Cheltenham.—The chief assistant electrical engineer (Mr. H. E. Soper) has tendered his resignation owing to ill-health.

Chester.—We gave brief particulars in our issue of March 31 of the financial results of the electricity undertaking for the year ended March, 1905, which were somewhat misleading. The following details are now available :—

The year's income was £17,123. Working expenses amounted to £7,921, interest on loans to £3,342, sinking fund £3,025, leaving a profit of £2,825, of which £1,300 has been transferred to reserve (making this £9,704 ; £1,525 has been applied in writing off obsolete stores and plant, leaving £108 to be carried forward.

Christchurch (New Zealand).—The work of conversion to electric traction of the horse and steam tramways in this city is being carried out by the New Zealand Electric Construction Co. They were officially taken over by the company on April 1. The overhead system, with poles in centre of road, has been adopted. Some of the sharp curves on the old horse lines are being avoided by portions of the lines being entirely relaid. The power house is situate at Linwood, on the border of the city.

Dundee.—At the Council meeting last week 14 voted for and 14 against a Sunday tramway service. The Lord Provost then gave his casting vote against.

Electric Locomotives.—The Atlas Car & Mfg. Co., of Cleveland, Ohio, U.S.A., write :—"We are constantly in the market for electric, oil and gasoline locomotives for handling industrial railroad cars, also mining cars, gauges 20, 24, 36, and 48in., and of from 2 to 10 tons' capacity. We shall be glad to receive catalogues, prices, &c., from makers of these machines in the United Kingdom."

Electrical Contractors' Association.—A general meeting of the London section of this Association will take place to-day (Friday) at the Restaurant Frascati, Oxford-street, London, W., at 8 p.m. There will be a discussion on "The Best Mode of Protecting Cables," which was adjourned from the last meeting.

Electrical Driving of Textile Mills.—The worsted-spinning mills of Thomas Burnley & Sons, Gomersal, have recently been completely equipped with electric motors and the whole mill is now driven electrically. Electrical energy is being purchased from the Yorkshire Electric Power Co. The advantages of electric driving in mill work are becoming so fully appreciated in other parts of the world that doubtless Messrs. Burnley's example will be rapidly followed by others in the Yorkshire Power Co.'s district.

Electrical Manufacturers' Combine in Germany.—It is announced that 28 firms belonging to the Union of Electrical Manufacturers (comprising over 200 European firms) recently met in convention at Munich, and organised a co-operative society to act for the members in the purchase of raw materials for manufacturing purposes.

Exhibitions.—Redditch Council have authorised their engineer, Mr. Ferguson, to organise an electrical exhibition to be held in Easter week.

The electrical exhibition which has been organised by the Salisbury Electric Light Supply Co. was held at the County Hall, Salisbury, last week. There was a good attendance throughout the week.

An exhibition has been organised by the Winchester Electric Light & Power Co., and will be held in the first week in May.

Exmouth.—Electric current was available for private lighting for the first time on Monday.

Glasgow.—There has been a re-arrangement of the staff of the Tramways department, and certain increases of salaries have been granted, including that of Mr. L. Mackinnon, traffic superintendent, from £400 to £550. Mr. John Ferguson was promoted to the post of chief engineer, with an increase of £150, to £550.

Holborn and Finsbury Electrical Exhibition.—This exhibition, organised by the County of London Electric Supply Co., terminated its successful run on Wednesday last week. The show was visited by nearly 50,000 persons. The amount actually received for admissions reached about £230. The number of visitors on the first day was 2,305, and on the last day 4,661. The power exhibits were much appreciated, and afforded considerable interest to a large body of traders and others.

Horsforth.—The Council have applied for an extension of 12 months to carry out the terms of their provisional order, 1903.

Hungary.—At a recent meeting at Budapest, with the Minister of Commerce in the chair, the conditions of concession with regard to the electrification of the three largest local railways around Budapest were laid down, one condition being that the conversion of the lines mentioned must be completed within four years. The lines are :—Budapest-Szent Endre (single track, 13·7 miles), Budapest-Czinkota (double track, 22·4 miles), Budapest-Soroksar (single track, 11·2 miles). The cost of electrification is estimated at £600,000.

The municipality of Abony (Hungary) intends to erect electricity works for lighting and power.

The municipality of Siklos (Hungary) intends to build electricity works for supply of current for light and power for both public and private purposes. Detailed specifications may be obtained from the municipal authorities.

It is announced that adjudication will shortly take place at the Municipal Offices, Görz, on tenders for the construction of a municipal tramway 5½km. in length, the works being estimated to cost about £15,000.

Inquest.—The coroner for Central London (Dr. Danford Thomas) held an inquest on Tuesday into the death of Bertram M. Coxeter, assistant engineer, who was killed at Islington (London) Electricity Works on Friday last.

James O'Brien, an employé at the works, stated that on Friday night deceased, who was in charge at the time, went into the rectifier room at about 11 p.m., and he saw him standing on a rubber mat before a rectifier using a key. He left the room, and a minute after, when he returned, he saw Mr. Coxeter lying on the floor shaking violently. He at once called assistance, and the body was removed and artificial respiration employed, but death ensued almost immediately. When he found deceased he had hold of the handle of the rectifier.

Mr. C. H. Higgins, electrical engineer, said about 11 on Friday night he went to the station to relieve deceased, who had been on duty since 3 o'clock. He found deceased lying between Nos. 1 and 3 rectifiers. He got him away, and, with others, used artificial respiration. A medical man was called, who pronounced life extinct. He thought it possible that the occurrence was due to deceased having slipped, and in putting out his hand to save himself had got in contact with some metal which was charged.

Dr. Dace stated that when he was called life was extinct. On making a post-mortem examination he found that the palm of the right hand was blistered, and there were blisters also on the chest and on the abdomen. These had been caused by electricity. The organs were all healthy. Death was clearly due to a violent shock.

Mr. Albert Gay, consulting and chief electrical engineer to the Borough Council said deceased, who was a most competent engineer, had been employed at the Eden Grove station for eight years, and he had great confidence in him. It was most difficult to explain what did happen, but he assumed that deceased was doing something to the brushes. Deceased would use a key for manipulating the work, and the blister on the palm of the hand showed, he thought, that he did not grasp the handle of the key which was insulated, and that a sudden slip of the hand brought it down to that portion that was alive. It was not possible to have the whole of the key covered, because if it was to do the operation that was necessary it would have to be uncovered. It was possible that deceased might have slipped, or that a temporary loss of memory caused him to make a mistake. Deceased was fully alive to the dangers of the work, which he would, perhaps, do several times in a day. The current was from 1,500 to 2,000 volts. Unless he slipped or his hand slipped down to the live portion of the key, to him the work would not be dangerous. It had not been their rule to use gloves at this particular work because the handle of the key was insulated, but he had to admit, after this accident, that had gloves been used the accident would not have occurred. He should in future see that, to prevent the hand slipping to the live portion, an ebonite disc should be attached to the handle, which would be made large, so that it would be a kind of shield. He examined the key afterwards, and found that it was not broken.

In answer to H.M. Electrical Inspector of Factories (Mr. G. Scott Ram), Mr. Gay said the key that was used was one that had always been considered the proper key to use, and it was made specially for the purpose. It was not before thought necessary to use gloves. Gloves were used when high tension was employed.

The Coroner said he took it that witness was of opinion that this was purely an accident. The work had been done thousands of times without accident. It seemed that there was no doubt the accident took place when deceased was attending to the brushes of the rectifier, and owing to his hand slipping. This was the first death from an electric shock that had occurred at the works.

The jury returned a verdict of Accidental Death.

Landing Rights.—The "London Gazette" for Friday last contains an announcement that the Direct United States Cable Co. has applied to the Board of Trade for a renewal of the licence granted by the Board to the predecessors of the company on Aug. 10, 1874, to lay and maintain on the foreshore and bed of Ballinskelligs Bay, Co. Kerry, a cable to Halifax, Nova Scotia. Objections to the Board by May 4.

Tuesday's "London Gazette" contains a notice that the Great Northern Telegraph Co., have applied to the Board of Trade for a renewal of the company's two licences for maintaining and using two telegraph cables from Sweden to Newbiggin, Northumberland. Objections by May 8.

Leyton.—An inquiry was held here recently into the application of the Council for permission to borrow £5,000 for electric lighting extensions.

The Clerk (Mr. R. Vincent) gave particulars of the outstanding loans, &c.

The Inspector (Mr. Bicknell) asked if the borough electrical engineer could distinguish between the cable required for public and private street lighting.

Mr. F. Harman Lewis said he could not do that. Besides laying the cable in the streets, part of the money was required for stock purposes, so that if a consumer wanted his house connected they would have the necessary cable in hand.

The Inspector said the Local Government Board had an impression that in the case of street lighting electric light was more costly than incandescent gas lamps. Leyton was in a peculiar position, as there were many streets of small houses, in which electricity would not be used by private consumers.

Mr. Lewis: We do not propose to use the £5,000 solely for lighting the streets. The application for £5,000 was for the Council to be in a position to supply consumers on demand. 1,000 out of 1,500 street lamps were now lighted by electricity. This loan would last them about 18 months.

Mr. Vincent explained that the Council were under an obligation to supply consumers with electricity.

Light Railway Order.—The Board of Trade have confirmed the Portsmouth and Hayling Island Light Railway Order, 1905, authorising the construction of a light railway in Portsmouth and Havant.

London County Council.—At Tuesday's meeting it was resolved to expend £26,000 on the removal, lowering or diversion of mains, pipes, wires, &c., required in the reconstruction of the tramways from Westminster Bridge and St. George's-circus, &c.

North Tramways. The Highways committee submitted for the Council's consideration the proposed terms of an agreement with the North Metropolitan Tramways Co., for the acquisition by the Council, on April 1, 1906 (prior to the termination of the lease in 1910), of the company's interest in the lines. The terms under which the company are prepared to surrender the lease are, payment to the company of £120,000 in respect of profits, compensation to directors and officials, and the purchase of certain leasehold properties, office furniture, and fittings, &c.; the Council to take over all the trade contracts made by the company in the ordinary course of business. The company is to afford the Council facilities before the appointed date of purchase to enable the reconstruction of certain sections of the tramways for electric traction. The company's rolling stock, horses, harness, plant, machinery, &c., which shall be suitable to and used by the company for the purpose of the undertaking, is to be taken over at a valuation as part of a going concern in the manner provided by clause 31 of the lease, the forage and general stock to be taken at cost prices, and "a sum equal to four times 4 per cent. of the difference between such valuation and £314,586 is to be deducted from, or added to, the amount to be paid for profits, &c., in order to adjust the calculations on which the value of the profits has been assessed." The committee set out at considerable length the financial bearings of the proposals, and estimate that the annual mileage run on the tramways thus acquired might be expected to reach 21,024,000 miles, and that the profit on working at 5d. per car-mile would amount to £438,000 a year. If provision for renewals be made at the rate of 1d. per car-mile £87,600 would have to be deducted from the estimated profit, leaving a balance of £350,400. The approximate interest and repayment charges to be made would amount to £252,500, leaving a balance of £97,900. These figures exclude street widenings, although additional widenings are proposed to be carried out in connection with the reconstruction of the tramways. These widenings are estimated to cost about £900,000, but will partly be in extension of improvement schemes already in hand. The adoption of conduit traction on the whole of the lines (continue the committee) would involve additional capital expenditure of about £470,000, adding to the annual capital charges on the cost of reconstruction a sum of about £32,250. In considering the question, however, of the extra first cost of adopting the conduit system throughout, regard should be had to the advantages of adopting a uniform system of traction on the whole of the lines. These may be said to include an increase of receipts over those obtainable in the case of a mixed system, caused mainly by the economy of working tramways on one system only, as well as by the rapidity of the services and the greater comfort afforded to passengers. The committee point out that if the lease were not acquired the Council would, immediately upon the termination thereof, take steps for the reconstruction of the tramways, and the same losses under the head of disorganisation of traffic as will occur with reconstruction at the present time would hold good then. By immediate acquisition, however, the Council secures the additional profits on electrical working covering a period of four years, and also the economy of working at the Greenwich generating station resulting from the addition to the power load at the station.—Discussion on the proposals was postponed.

Louth.—On Wednesday the Council adopted an electric lighting scheme prepared by Messrs. Handcock & Dykes, and estimated to cost £13,010.

Macclesfield.—The Board of Trade notify that unless the Council carry out their provisional electric lighting order by the end of 1905 it will be revoked.

Milan Exhibition.—The tender of the Comitato per la Trazione Elettrica, Dr. G. Finzi, Milan, has been accepted for the construction of the high-tension single-phase electric railway which is to connect the two localities of this exhibition (Parco-Piazza d'Armi). On this eleveted double-track line, 1,500yds. long, four trains will run, each capable of carrying 200 passengers, and made up of four cars equipped on the multiple single-phase Finzi system. The cars will have both mechanical and electrical braking apparatus. The machinery will be built at the works of Gadda, Brioschi & Finzi, Milan.

Motherwell.—Extensions of the electric lighting plant and mains, estimated to cost £6,500, have been authorised. Application has been made for sanction to borrow £20,000 to cover this amount and to meet the cost of further extensions.

Newcastle-on-Tyne.—To introduce the new tramways manager (Mr. E. Hatton) the Mayor and Mayoress (Ald. and Mrs. J. B. Ellis) entertained in the Corn Exchange and Town Hall on Wednesday and Thursday evenings the tramways staff. The Tramways committee employ about 1,100 persons.

The Mayor said they had passed through a period of difficulty and anxiety, but they were determined that, if possible, their tramway enterprise should be a success. He thanked the employés for their support. He had much pleasure in introducing Mr. Hatton, their new manager, who came to Newcastle-on-Tyne with a reputation and a determination to work. He would deal honestly and fairly by the men, and anyone of the employés who thought he was suffering from the slightest injustice would have access to the manager, and through the manager to the committee.

Mr. Hatton said he was very grateful for the cordial welcome they had given him to Newcastle. They were fortunate in having the Mayor as chairman of the Tramways committee. They should be united in their efforts to make the tramways a success and a credit to the city. First consideration would ever be given to the welfare of the men and of the employés generally, consistently with the conditions of the undertaking.

Paddington Electricity Exhibition.—This exhibition (organised by the Metropolitan Electric Supply Co.) was closed on Saturday evening last, having proved a great success. An average attendance of over 8,000 visitors per day was secured. To celebrate the holding of this successful show of electrical plant, apparatus and accessories, Mr. J. C. Page, the Metropolitan Company's representative, was presented by the exhibitors with a handsome silver cigar box in recognition of his services. It was generally agreed that the arrangement of the display at the Queen's-road Baths was both artistic and compact.

Para.—Some time ago it was decided to convert the animal-drawn tramways of this city to electric lines, and an English syndicate purchased the city system for this purpose. Messrs. Moller & Co., New Broad-street House, London, E.C., are agents for this syndicate, and Mr. Moller (it is stated by an American contemporary) is now in London in connection with the business of the syndicate.

Partick.—Extensions of the electric lighting plant and mains are to be carried out at an estimated cost of about £9,000.

On Monday the chairman of the Electric Lighting committee (Ex-Provost Wood) said there had been an increase of nearly 80 per cent. in the demand for electric current, and it was absolutely necessary they should have additional plant.

Personal.—Mr. F. A. Glover (managing director of F. A. Glover & Co. (Ltd.) is to be married on 20th inst. The whole of the staff and employés of the firm will have a holiday on that day, and the offices and works at Vine-street, Clerkenwell, London, E.C., will be closed.

Mr. Alfred Jaray (director of Frank Suter & Co., Ltd.) was married in Vienna last Sunday.

Provisional Order Revocation.—Harwich (Corporation) Electric Lighting Order, 1902, has been revoked.

Reigate.—Application has been made for sanction to borrow £4,000 for electric lighting extensions.

St. Pancras (London).—The Council have decided to increase the salary of the borough electrical engineer (Mr. Sydney W. Baynes) to £1,000 per annum. Several members of the Council spoke in highly eulogistic terms of the services rendered by Mr. Baynes.

Southend.—An inquiry was held here last week into the Council's application for permission to borrow £10,000 for a dust destructor.

Spanish-French Water Power Scheme.—A French company is negotiating with Barcelona Municipality for a concession for permission to transport from the department of the Ariège (France) to Barcelona some 40,000 H.P. of electrical energy, derived from the water power available on the other side of the French frontier. Supply in Barcelona is to comprehend public lighting, private and industrial purposes.

Stourport.—Ratepayers recently petitioned the Council to consider the question of electricity supply, or to induce a company to obtain a provisional order. The General Purposes committee have been asked to report.

Technical Bureau.—We learn that a bureau has been formed at Prince's Chambers, John Dalton-street, Manchester, for the purpose of lending out technical books of all descriptions to annual subscribers. It is stated that the bureau will endeavour to cover every branch of engineering, surveying, architecture, quantities, sanitary science, and the law in relation to public health and property.

Telephonic Communication with Moving Trains.—Some two years ago experiments were carried out by M. Coutant, deputy for Ivry, between Château-du-Loir and Château-La-Vallière (France) for maintaining telephonic communication between trains in motion. It is stated that M. Coutant intends repeating these experiments this year, and will ask the French Government to render him substantial help.

Thornhill (Yorks).—The Yorkshire Electric Power Co. recently offered to instal 160 20 c.p. incandescent lamps on 80 posts (the lamps to be fixed on the trolley poles) for a charge of £192 per annum. The company have been asked to erect two trial lamps.

Trespassing on Electric Railways.—The Lancashire & Yorkshire Railway Co. are vigorously proceeding against persons who cross their electric railways at other than appointed places. Last week three youths were fined 5s. and costs for trespassing and the magistrates intimated that future cases of a similar character would be severely dealt with.

Wandsworth (London).—Subject to the insertion of a clause limiting the building line of the land of the County of London Electric Supply Co.'s new station at Wandsworth Creek, the Council's opposition to the company's bill in Parliament will, we understand, be withdrawn.

Willesden.—An account for £1,843. 5s. 9d. for current supplied in bulk by the North Metropolitan Electric Power Supply Co to March 31 was passed for payment by the Council on Tuesday.

It has been decided to charge a flat rate of 1¼d. per unit for power provided supply be automatically switched off at dusk; a flat rate of 1½d. per unit is to apply where power is available continuously. A scale of charges is to be framed for large power users, under which the price will vary both with the load-factor of demand and the total number of units consumed.

Sanction has been received to a loan of £2,000 for purchase of electric motors.

The resident electrical engineer is to ascertain whether there is any demand in the district for motors on the hire-purchase system, and to frame a scale of charges in connection therewith.

Main extensions, to cost £359. 10s., have been sanctioned.

Woodford.—The Council have decided to apply for a provisional electric lighting order.

Workhouse Lighting.—Recently Hammersmith (London) guardians provisionally accepted a tender at £7,861 for wiring and fitting up the new workhouse. The Local Government Board have notified the Board that they have been advised that the work should be done at a much less cost, especially having regard to the approximate reductions in the amounts of tenders received, though not accepted, by the Guardians.

The Clerk said he had also received a letter from the consulting engineer, who suggested that by the adoption of his original plan £1,000 could be saved in the cost of transformers. The engineer had had an interview with the L.G.B. representative, and he had no doubt that if this reduction were made the Board would sanction the immediate commencement of the work

Mr. Jones urged that it was the duty of the Board to have accepted the lowest tender at first. If this course had been followed none of their present trouble would have arisen.

Football.—The return match between teams representing the Witton works of the General Electric Co. and the Robertson Electric Lamp works, was played on Saturday at Witton, resulting in a victory for the home club by three goals to none. After the match Witton Club entertained the visitors at dinner, when the toasts of the "Robertson Football Club" and the "Witton Works Football Club" were proposed by their presidents, Mr. C. Wilson and Mr. Railing. A smoking concert followed.

Dinners.—The third annual dinner of the Northampton Institute day students was held on the 6th inst. The chair was occupied by Mr. G. Van Vestraut, and among others of the staff present were Principal R. Mullineux Walmsley, D.Sc., Dr. C. V. Drysdale and Mr. C. E. Larard.

The annual dinner of the athletic club and employés of Croydon Tramways department took place on Friday last.

The general manager (Mr. T. B. Goodyer) occupied the chair, and among the visitors were Mr. Jas. Devonshire, chairman of the Tramways company, Mr. H. B. Harris, engineer, Mr. C. G. Foster, superintendent, and a number of the borough officials. The prizes were presented by Mr. Devonshire.

Mr. Goodyer said that in the past year the wages of the department amounted to £20,000, the rental paid to corporation was £15,404, cost of current was £12,077, and rates and taxes came to £2,120. The population of Croydon was carried 99·11 times.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1905 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date (to Feb. 22), and the Directorial Division of the new volume has been corrected up to February 11th, 1905. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. The number of large sheet Tables, &c., has been increased, and the 1905 Edition of this indispensable work is offered as the most complete book of the kind ever published.

Among the chief features of the Handbook Division are Notes of the Year on Electric Traction and Electric Power, Turbine Notes, Electric Lamp Notes, Wireless Telegraph Notes (very full), Parliamentary Summary, Legal Decisions, and a complete set of all the chief documents used by Government Departments affecting the Electrical Industry (including the new "Special Mining Rules," issued Feb. 22).

TENDERS INVITED.

Fulham (London) Borough Council invite tenders for supply and erection of condenser piping, sump and river work, steel roof and bunker work, and coal conveying apparatus. Specifications, &c., from the borough electrical and consulting engineer, Mr. Arthur J. Fuller. Tenders to the town clerk (Mr. R. M. Prescott), Town Hall, Fulham, S.W., by noon 26th inst. See also an advertisement.

Glasgow Corporation invite tenders for 1,000kw. motor generators, switchgear, condensing and coal conveying plant, and feed pumps. Specifications, &c., from the chief electrical engineer (Mr. W. W. Lackie), 75, Waterloo-street, Glasgow. Tenders to Mr. John Bowers, town clerk, by May 2. See advertisement.

Glasgow Corporation also invite tenders for main cables, electricity meters and carbons for 12 months from 31st prox. Tenders to Mr. John Bowers, town clerk by 17th inst.

Glasgow Corporation also require tenders by 17th inst. for supply of cast-iron joint-boxes for the Electricity department.

Glasgow Corporation also want tenders by 5 p.m. 19th inst. for supply of fuel for Pinkston power station and the tramway depots.

Edinburgh Corporation invite tenders for supply and erection of water tube boilers at the M'Donald-road electricity works. Specifications, &c., from the chief engineer (Mr. F. A. Newington) after 19th inst. Specifications and drawings can be seen at, but not obtained from, the office of the consulting engineer (Dr. A. B. W. Kennedy), 17, Victoria-street, London, S.W. Tenders to the town clerk (Mr. Thomas Hunter), City Chambers, Edinburgh, by May 8. See also an advertisement.

Wimbledon District Council invite tenders for supply and erection of a 1,000kw. steam-driven turbo-alternator, with condensing plant, high-tension switchboard and pipe work, and are prepared to accept one tender for the whole of the work. Tenders addressed to the offices of the chief electrical engineer (Mr. H. Tomlinson-Lee), chairman of Electric Lighting committee, Durnsford-road, Wimbledon, before noon 28th inst.

Wigan Corporation invite tenders for steam dynamo and accessories, steam and water piping, ejector condenser and motor driven, centrifugal pump; paper and lead-covered, dry-core telephone, paper and lead-covered twin-service and vulcanised-rubber cables. Tenders to the town clerk (Mr. Harold Jevons), by noon 17th inst.

Cardiff Corporation invite tenders for extra high-tension three-phase main switchboard for power station, switchboards for sub-stations, motor generators, rotary converters, &c. Tenders to the town clerk (Mr. J. L. Wheatley), Town Hall, Cardiff, by April 17.

Tenders are invited for the supply of a surface condenser with electrically-driven pumps for *Devonport* electricity works. Tenders to the borough electrical engineer (Mr. J. W. Spark), Electricity Works, East Stonehouse, Devon, by April 18.

Woolwich Guardians invite tenders for wiring Woolwich Union Infirmary and Nurses' Home, and for supplying fittings. Tenders to the clerk (Mr. Tom Cutter), 30, Rectory-place, Woolwich, S.E., by 4 p.m. April 19.

Luton Town Council invite tenders for supplying and erecting certain plant and machinery at the electricity works, Luton. Tenders to the town clerk (Mr. Geo. Sell), Town Hall, Luton, by 4 p.m. May 19.

Batley Corporation invite tenders for permanent-way construction and paving of Bradford-road tramway route, overhead equipment, steel poles, &c., feeder cables, conduits and accessories. Tenders to the town clerk (Mr. Jos. Hanson Craik) by April 17.

Govan Town Council require tenders by 25th inst. for 12 month's supply of stores for the electricity department, including cables, meters, house fuse boxes, arc lamp carbons, joint boxes, motors, &c.

Wallasey District Council require tenders for twelve months' supply of stores for their Ferries department, including electric globes and carbons, lamps, iron, steel, tubing, engineers' stores, &c. Tenders by 10 a.m. May 8.

Bristol Docks committee require tenders by 10 a.m. May 1 for supply (and maintenance for 12 months) of two electric goods lifts and one electric passenger lift.

Portsmouth Corporation require tenders by noon, May 1, for 12 months' supply of various materials and stores for the tramways department.

Bournemouth Corporation require tenders by 10 a.m. 20th inst. for steel poles, overhead line, section boxes, &c., for the tramway department.

Aberdeen Corporation invite tenders for one surface condenser with air pump, oil separator, &c. Tenders to the city electrical engineer (Mr. J. Alex. Bell) before noon April 19.

Stockport Gas and Electricity committee invite tenders for supply of a 500kw. steam generator. Tenders to chairman of committee by April 26.

Hull Corporation invite tenders for air-space telephone cable. Tenders to the town clerk (Mr. E. Laverack), by 10 a.m. April 17.

Swindon Corporation require tenders by 10 a.m. April 17 for three years' supply of electric motors.

Tenders are wanted by 29th inst. for an electric light installation for the hall to be used at the Argyllshire gathering at *Oban*. Mr. Alex. Shairp is secretary.

Johannesburg Municipal Council invite tenders for supply and erection of switchboards and accessories for their new direct and alternating-current power station. Specifications from and tenders to the consulting engineers (Messrs. Mordey & Dawbarn), 82, Victoria-street, Westminster, S.W., by noon April 27.

The Commonwealth authorities invite tenders up to noon 7th June for the supply of telegraph stores and material, including 6 tons sulphate of magnesia, 3 tons sal ammoniac, 5,000 shackle heads, 5,000 battery corks and tubes, 14,000 battery zincs, 9,000 battery leads, 2,000 battery binding screws, 10 miles No. 16 tinned copper insulated wire, 10 miles No. 18 ditto, 4 miles No. 20 ditto, and 600 yards 12 pair submarine cable. Tenders will be received at the office of the Acting Deputy Postmaster-General, Adelaide, and may be for the whole or any proportion of the materials required. Specifications, &c., can be seen and forms of tender obtained at the General Post Offices at Adelaide, Melbourne, Sydney and Brisbane.

Tenders will be opened at the Casas Consistoriales, *Baez*, Spain, on May 27th, for a concession for the electric lighting of Baez for a period of 10 years, commencing August 4th next. The "Madrid Gazette" for April 3 contains additional particulars.

At noon, April 26th, at the office of the Director-General of Public Works, *Madrid*, tenders will be opened for a concession for an electric tramway in that city. Application for the concession has already been lodged by the Madrid Eastern Tramway Co., who (for an equal offer) will enjoy preferential rights over other tenderers. The "Madrid Gazette" of April 5 contains further particulars.

Kiskunfelegyhaza (Hungary) Municipal Council invite offers for concession for erection, equipment and running of electricity works, or, alternatively, for erection of generating station to be taken over and managed by the municipality. Distribution on the continuous-current 3-wire system at 200 volts. The public lighting required at the outset will be 16 12 ampere arcs and 600 16 c.p. incandescents. A demand by private consumers equivalent to 5,000 16 c.p. lamps is to be provided for. Further information from the Burgermeister's office. Offers by May 15.

TENDERS RECEIVED AND ACCEPTED.

Condensing Plant Contracts.—Among the contracts for condensing plant secured last month by the Worthington Pump Co. were the following:—

Fulham Electricity Station: One complete condensing set to deal with 20,000lb. of steam; Milan Electricity Station: One complete condensing set: Belfast Tramways: Three oil separators, each to deal with 20,000lb. of steam (repeat order); Pekin Electricity Station: One separator.

The following tenders for supplies to the electricity and tramway departments have been accepted by Salford Corporation:—

F. Smith & Co., six drums of copper trolley wire, 9d. lb.; W. T. Glover & Co., cable (Ship Canal Dock), £1,918; Johnson & Phillips, rubber insulated fire-resisting cable, £265. 10s.; Tudor Accumulator Co., repairs and renewals of storage batteries, £820; Baxendale & Co., car accessories (electrical and mechanical), Brockie Pell Arc Lamp (Ltd.), arc globes at 5s. 3d. each; Electrical Co., two 600 ampere and two 300 ampere meters; Howard Conduit Co., asphalt troughing; British Insulated and Helsby Cables, house fuse boxes, rubber solution, pure rubber strip, compound for cable joints, plumbers' metal and mica sheets; Doulton and Co., pipes and conduits; General Electric Co., arc lamps, carbons, screwed tubing, cut-outs, Angold arc lamps, high and low speed motors (½, 1, 2, 3 and 5 H.P.); United Asbestos Co., packings, pure asbestos, twine, tape, millboard, cloth and rubber insertion, and salamander joint rings; Kenyon and Co., sight feed glasses and boiler gauge glasses; Andrews & Co., copper binding and fuse wire, tin foil, rubber gloves, boiler gauge cones and sight feed rings; Western Electric Co., lead-covered single and twin cables; St. Helens Cable Co., workshop flexible cables; C. Macintosh & Co., rubber insulated cable; Siemens Bros. & Co., black tarred and white tape; Rowland Carr & Co., Trinidad bitumen, 5s. 2d. cwt.; Simplified Underground Conductor Co., asphalte concrete, £2. 1s. 9d. per ton; Reason Mfg. Co., house meters (2½, 5, 10 and 25 amperes); Ferranti (Ltd.), house meters (25, 50, 75 and 100 amperes); Chamberlain & Hookham, house meters (50, 75 and 100 amperes); Lancaster and Tonge, disconnecting boxes, 10s. cwt.; Supplies (Ltd.), incandescent lamps; Sperryn & Co., tumbler and link switches; Veritys (Ltd.), double-pole main switches; Royce (Ltd.), high-speed motors (7, 10, 15, 20, 25 and 30 H.P.); Lancashire Dynamo and Motor Co., high-speed motors (7, 10, 15, 20, 25 and 30 H.P.), low-speed ditto (7, 10, 15, 20 and 25 H.P.); Grant & Aldercroft, creosoted wood troughing.

Colchester Town Council have placed an order with the Harris Patent Feed-Water Filter (Ltd.) at £440 for a patent feed-water filter, capable of dealing with 4,000 gallons of water per hour during 8 hours per day continuously, and 1,000 gallons per hour for the remainder of the day.

Mr. F. A. Anderson, who attended the meeting of the Electric Light and Power committee by invitation, explained in detail the working of the patent feed-water purifier, and gave demonstration of the process and effect of purification. On the figures supplied by the borough electrical engineer (Mr. A. R. Sillar), Mr. Anderson estimated that, by using the filter, a saving of about £370 per annum would be effected in the water bill and in other ways, and said that his company were prepared to definitely guarantee that at least 60 per cent. of that sum would be saved.

Marylebone Electric Supply committee has received the following tenders:—

For supply, erection and connecting up of 880yds. of 2 sq. in. and 440yds. of 1 sq. in. fire-resisting cables. St. Helens Cable Co. (*provisionally accepted*), £1,381; W. T. Glover & Co., £1,723. 0s. 10d., British Insulated & Helsby Cables, £1,732. 10s., Siemens Bros. & Co., £1,779. 12s., W. T. Henley's Telegraph Works Co. £1,901. 3s. 4d.

For supply of cards and cabinets required for working the sections of the department on the card system: Shannon Limited (*provisionally accepted*) £189. 10s., Library Bureau £208. 10s., Library Supply Co. £217. 16s.

Fulham (London) Council have accepted the following tenders for annual supplies of engineer's stores for the Electricity undertaking:—W. H. Wilcox & Co., asbestos goods; J. Gibb & Co., rubber goods and street lighting (excepting arc lamp globes); General Electric Co., carbons; British Insulated and Helsby Cables, service boxes (excepting house fuse boxes).

The Electrical Co. has recently obtained a contract for the electrification of the Penhriw Colliery, Pontypridd, which includes supply of the following:—High-tension transmission lines, sub-station equipment, switchboards, power and lighting transformers, motors for electric haulages and dip pumps, motor-generator and motor-driven high-lift centrifugal pump.

The tender of the Electrical Co. has also been accepted by the Mersey Dock and Harbour Board for supply and erection of arc lamps, posts, cables, &c., required for lighting the entrance to Sandon Dock, the north and south passages to Huskisson Dock and the Huskisson Dock and branches.

The Electrical Co., 121-125, Charing Cross-road, London, W.C., have just completed the contract for supply of a high-tension electrical pumping plant with high-lift centrifugal pumps at Bolckow, Vaughan & Co.'s Shildon Lodge Pit. This plant is claimed to be the largest of its kind installed in England.

Shoreditch (London) Council have accepted the following tenders for annual stores, &c., for the electricity supply department:—

Cables and Sundries: Johnson & Phillips, Western Electric Co. and Siemens Bros. & Co. Engineer's Stores: Jas. Gibb & Co. and Middleton Bros.

Bolton Tramways committee have accepted tenders for annual stores from the General Electric Co., the Robertson Electric Lamps, Bolton Corporation Fittings Department, R. W. Blackwell & Co. and the Electric Tramway Equipment Co.

Swindon Town Council have accepted tenders from Ed. Bennis & Co. for a mechanical stoker at £127. 10s.; from Siemens Bros. &

Co. for rewinding armatures of motor generator at £46. 8s. 6d. each; and from W. & T. Avery for a 10-ton weighbridge at £70.

Yarmouth Corporation have accepted the tenders of Willans & Robinson for a steam alternator at £2,358, Babcock and Wilcox for boiler at £1,500, G. & J. Weir for condensing plant at £1,400, and of the British Insulated & Helsby Cables for cables at £911. 17s. 10d.

Birmingham Corporation have placed an order with Hadfield's Steel Foundry Co. for the steel points and crossings required in the lay-outs and special work of the new tramways.

Salford Corporation have placed with R. J. Nicholson & Co. a contract for the electric lighting of Seedly schools and supply of the necessary fittings.

Stalybridge, Hyde, Mossley & Dunkinfield Tramways & Electricity Board have placed an order for five tramcars with the British Westinghouse Co.

At a meeting of the Dundee, Broughty Ferry and District Tramways Co. on Tuesday the contract with J. G. White & Co., for the construction of the lines, was sealed.

Lowestoft Town Council have accepted the tender of Babcock & Wilcox for a boiler and superheater, with brickwork settings, &c., at £1,387.

Bury (Lancs.) Town Council have accepted the tender of Chas Walmsley & Co for a condenser.

Leith Corporation have placed an order with Ferranti Limited for a traction switchboard.

Southwark (London) Council has placed an order at £97. 5s. with the British Insulated and Helsby Cables, for 440yds. of ·1 cable.

Battersea (London) Council has placed an order with C. A. Parsons & Co. for a spare armature at £573.

Melbourne (Australia) City Council have placed an order with the Austral Otis Co. for supply of 160,000 flame arc-lamp carbons at £553. 18s. 9d.

BUSINESS NOTICES.

Capt. Sankey, R.E. (retired), M.Inst.C.E., and Mr. G. P. Mair, A.M.Inst.C.E., announce that they have entered into partnership, and are prepared to undertake consulting work; also to carry out complete mechanical and commercial efficiency tests of steam and gas engines, petrol engines, boilers, dynamos and other mechanical appliances, and to advise on improvements and fuel economy in factory power plants. The address of the new firm is 6, Dean's-yard, Westminster, S.W.

The transfer of the business of the British Schuckert Electric Co. (Ltd.) to Siemens Bros. & Co. (Ltd.) has been completed, and Mr. Arthur Jacob, general manager of the former company, has entered the service of Siemens Bros. & Co. Future communications concerning the transfer should be addressed to York Mansions, York-street, Westminster, S.W.

We are informed that the Verkaufsstelle der Deutschen Gas und Siederohrwerke (G.m.b.H.) have appointed Chas. Hatton & Co and Edward Lomer, of London, sole agents for Great Britain and Ireland. The Trust controls the entire output of 20 of the leading German works in wrought-iron tubes up to 4in. diameter.

Messrs. Harry William Sutton and Geo. Aaron Benton, electrical engineers, 8, The Exchange, Muswell Hill, N., and 14, Windmill-street, London, W., have dissolved partnership. Debts by Messrs. Miller & Smiths, solicitors, 8, Salter's Hall-court, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

The adjourned first meeting of creditors of James Tarbotton Armstrong, electrical engineer, Moorgate Station Chambers, London, E.C., was held yesterday.

For the last 10 years debtor has carried on business as an electrical engineer, and has been engaged on various inventions for wireless telegraphy and telephony and the navigation of torpedo boats, for which many patents were granted. In October, 1902, he assigned the bulk of the patents to a company, and, as vendor, received £120,000 in shares. The company, of which he is managing director, has been engaged in the construction, development and demonstration of apparatus, and in attempting to dispose of licences to use its patents, but so far it has not been a financial success. Debtor attributes his failure to inability to realise his household effects, a large part of which consisted of antique furniture, prints, curios, &c., and to obtain repayments of moneys paid by him on behalf of the company. Liabilities were returned at £6,933, of which £4,845 were unsecured, with an estimated surplus in assets of £7,101.

Harry Thorpe, electrician, &c., 11, Bartholomew-villas, Kentish Town-road, N.W., and late of 235, High Holborn, W.C., and Eden-grove, Holloway, N., London, has been adjudicated bankrupt. The first meeting of creditors will take place on 19th inst. and the public examination on May 16 at Bankruptcy-buildings, London, W.C.

John Morley, electrician, &c., 7, North-street, Hull, has been adjudicated bankrupt.

Claims against Charles Aubrey Smith, electrician, 23, King-street, Regent-street, W., and 6, Granard-road, Wandsworth, S.W., London, by 20th inst. to Mr. R. J. Ward, 2, Clement's Inn, London, W.C.

In the winding-up of the Automatic Telephone Co. (1900), Ltd., Mr. Max Margowski is to be examined on April 17 at Bankruptcy-buildings, London, W.C.

The Electrical Treatment Association (Ltd.) is to be wound up voluntarily. Mr. H. A. Maw, 4, Harrington-street, Liverpool, is liquidator.

A meeting will be held on May 8 at 3, Princes-street, Westminster, S.W., to receive an account of the winding up of the Rangoon Electricians Synd. (Ltd.).

Sales by Auction.—Messrs. Scottorn & Smedley have been instructed by the trustee (Mr. A. G. Mellors, C.A.), under a deed of assignment, to sell by auction at 65, Alfreton-road, Nottingham, on Wednesday next, April 19, at 11 a.m. prompt, the stock-in-trade of an electrical engineer, including dynamos, motors, testing set, electroliers, pendants and brackets, casing, cable, lamps, shades, switches, &c. Catalogues from Messrs. Mellors, Basden & Mellors, Bridlesmith-gate, Nottingham, or of the auctioneers, 86, Upper Parliament-street, Nottingham. See also an advertisement.

Electric Lamps for Sale.—In the liquidation of the Sir Hiram Maxim Electrical & Engineering Co. (Ltd.), 44, Gillingham-street, Pimlico, London, S.W., tenders are invited (by order of the Court) for purchase of about 500,000 high-class incandescent lamps, for voltages ranging from 80 to 280 and from 2½ c.p. to 32 c.p. Catalogues and forms of tender may be obtained from Messrs. W. H. Smith & Son, solicitors, Gresham House, London, E.C., Messrs. Lumley & Lumley, solicitors, 15, Old Jewry-chambers, London, E.C., or the auctioneers, Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., and Albert-square, Manchester. Tenders must be in by April 14. See also an advertisement.

Plant for Sale.—Messrs. Kynoch (Ltd.), Witton, Birmingham, have for sale some electric lighting plant, including three electric generating sets. See an advertisement.

Mr. James R. Cull, Newton Abbot, Devon, has for sale some electric lighting plant, including Crompton dynamo, horizontal engine, arc and hand lamps, pendants, switch and distributing boards, cable, &c. See also advertisement.

Some electric lighting plant, including gas engine, dynamo and accumulators, is advertised for sale in another column.

A 15 B.H.P. Laval steam turbine is for sale. Apply to engineer-in-chief, St. James's Gate Brewery, Dublin. See advertisement

Factory Sites for Sale.—A freehold factory recently completed, with all the L.C.C. requirements, fireproof construction, electric lift, &c., and with buildings covering an area of about 15,700ft., is advertised for sale in another column.

John W. Collis & Co., 143 and 144, Holborn Bars, London, E.C., have for sale some conveniently situated and well appointed freehold factory premises at Belvedere, Kent. See an advertisement.

Catalogues, &c.—The Electrical Co. have ready a specification of single, two and three-phase motors of semi-enclosed (protected), ventilated-enclosed or totally-enclosed types. These motors have been designed to meet the demand for machines occupying small space, of light weight and with large over-load capacity, together with high efficiency, large starting torque, high power-factor and low temperature rise. A special feature of the machines is the comparatively small diameter of the rotor, in consequence of which its inertia is reduced to a minimum. The specification is fully illustrated.

Siemens Bros. & Co. forward particulars of the "Vilex" completely-enclosed watertight electric bell. The accompanying illustration shows the bell one-fourth size. It is claimed that this bell is suitable for working in mines, chemical factories, powder mills, on board ship, and under water. The whole of the mechanism is contained within the gong, the latter being made to form a hermetically-sealed case, into which the leads enter through a stuffing-box, which is not subjected to movement.

A very effective sheet list of the most used parts of Simplex fittings is issued by the Simplex Steel Conduit Co., who will be pleased to supply copies of this sheet to the trade on request. A short classified list of Simplex conduits and accessories is given.

Ferranti Limited have ready a new list (No. 11), illustrating the Ferranti 11in. round-type moving-coil instrument for continuous current. The list is illustrated, and contains a specification of the instrument.

B.T.-H. voltage regulators for alternating and continuous-current generators are described and illustrated in pamphlet 178 issued by the British Thomson-Houston Co. In pamphlet 179 generating and sub-station switch gear is fully described. Some very effective illustrations of switch-gear equipments are given.

A revised list of "Lundell" and "Castle" motors is issued by J. H. Holmes & Co., Newcastle-on-Tyne.

Switch fuses for all currents up to 1,000 amperes are illustrated on a hanging card being sent out by Cecil Hodges & Co.

The Hunt noiseless conveyor is very fully illustrated and described in a pamphlet issued by the C. W. Hunt Co. of New York.

Calendars.—We have received from the Western Electric Co. a serviceable March-to-March hanging calendar, upon which some good illustrations of the company's works and of some of the specialities manufactured thereat are shown.

Imports.—The following are official values of imports of electrical machinery, material and apparatus into this country during March :—Electrical machinery £48,174 (a decrease of £4,742 compared with March, 1904) ; telegraph cable and apparatus, £2,911 (increase £380) ; other electrical goods, £85,728 (increase £17,098). The total values of imports of the three classes for the three months ended March 31 last were, respectively, £126,498 (decrease £12,838), £20,059 (increase £10,813) and £242,221 (increase £34,161).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from April 5 to April 11, with the ports of destination :—

Aden—£32 (telegraph material). *Africa*—Alexandria, £67 (telegraph material) ; Beira, £8 ; Cape Town, £109 ; Delagoa Bay, £10 (telegraph material) ; Durban, £3,662 (including £325 telegraph material) ; East London, £35 ; Mombasa, £197 (including £152 telegraph material) ; Port Elizabeth, £525 (including £214 telegraph material). *Argentina*—Buenos Ayres, £284 (including £129 telegraph material) ; Rosario, £67. *Australasia*—Adelaide, £72 (including £13 telegraph material) ; Auckland, £165 ; Fremantle, £234 ; Hobart, £180 (telegraph material) ; Melbourne, £445 ; Perth, £287 ; Sydney, £318 ; Wellington, £380. *Belgium*—Antwerp, £2,425 ; Ostend, £29. *Burma*—Rangoon, £63. *Canada*—Halifax, £4,460 (telegraph material). *Ceylon*—Colombo, £36. *China*—Shanghai, £98 ; Tsingtau, £135. *Cochin China*—Saigon, £97. *Holland*—Amsterdam, £124 ; Rotterdam, £56. *Hong Kong*, £249 (including £85 telegraph material). *India*—Bombay, £1,766 ; Calcutta, £1,971 ; Madras, £51. *Japan*—Moji, £237 ; Yokohama, £71. *Russia*—Reval, £60 ; Riga, 70 ; St. Petersburg, £1,070 (telegraph instruments). *Siam*—Bangkok, £24. *Spain*—Bilbao, £158. *Straits Settlements*—Singapore, £154. Total £20,781 against £17,973 for twelve days last year (April 1 to 12).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1904.

4,937 Andrews and Manufacturing Electric Co. Arc lamps.
5,064 Demmo. Electrical working of signals, &c., on railways.
5,294 Kiewehr. Electric alarms.
5,374 Björnstad. Electric gear for controlling lifts or hoists.
6,690 Bush. Electrically-controlled lifts.
7,312 Lake (Risso). Lightning arresters.
7,428 Tierney and Malone. Moving electrically points on electric tramways.
7,660 Levis (G.E. Co., U.S.). Arc lamps.
7,676 Lee. Telephonic communication.
8,054 Dearlove. Apparatus for transmitting and reproducing sounds.
8,064 Jacobs. System of working single lines of railway.
8,922 Haywood and Brounger. Automatic circuit-breakers for controlling motors.
9,660 B.T.-H. Co. (G.E. Co., U.S.). Starting devices for electric motors.
9,841 B.T.-H. Co. (G.E. Co., U.S.). Commutators for dynamo-electric machines.
9,842 B.T.-H. Co. (G.E. Co., U.S.). Resistance units and making same.
9,844 B.T.-H. Co. (G.E. Co., U.S.). Vapour electric apparatus.
9,844 Soar and Joel. Controller for electric motors.
10.019 B.T.-H. Co. (G.E. Co., U.S.). Dynamo-electric machines.
11,604 Wilson. Dynamo-electric machines. (Date applied for, June 1, 1903.)
11,832 Von Recklinghausen. Vapour electric apparatus for rectifying alternating currents.
12,076 Wall and Goldstone. Insulating cases carrying switches, fuses, &c.
15,061 Thomson (Wetherby Electric & Mfg. Co.). Signalling apparatus.
21,995 Birnbaum and White. Intercommunication telephone systems.
22,813 Ernst Heinrich Geist Elektrizitäts Akt.-Ges. Scraper for electro-magnetic separator. (Date applied for, Jan. 18, 1904.)
22,326 Justice (Voltage Controller Co.). Controllers for electric motors.
23,001 Scott. Automatic switches.
23,182 Hopkinson. Electric fire alarms. (Date applied for, April 15, 1904.)
24,675 Ransford (American Electric Brake Co.). Electric brakes.
25,378 Lake (Electric Radiation Co.). Electric spark-gap apparatus for high-frequency current.
25,382 Lake (Electric Radiation Co.). Rotary spark-gap apparatus for high-frequency current.
26,098 Eastwood. Electric current controlling systems. (Date applied for, June 4. 1904.
26,699 Eastwood. Electric motor-control systems.
26,917 Whitney. Electrodes for arc lamps. Date applied for, Dec. 10, 1903.)
27,185 Sorg. Electric couplings.
27,538 Steinmetz. Means for transforming direct current into multiphase alternating current. (Date applied for, Dec. 17, 1903.)
27,860 Gardiner. Forming tank for accumulator elements.
27,916 Hindersin. Locking apparatus for watchman's electric controls and the like.
28,155 Phœnix Dynamo Mfg. Co. (Pohl and Pohl). Dynamo electric machines.
28,156 Phœnix Dynamo Mfg. Co. and Pohl. Construction and ventilation of field coils of dynamo-electric machinery.
28,350 Hooper. Attachment for use with suspended electric lamps.
28.369 Harrison (Guett). Switches.
28,409 Fairweather (Marquette Electric Co.). Arc lamp.
28,852 Hepworth-Collins. Conduit for cables and wires.

COMPANIES' MEETINGS AND REPORTS.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.)—Mr. J. B. Concanon stated at the meeting on Tuesday that during 1903 the increase in receipts was £74,000, and they had during 1904 increased receipts of £89,000. Working expenses showed an increase of £53,102, and the net increased profit was, therefore, £35,937. Working expenses worked out in 1904 at 54·42 per cent., as against 53·10 per cent. in 1903. The traffics for this year up to March 25 showed a total increase of £13,685.

BABCOCK & WILCOX (LTD.)—At the meeting on Tuesday Mr. John Dewrance, in moving the adoption of the report given in our last issue, said that the most interesting point was the fact that the company had made a profit of £289,784. This profit of the past year must be regarded to some extent as abnormal. The company was an industrial concern, and while it had had an exceptionally good period of trade last year, it had to be prepared to meet the heavy competition to which all industrial concerns were subjected. There was the competition of the internal combustion engines and new types of water-tube boilers. The success that the company had met with, however, was not necessarily due to the particular type of boiler it made, but largely to the exceptionally successful management of the concern, and also to the fact that the company did not confine itself entirely to boilers. The company's marine boiler business was rapidly growing, but they were really only just making a commencement in that business. The results so far had been very satisfactory. No less than 12 ships in the British Navy had been, or were being, fitted with the company's boilers.

BARCELONA TRAMWAYS CO. (LTD.)—The traffic receipts for 1904 were £103,698, increase £15,400. Working expenses were £63,054, increase £1,333, leaving a profit (Barcelona) of £40,790, increase £14,171. £3,940 had been received from the Ensanche Co., increase £1,368. The proportion of working expenses to receipts was 59·57 per cent. in 1903 and 53·49 per cent. in 1904. Interest and sinking funds had absorbed £16,600, interest on loans £723 and preference dividend £5,000. The directors had placed a further £10,000 to renewal fund and recommend a dividend on the ordinary shares of 12s. per share (6 per cent.).

BRITISH ALUMINIUM CO. (LTD.)—The profit for 1904 is £53,411. 8s. 11d. After deducting the debit balance (£3,837. 17s. 10d.) from 1903 and interest (£15,000), the balance is £36,573. 6s. 1d. Out of this £3,949. 10s. 9d. has to be set aside for redemption of deferred commission warrants, leaving £32,623. 15s. 4d. One-fourth of this (£8,155. 18s. 10d.) will be applied in redeeming and cancelling £8,000 debenture stock, and the directors propose to apply the balance to the payment, on July 1 next, of the deferred warrants issued for arrears of preference dividend to Dec. 31, 1902 (£10,169. 11s. 9d.), a dividend of 6 per cent. on the A preference shares for the two years 1903-1904 (£11,983. 8s. 4d.), a dividend at rate of 7 per cent. from Nov. 22, 1904, to Dec. 31, 1904, on the 7 per cent. preference shares (£1,500), and a dividend of 7 per cent. for 1904 on the ordinary shares (£700), leaving £114. 16s. 5d. to be carried forward. To provide for the development of the Loch Leven power scheme, the capital has been increased to £500,000. The company's interest in the Loch Leven power scheme has been transferred to the Loch Leven Water & Electric Power Co., as that company must carry out the works under the terms of the Loch Leven Water Power Act. Plans and specifications for the scheme have been prepared by Thomas Meik & Sons, and have been submitted to Sir Alexander Binnie for approval. So soon as this has been obtained tenders will be invited for carrying out the works. The extension of the Foyers water power installation was completed in December. Since then the whole of the available power there has been employed in the production of aluminium, the demand for which continues to expand steadily.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The directors' report for the half-year ended Dec. 31 last states that the total receipts were £13,814. 19s. 8d., and expenses £8,368. 14s. 11d., leaving £5,446. 4s. 9d., added to £4,647. 2s. 5d. from last account, making £10,093. 7s. 2d. Preference dividend shares absorb £3,000, and the directors recommend a dividend at the rate of 5 per cent. on the ordinary shares (tax free). £3,093. 7s. 2d. is carried forward. The new cable contracted for was duly laid between Cienfuegos and Santiago de Cuba, and was taken over on Feb. 18. The Cape Cruz–Santiago cable has since been repaired and is now in good working order. The Cuban Government, having refused payment of the subsidy for the coast cables, the company's agent in Havana has been instructed to appeal to the Courts against the President's decision. The claim against the United States Government for payment of the cost of repairing the damage done to the cables during the Spanish-American War is still unsettled.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—At the meeting last week Ald. Spurgen said that they had had to put in a new turbine engine as well as a foundation for a second one. The station extensions had been carried out, as had also that of the mains. There was an increased connection of 10,110 8 c.p. lamps during the year and they now had 1,351 consumers, of whom 435 were taking current by means of slot meters. In the first three months of this year, they had added 3,957 8 c.p. lamps. It was proposed shortly to make a further issue of 4½ debenture stock to existing share and stockholders.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—At the recent meeting Dr. F. R. Russell stated that the gross receipts for the year had been £4,859. 15s. 11d., against £3,807. 7s. 7d. for 1903, and after paying preference dividend, debenture interest, &c., the balance was £438. 14s. 2½d., out of which the directors recommended a dividend of 3 per cent. on the ordinary shares. 211,374 units were sold last year, against 145,804 in 1903. The units sold for power in 1903 were 9,185 and in 1904 28,269. They had put on 86 new consumers. Further plant would be required, and the directors proposed to raise the necessary capital by issuing £25,000 5 per cent. debentures, paying off the existing £15,000 6 per cent. debentures and a bank draft for about £6,000.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—The report of the directors for the year ended Dec. 31 last, states that the agreements between the Postmaster-General, the Imperial German Post Office and the company, for the leasing of land wires in this country and submarine cable wires between Lowestoft and the German coast, have now been finally concluded. The lines of the company continue to work efficiently, and the direct Wheatstone working now in operation between London (Manchester and Liverpool) and Teheran [described in *The Electrician* for Jan. 13, 1905] as well as over the company's direct wires to and from South Russia, and over the company's direct line for Continental telegrams from Berlin to and from Teheran, for the East, enables the traffic to be carried with a maximum of speed and accuracy. The retirement trust fund, constituted by consent of the shareholders, has been duly established, and the amounts voted handed over to the trustees. The company's revenue for the year from all sources amounted to £141,400. 17s. 2d., compared with £139,094. 10s. 1d. for 1903, an increase of £2,306. 7s. 1d. The total expenses were £71,930. 1s. 10d., against £68,893. 16s. 5d., increase £3,036. 5s. 5d. Revenue therefore shows a balance of £69,470. 15s. 4d., which is carried to profit and loss. Bringing forward £16,365. 17s. 3d. from 1903, and deducting income tax (£3,944. 19s.) and interim dividend (£10,625) there remains £71,266. 13s. 7d. The directors propose a dividend for the six months ended Dec. 31 of 17s. 6d. per share (making 6 per cent. for year) and a bonus of 20s. per share, both tax free. They propose to add £15,000 to the equalisation of dividends fund, and to hand over a further £5,000 to the trustees of the retirement trust fund, carrying forward £19,391. 13s. 7d. The directors do not consider it necessary on this occasion to re-invest for the benefit of the reserve fund interest accrued during 1904 upon the investments representing that fund, and therefore propose to make a special distribution to the shareholders from this source of £12,750, equivalent to 15s. per share, tax free. To the very great regret of his colleagues, Mr. W. S. Andrews has resigned his seat on the Board, owing to failing health, having served as manager and secretary, managing director, and director. The company largely owes its present position to Mr. Andrews' knowledge, tact, and unfailing energy, placed ungrudgingly at its disposal over the long period of 34 years. Sir Francis Mowatt, G.C.B., joins the board in Mr. Andrews' place.

KIDDERMINSTER & DISTRICT ELECTRIC LIGHTING & TRACTION CO. (LTD.)—Mr. W. L. Madgen, at the meeting last week, stated that, as the directors could not come to terms with the Council in regard to the Kidderminster to Bewdley line, they had now given the Council notice that they did not intend to ask for an extension of the order. Recently the company had made a satisfactory arrangement with the British Electric Traction Co. by which the latter had taken over 27,500 of 4½ per cent. debenture stock at par. The Great Western Railway had commenced to run motor cars between Kidderminster and Stourport, but they did not apprehend that their traffic would be affected by such competition.

MARKET DRAYTON ELECTRIC LIGHT & POWER CO. (LTD.)—At the meeting on Wednesday Mr. R. C. Donaldson Hudson said that during 1904 the number of lamps connected had increased from 4,759 to 7,161 8 c.p. The net profit was £552.

MELTON MOWBRAY ELECTRIC LIGHT CO. (LTD.)—At the recent meeting the report for 1904 stated that the number of lamps connected had increased from 11,028 to 13,543 at the close of the year, an increase of 22 per cent., the number of consumers now totalling 469. The public lighting contract had again been secured for 5 years further. Out of the profits of the year the directors recommended a dividend on the ordinary shares of 2½ per cent.

METROPOLITAN ELECTRIC TRAMWAYS (LTD.)—The total revenue for 1904 amounted to £113,254. 3s., including dividends on shares held by the company, and interest on advances made to the North Metropolitan Electric Power Supply Co. Gross traffic receipts amounted to £81,845 9s. 8d., compared with £66,973. 1s. 9d. for the previous year. The lines now working by electric traction were not opened until the second half of the year. After deducting all expenses chargeable to revenue, the surplus was £32,283. 9s. 9d. Preference dividend amounted to £25,000, and after providing for repayment to the British Electric Traction Co. of balance due under their guarantee of preference share dividend, the available balance was £3,854. 13s. 11d., which the directors recommend should be carried forward. The directors propose to make an issue of ordinary shares at par to holders of all classes of shares and to debenture stockholders. The company is now working 12½ miles of tramways and light railways by electric traction. The reconstruction of the remaining portions of the company's tramways is nearing completion. Another light railway (4½ miles), running along the Great North Road from Highgate Archway to North Finchley, will be ready for working shortly after Easter. The two light railways connecting the tramways of the Company with the Alexandra Palace are in course of construction by Middlesex County Council, and will, it is hoped, be ready for working during the summer. The tramways in Wood Green and Edmonton were purchasable under sec. 43 of the Tramways Act, 1870, in 1925, but agreements have recently been made with the local authorities extending the company's tenure until 1930.

POTTERIES ELECTRIC TRACTION CO. (LTD.)—At the meeting on Tuesday, Mr. G. F. M. Cornwallis-West said the traffic receipts, including receipts from parcels had increased. The latter traffic was engaging the attention of other tramway undertakings and in many instances it was on the model set by their company. It was probable that a combination would be formed whereby the different companies would be able to act as each other's agents in the districts they respectively serve.

PRIMITIVA GAS AND ELECTRIC LIGHTING CO. OF BUENOS AIRES (LTD.)—The report states that the balance of revenue and interest received from the Cia Allemaña Transatlantica Electrica amount to £115,386. The directors recommend a dividend of 6s. per share (6 per cent.) for the year on the ordinary shares, leaving £16,469 to be carried forward.

THAMES IRONWORKS SHIPBUILDING & ENGINEERING CO. (LTD.)—Mr. A. F. Hills at the meeting on Wednesday said the trade depression had affected them more lightly than other companies. They had contracts on hand exceeding by £1,500,000 those they held last year. The engineering works at Greenwich and Deptford had made a very large profit. Referring to the subject of turbines, he said he did not believe they would ever entirely supplant the reciprocating engine.

WESTERN UNION TELEGRAPH CO.—This company have issued their report for the quarter ended March 31, 1905. The following statement, dated March 8, shows the condition of the company at the close of the quarter ended Dec. 31, 1904:—

Surplus Oct. 1, 1904, as per last quarterly report ...		$15,434,862 80
Net revenues, quarter ended Dec. 31, 1904		1,872,965 91
From which deducting for—		$17,307,828 71
Dividend of 1¼ per cent. paid Jan. 15	$1,217,021 25	
Interest on bonded debt	297,550 00	
		1,514,571 25
Left a surplus Jan. 1, 1905, of		$15,793,257 46
The net revenues of the quarter ending March 31, based upon nearly completed returns for January, partial returns for February, and estimating the business for March, will be about........................		1,600,000 00
From which appropriating for—		$17,393,257 46
Interest on bonds		300,000 00
		$17,393,257 46
It requires for a dividend of 1¼ per cent. on capital stock issued, about		1,217,021 25
Deducting which leaves a surplus, after paying dividend, of..		$15,876,236 21

In view of the preceding statements, the committee recommend that a dividend of 1¼ per cent. on the capital stock of the company be declared.

WINDSOR ELECTRICAL INSTALLATION CO. (LTD.)—At the meeting last week Mr. H. L. Prior moved the adoption of the report for 1904, which stated that during the year 3,139 8 c.p. lamps were added, bringing the total to 31,025, of which 2,362 represent motors. The revenue from lighting was £11,484. 10s. 1d., and the total net profit, after providing for interest, was £4,485. 12s. 3d. The directors recommended that £1,000 be added to depreciation, renewal and reserve fund, and a dividend of 4½ per cent. (less tax) was recommended (making 7 per cent. for the year).

NEW COMPANIES.

EDINBURGH SUBURBAN ELECTRIC TRAMWAYS SYNDICATE (LTD.) (5,833).—Reg. in Edinburgh on April 3, capital £10,000 in £1 shares, to construct, lease or otherwise acquire, equip, maintain and work by electricity or other power, tramways between any part of Edinburgh or Leith and any places within the Counties of Midlothian, East Lothian and West Lothian, and to carry on the business of tramway, railway and omnibus proprietors, carriers of passengers and goods, &c.

RICHARDSON ELECTRICAL CO. (LTD.) (84,179).—Reg. April 6, capital £2,500 in £1 shares (1,000 preference), to carry on the business of electrical and mechanical engineers, electricians, suppliers of electricity, manufacturers of and dealers in all apparatus used in the generation, distribution, supply, accumulation and employment of electricity, &c., and to adopt an agreement with C. F. Richardson and E. H. Walker. First directors, F. C. F. Richardson, E. H. Walker, F. G. S. Ham and C. M. Samson. Reg. office, 16, Dorset street, London, W.

YORKSHIRE (WEST RIDING) ELECTRIC TRAMWAYS CO. (LTD.) (84,1[illegible]).—Reg. April 5, capital £[illegible] in £5 shares (70,000 preference), to adopt agreements with Yorkshire Electric Tramways Construction Syndicate and Wakefield & District Light Railway Co., and with Dick, Kerr & Co. and Yorkshire Electric Tramways Construction Synd., to construct, lay down, equip, work and maintain the tramway authorised by the Wakefield & District Light Railway Order, 1901, the Wakefield & District Light

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 8	1,194	− 61	45	59,628	+ 5,546
Airdrie	Mar. 31	179	− 5	13	2,499	− 2
Ayr Corporation	April 8	2 8	+ 72	47	13,357	+ 600
Barnsley	Mar. 31	163	− 13	13	1,967	+ 44
Barrow	" 31	105	+ 16	13	2,410	+ 393
Bath Electric Trams, Ltd.	April 5	618	− 220	14	7,636	+ 422
Birkenhead	...	...	...	...	...	...
Birmingham Corporation	" 8	362	+ 45	1	362	+ 45
*Birmingham & Mid.	Mar. 31	1,795	+ 296	13	21,791	+ 2,958
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	April 6	412	...	52	67,798	+ 6,468
Blackpool and Fleetwood	" 8	244	− 367	14	2,789	− 616
Blackp'l, St. Anne's & Lytham	" 8	170	− 480	23	3,152	...
Bolton Corporation	" 9	1,890	+ 10	2	2,525	− 461
Bournemouth Corporation	...	...	...	...	...	...
Bradford Corporation	" 8	8,958	− 678	1	8,958	− 678
Brighton Corporation	" 9	810	− 169	2	1,076	− 244
Brisbane Tramways	Feb. 15	2,841	+ 13	7	14,181	+ 470
	" 22	2,828	+ 94			
Bristol Trams & Carriage	April 7	4,526	− 196	9	40,815	− 691
Buenos Ayres & Belgrano	Mar. 5	3,174	− 243	21	18,879	− 498
	" 12	3,403	+ 380			
Buenos Ayres Elec. Trams	" 11	1,106	...	10	10,790	...
Burnley Corporation	April 8	1,127	+ 156	1	1,127	+ 156
Burton Corporation	" 9	301	− 62	11	396	− 62
Calcutta Tramways Co.	" 8	a40,874	+ a8,208	14	a567,534	+ a88,087
Camborne-Redruth	" 10	111	+ 7	29	2,407	− 190
Cardiff Corporation	" 8	1,807	+ 197	1	1,967	− 297
Carlisle Tramways Co.	" 5	177	− 54	14	2,043	− 381
Central London Railway	" 4	7,158	+ 486	14	100,865	+ 2,161
Chatham & Dist. Lt. Rys.	" 6	668	− 110	14	8,089	+ 896
*City of Birm'gh'm Tram Co	Mar. 31	5,7.0	+ 535	13	60,893	+ 4,301
City & South London Rly.	April 9	2,804	− 18	15	44,401	− 2,536
Colchester Corporation	" 6	169	..	10	7,152	...
Cork Electric Trams Co.	" 5	462	...	14	5,095	+ 225
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	Mar. 31	429	− 92	13	5,600	− 271
Dover Corporation	April 8	176	− 60	1	176	− 60
Dublin & Lucan Railway	" 7	104	− 83	14	1,337	− 8
Dublin Southern District	" 7	812	− 106	14	61,460	+ 921
Dublin United	" 7	3,805	− 218			
Dudley—Stourbridge	Mar. 31	819	+ 59	13	9,716	+ 891
Dundee Corporation	April 6	825	− 35	¶25	20,356	+ 364
East Ham Council	" 8	751	− 82	1	751	− 81
Gateshead & Dist. Trams	Mar. 31	862	− 48	13	11,145	+ 797
Glasgow Corporation	April 8	15,185	+ 1,136	†36	640,782	+ 34,087
Glossop	" 8	112	+ 11	14	1,522	+ 134
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	Mar. 31	102	− 37	13	2,124	− 248
Gt. Northern & City Rly.	April 8	1,619	+ 6 5	14	22,458	...
Greenock & Port Glasgow	Mar. 31	616	+ 187	13	6,747	+ 983
**Halifax Corporation	April 5	2,680	− 345	2	2,680	− 393
Hartlepool Tramways	Mar. 31	255	− 22	13	3,118	+ 12
Huddersfield	April 8	1,223	− 323	1	1,223	− 323
Hull Corporation	" 8	2,004	− 118	1	2,004	− 118
Ilford District Council	...	...	...	...	...	...
Ilkeston Corporation	" 5	116	− 70	1	116	− 70
Ipswich Corporation	" 8	418	+ 309	1	418	...
Isle of Thanet Co.	" 8	311	− 295	27	10,312	− 5,635
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	Mar. 31	96	− 7	13	1,172	− 27
Kilmarnock	...	...	...	...	...	...
Kirkcaldy Corporation	April 5	241	+ 7	5	1,080	+ 27
Lanarkshire Trams Co.	" 6	658	+ 48	14	8,703	+ 774
Leeds Corporation	" 8	5,476	− 519	2	10,947	+ 481
Leicester Corporation	" 8	1,964	...	14	25,406	...
Liverpool Corporation	" 1	10,[illegible]	+ 1,0.2	13	129,.55	+ 5,7.4
Liverpool Overhead Rly.	" 9	1,499	327	15	24,064	− 1,123
*London County Council	Mar. 31	11,249	+ 2,373	§53	669,907	+ 167,200
Lowestoft	April 8	119	− 75	14	1,700	...
Maidstone Corporation	...	...	...	...	...	...
Manchester Corporation	" 8	11,982	− 145	1	11,982	− 145
Mersey Railway	" 8	1,600	− 79	14	22,344	+ 1,289
Merthyr	Mar. 31	175	− 40	13	2,263	− 151
*Metropolitan Elec. Trams	" 31	2,320	+ 969	13	24,977	+ 10,901
Middleton	" 31	185	− 18	13	3,409	+ 100
Musselburgh	April 6	206	...	16	2,886	...
Nelson Corporation	" 8	123	+ 10	2	285	...
Newcastle-on-Tyne Corp.	" 8	3,005	− 189	14	49,628	+ 494
Newport (Mon.)	" 8	522	− 89	1	522	− 19
Northampton Corporation	" 7	371	+ 176	42	14,839	+ 7,326
Oldham, Ashton & Hyde	Mar. 31	516	− 76	13	6,836	+ 76
Oldham Corporation	April 9	1,452	+ 261	2	2,655	+ 646
Perth (W. A.) Elec. Trams	" 7	1,898	− 45	14	20,190	+ 1,171
Peterborough	Mar. 31	124	− 20	13	1,818	− 78
Pontypridd Dist. Council	April 8	166	...	1	166	...
Poole and District	Mar. 31	251	− 14	13	2,964	− 48
Portsmouth Corporation	April 8	1,606	− 562	1	1,606	− 562
Potteries	Mar. 31	1,918	+ 116	13	21,201	+ 549
Reading Corporation	April 6	571	− 162	1	571	− 162
Rochdale Corporation	" 8	497	+ 260	1	497	+ 260
Rotherham Corporation	" 6	422	− 197	1	422	− 197
Rothesay	Mar. 31	51	− 3	13	582	+ 83
Salford Corporation	April 10	6,065	+ 94	¶1	6,720	760
Sheerness	Mar. 20	69	+ 16	13	704	+ 140
Sheffield Corporation	April 9	4,642	− 265	2	9,746	− 946
Southampton Corporation	" 8	870	− 187	1	870	− 187
Southend Corporation	" 5	266	− 123	1	266	− 123
Southport Tramways	Mar. 31	255	− 35	13	2,974	− 50
S. Staffordshire Trams.	" 31	682	− 10	13	8,353	− 411
Stockport Corporation	April 7	469	− 20	1	469	− 20
Sunderland Corporation	...	...	...	...	...	...
Swansea Trams	Mar 31	478	− 40	13	5,960	+ 165
Swindon	April 5	196	...	1	196	...
Taunton Trams	Mar. 31	47	+ 1	13	621	− 65
Tynemouth and District	" 31	184	− 69	13	2,514	− 290
Tyneside Trams Co.	April 5	365	− 87	14	4,631	+ 610
Wallasey District Council	" 8	671	− 115	1	671	− 115
Walsall	" 8	457	− 122	14	6,323	− 259
Warrington Corporation	" 6	319	− 33	1	319	− 33
West Ham Corporation	" 6	1,167	+ 860	1	1,167	+ 860
Weston-super-Mare	Mar. 29	80	+ 9	13	865	+ 62
Wigan Corporation	...	...	...	...	...	...
Wolverhampton Corpn.	April 5	722	+ 17	1	722	+ 17
Wolverhampton District	Mar. 31	361	+ 14	13	4,415	+ 108
Worcester	" 31	276	+ 21	13	3,461	+ 231
Wrexham	" 31	16	− 23	13	1,204	− 41
Yorkshire Woollen District	" 31	609	+ 52	13	7,931	− 807

( ) These comparisons are with the corresponding period last year. † Minus 5 days. § Plus 2 days. ¶ Plus 8 days. ** Fortnight. * Partly electrical.

Railways (Extensions) Order, 1902, and the West Riding Tramways Act, 1904, or any other tramways and light or other railways in Great Britain, and to carry on the business of tramway and railway proprietors, engineers, electricians, contractors, manufacturers of rolling stock and vehicles, suppliers of electricity, &c. First directors, H. S. Leon, W. B. Keen, G. E. Leon, and E. Schenk.

CITY NOTES.

MEMORANDA (April 13).—Bank rate 2½ per cent. (since March 9, 1905). Price of silver 26¼d. per oz. Consols 90⅞—91 for money, 91—91⅛ for account; 2½ per cent. annuities 89⅞—90. Consols Pay Day, May 4. Stocks and Shares Continuation Days, April 26 and May 10; Ticket Days, April 27 and May 11; Pay Days, April 28 and May 12; Mining Share Carry-over Days, April 25 and May 9.

ANGLO AMERICAN TELEGRAPH CO. (LTD.)—The directors after placing £5,000 to credit of renewal fund, have declared an interim dividend for the quarter ended March 31 of 15s. per cent. on the ordinary and £1. 10s. per cent. on the preferred stock, less tax, payable May 1.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The directors recommend payment of a dividend (on May 6) at the rate of 10 per cent. per annum for the half-year ended Dec. 31 (making 8 per cent. for the year).

COMPANIA TALEGRAFICO TELEFONICA DEL PLATA (MONTE VIDEO).—The profit for 1904 was $109,129·35 (m/n), and a dividend of 12 per cent. has been declared.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The transfer books and register of holders of the second debenture stock will be closed from 17th to 30th inst., inclusive, preparatory to payment of interest.

EASTERN TELEGRAPH CO. (LTD.)—Payment will be made by warrant on May 1 of interest for the half-year ended April 29 on the 4 per cent. mortgage debenture stock. The transfer books will be closed from 26th to 29th inst. inclusive.

EASTERN & SOUTH AFRICAN TELEGRAPH CO. (LTD.)—Payment will be made by warrant on May 1 of the interest on the 4 per cent. Mauritius subsidy debentures. The transfer books will be closed from 26th to 29th inst. inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.) The directors have declared a dividend for the quarter ended Dec. 31 last of 2s. 6d. per share, together with a bonus of 4s. per share (2 per cent.), making a total distribution of 7 per cent. for the year 1904, payable May 4. The share register will be closed from 26th inst. to May 3 inclusive.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to grant quotations to a further issue of 85,368 £1 fully-paid 7 per cent. cumulative preference shares of the *South Metropolitan Electric Light & Power Co. (Ltd.)* and 70,000 $100 shares and $5,500,000 $500 30-year 5 per cent. gold bonds of the *Sao Paulo Tramways, Light & Power Co. (Ltd.)*.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend.	Name.	Price Wed., April 12.	Rate per cent. yielded.*	Dividend Due.	Business, Week to April 12. Highest.	Business, Week to April 12. Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
	3/0	Anglo-Argentine Ord. Shares	5⅝—5⅞	3 7 4	Ap., Oc.	[illegible]	[illegible]
	6	Do. 5% Cum. Pref.	5¾—6	4 3 4	—	5[illegible]	[illegible]
St.	6%	Do. Permanent 6% Deb. Stock	140 —143	4 3 11	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	105 —107	4 14 4	—	106½	106¼
5	6%	Barcelona Tramways Ord.	12 —12½	2 6 2	—	12½	12¼
5	5/0	Do. 5% Cum. Pref.	9¾—10	5 0 0	—	10	9¾
St.	4½%	Do. 4½% Deb. Stock (red.)	98 —100	4 10 0	—	..	..
10	5%	Do. 5 per Cent. Debs.	99 —102	4 18 1	—	..	..
..	..	Brisbane Electric Trams. Invest Ord.	1 —1½	..	..	..	..
1	5/6	Do. 5 per Cent. Cum. Pref.	5½—[illegible]	5 17 5	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	94 —96	4 11 10	..	96	..
St.	6%	British Columbia Elec. Rlwy Def. Ord.	104 —107	5 12 2	—	105½	..
St.	5%	Do. Pref. Ord. Stock	100 —103	4 17 2	—	..	..
1	5/0	Do. 5% Cum. Perp. Pref.	10 —10½	4 10 11	—	..	..
	4½%	Do. 4½ per Cent. 1st Mort. Dbs	105½—107½	4 5 9	—	..	..
	4½%	Do. Vancouver Power Debs.	99 —102	4 8 3	..	..	..
	1/6	Buenos Ayres and Belgrano Ord.	[illegible]	5 12 6	—	[illegible]	[illegible]
	5/0	Do. 6 per Cent. "A" Cm. Pref	[illegible]	5 2 2	—	5½	[illegible]
	5/0	Do. "B"	[illegible]	5 6 8	—	5[illegible]	..
St	5%	Do. 5 per Cent. Debs.	107 —109	4 11 5	—	..	..
St	5%	Do. 5% 2nd Deb. Stock Prov Certs.	103 —106	4 15 3	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	97 —99	5 1 0	..	..	..
5	3/0	Calcutta Tramways	[illegible]	3 16 4	—	[illegible]	5¾
100	4½%	Do 4½% 1st Deb. Stock (red.)	106 —108	4 5 4	—	..	..
1	1/6	Cape Electric Tram Shares	1⅜—1⅝	4 12 6	—	..	..
St	5%	Colombo Trams & Ltg. 5% 1st Mt Deb. (red)	103 —105	4 17 2	..	104½	..
St	6%	Madras Elec. Trams 6% Deb. Stk.	101 —103	4 17 3	Ja., Jul	..	..
100	5%	Montreal St. Ry. St'g 5% Mort Debs. (1908)	101 —104	4 16 3	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	103 —105	4 5 9	..	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	103 —105	4 13 6	..	[illegible]	..
		ELECTRICITY SUPPLY.					
5	3/0	Calcutta Electric Supply Ord.	9 —9½	3 13 5	—	9¼	..
1	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	[illegible]	..	..	..	..
St.	5%	Do. 5% Debs.	86 —91	5 9 11	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	—	—	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	[illegible]	..	—	..	..
1	..	Rand Electric	[illegible]	..	..	..	..
100	4½%	*†Royal Elec., Montreal 4½% 1st Mort. Deb	98 —100	4 10 0	Ap., Oct	..	...

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., April 12.	Rate per Cent. Yielded.	Dividend Due.	Business Week to April 12. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
1	..	Bath Elec. Trams Pref. Ord.	1¼—1½	..	..	..	..
1	11 pd.	Do. 6% Cum. Pref.	1¼—1⅜	4 14 1	..	..	..
St.	4½%	† Do. 4½ 1st Mort. Deb. Stock (red.)	102—104	..	..	103½	103½
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	99—101	..	..	100	..
10	9%	Bristol Tramways and Carriage Ord.	17½—18½	4 17 6	Feb, Aug	..	..
10	6%	Do. Cum. Pref. (fully paid)	10—10½	5 18 2	..	..	..
St.	4%	Do. 4 per Cent. Debs.	105—107	3 14 10	Feb, Aug	..	..
10	8/0	British Electric Traction Ord.	9—9½	6 8 2	..	9½	9
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅞—11½	5 6 8	Feb, Aug	11⅛	11¼
St.	5%	† Do. 5 per Cent. Perpetual Debs	120—122	4 2 0	—	121½	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	98—100	4 10 0	—	98½	98½
St.	4%	Central London Ordinary Stock	92—94	4 5 1	June, Dec	92	..
St.	4%	Do. 4 per Cent. Pref. Stock	101—103	3 17 8	—	..	..
St.	4%	Do. Deferred Stock	82—85	4 14 3	—	84½	..
100	4%	Do. 4 per Cent. Debs.	111—113	4 10 9	—	112½	..
5	2/6	City of Birmingham Trams 5% Cm. Prf.	4½—4¾	4 17 6	—	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	101—104	3 17 8	..	..	..
St.	1½%	City and South London Rly. Con. Ord.	44—46	5 0 0	Feb, Aug	45	44
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120—122	4 1 4	Feb, Aug	120½	120
St.	5%	Do. (1896)	118—121	4 2 8	..	..	..
St.	5%	Do. (1901)	115—118	4 4 9	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109—111	3 12 1	May, Nov	109½	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13½—14½	4 2 8	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15½—16½	3 12 9	—	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	6—6½	5 12 0	—	..	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9½—9¾	4 4 2	..	..	..
10	9%	‡ Imperial Tramways Ord	17½—18	5 0 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	13½—14½	4 4 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	107—109	4 2 7	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2¾—3¼	7 13 10	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88—90	4 8 11	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3½—3¾	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10—10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—101	3 19 3	Jan, July	..	..
10	8/0	London United Trams. 5% Cum. Pref.	10—10½	4 15 3	—	10¼	10⅛
St.	4%	Do. 4% 1st Mort. Deb. Stock	99—102	3 19 3	—	101	100
St.	—	Mersey Con. Ord. Stock	4—7	..	—	..	..
St.	—	Do. 3 per Cent. Perp. Pref.	10—13	..	—	..	..
1	..	Metropolitan Electric Trams Def	¼—⅜	..	—	⅜	..
1	0/6	Do. 5% Cum. Pref.	1—1⅛	4 14 1	—	1⅛	1
St.	4½%	Do. 4½% Deb. Stock	106—107	4 5 0	..	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	¾—1¼	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	9½—10	5 0 0	..	9½	9½
10	5/0	Do. 5 per Cent. Cum. Pref.	9½—10	5 0 9	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	105—107	4 4 11	—	..	..
1	—	South Lancs. Elec. Trac. & Power Ord.	—	..	..	..	..
1	—	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London	99½—100½	4 19 8	..	102½	100½
St.	1½%	Waterloo and City Ord.	92—94	3 6 5	June, Dec	..	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	99—102	4 0 0	Jan, July	..	..
10	—	Amazon Telegraph	7¼—7¾	..	Jn, Dec ..	..	..
100	..	Do. 5% Debs. (red.)	73—77	..	..	..	..
St.	17/6	Anglo-American	61—63	4 7 3	F,My,Ag,N	62	..
St.	25/0	Do. Preferred	107—108	5 1 10	F,My,Ag,N	108	107
St.	2/0	Do. Deferred	18¼—18¾	..	F,My,Ag,N	18	18⅛
St.	4%	† Commercial Cable 4 per Cent. Deb. Stk	97—99	4 1 8	Jn,Ap,Jy,O	98½	97½
10	5/0	Cuba Submarine Ord.	8½—9	5 11 2	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	17—18	5 11 1	Feb, Aug	—	..
5	2/0	† Direct Spanish Ord.	3½—3¾	5 11 9	April, Oct	..	..
5	5/0	† Do. 10 per Cent. Cum. Pref.	8½—9	5 11 2	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	101%—103%	4 7 10	Jan, July	..	..
20	8/0	Direct United States Cable	11½—11¾	5 8 5	Ja,Ap,Jy,O	11⅝	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100—102	4 7 7	Jn, Dec ..	..	..
St.	35/0	Eastern Ordinary	141—144	4 17 2	Ja,Ap,Jy,O	144½	143½
St.	17/6	Do. 3½ per Cent. Pref. Stock	92—94	3 14 5	Ja,Ap,Jy,O	93½	93
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	108—110	3 12 9	May, Nov	109½	108½
10	2/6	Eastern Extension	14—14½	5 3 5	Ja,Ap,Jy,O	14½	14½
St.	4%	Do. 4 per Cent. Deb. Stock	105—107	3 14 9	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1900	100—102	3 18 5	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%—103%	3 17 6	May, Nov	..	..
10	5/0	Great Northern (of Copenhagen)	27—29	3 17 0	Jan, July	28½	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100—102	4 8 2	June, Dec	..	..
25	12/6	Indo-European	51—53	4 14 4	May, Nov	51	51½
100	$1	Mackay Companies Common	41⅝	2 5 2	Jun, July	..	..
100	$1	† Do. Preference	76⅛	1 6 2	Ja,Ap,Jy,O	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99—102	3 18 5	June, Dec	..	—
10	4/0	West African Telegraph Shares	8—8½	5 17 8	—	8½	..
2½	..	West Coast of America	¼—½	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	100—102	3 18 5	Jan, July	..	..
10	—	West India and Panama	1½—1¾	..	May, Nov	½	..
10	7/0	Do. 6% 1st Pref.	8½—9¼	8 17 0	May, Nov	..	..
10	—	Do. 6 per Cent. 2nd Pref.	8—8½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	103—105	4 15 8	Jan, July	..	..
10	8/0	‡ Western Telegraph	13½—14	5 0 0	Mr,Jn,O,D	13½	13½
100	5%	* Do. 5% Debs. (2nd Series, 1903)	101—103	4 17 1	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	103—105	3 16 11	—	..	..
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	6½—6¾	5 1 9	August ..	6½	..
1	0/7½	Monte Video Telephone Ord.	1⅛—1⅜	2 11 9	—	..	..
St.	6%	National Co. Pref. Stock	108½—109½	5 9 7	—	108½	109
St.	5%	Do. Def. Stock	100—102	4 18 1	..	101½	101½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13½—13¾	4 8 11	Feb, Aug	—	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11½—12½	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5¾	4 13 0	Feb, Aug	5⅝	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	100—102	3 8 7	June, Dec	101½	101½
St.	4%	Do 4 per Cent. Deb. Stock (red.)	103½—105½	3 15 10	..	105½	103½
1	0/7½	Oriental	1½—1¾	4 4 2	April, Oct	1½	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 11 6	—	1⅛	..
St.	20/0	Telephone Co. of Egypt 4½% Db. Stk. Rd.	102—105	..	..	..	—
5	5/0	United River Plate	7—7½	6 6 5	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4 17 9	June, Dec	5⅛	—
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	107—109	4 11 9	June, Dec	—	..
		FINANCIAL, INVESTMENT, &c.					
5	[illegible]	Elec. & Gen. Investment 6% Cum. Pref.	6½—6¾	5 14 4	—	..	..
10	5/0	Globe Telegraph and Trust	10½—11	5 1 0	Ja,Ap,Jy,O	10½	10⅝
10	6/0	Do. 6 per Cent. Pref.	14½—15½	4 0 8	Ja,Ap,Jy,O	14½	14½
100	6%	Submarine Cables Trust (Cert.)	125—130	4 12 9	April, Oct	..	..

Share.	Last Dividend.	Name.	Price Wed., April 12.	Rate per Cent. Yielded.	Dividend Due.	Business Week to April 12. Highest.	Lowest.
		ELECTRICITY SUPPLY.		£ s. d.			
10	14/0	† Bournemouth & Poole Elec. Sup. Ord.	12½—13½	5 14 3	..	12	11½
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 7 10	..	10½	..
10	6/0	Do. 6% Cum. Second Pref.	11—12	5 0 0	—	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	105—107	4 4 1	—	..	..
5	2/0	Bromley (Kent) El. Lt. & Power Shares	5½—5¾	3 9 7	..	..	..
St.	4½%	Do. Do. 1st Debs	103—106	4 4 10	—	..	..
5	5/6	† Brompton & Kensington Elec. Sup. Ord.	9½—10½	4 16 5	..	..	..
5	3/6	Do. 7 per Cent. Pref.	9½—10½	3 6 8	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105—108	3 14 1	—	..	..
5	4/0	Charing Cross (W. End & City) El. Sup. Co.	5½—6½	4 14 2	Feb, Aug	5½	5½
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4 0 0	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	105—107	3 14 9	..	105½	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	5—5½	4 4 9	—	5⅛	..
5	2/3	Do. Do. (1903)	5—5½	4 7 10	..	5⅛	5
5	3/9	Chelsea Electric Supply Ord.	6½—7	4 5 3	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	109—111	4 1 1	Jn, Dec ..	..	..
10	7/0	City of London Electric Lighting Ord.	11—12	5 0 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13½—14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	125—127	3 18 8	Jn, Dec ..	..	—
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	103—105	4 5 9	..	..	..
10	5/0	† County of London Elec. Supply Ord.	9—9½	4 14 9	..	9½	9
10	6/0	† Do. 6 per Cent. Cum. Pref.	12—12½	4 16 0	Mar, Sept	12⅛	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	110—113	4 0 2	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	104—108	4 6 7	—	105	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5½—6	..	—	..	..
5	..	Do. 5 per Cent. Cum. Pref.	5—5½	4 11 9	—	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101—104	4 6 7	..	..	—
5	2/6	Hove Electric Lighting Ord.	7¾—8½	5 3 0	..	8	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	101—103	4 9 1	..	..	..
5	7/0	Kensingtn. & Kngtsbdg. Ord	12—13	4 11 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	—
St.	4%	† Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101—103	3 13 5	—	..	..
8	1/6½	London Electric Supply Ord.	5½—5¾	3 5 3	—	..	..
5	3/0	Do. 6 per Cent. Pref.	4½—4¾	6 4 6	..	4½	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	99—101	3 19 2	Mr,Jn,S,D	99	..
10	11/0	Metropolitan Electric Sup. Ord.	17½—18½	6 0 0	April, Oct	18	17½
5	2/3	Do. 4½ per Cent. Cum. Pref.	5½—5¾	3 16 5	Jan, July	5½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109—114	3 18 11	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97—99	3 10 8	..	98½	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	99—101	4 9 1	..	100	—
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	13½—14	5 5 8	Feb, Aug	..	..
5	8%	† Newcastle Elec. Supply Ord.	7½—7¾	5 2 7	Feb, Aug	7½	7½
5	5%	† Do. 5 per Cent. Non. Cum. Pref.	6—6½	4 3 8	Feb, Aug	6⅛	6
1	5%	† Northern Counties Elec. Sup. 17/- paid	16/3—16/9	5 2 2	Mar, Sep	..	..
10	6/0	Notting Hill Electric Ord.	14½—15½	4 0 0	March....	..	..
100	4%	† Do. 4 per Cent. 1st Mt. Debs.	100—102	3 14 5	..	..	..
5	4/0	Oxford Electric Ord.	6½—6¾	5 16 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	95—100	4 0 0	..	..	..
5	9/6	St. James' & Pall Mall Elec. Ord.	15½—16½	6 0 0	Feb, Aug	16⅛	..
5	3/6	Do. 7 per Cent. Pref.	8½—8¾	4 0 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98—100	3 10 0	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2½—2¾	6 10 7	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	79—85	4 13 6	..	..	..
5	4/6	South London Electric Supply Ord.	8½—8¾	4 16 3	—	..	..
1	..	South Metrop'n Elec. Lt. & Power Ord.	½—1	..	—	..	..
1	0/2½	Do. 7% Cum. Pref.	1⅛—1¼	4 17 0	—	..	..
St.	4½%	† Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	105—108	4 4 0	—	..	..
5	2/0	† Urban Electric Supply Ord.	4½—5⅛	4 19 0	—	..	..
5	2/6	† Do. 5% Cum. Pref.	5—5½	4 15 8	..	..	..
St.	4½%	† Do. 4½% 1st Mort. Deb.	104—106	—	..	105	..
5	7/6	Westminster Electric Supply Ord.	12—13	5 7 8	Mar, Sept	12½	12⅛
5	2/6	Do. 5 per Cent. Cum. Pref.	6—6½	3 16 11	—	6½	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	½—¾	5 6 6	..	..	..
1	6d.	Aron Elec. Meter 6% Cum. Pref.	⅞—1¼	..	..	..	..
5	4/0	† British Insulated & Helsby Cables Ord.	5½—6	6 13 4	July, Feb	5½	..
5	3/0	Do. 6 per Cent. Pref.	5½—6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	101—104	4 6 6	—	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	99—101	4 9 1	—	..	..
5	3/0	British Westinghouse 6% Pref.	3¼—3½	9 12 0	—	3½	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	91—95	4 6 0	..	..	..
2	..	Brush Electrical Engineering	¼—½	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½—2	6 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	92—96	4 14 9	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	79—82	5 9 9	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	11—11½	5 6 5	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 7 0	Jan, July	5⅝	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	107—109	4 3 6	Nov, May	108	..
1	9½d.	Castner-Kellner Alkali Co. (fully paid)	2—2¼	4 9 5	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	91—96	4 13 9	..	..	..
1	0/1½	Chadburn's (Ship) Telegraph Ord.	1—1¼	6 17 6	..	..	..
1	7½d.	† Do. 6% Cum. Pref.	1—1¼	5 6 8	..	—	..
2	1/6	Crompton and Co. (Nos. 1 to 54,000)	2½—2¾	5 5 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95—98	5 2 0	Jan, July	—	..
5	10/0	Dick, Kerr & Co. Ord.	7½—8	6 5 0	Sept	..	..
5	3/0	† Do. 6% Cum. Pref.	5½—6	5 0 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	106—107	4 4 1	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	1—1¼	..	Feb, Aug	1	..
5	..	Do. (£5 paid)	1½—1¾	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	80—85	4 14 2	June, Dec	..	..
St.	5%	† Do. 5 per Cent. 2nd Deb. Stock	84—89	5 12 4	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	6—6½	6 12 0	H'lf-yearly	6	..
5	5/0	Do. 6 per Cent. Cum. Pref.	6½—6¾	4 15 8	—	6⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	106—108	4 3 5	..	..	..
2	1/6½	Electric Construction Co.	1—1½	6 8 0	July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	1½—1¾	6 12 9	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97—99	4 0 10	Jan, July	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90—95	5 5 3	—	..	..
10	6/0	General Electric (1900) 6% Cum. Pref.	9½—10	6 0 0	—	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Debs.	97—101	3 19 2	..	..	..
5	10/0	Henley's Telegraph Works Ord.	11½—12½	6 0 0	Feb, Aug	12	..
5	3/3	Do. 4½ per Cent. Pref.	5½—5¾				
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	109—111				
10	8/0	India Rubber, Gutta Percha, &c., Wrks.	16—17				
100	4%	† Do. 4 per Cent. 1st Mort. Deb (red.)	103—105				
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11½—11¾				
12	24/0	Telegraph Construction & Mainten'ce.	36—38				
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	103—105				
5	—	Willans and Robinson Ord.	1—2				
5	—	Do. 6 per Cent. Cum. Pref.	2—3				
	4%	Do. 4 per Cent. 1st Mort. Debs.	75—8				

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* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange C

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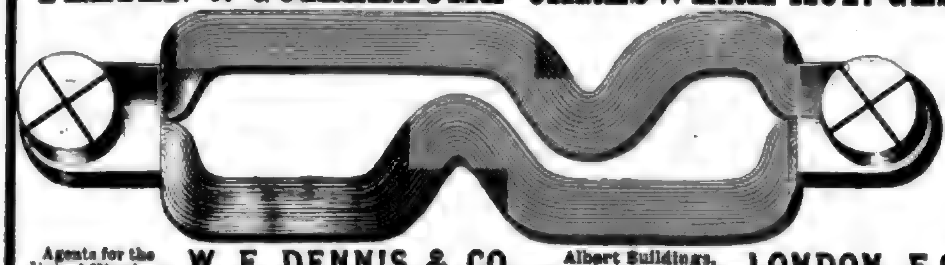

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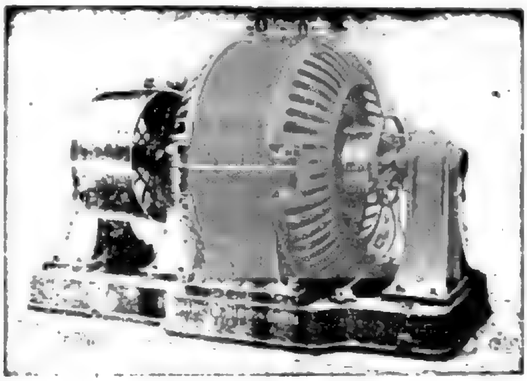

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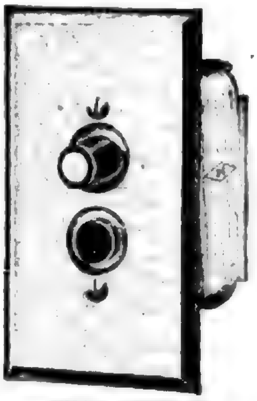

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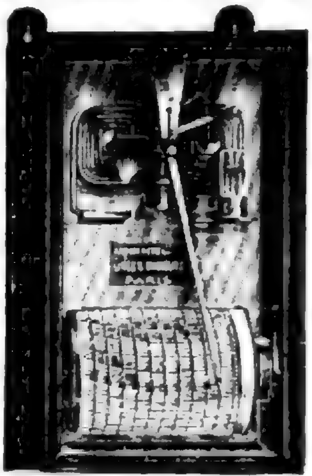

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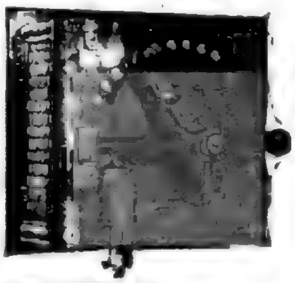

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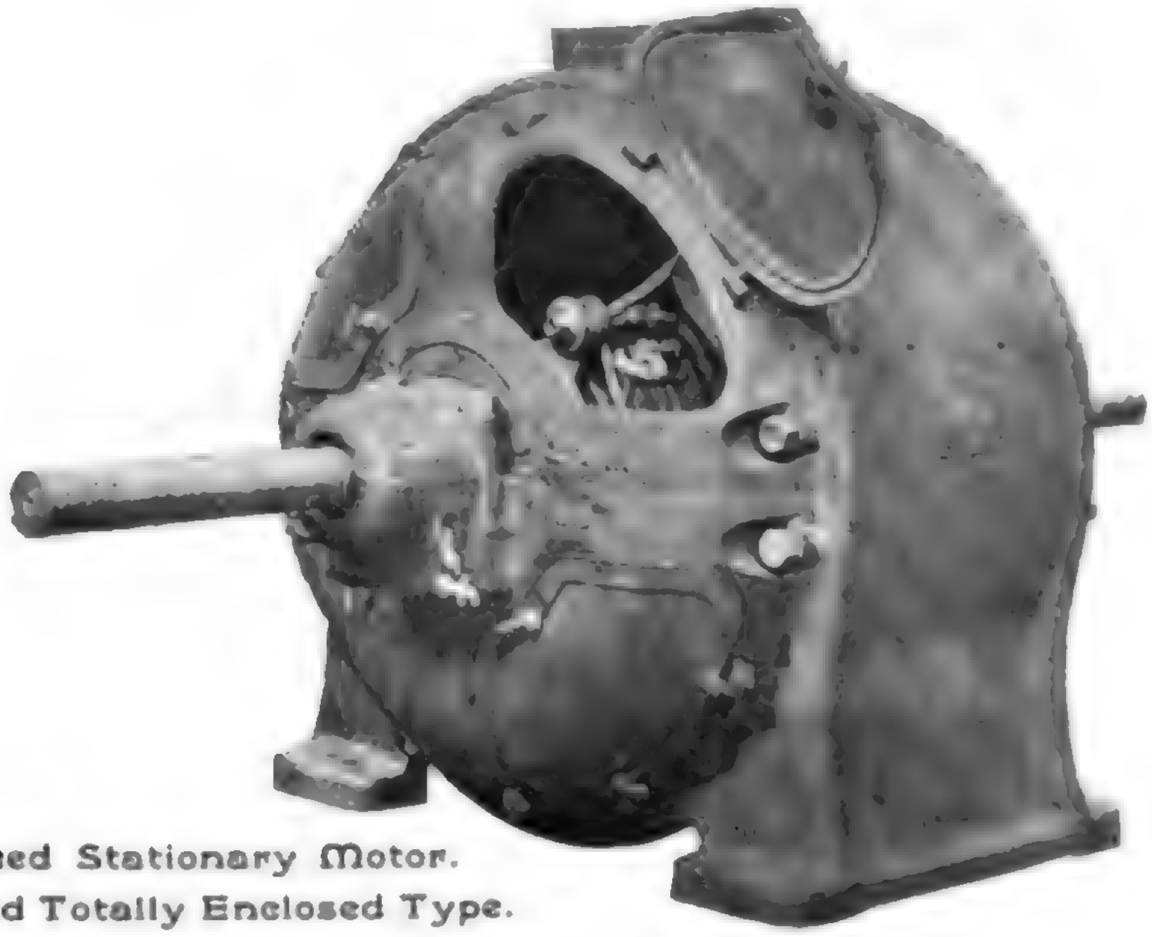

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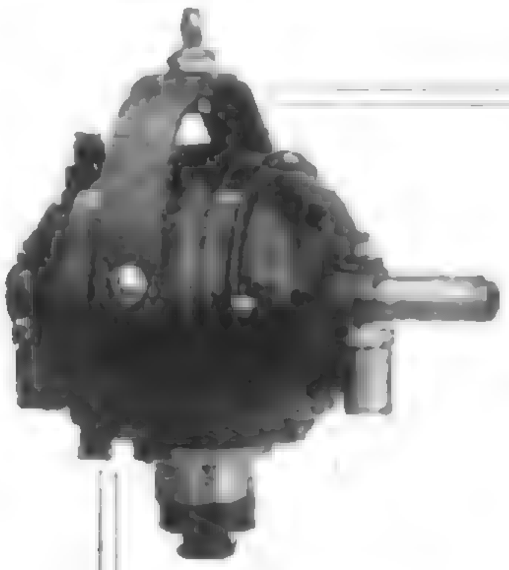

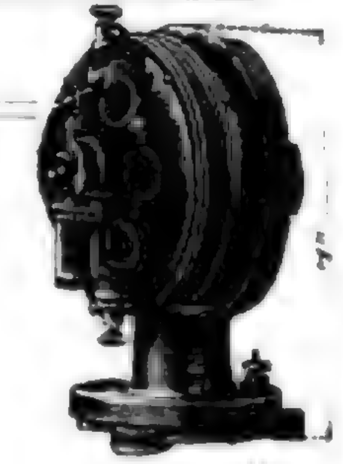

SMALL MOTORS

FOR DRIVING

DENTIST and MASSAGE APPARATUS,
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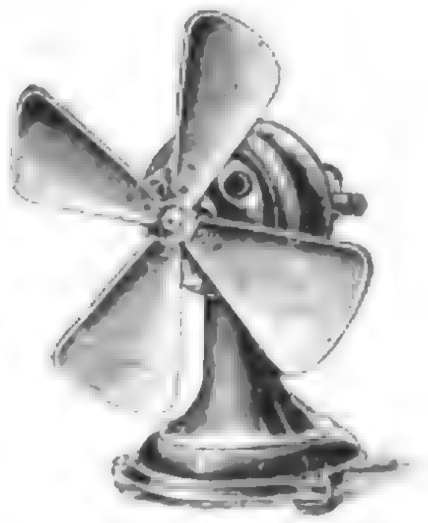

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CURRENT, **with** WIRE GUARD, 110 v.,
25/- subject.

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THE ELECTRICAL COMPANY, Limited,

121, 122, 123, 124, 125, CHARING CROSS ROAD, LONDON, W.C.

Telegrams:
GALVANOSCOPE LONDON.

Telephone Nos.:
4311, 4312, 4313 & 4314 GERRARD.

CALLENDER'S
CABLE & CONSTRUCTION CO., LTD.,
HAMILTON HOUSE,
VICTORIA EMBANKMENT, LONDON, E.C.
Works: BELVEDERE, KENT.
Telephone: 1911 Holborn. Telegrams: Callender London.

LAYING CALLENDER MAINS ON SOLID SYSTEM IN
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NEW LIST OF
HIGH TENSION
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NOW READY.
Ask for List VI. H.

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151, QUEEN VICTORIA STREET,
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ELECTRICAL ENGINEERS.
MULTIPHASE
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Dynamos and Motors.
ELECTRIC CRANES.
OF ALL KINDS AND SIZES WITH ONE OR THREE MOTORS.
ELECTRIC WINCHES, CAPSTANS for all Loads and Voltages a Speciality.
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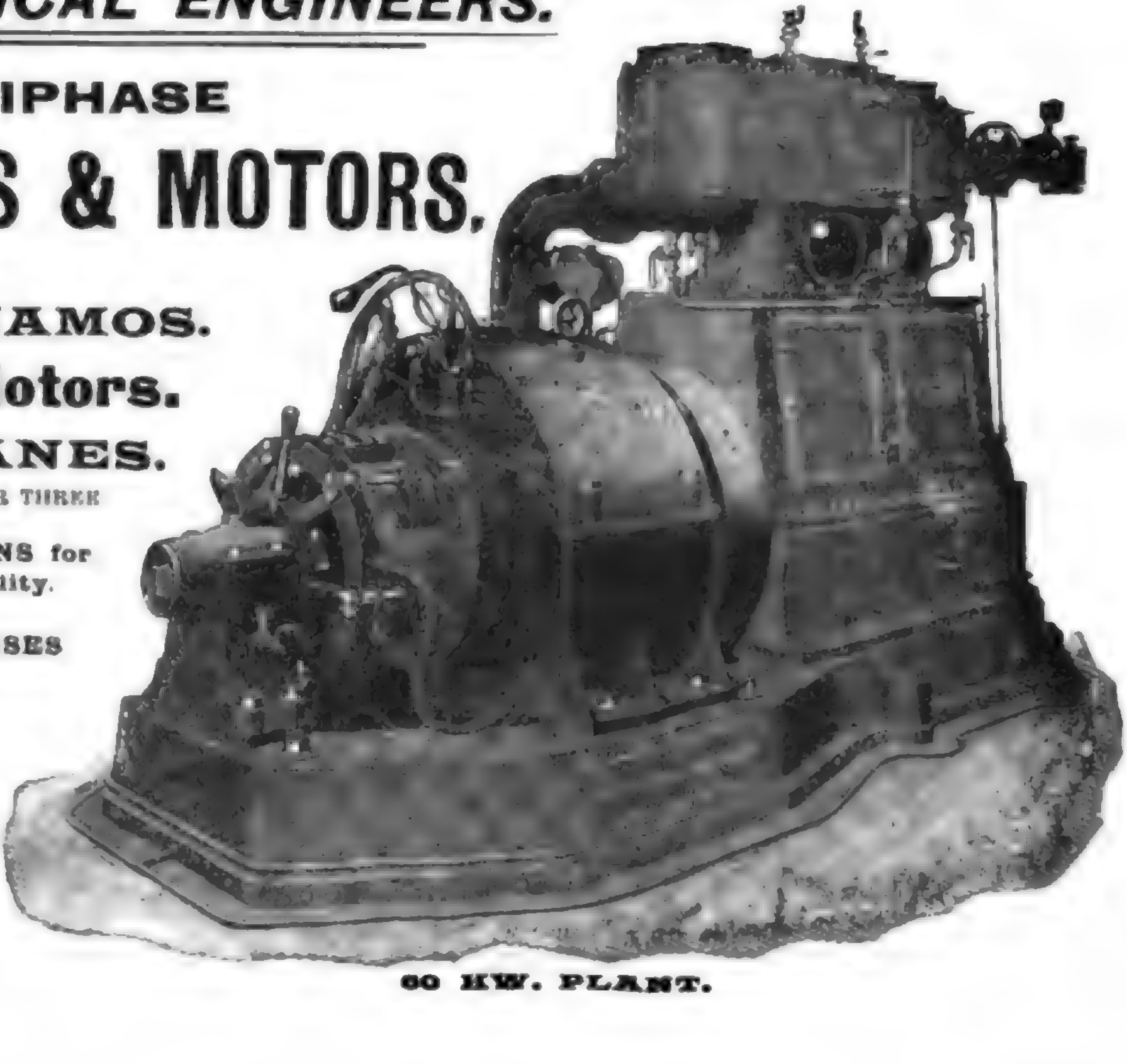

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RECORD

AT SHEFFIELD ELECTRIC LIGHTING STATION.

LOWEST COAL COST PER UNIT

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WITH BENNIS STOKERS, BENNIS COMPRESSED AIR FURNACES WITH PATENT HOT AIR FEED TO BARS AND ELLIS & EAVES INDUCED DRAUGHT SYSTEM.

Mr. S. E. FEDDEN, Manager to the Sheffield Corporation Electric Supply Department, Commercial Street, Sheffield, says in *Engineering*:—

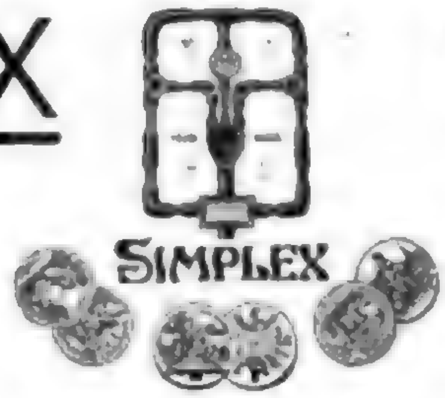
> ***"Experience with similar machines in the Sheaf Street Station does not lead me to fear any notable increase in the upkeep charges after the period of maintenance has expired."***

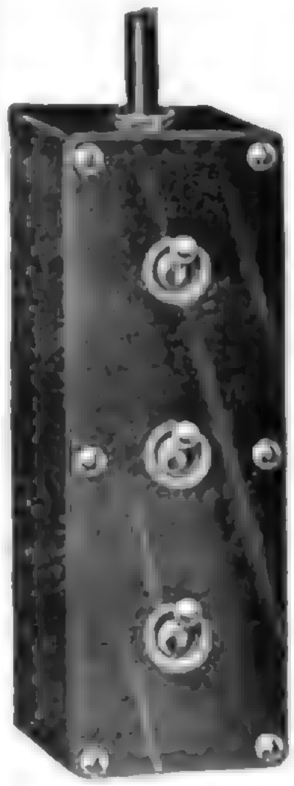
ED. BENNIS & CO., LTD LITTLE HULTON, BOLTON

SIMPLEX

STEEL CONDUIT
SYSTEM.

MULTIPLE
SWITCH
BOXES.





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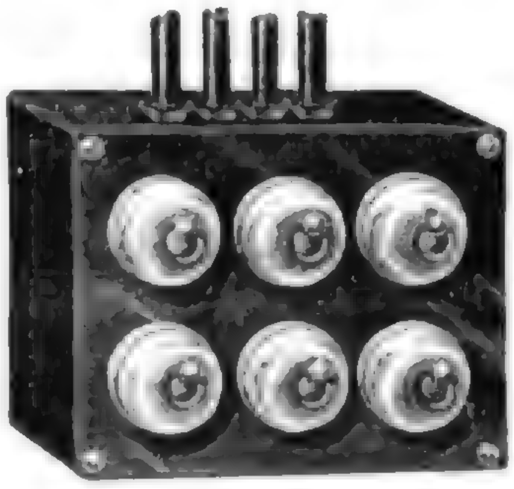
It is often found necessary to group switches together, and the above arrangements show a very convenient way of meeting such requirements.

The cover of these boxes can be readily removed for wiring or inspection purposes.

If desired, an enamelled sheet metal or polished brass cover can be fitted.



Flush Type.

FLUSH OR SUNK MOUNTING.

IN ALL SIZES and UP TO NINE WAYS LISTED.

NOTE.—These boxes are for drilling and tapping to customers' requirements.

Simplex Steel Conduit Co., Ltd.

80, Digbeth,
BIRMINGHAM.

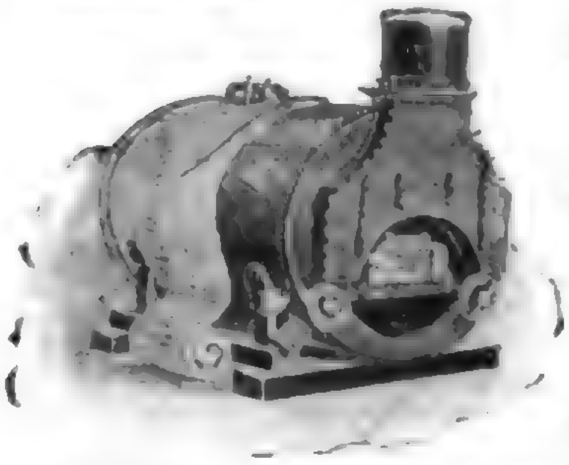
20, Bucklersbury,
LONDON, E.C.

Adopted by
Leading
ELECTRIC
LIGHT
STATIONS.
Railways,
Shipping, &c.

BLUE ASBESTOS REMOVABLE COVERINGS

FOR Boilers, Steam Pipes, Flanges, &c.

FOR
Efficiency,
Durability,
Lightness.



THE CAPE ASBESTOS CO., LTD.,

KIMBERLEY. LONDON. TURIN.

Tel. Address: INCORRUPT LONDON. Head Offices: 8, MINORIES, E.C. Telephone: 272 AVENUE.

WHITE ASBESTOS PACKINGS for STEAM and HYDRAULIC.
FINE BLUE and WHITE ASBESTOS YARNS, and PAPER, CLOTH, &c.
CAPYT, for Electrical Insulation. Possessing Highest Insulating Properties, Greatest Resistance against Heat, Great Mechanical Strength.

GENUINE

STEWART ARC LAMPS

CAN BE HAD ONLY FROM

J. DEFRIES & SONS, LTD., 146 & 147, HOUNDSDITCH, LONDON, E.C.

THEIR AGENTS AND CUSTOMERS.

SERIES, SINGLE-BURNING and HIGH ECONOMY.

Lamps described in List E 44.

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& DYNAMO COMPY.
CATALOGUES ON APPLICATION.
LONDON & MANCHESTER.

HEAD OFFICES & SHOWROOMS: 15, Gray's Inn Road, London, W.C. (Holborn end.) Telegrams: DYNAMODE LONDON. DYNAMODE MANCHESTER.

MOTORS, DYNAMOS, TRANSFORMERS, LIFT & HOISTING MACHINERY, CONTROLLERS & ACCESSORIES.

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IRON-CASED

MINING TELEPHONES,

Bells,

AND

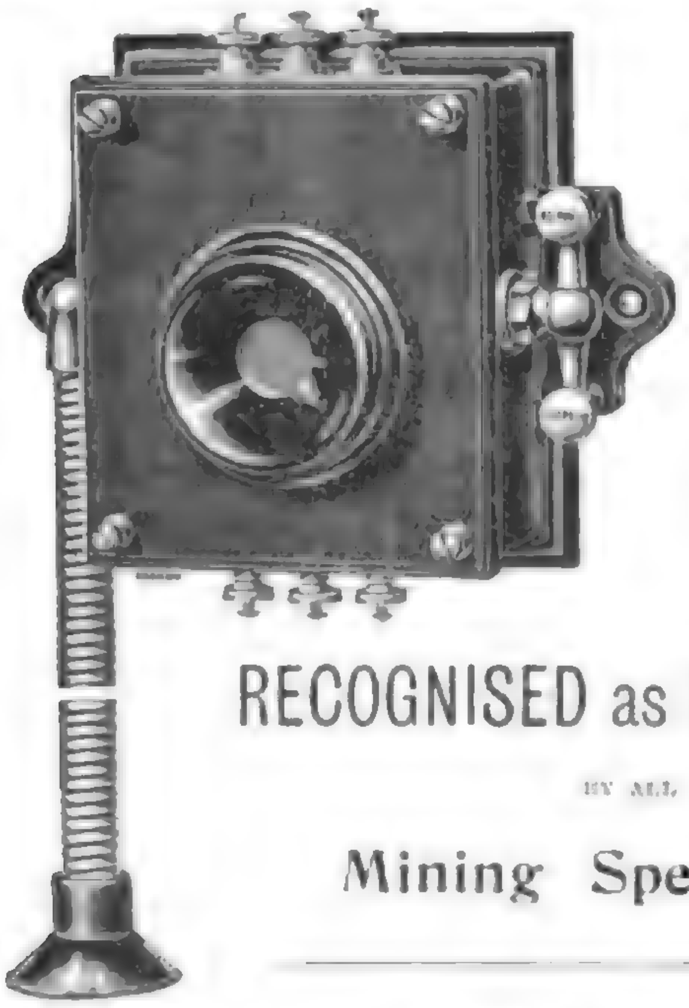
Morse Keys

ARE

RECOGNISED as STANDARDS

BY ALL

Mining Specialists.



THE INTERNATIONAL ELECTRIC Co

55, Redcross St., Barbican,
LONDON, E.C.
&
34, Robertson St.,
GLASGOW.

LORD KELVIN'S (27)

RECORDING INSTRUMENTS.

Ammeters,
Voltmeters,
Wattmeters

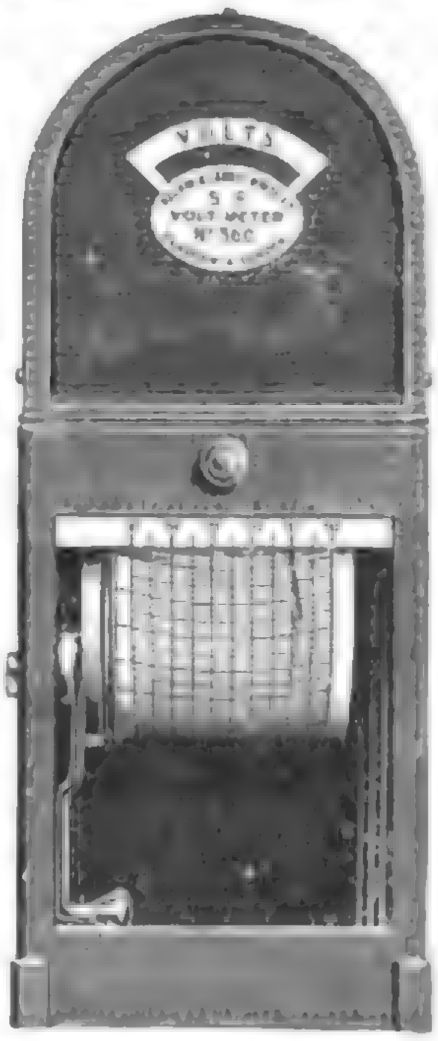
For Direct or Alternatin
Circuits,

TRACTION
AND **LIGHTIN**

For Board of Trade Tracti
Panels and Middle w
Earthing Panels.

DEAD-BEAT,
LARGE OPEN SCALES,
ACCURA

Movement to Change Rec
also Winds Clock.



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CLOCK PEN CANNOT BE OVERWOU DAMAGED.

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KELVIN & JAMES WHITE, Ltd

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Periodical Valuations, Stock-takings and Reports for DEPRECIATION, RENEWALS &c., in conformity with the Acts.

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SALES BY AUCTION.

By Messrs. SCOTTORN & SMEDLEY.

Under a Deed of Assignment

Re HUGH ROSSELL, Electrical Engineer and Contractor,
65, Alfreton-road, Nottingham.

WEDNESDAY NEXT, APRIL 19, 1905.

MESSRS. SCOTTORN & SMEDLEY are favoured with instructions from A. O. Mellors, Esq., Chartered Accountant, Nottingham, the Trustee, to SELL BY AUCTION, on the Premises, as above, the **ELECTRICAL ENGINEER'S STOCK-IN-TRADE**, comprising in brief, **DYNAMOS, MOTORS, TESTING SET**, costly **ELECTROLIERS**, Pendants and Brackets, Casing, Cable, Flexible Lamps, Shades, Switches, Fuse Boards, Batteries, Bells, Wire, Novelties, Arc Lamps, Incandescent Fittings, Mantles, &c., &c.

On view the day prior to Sale from 10 to 4.

Sale to commence at 11 o'clock prompt.

For descriptive Catalogues and further particulars, apply to Messrs. MELLORS, BASDEN & MELLORS, Chartered Accountants, Bridlesmith Gate, Nottingham, or to the AUCTIONEERS, at their Mart, 86, Upper Parliament-street, Nottingham. Nat. Tel. 1489.

ELECTRIC LIGHT PLANT, with horizontal Engine (no boiler), Crompton 60-ampere 110-volt Compound Dynamo, Arc and Hand Lamps, Pendants, Switch and Distributing Boards, Cables, Wires and Fittings, suitable for private works or other purposes, cost £300 18 months ago, to be SOLD by PUBLIC AUCTION on APRIL 14th, unless previously disposed of.—Apply, JAMES R. CULL, Newton Abbot, Devon.

CHEAP PREPAID ADVERTISEMENTS.

MISCELLANEOUS PLANT, &c., WANTED, FOR SALE OR FOR EXCHANGE.

Three Lines and under (Minimum)	1s. 6d.
Per Line after	6d.

Words to the Line.

Where answers to any of the above Advertisements are to be sent to the Publishing Offices to be forwarded, the sum of 3d. must be sent with the order to pay for postage of these replies. Six Words must be allowed for the address of the Publishing Offices.

MISCELLANEOUS PLANT, &c., WANTED.

ACCUMULATORS (second hand) WANTED. Also Dynamos, Machinery, Copper Cable Scrap, Metals, and Metallic Dross of any description purchased for cash. Town or country. Write, JOSEPH AMOS, 20 and 22, Kingsland-road, N.E. Telegraphic address, "Jorramos," Telephone 1917 London Wall.

WANTED, Two Direct-coupled ENGINE and DYNAMO SETS, each capable of a duty of 700 amperes at 110 volts—with 80lb. per square inch at cylinders—non-condensing. Also Two Direct-coupled Sets, as above, for 350 amperes at 110 volts. Quotations wanted for good secondhand nearest sizes, or new plant.—Reply, C. E. B., *Electrician* Office, Salisbury-court, Fleet-street, London.

WANTED, LAMP TOPS, with Platinum, Scrap Platinum, &c.—EDEY & Co., 29, Ludgate-hill, London, E.C.

MISCELLANEOUS PLANT, &c., FOR SALE.

FOR SALE.

One Second-hand Electric Generating Set, Willans 2 I Compound Engine, Siemens Two-pole Compound Dynamo, 120-140 volts, 900 amperes, at 350 revolutions, 140lb. steam.

Two Second-hand Electric Generating Sets, Willans 2 G Compound Engines, 50kw. two-pole Dynamos, 128 volts, 400 amperes, at 420 revolutions, 120lb. steam.

The above are now in thorough working order and can be seen running at these works at any time by appointment.

Apply, KYNOCH LIMITED, Witton, Birmingham.

FOR SALE, 1-H.P. Crossley Gas Engine, E.C.C. Dynamo, 15 amp., 65 volts at 1,200 revs.; 27 E.P.S. K 7 Cells, Ediswan Accumulator Switchboard, with Instruments. Price £60. Now lighting 13-room house. Owner leaving. Can be seen working by appointment.—B., 29, Wimbledon Park-road, Wandsworth, London, S.W.

DYNAMOS FOR SALE, in good order.—One Shunt-wound Dynamo, each capable of giving 300—60, 50 and 30 amperes, respectively, at 110 volts.—Apply, EDMUNDSON, Capel-street, Dublin.

MISCELLANEOUS PLANT FOR SALE continued on next page.

Telegrams: Turnstile London.

STANLEY

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Of Every Description, of the Highest Quality and Finish, at the most Moderate Price

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THE EASTERN TELEGRAPH COMPANY, LIMITED.

NOTICE is Hereby Given that the TRANSFER BOOKS of the FOUR PER CENT. MORTGAGE DEBENTURE STOCK of this Company will be CLOSED from the 20th April to the 29th April, both days inclusive.

By order,
A. R. HARDIE, Secretary.

Electra House, Finsbury Pavement,
London, E.C., 11th April, 1905.

THE EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY, LIMITED.

NOTICE is Hereby Given that the TRANSFER BOOKS of the FOUR PER CENT. REGISTERED MORTGAGE DEBENTURES (MAURITIUS SUBSIDY) of this Company will be CLOSED from the 20th April to the 29th April, both days inclusive.

By order,
A. R. HARDIE, Secretary.

Electra House, Finsbury Pavement,
London, E.C., 11th April, 1905.

THE COUNTY OF LONDON ELECTRIC SUPPLY COMPANY, LIMITED.

NOTICE is Hereby Given that the TRANSFER BOOKS and REGISTER OF HOLDERS OF SECOND DEBENTURE STOCK of this Company will be CLOSED from the 17th to the 30th inst., both days inclusive, preparatory to the payment of the Interest due on May 1st, 1905.

By order,
H. B. RENWICK, Secretary.

Moorgate Court, Moorgate Place,
London, E.C., April 10th, 1905.

TENDERS INVITED.

METROPOLITAN BOROUGH OF FULHAM.

ELECTRICITY DEPARTMENT.

The Fulham Borough Council is prepared to receive TENDERS for the Supply and Erection of -

Contract M. CONDENSER PIPING, SUMP and RIVER WORK.
" N. STEEL ROOF and BUNKER WORK.
" O. COAL CONVEYING APPARATUS.

Specification, Drawings and Forms of Tender may be obtained from the Borough Electrical and Consulting Engineer, Mr. Arthur J. Fuller, after the 15th inst. on payment of a deposit of One Guinea, which will be returned on the acceptance of one of the Tenders.

Tenderers to state which Contract they wish to Tender for.

Tenders made out on Form supplied, addressed to the Town Clerk, Town Hall, Fulham, and endorsed "Tender for Contract ....," to be delivered at the Town Hall not later than 12 noon on WEDNESDAY the 26th inst., 1905.

The lowest or any Tender not necessarily accepted.

R. M. PRESCOTT, Town Clerk.

Town Hall, Fulham-road, Fulham,
April 5th, 1905.

TENDERS INVITED continued on next page.

GAMBRELL BROS.

Durham House, North Side,
Clapham Common, London, S.W.

MANUFACTURERS of ELECTRICAL TESTING INSTRUMENTS.

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Royal Doulton Potteries.

INSULATORS

AND ALL KINDS OF

POTTERY FOR ELECTRICAL PURPOSES.

DOULTON & CO.,

LIMITED,

Lambeth, LONDON, S.E.

EVERSHED & VIGNOLES, LIMITED.

Our New List of AMMETERS and VOLTMETERS will be forwarded post free on application.

Makers of all kinds of ELECTRICAL INSTRUMENTS,
Acton Lane Works, CHISWICK, LONDON, W.

TENDERS INVITED—*continued.*

EDINBURGH CORPORATION ELECTRICITY SUPPLY.

The Lord Provost, Magistrates and Council invite TENDERS for the following Work in connection with their Electricity Supply Station at M'Donald-road:—

Specification No. 16.—**WATER-TUBE BOILERS.**

Copies of the Specification, Form of Tender, General Conditions and Drawings can be obtained from the Engineer, Dewar-place, Edinburgh, after Wednesday, 19th April, upon payment of a deposit of Two Guineas, which will be refunded on receipt of a bona fide Tender and on the return of the Specification, General Conditions and Drawings.

The Specification, General Conditions and Drawings can be seen at, but not obtained from, the Office of Dr. A. B. W. Kennedy, 17, Victoria-street, London, S.W.

Tenders, on the prescribed Form, enclosed in sealed envelope, and endorsed on the outside "Electricity Supply - Tender for Specification No. 16," must be delivered at the Office of the undersigned not later than MONDAY, 8th May, 1905.

THOMAS HUNTER, Esq., Town Clerk.

City Chambers, Edinburgh,
April 7th, 1905.

CORPORATION OF GLASGOW.

ELECTRICITY DEPARTMENT.

The Corporation invite TENDERS for the Supply of (1) 1,000 kw. MOTOR GENERATORS; (2) SWITCHGEAR; (3) CONDENSING PLANT; (4) COAL CONVEYING PLANT; and (5) FEED PUMPS. Copies of the Specifications and Forms of Tenders may be obtained on application to Mr. W. W. Lackie, Engineer, 75, Waterloo-street, Glasgow, on payment of a deposit of One Guinea for each Specification. The amount deposited will be returned on receipt of a bona fide Tender or Tenders. Sealed Offers, marked "Electricity Department. Tender for ...." must be lodged with the Subscriber on or before TUESDAY, the 2nd May.

The Corporation do not bind themselves to accept the lowest or any Offer.

JOHN BOWERS, Town Clerk.

City Chambers, Glasgow, April 13th, 1905.

MOSELEY'S

SPECIALLY ADAPTED FOR ELECTRICIANS.

RUBBER GLOVES.

Perfect Soft Finish.

Never Harden.

Stand any Climate

Guaranteed Absolutely

Fine Pure Para.

DAVID MOSELEY & SONS, L^D
INDIA RUBBER MANUFACTURERS,
ARDWICK, MANCHESTER.

MISCELLANEOUS PLANT, &c., FOR SALE—*continued.*

FOR SALE.—One Laval Steam Turbine, 50 B.H.P., when working with 150lb. steam and condensing; with steam stop valve, governor, speed-reducing gear, and driving pulleys, running at 1,500 revs. per minute. All in very good condition.—Apply to the ENGINEER-IN-CHIEF, St. James's Gate Brewery, Dublin.

ELECTRIC LIGHTING PLANT FOR SALE, including Gas Engine, Dynamo and Accumulators. Can be seen working.—Write L. P., Box 482, Willing's, 125, Strand, London, W.C.

CARPET-BEATING MACHINE, complete, with Fan, FOR SALE.—Write, C B., Box 483, Willing's, 125, Strand, London, W.C.

FOR SALE.—One 25 H.P. Crossley Gas Engine, No. 43525, specially made for electric lighting and in thorough working order. This engine was only put down about two years ago and is being removed to make room for a plant of three times the size. It can be seen by appointment and is near Southampton. Price on site £75.—Apply to LEO SUNDERLAND & Co., 39, Victoria-street, London, S.W.

ONE CONTINUOUS-CURRENT MOTOR TRANSFORMER, with starting Panel and Generator Panel on Marble Base. Motor 440 volts, generator 60 volts, 100 amperes, B.T.-H. make, about 1,100 revs., direct-coupled, on cast-iron bed, enclosed type; new.—Apply, C. E. C., *Electrician* Office, Salisbury court, Fleet street, London.

FOR SALE or HIRE, high-class Dynamos, Motors, Alter nators, Cable and Electrical Apparatus.—PERCY HUDDLESTON & Co 72, Finsbury Pavement, London, E.C.

WIRE-COVERING MACHINERY for SALE for Cott Covering all ordinary sizes of wire.—Apply, BRITISH ELECTRIC TRA FORMER Co., Hayes, Middlesex.

GAS ENGINE for SALE, 65 B.H.P. National make, wi specially heavy flywheel for electric driving, self starter and usual accessor new in 1902; seen running by appointment.—Apply, BRITISH ELECTRIC TR FORMER Co., Hayes, Middlesex.

LOCKERS.—Sheet Steel, Expanded Steel or Wirew Lockers for motor garages, workshops, power and light stations, delivered anywhere. Send for illustrated list.—THE METAL FITTINGS Co., Pag street, Battersea.

SEARCHLIGHTS FOR SALE or HIRE.—JOHNSON PHILLIPS, Victoria Works, Charlton, Kent.

GLASS SHADES for Electric Lighting in every varie design and colour.—JOHN WALSH WALSH, Glass Manufacturer, Birmin

TO ELECTRICIANS.—Look up page xxvii. and see ill tions of up-to-date overalls.

LOW RESISTANCES TESTED. Write for Sc Fees.—WESTMINSTER ELECTRICAL TESTING LABORATORY, York York-street, Westminster, London, S.W.

J. W. BARNARD,
Offices: 4, GREAT WINCHESTER ST., E.C.
Warehouse: 6, Great Winchester St.
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MANUFACTURED BY THE
ELECTRICAL POWER STORAGE
Battery Makers by appointment to His Majesty th

C. PASS & SON, I
Bedminster Smelting Works, BRISTO
SELLERS OF
ANTIMONIAL LEAD OF ALL GR
BUYERS OF
LEAD ASHES AND LEAD RESIDUES FROM ACCU
Telegrams: "Pass Bristol." Telepho

PAUL

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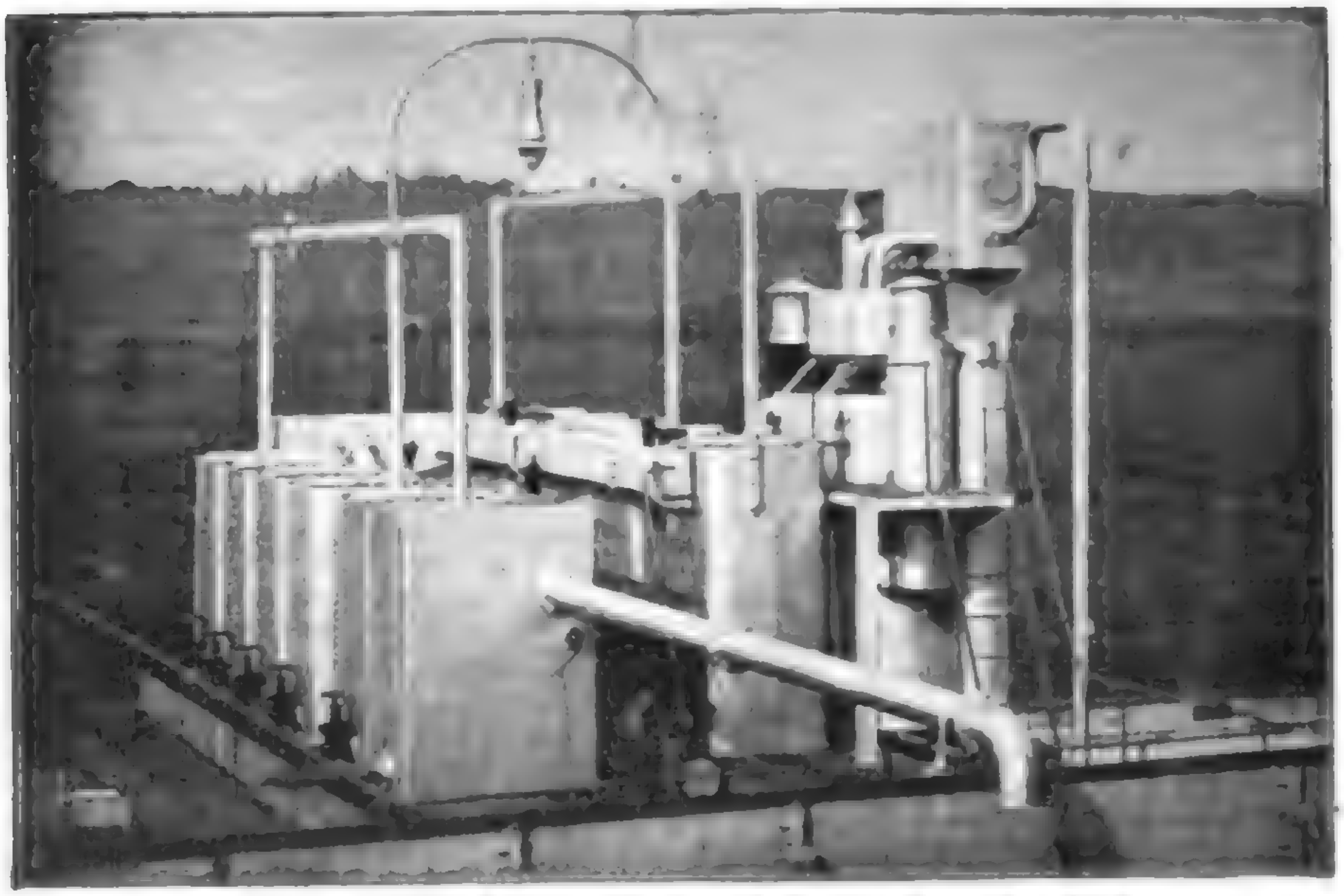
ELECTRICAL AN
INSTRUM
Newton Avenue Works
LONDO

NO MORE COLLAPSED FURNACES OR BUCKLED TUBES

THROUGH GREASE
IF YOU PURIFY THE CONDENSED WATER
WITH THE "HARRIS-ANDERSON" PURIFIER.



"HARRIS-ANDERSON" PURIFIER, Cardiff Electric Generating Station.
Capacity, 10,000 gallons per hour.

Grease Absolutely Removed.
No Objectionable Matter introduced
Automatic and Simple Action.
Minimum Waste of Water.
Numerous Plants now at work in Electric Light & Power Stations, &c.

WRITE for FULL PARTICULARS to the—

HARRIS PATENT FEED WATER FILTER, LTD.,
82, Victoria St., Westminster, LONDON, S.W.
Telegrams: WINDTIGHT LONDON.
Nat. Tel.: 376 WESTMINSTER
26, St. Thomas Street, SUNDERLAND.
Telegrams: WINDTIGHT SUNDERLAND. Telephone 569
Hamilton Street, GREENOCK.
Telegrams: WINDTIGHT GREENOCK. Telephone 191

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Telegrams:
VICKERS SHEFFIELD.

SHEFFIELD.

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ELECTRIC DRIVING
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STANDARD SEMI-ENCLOSED MOTOR.

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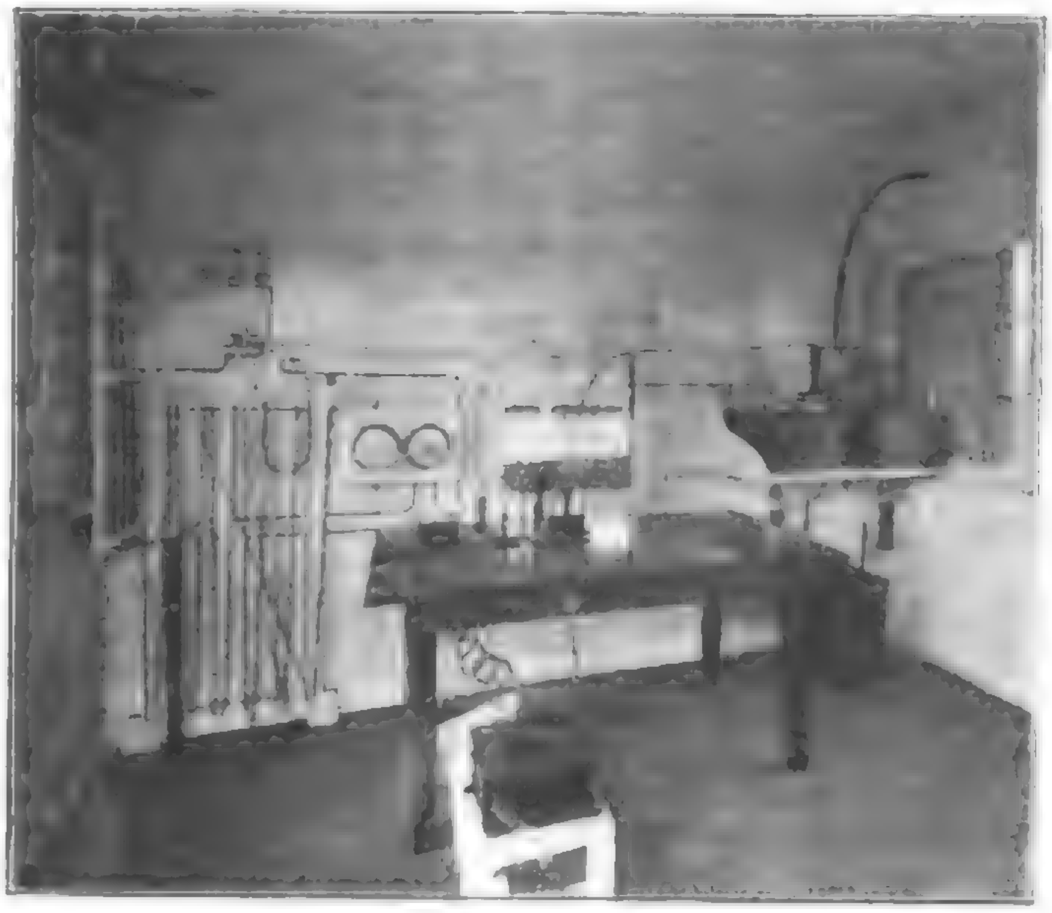
FULL POWER at
ALL SPEEDS.

FESSENDEN Wireless Telegraph System

NATIONAL ELECTRIC SIGNALLING COMPANY.



Interior of 250-mile Standard Station.

AS the result of five years' experimental work, including a working test of a full year, this system is now put on the market as being equal as regards speed and reliability to manually operated wire lines, while first cost and maintenance are only a small fraction of that of wire lines.

On August 23rd the U.S. Navy Wireless Board made a severe test of method of preventing interference. Three 2 H.P. stations with 40 metre masts, at distances of 5 miles, 1,000yds. and 300yds. from receiving station, and one 10 H.P. station 200ft. high, 174yds. away were operated at full power for the purpose of interference, but only the last-mentioned station was able to prevent perfect receiving of messages. Apparatus guaranteed to give these results can be obtained by annual rental, as also for secret sending without using code.

This system does not infringe the patents of any other company, and the operation of the apparatus is guaranteed.

Telegraphic sets for working up to 250 miles overland or to 750 miles over sea are now standardised and can be supplied from stock or on short notice. Sets for working over longer distances supplied at short notice. Sets can be tested by purchaser before delivery between the Company's test stations, approximately 250 miles apart overland, or between the Company's marine stations.

No expert knowledge needed, as any telegraph operator can handle after a week's practice.

NATIONAL ELECTRIC SIGNALLING COMPANY,
WASHINGTON, D.C., U.S.A.

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AT EASTER.

Telephone No. 9999 CENTRAL.

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(Embracing those branches prescribed in the Syllabus issued by the City and Guilds Technical Institute.)

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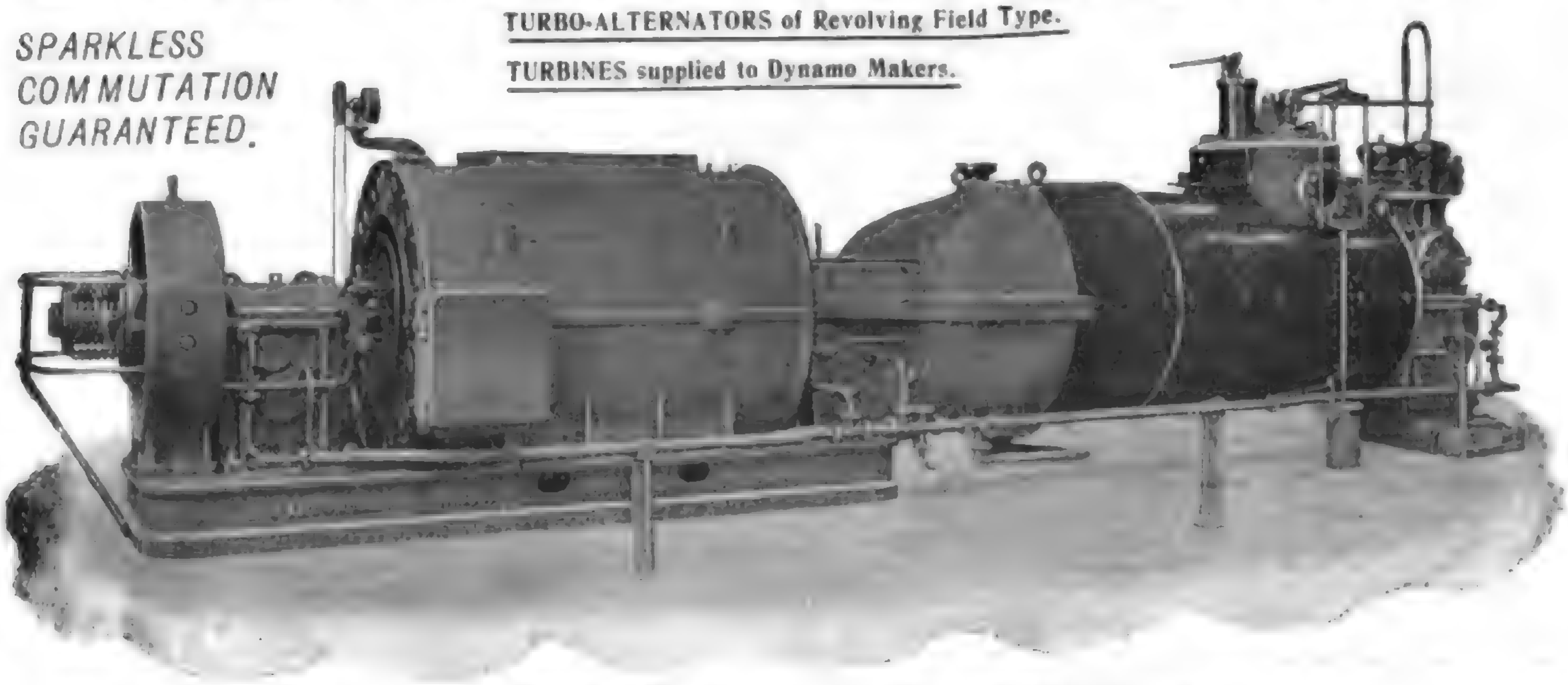

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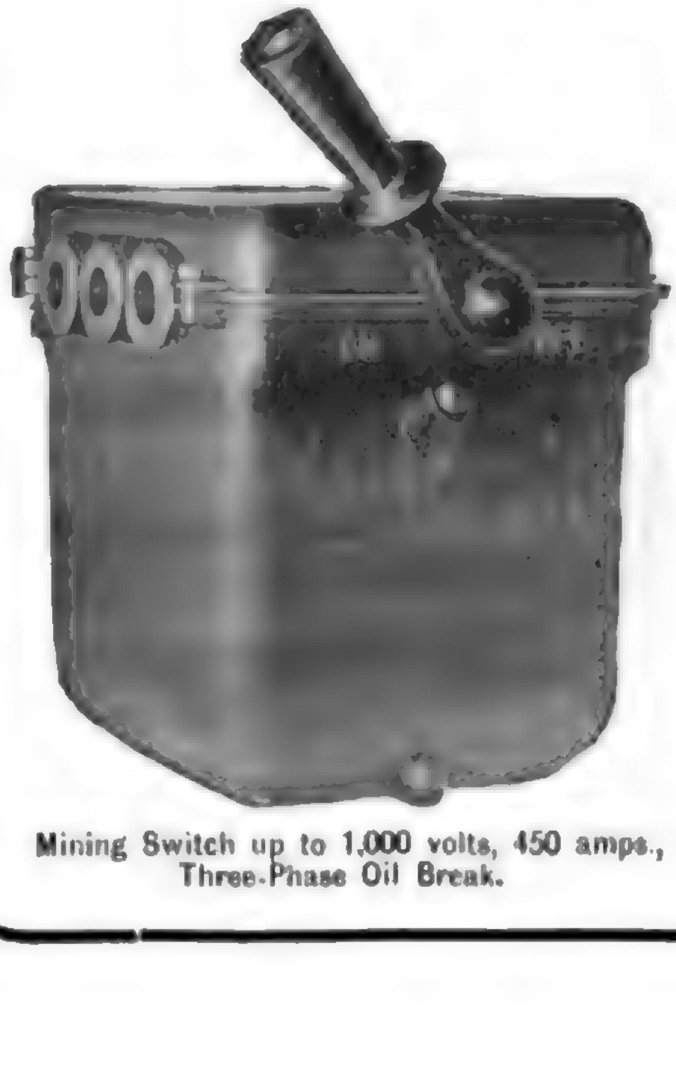

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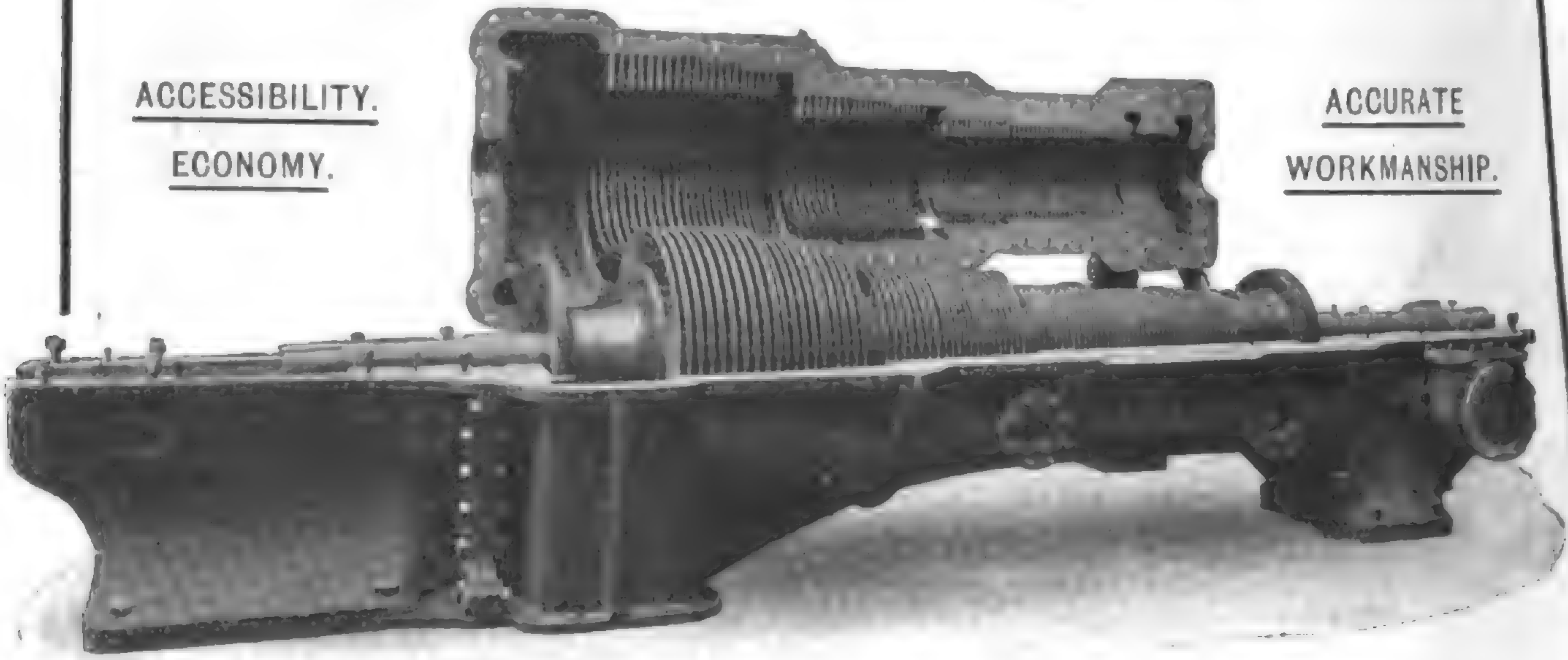

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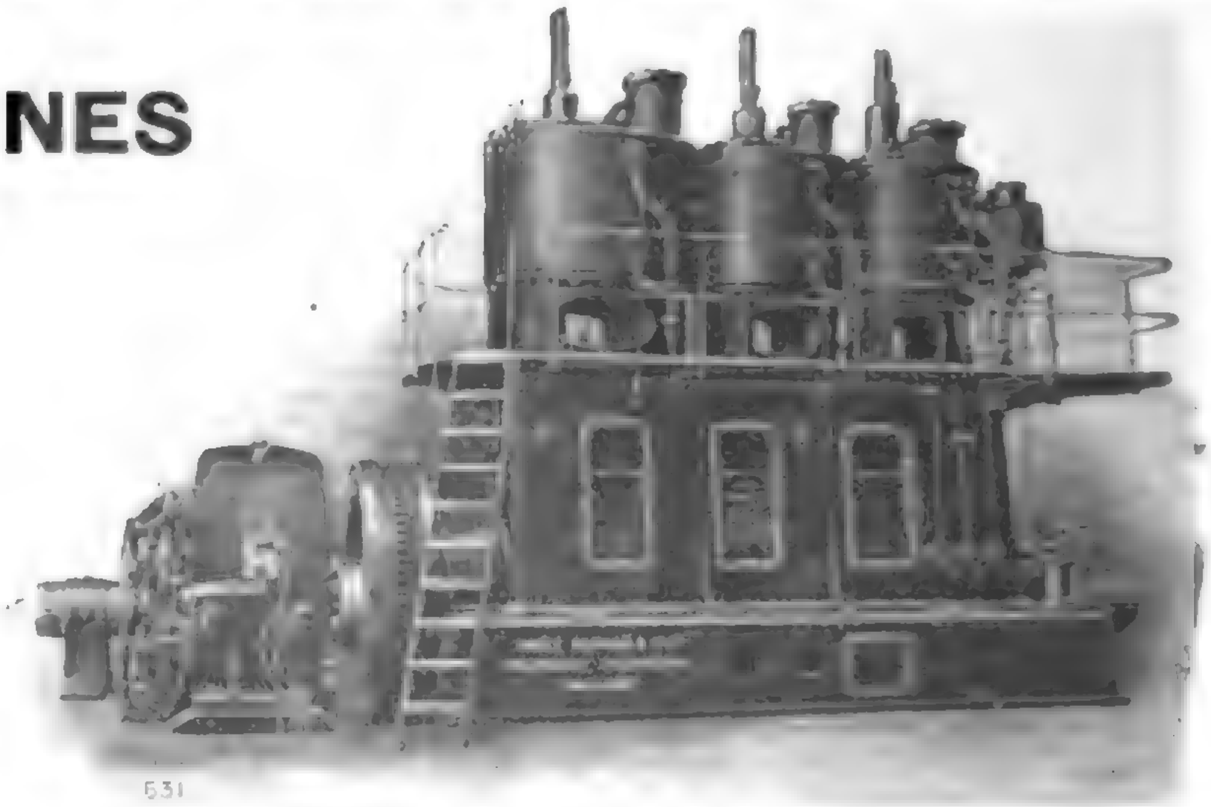

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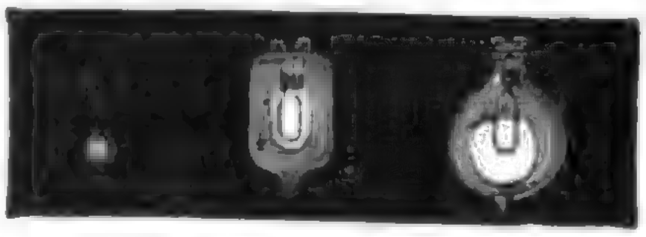

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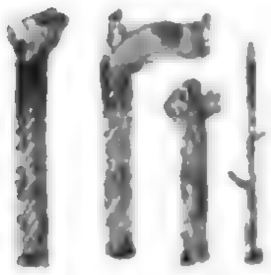

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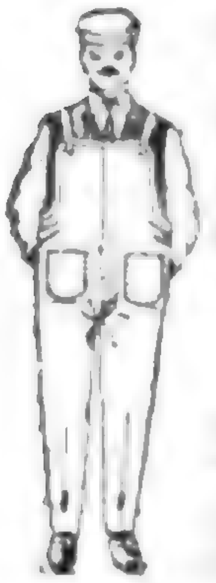

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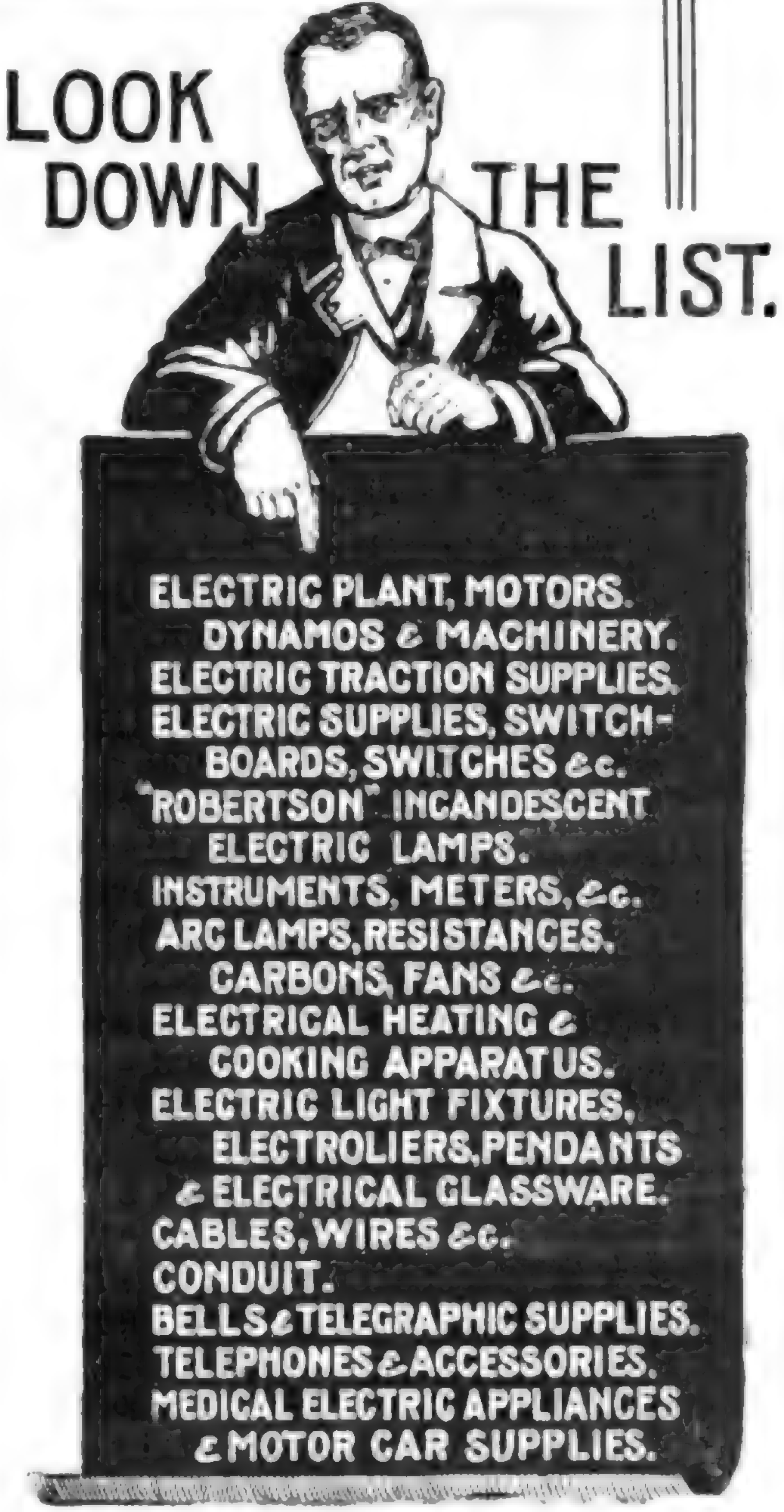
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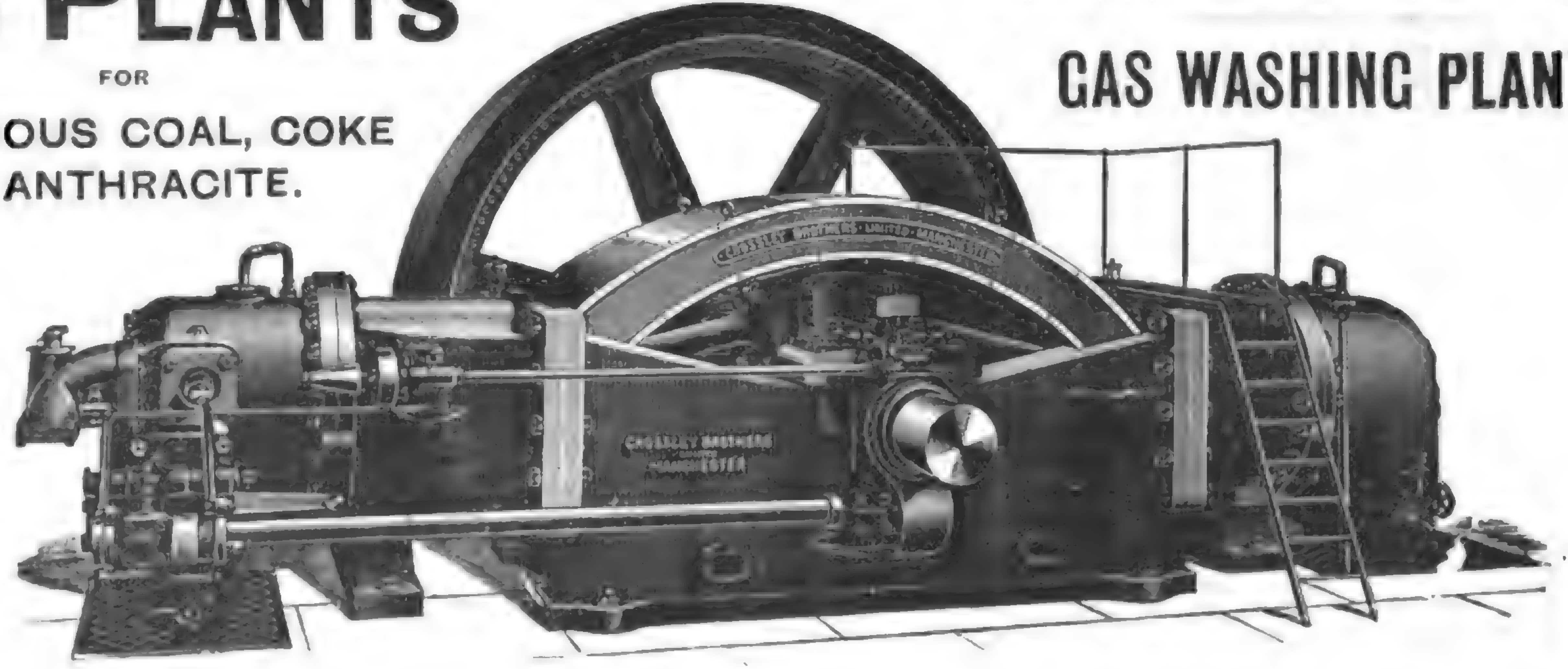
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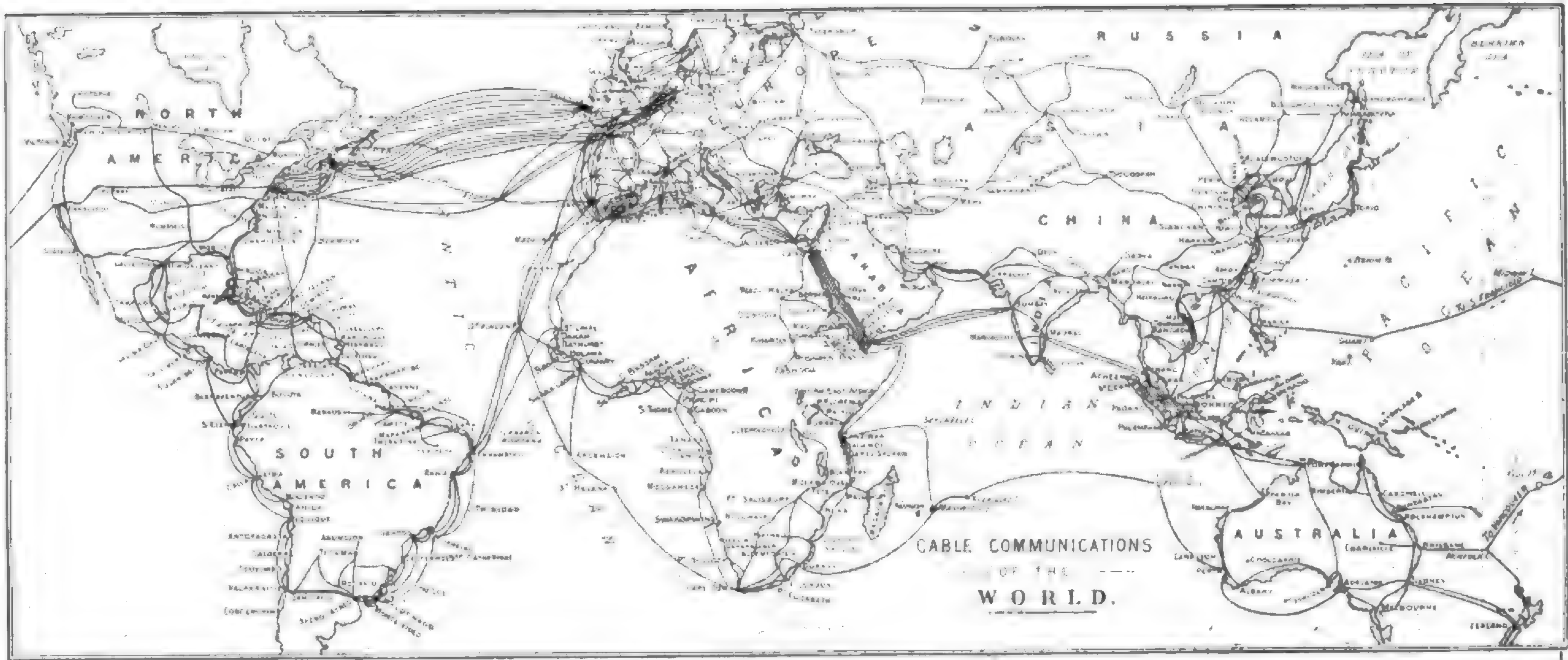
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„ Government Stations	8	9
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„ Government Stations	11	0
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BONNY	5	0
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„ Other Places	4	5
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„ Other Places, via Japan	5	11

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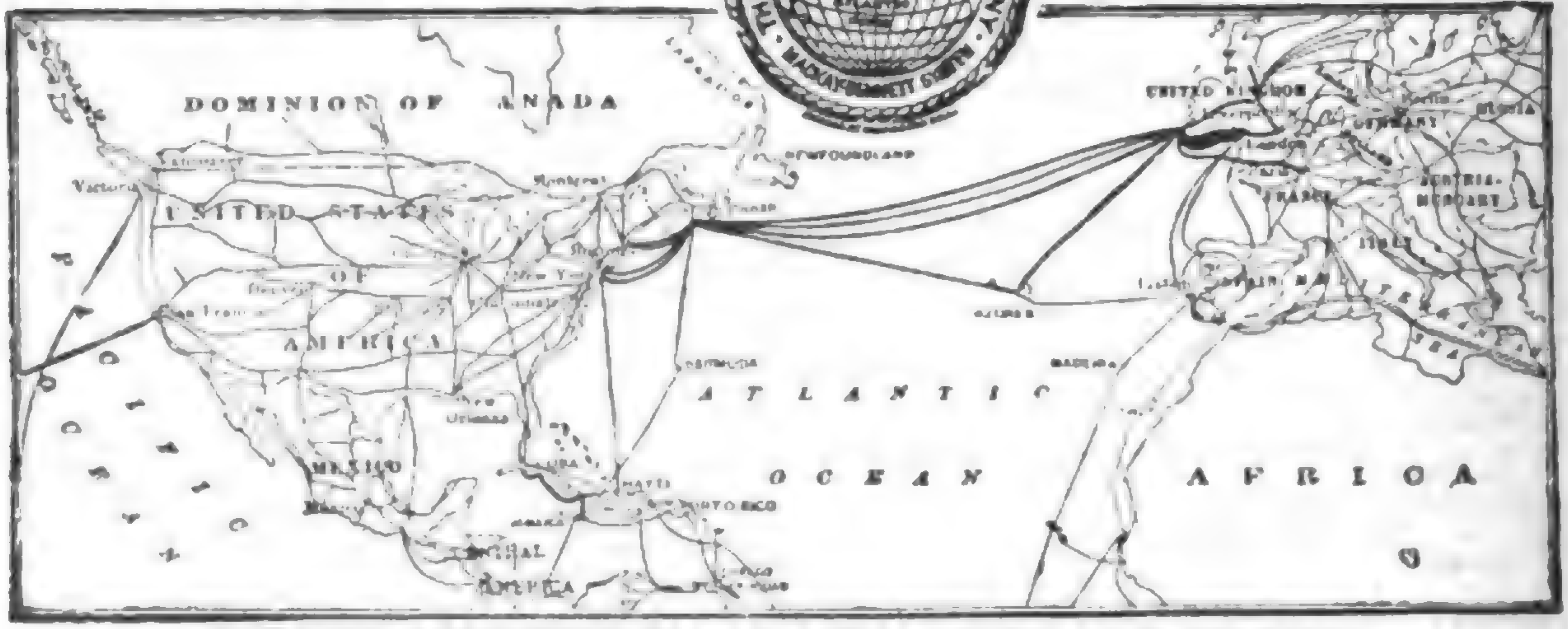

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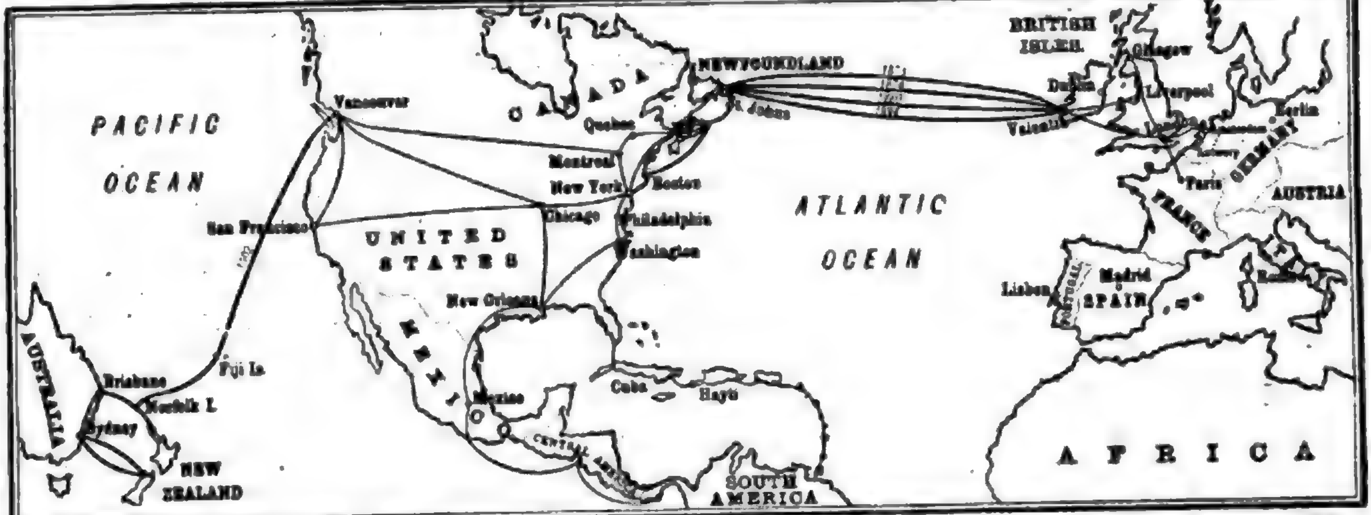
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